Reuse, recycling and the KPN network

A case-study on factors leading to the minimization of residual waste from the KPN network

By

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Preface

Before you lies the master thesis 'Reuse, Recycling and the KPN Network'. For accomplishing this work I want to thank my supervisor Mark Wiering from the Radboud University in Nijmegen for coaching me through the process of writing a thesis. I also want to thank my supervisor Daan Helming from KPN, for giving me the experience of working in - and guiding me through - the corporate environment of KPN. Finally, I want to thank all those who are close to me, for their continuous support and faith in me.

This all resulted in the thesis that you are about to read. My interest in the concept of the Circular Economy emerged from an 'Tegenlicht' episode from 2015. Thomas Rau explained in a sharp and accessible way what problems mankind faces and how we have to fundamentally rethink our entire economy. Waste does not exist, resources can be used infinitely, the Earth is a spaceship. This qualitative case-study was conducted with the aim of gaining insight into the factors that influence the minimization of waste. As an intern I was granted access to the sustainability team from Access Core Networks KPN. A main concern for the team was; how to reduce incineration and enable recycling and reuse?

This desire to manage resources more efficiently resulted in this thesis. A thesis that shifted shape several times due to the imminent consequences of the COVID-19 Pandemic. Despite the circumstances, this qualitative case-study was conducted with the aim of gaining insight into the factors that influence the minimization of waste. Even though the most basic of data collection methods became instruments that were impossible to play, the results have led to possible improvements on how to minimize the residual waste stream from the KPN network. This work, therefore, not only presents insight into the issue it revolves around, but also presents what challenges are faced whilst doing research during a pandemic.

Luc de Wit,

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Abstract

The circular economy is a relatively novel concept that has the potential to provide tangible solutions to the environmental challenges that society faces. The global economy has to fundamentally change in order to achieve circularity. The corporate environment plays a crucial role in this transition. KPN, a corporate entity, attempts to be one of the leaders in this transition. This thesis will examine the circular potential of the residual waste stream that originates from KPN network activities. This means the residual waste no longer ends up at landfill or incineration plants, but enters a new material-cycle. The data for this case-study is collected via virtual interviews with involved actors, observations of the corporate environment and an analysis on internal strategies and policy. The results of this data have been analyzed and discussed in order to establish what factors influence the minimization of the residual waste stream from the KPN network. This examination attempts to comprehend the full scope of the process in which materials end up as waste. This thesis involves a qualitative strategy that focuses on actors and contextual factors. Hence it will contribute to understanding the factors involved in waste minimization for.

Keywords:

Circular Economy, Material Cycles, Sustainability, Waste-Management, Waste-minimization,

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1. Introduction

1.1 Background

Half a century ago, in 1972, a group of scientists known as the Club of Rome published Limits to Growth. Their key message was that the current economic model of ‘take-use-waste’ is unsustainable. This system will eventually lead to resource depletion and an exponential increase in emissions. As a consequence this will harm the natural environment and therefore puts tremendous stress on society (Meadows et. al., 1972). Almost 50 years later, the pressure on the environment and her resources is ever-increasing. If society would continue using a linear economic model, then the available raw materials will become insufficient to maintain (or develop) a high standard of living for the global population (Cramer, 2014). The circular economy, which is a closed economic system, could present a part of the solution to the linear economic model. The Ellen Macarthur Foundation, a leading organisation that is engaged in changing the current economic model and tries to weave circularity into both the economy and society, has defined a circular economy as: “an industrial system that is restorative or regenerative by intention and design” (Ellen MacArthur Foundation, 2013:7). The main principle of the circular economy is that natural resources are used again and again. In the circular economy, materials are supposed to be reused, recycled, upcycled but never discarded. Through design, the amount of waste at a product's end-of-life stage can be minimized by using less material or making a product dismountable. In a utopian, perfect circular economy, we would no longer need extraction from nature anymore (Kovacic et al., 2019).

The transition to a circular economic system presents several challenges. The absence of high quality, re-usable, or second-hand natural resources, makes that resource extraction is still a necessity (Kovacic et al., 2019). In other words: “*The continuous extraction of resources to produce the goods and services we demand, coupled with dramatic shifts in the way we use and dispose of these resources, is threatening both their availability and affordability*” (Antink et. al., 2019:38). The availability and affordability of non-ferrous metals such as Titanium, Gold, and Cobalt will decline drastically as demand continues to rise. In a corporate environment and especially in those that are engaged in the use of these metals, could a significant increase in prices be a threat to their very existence (Robertson, 2012). The novelty of circularity makes that it has not yet provided sufficient tangible answers on how to achieve a circular business model.

Some scholars might argue that the ideas of a circular economy are not new at all. Evidence of circularity can be found in the natural world all around us. in the natural world. A tree, for instance, uses nutrients from the ground to bloom. When it produces fruits or sheds its leaves these nutrients return to the earth's surface, just to be used by the tree again in the next year. The first description of circularity in an economic context was by Leontief in 1928. He described ‘a ring of in- and outputs (Miller & Blair, 2009). In 1966, Kenneth Boulding, although not phrased in such way, published an essay called: “The Economics of the Coming Spaceship Earth”. In his essay, Boulding described that just as in space, where astronauts have to deal with whatever resources they have, the situation on earth is similar (although larger in scale). They can not add components to their ship, they can only alter existing components into new ones. Boulding realized that just like the Apollo, Earth is a spaceship (Boulding, 1966). Humanity needs to work with what it has and once a non-renewable resource has been depleted, there is no way to get it back. Tim Jackson (1990) started advocating steering away from the linear ‘take-use-waste’ system by identifying the absence of a built-in recycling mechanism (Jackson, 1990; 1996). Since the turn of the millennium, circularity has experienced a significant increase from scholars. The amount of academic publications with the topic of circular economy has increased twenty-fold between 2006 and 2016 (Martin et. al., 2016).

1.2 Problem statement

The novel societal attention, the fundamentally different way of thinking about economics, revolutionary designs and using good as service instead of purchasing, make that the transition towards a circular economy is challenging. With the current linear economy, economic growth is coupled to environmental degradation (Kahuthu, 2006). This is by itself problematic as most businesses and states apply economic growth strategies, and harm to the environment seems inevitable (Stern et al., 1996). New-Zealand is the first country to apply degrowth purposely to protect the environment (Graham-McLay, 2019). This new strategy is just as novel as that of the circular economy yet the former has many uncertainties considering the amount of jobs needed (Barca, 2019; Tokic, 2012).

A circular economy seems a feasible way of decoupling economic growth and environmental degradation (Pao & Chen, 2020; Zhang et al., 2016). For companies to fulfill this transition, there is no immediate obvious solution (van Loon & Van Wassenhove, 2020). Many 'roadmaps' to circularity propose steps (Angelis & De Angelis, 2018) and mechanisms (Ewen et al., 2017; Maina et al., 2017) that are quite abstract and need customization to fit the organization trying to apply the strategy (EESC, 2019). The transition towards a circular economy is characterized by trial and errors (Sillanpää & Ncibi, 2019). This shift is significantly more difficult for businesses that deliver services instead of products. Therefore they have to depend on the willingness of suppliers and manufacturers to alter their production methods in order to facilitate the service-oriënted businesses (Heyes et al., 2018). It is therefore of the utmost importance that these service-orientated businesses gain insight into what they can do to overcome the problems of becoming circular.

1.3 Case introduction

For this thesis, I will dive into a corporate environment in the form of KPN and examine their waste streams in an attempt to minimize waste incineration and maximize circular practices. A lot of recyclable materials are incinerated at the end-of-life stage, instead of re-entering a new material cycle. The problem is that it is unclear how these materials end up in the waste-flows that get incinerated. Insight into the journey that these materials undergo from the moment they are considered waste, until the moment that they get discarded, could present viable answers to where possible intervention can contribute to the minimization of waste.

The research, which is combined with an internship, will take place at KPN. KPN is a Dutch telecom service provider that is involved in constructing a 5G-network and other telecom/IT service solutions. It employs over 12.000 people and has a revenue of 5.6 billion euros (KPN, 2019). The Dow Jones Sustainability Index has awarded several prices to KPN concerning their sustainable accomplishments. For their network, KPN aims to be close to 100% circular in 2025. Their network includes the mobile as well as the fixed network. The latter consists of over several thousand kilometers of subterranean infrastructure as well as old phone exchange buildings. The mobile network primarily consists of antennas. Whenever the networks get renewed, deconstructed or repaired old parts go out, new parts go in. This eventually leads to the production of waste. KPN is involved with multiple actors that contribute to the waste-process of KPN. Allinq and VolkerWessel Telecom (VWT) are prominent actors when it comes to deconstructing old infrastructure and renewing/ repairing the current network. Both of these partners manage an on-site 'waste street' (Milieustraat). On these waste streets the waste is placed into containers whereafter waste-companies Suez and Renewi processes the waste. Allinq makes four distinctions in the way that waste is processed. For the Fieldforce this is (1) they reuse 0% of materials (2) They recycle 74% of all materials (3) Incinerating 25.3% of the materials (4) and 0.6% of materials end up at landfills. The total amount of waste is 642.340kg . Most of the 16 individual waste streams have an incineration rate ranging from 0% to 10%. The residual waste stream is an exemption, this waste stream is for 100% being incinerated. This stream has a mass of 149.890kg and therefore accounts to 23,33% of the total amount of waste at Allinq, therefore, it is the main target for this thesis.

This research took place in the first half of 2020. Unfortunately, the world got struck by the COVID-19 virus. This altered the case in several ways. The main reason for this was that the Dutch government ordered all people without a 'vital' profession to work from their homes instead of offices. Moreover, meetings were advised to take place via video calls and only strictly essential visits were allowed. This meant that I had to conduct most of the research from home, and field research was no longer possible. Moreover, this is in the methods section.

1.4 Research aim and questions

1.4.1 Research aim

This thesis is aimed at examining the circular potential of the residual waste from the KPN network that is processed by Allinq. An assessment of available waste-discarding facilities will involve an 'as-close-as-possible' examination of every step in the waste its journey from where it originates until it reaches its final or new destination. The research will take place from my own home, as the current situation does not allow me to visit places. Through intensive (video) calls and pictures I am hoping to gain insights into where the waste is created, what the transport looks like and how it is handled at the milieustraat of Allinq at in Harderwijk or other sites. According to the involved waste company Suez does 50% to 75% of the residual waste at the Allinq milieustraat have the potential of entering the circular material flows of reuse and recycle. This circular potential is based on a report in which they describe observations of large amounts of paper/card boxes, plastic packaging and more recyclable materials that were found in the residual waste stream. These materials could, if separated properly, enter one of the 15 other KPN waste streams and would then be more likely recycled or reused. This makes that the residual waste stream has a high potential in making a contribution to the circular economy. Landfill and incineration are, according to the waste-management framework, the least desired EOL solutions for materials. It is considered more desirable to recycle, reuse or reduce waste (Yu et al., 2014). The three more desired ways of handling waste are what is referred to as the 'circular potential' of waste.

1.4.2 Research questions

In order to assess the circular potential of the residual waste from the KPN network, the following research question and sub-questions have been constructed.

Main research question:
What factors influence the minimization of waste in the process of handling the residual waste-stream from the KPN network?

Sub-questions

To what extent are the the KPN network activities considered circular?

What steps can be identified in the materials journey of becoming waste?

What factors influence the generation of residual waste from the network?

1.5 Societal relevance

Since the industrial revolution of the 19th century, the global economy has grown exponentially. Consumerism has skyrocketed to extremes leading to an ever-increasing pressure on natural resources. As the current linear economic model of 'take - make - waste' fails to recover materials, non-renewable resources become scarcer by the day. The global population is expected to continue to grow to over 10 billion people. And combined with an expected increase in economic prosperity amongst non-western states contributes to an ever-rising demand for natural resources (Riekhof et. al., 2018; Repetto, 1989).

The increasing demand for non-renewable resources such as rare metals used for batteries or other personal and industrial purposes will increase in parallel to both population- and economic growth (Robertson, 2012). The Earth only has a limited amount of these resources. Without interference, the increase in demand has a direct influence on availability. These non-renewable materials will become scarcer until depleted. This affects the price of materials to such an extent that eventually production will be unprofitable and the economy will shrink (Kovacic et al., 2019). Moreover, CE provides a strategy in which economic growth can continue without increasing pressure on the environment. This decoupling of economic growth and environmental harm makes that developing countries are able to increase the standard of living to that of the developed countries with less negative externalities.

From a geopolitical perspective, the re-use of imported materials means that the EU, a state, or a business becomes less dependent on other countries for the supply of natural resources. This might affect society to such an extent that re-using rare metals could be the weapon of choice in combating undesirable human rights violations that are linked to the extraction of these rare metals from locations which are difficult to monitor, e.g., cobalt mining in the Democratic Republic of Congo (Ridder, 2013).

Lastly, the results of this research are expected to have a positive influence on the amount of waste that is being incinerated. Waste, or resources entering an incineration, could potentially be diverted in order to enter recycling of reuse loops. The global process of raw-material depletion is thereby inhibited.

1.6 Academic relevance

Since the last decade, the circular economy has experienced a significant increase in attention among scholars (Geissdoerfer et al., 2017). As mentioned in section 1.2, there is a lack of practical implication of theories concerning the transition to the circular economy. Academic research concerning factors that contribute to the generation of waste are often aimed at municipal solid waste and less often about non organic residual waste. The majority of research concerning non-residual waste comes from the construction industry. The difference between the construction industry and this research concerning a telecom company, is that the former is involved in the use of raw materials. A building needs wood, stone, copper etcetera. A telecom network is way more complex and is built with pre-manufactured goods such as cables, antennas and routers. There is an obvious gap in data when it comes to studies concerning innovative waste strategies for waste reduction in more specific construction processes (Treloar et al., 2003). This will become more clear in the literature discussed in the next chapter. Therefore this research potentially contributes to analyzing factors of minimizing and generating waste of less frequently studied waste streams.

Besides the aforementioned gap that this thesis will position itself into, it will also present new insights into the advancement of CE in the telecom industry. There has barely been any case-study conducted to examine the circular transition of the telecom industry. Available literature mainly concerns technical aspects, this includes LCA's on the production of mobile phone development, servers and more. KPN is, when it comes to sustainability and CE, more advanced than most of its counterparts. This research therefore could help telecom businesses that are struggling with how to address CE as it describes how this topic is dealt with by KPN. Above all, this thesis is a valuable contribution to theory development on the circular transition that awaits service-oriented industries involved with ICT, all over the globe.

1.7 Reading guide

In this introductory chapter you have read that the journey towards the circular economy has only just begun. Just like this thesis. So far you have become acquainted with the background of circularity and its ties to the natural environment as well as its effects on society. Furthermore has the research case been introduced together with the research questions that this thesis revolves around. The next chapter will be a thorough examination of existing literature. It will start with a brief section concerning sustainable development that is followed by an attempt to define CE. Thereafter similar, related concepts are discussed. The majority of section two will take the most generally accepted definition of CE and discuss every single aspect of it. Finally this chapter will be concluded by presenting a conceptual model that is constructed to visualize this research. The third chapter is all about the methodology and methods. It discusses the philosophy behind the research and clarifies on what techniques and tools are used to obtain viable answers to the research questions.

After chapter 3, the results are discussed. Chapter 4 consists of four sections. The first will discuss sustainability and circularity at KPN internally. What direction do they set sail to, do the practice what they preach, and what results have come from this so far. This section is followed by an analysis of the interviews. Significant information is highlighted in an attempt to present you with a clear insight on what the interviews have shed light on. Thereafter the observations are discussed. Chapter four concludes with an implication of the results and theories of potential factors. Full interviews and observations can be found as online data. In the fifth chapter the results of chapter four will be used to present an answer to the research questions. First the sub-questions will be answered, together they form the main input on the answer to the main research question. Finally chapter six, will conclude this research with a discussion concerning the results, limitations and suggestions for further research.

2. Theories

2.1 Perspectives on Sustainable development

What is considered sustainable and how it is linked to development has been a point of discussion among scientists for decades. Sustainability and development are compatible, or even interdependent by some (Geary, 2004). Yet they seem Irreconcilable to others (Verburg & Wiegel, 1997). De Vries and Petersen (2008) did not make an understatement when they stated that: "*Hundreds of definitions of sustainable development have been given since the notion emerged in the 1980s*" (Vries & Petersen, 2008:1007). The Brundtland Report defines sustainable development as follows: "*Sustainable development is a development that meets the needs of the present without compromising the ability of future generations to meet their own needs*" (Brundtland, 1987:1). As the needs of future generations are expected to increase and put more pressure on natural resources, the world needs to adopt new methods in order for this to be sustainable. A circular economy could therefore provide tangible solutions to sustainable development. Yet the pathway on how to achieve sustainable development is heavily debated. Two major perspectives on this area are that of technocentrism and ecocentrism. Technocentrism, as the term implies, revolves around technology. A typical technocentric approach to sustainable development is investing in technology that eventually mitigates climate change. Enabling the market to find solutions could in this way achieve economic growth whilst at the same time be a sustainable development (Bailey & Wilson, 2009). The other approach to sustainable development is ecocentrism. Ecocentrism places nature and eco-systems at the heart of development. Ecocentrists believe that developing healthier ecosystems will eventually lead to more sustainable development. In their view nature is placed in the centre of the universe, where technocentrists take a more anthropogenic stand point wherein man is at the center of the universe (Hoffman & Sandelands, 2005).

2.2 Circular economy

2.2.1 Defining CE

As stated before, a promising strategy that could drive sustainability whilst enhancing economic growth comes in the shape of a Circular Economy (CE). CE is the counterpart of the linear economy. The latter is the dominant contemporary production process which is characterised by a 'make-use-waste' life cycle. The Ellen MacArthur Foundation, a leading UK-based knowledge institution concerning CE, defines the circular economy as:

"an industrial system that is restorative or regenerative by intention and design. It replaces the 'end-of-life' concept with restoration, shifts towards the use of renewable energy, eliminates the use of toxic chemicals, which impair reuse, and aims for the elimination of waste through the superior design of materials, products, systems, and, within this, business models."
(Ellen MacArthur Foundation, 2013).

The definition from the Ellen MacArthur foundation is interesting because it touches upon important concepts within circularity such as: industrial system, design, end-of-life, reuse, elimination and business model. All of these will be discussed further down this section of the literature review. Although the Ellen MacArthur Foundation's definition is thorough, there are many definitions of CE available. According to Kovacic et al. (2019) there is no ultimate definition of the circular economy yet they state: "The circular economy is a policy in the making, it is an imaginary about the future, and it is far removed from what is known about the economic process in biophysical terms" (Kovacic et al., 2019:6).

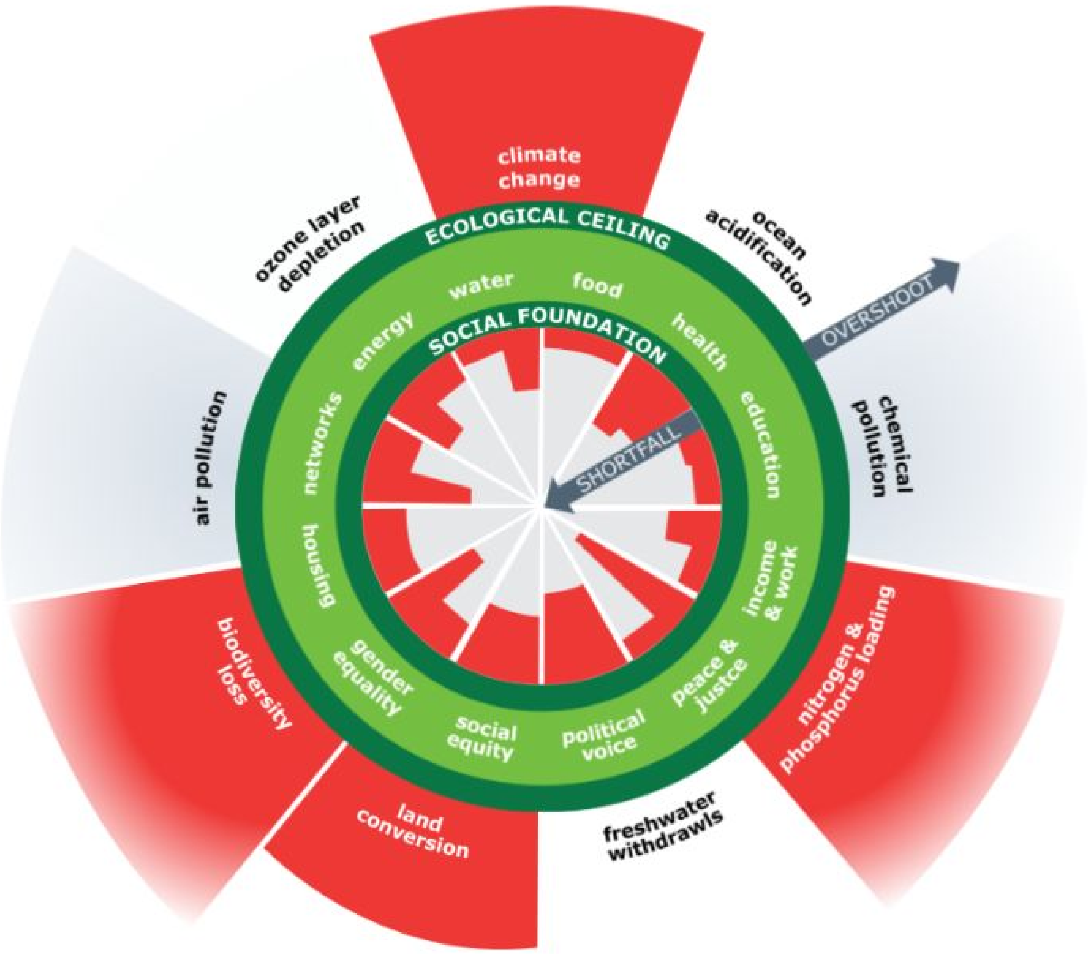
The European commission defines CE an economy that "Aims to maintain the value of products, materials and resources for as long as possible by returning them into the product cycle at the end of their use, while minimising the generation of waste" (Eurostat, 2019:2). The implementation of CE practices is of high significance for the EU, as the European continent has little natural resources compared to other continents (Sachs & Warner, 2001). Another definition, this time from the UN defines CE as: "The concept of a circular economy, an economy in which waste and pollution do not exist by design, products and materials are kept in use, and natural systems are regenerated provides much promise to accelerate implementation of the 2030 Agenda" (UN, 2018:1)

In their description, Geissdoerfer et al. (2017) recognize some of the same core aspects of CE as the Ellen MacArthur Foundation. These include long-lasting design, maintenance, repair, reuse, remanufacturing, refurbishing and recycling. They define CE as: "a regenerative system in which resource input and waste, emission, and energy leakage are minimised by slowing, closing, and narrowing material and energy loops. This can be achieved through long-lasting design, maintenance, repair, reuse, remanufacturing, refurbishing, and recycling" (Geissdoerfer et al., 2017). All of the above definitions have overlap and a lot in common. The next section of this chapter discusses concepts that can be linked to that of the circular economy in one way or another. The factors that have been mentioned in the definitions above will be discussed in the section thereafter. This chapter will conclude with something that could benefit circular practices significantly, but has not been mentioned in any definitions.

2.2.2 Overlapping concepts

The concept of the circular economy did not come out of nowhere. Rather it can be seen as a system that incorporates concepts of a similar nature. One of these is the concept of Industrial Ecology (IE). IE is generally seen as the origin of CE (Netter et al., 2019) According to (Krrishnamohan & Herat, 2000) (2000) IE is: "*a novel approach to achieve sustainable development. It aims to optimize the consumption of natural resources and energy and minimize the generation of waste. Industrial Ecology is the study of the means by which humans maintain a desirable carrying capacity given continued economic, cultural and technological evolution. The concept requires that all industrial systems be viewed not in isolation from surrounding system, but in concert with them. Several examples are discussed to illustrate how this can be achieved*" (Krrishnamohan and Herat, 2000:387). Eco-industrial Development (EID), therefore, tries to connect traditionally separate industries in order to create a collective competitive advantage by exchanging materials, energy, water or by-products (Lin et al., 2020). An efficient way of doing so is by establishing Eco-Industrial Parks (EIP). A definition of an EIP presented by Lambert and Boons (2002) states: 1. EIP is: "A *community of businesses that collaborate with each other and with the local community to efficiently share resources (information, materials, water, energy, infrastructure and natural habitat), leading to economic gains, gains in environmental quality, and equitable enhancement of human resources for the business and local community*" (Lambert & Boons, 2002:472). If all is exercised correctly, this could lead to Industrial Symbiosis (IS). IS is realized when two or more industrial entities develop mutually beneficial relationships. In most cases this would mean that one of these entities makes use of a material stream that is considered waste by the other (United Nations, 2015). The term 'symbiosis' is derived from biological symbiosis. The latter refers to the relationship between otherwise unrelated species (E.g., a tree and a bird) that exchange materials or energy in a mutually beneficial manner (Chertow, 2000). That IS is closely related to CE becomes evident through case-studies from the Ellen Macarthur Foundation. The foundation recognizes the significant role of IS in the transition towards the CE (Ellen Macarthur Foundation, n.d.). The main difference between all the above and CE, is that CE addresses the foundation of the economy as a whole. IS involves closed loops between firms and/or communities to gain benefits. CE attempts the same, but also tries the same, but goes beyond IS by fundamentally leaving the linear economic model.

Another economic model advocated by Kate Raworth is that of the doughnut economy. The doughnut economic model is based on planetary boundaries. These boundaries have been identified by Röckstrom et al., (2009) and relate to the carrying capacity of Earth's vital systems. Among the nine identified boundaries are Ozone Depletion, Ocean Acidity and Freshwater use. These planetary boundaries are basically Earth's playing field. Crossing these will eventually lead to environmental degradation and could threaten human development globally (Rockström et al., 2009). The economic model of the Doughnut Economy adds a dimension of a social foundation. Simply put, humanity needs water, not too much and not too little. A shift in either direction is problematic, as they both entail a shortage of fresh water. As visible in figure 1 the doughnut economy presents a 'safe operating space' between shortcomings of social needs, and the overshoots of planetary boundaries (Raworth, 2017). The similarity between CE and Kate Raworth's doughnut economy is that both models identify a future catastrophe if the economy continues business as usual. The main difference between the two is that Raworth advocates a better distribution of resources, where as CE promotes a more efficient use of resources.



(Figure 1: Visualization of the Donut economy, Raworth, 2017)

2.2.3 Regenerative designed industrial system

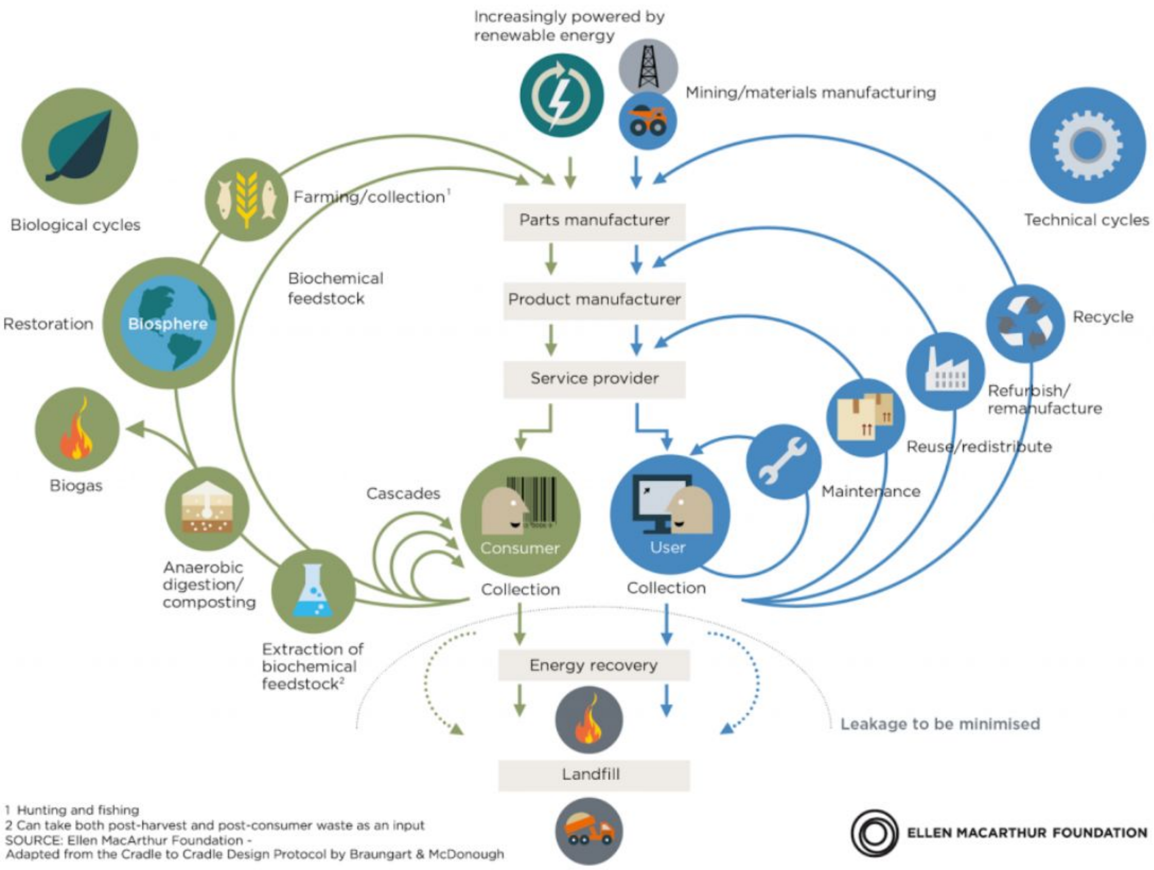
From the definition by the Ellen Macarthur foundation, the first mentioned aspect of circularity is an industrial system that is restorative and regenerative by intention and design. Before diving further into this sentence it is first parsed. Restorative, according to the Oxford Dictionary, means: “something that makes you feel strong and healthy again” (Oxford, n.d.). The word is derived from restoration, which means that something is returned to its original state. Regenerative, according to the same dictionary means: “having the effect of making something develop or grow strong again”. Although both words seem to have quite similar definitions, restorative seems to be achieved through external influences, where regenerative seems to develop internally. The Ellen MacArthur foundation connects both words to design.

Regenerative design, according to Cole (2012), relates to: ”approaches that support the co-evolution of human and natural systems in a partnered relationship. It is not the building that is ‘regenerated’ in the same sense as the self-healing and self-organizing attributes of a living system, but by the ways that the act of building can be a catalyst for positive change within the unique ‘place’ in which it is situated” (Cole, 2012:1). The problem of the lack of ‘re’-generativity becomes more evident when examining cities and industries. Starting with the former, cities take a vast amount of resources from the hinterland and beyond. Raw materials are extracted, transported and processed into consumer products that eventually end up as rubbish and cannot be reabsorbed by nature (Girardet, 2017). Concluding the latter, the industry is linear. Although it would be in the interest of industry to use renewable energy sources, because fossil fuels will become scarcer, increase in price and eventually deplete, the use of oil is still the prominent source of energy (EIA, 2016). Changing this old-school mindset, this outdated production method, this dangerous industrial system, according to Galdwin (1997) is going to be a long run of trial and error. Galdwin states that humanity has developed a dysfunctional relationship with nature over the past centuries. Especially western societies seem to have lost their connection with nature (Galdwin, 1997). Plessis et. al., (2011) acknowledges this and continues that the sustainable effort from the World Bank to alter current business models is insufficient. She states that the current sustainability paradigm, based on ‘green-design’ is headed towards a dead-end because of its inability to deal with complex living systems (Plessis et al., 2011). Green design an “idea in the era of sustainable development, which focuses on the efficient utilization of resources and energy, gives consideration to both economic and environmental benefits and closely links them” (Li & Sun, 2019)2019:2). Plessis advocates for a new ‘regenerative sustainability paradigm’ that needs to: “*address the dysfunctional human–nature relationship by entering into a co-creative partnership with nature [and aims] to restore and regenerate the global social–ecological system through a set of localized ecological design and engineering practices rooted in the context and its social–ecological narratives*” (Plessis et. al., 2011:19). A distinction between both a green design and regenerative design is the relationship to other places. Green design can be considered technocratic and top-down, commonly lacking social-ecological engagement. In contrast, regenerative designs attempt to understand the whole system beyond the regional (Cole, 2012). According to Mang (2011), regenerative design includes the ‘story of place’. It provides a holistic and understandable picture through the coherent organization of information and underlying narratives (Mang, 2011). A regenerative designed industrial system would therefore consider all possible environmental aspects. This includes a thorough analysis of every step in the supply chain, of every drop of water that is used, and every co2 particle that is emitted in order to minimize environmental harm and maximize environmental benefits.

2.2.4 Replacing the 'end-of-life' concept with restoration

The second part of the Ellen MacArthur definition is that CE replaces the end-of-life concept with restoration. Traditionally the end-of-life state of a product leads to discarding of goods and therefore resources. Historically, products rarely had an end-of-life phase. Resources were much harder to obtain and most products were repaired or their resources were reused (Woodward, 1985). In the early days of the industrialization manufacturers attempted to increase the quality of goods, to get a market advantage over competitors. At the beginning of the twentieth century economies were still predominantly organized nationally and when the manufacturing process became increasingly efficient, the national markets became saturated. Scientists were then hired by manufacturers to rig their own goods in such a way that the product's life cycle was shortened. This process was seen as a business essential in order to maintain a 'healthy' business model (Fincher, 2015). Moreover, for a business being able to 'plan' its production more efficiently, it can produce cheaper and maximize profits (Levitt, 1965). In the second half of the twentieth century, and especially during the period of neoliberalisation, companies could now penetrate new markets to establish economic growth instead of manipulating their national markets. The short lifetime goods now flood the global markets leading to mass consumption (Short, 1985).

The environmental and social impact of extracting all these non-renewable materials over and over again, to produce the same good over and over again today is undesirable. Therefore restoration has to replace the end-of-life phase. Before diving deeper into restoration, there has to be a distinction between two product cycles. These cycles are either biological or technical (Mestre & Cooper, 2017).



(Figure 2: Product Cycles, Ellen MacArthur Foundation, n.d.)

When discussing the replacement of a product's ‘end-of-life’ phase with restoration, one has to take into account whether a product is biological, technical or a bit of both. The reason is that biological materials are much more difficult to reuse. Simply put: when someone eats a chicken, it is impossible to get back a chicken. Yet, instead of flushing the end result down the toilet, it could be used as fertilizer for corn, to feed other chicken and thereby remain in the biological circle. This principle of ‘cascading’, is the sequential and consecutive use of resources (Campbell-Johnston et al., 2020). Although most commonly used in connection with bio-materials, cascading is also used to create added value in the technical cycle (Mair & Stern, 2017). In contrast to the biological cycle, does the technical cycle present possibilities to reuse materials infinite times. Gold that has been used in a watch, is still there after a hundred years and can then be melted again and turned into something new.

As is made clear above, replacing the end-of-life phase for the biological cycle is mainly a matter of energy and nutrient preservation. The technical cycle presents four possible loops (1) repair (2) Reuse (3) Refurbish (4) recycle. If the end-of-life of a product becomes inevitable is this referred to as leakage. Leakage mainly consists of incineration with energy recovery. If that is also not possible, for instance when it concerns hazardous waste, the waste will end up in landfill. The here mentioned order in steps are considered the order of most desired ways of waste management (Yu et al., 2014). This can be realized through regenerative design. Moreover this further in this chapter.

2.2.5 shift towards the use of renewable energy

Drilling up oil, or digging up coal to burn it in order to generate energy is a linear process. Not only is it impossible to use the incinerated resources again, the process also emits substances that are harmful to the environment into the atmosphere. Yet to an extent, fossil fuels are also renewable over a long period of time. This section will discuss what is considered a ‘renewable’ in terms of energy, and which is considered more or less desirable than the other. One has to take in mind that just with the biological cycle, energy flows can only cascade and be utilized in different forms.

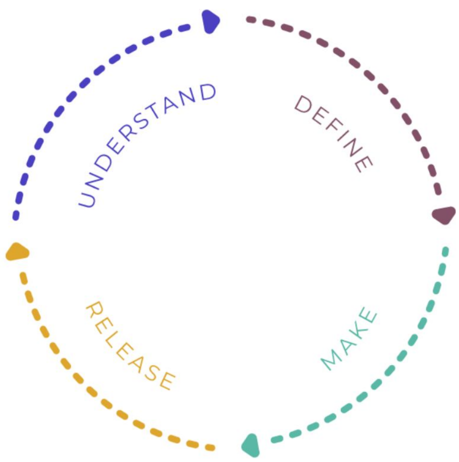
When it comes to renewable energy, there is an abundance of sources from which it can be derived. Technology is able to harvest energy from solar, wind, biomass, landfill gas, hydro, including tidal, as well as earth’s thermal energy resources (Kurochkin et al., 2019). And when it comes to applying renewable energy to the economy, it does not take long to find flaws and realize a lot of progress still has to be made. Solar and wind energy are currently the most commonly deployed techniques to generate renewable energy (Nikitenko et al., 2019) These energy sources are popular because they can be found globally and can be used until infinity. A downside for using wind and solar energy is that the availability fluctuates enormously. In summer sun could be available in abundance, and storms might make the wind turbines work extremely hard. Yet it is difficult to store this energy to use it a week later when the sun and wind are absent. Therefore, storage of renewable energy is considered a key development in establishing a steady power grid that is fueled by renewable sources (Rosa & Da Rosa, 2013).

2.2.6 Elimination of waste through design

Waste can be seen as an end-of-the-pipe byproduct of a product. Yet it is usually the design phase where waste is being generated (Birkeland, 2007). Eliminating toxic materials and other waste by design is an important step in achieving circularity. For instance, the use of asbestos in construction prevents materials from being recovered as asbestos poses a hazard to human health. This leads to an inevitable landfill. The same accounts for a wide variety of chemicals and other hazardous materials. Countries in the EU make legal distinctions between regular waste and ‘small hazardous waste’, the latter includes materials such as paint, cleaning products and batteries (Rijkswaterstaat, n.d.). Today many smartphones are designed in a way that batteries can not be separated from the rest of the phone. This in turn, makes that the entire phone is considered 'hazardous waste' and can not be processed or transported as 'regular waste' resulting in many valuable materials being lost (Jacomij, 2020). It is not only chemicals that pose challenges to the reuse or recycling potential of materials. Cotton from jeans, for instance, can only be reused if the fabric consists of at least 96% cotton (MUD Jeans, n.d.).

The Ellen Macarthur foundation identifies four critical stages in the circular design process. The first is: Understand. Designers should get to know the user and the system. Then define; Here the designer has to put into words what the intention of the design is and what challenges have to be faced. The third step is 'make' this includes ideate and prototype as many iterations and versions as you can. Finally comes the 'release' phase. Here the design is launched into the wild and a narrative is built. It is important to create loyalty in customers and deepen investment from stakeholders through storytelling (Ellen Macarthur Foundation, n.d.).

It is not only the product that needs to be designed according to circular practices. The transportation process, and therefore packaging, should also be included. The entire supply chain needs to be considered when designing a product. Simply put; transporting a phone from China to the Netherlands emits more CO2 than transporting a phone from portugal to the Netherlands. Therefore there is less carbon waste, and maybe even less packaging when the manufacturing is done in Portugal. The term 'circular supply chain management' is often used interchangeably with concepts like sustainable supply chains, green supply chains, environmental supply chains, and closed-loop supply chains (Farooque et al., 2019). CSCM can be defined as "the coordinated forward and reverse supply chains via purposeful business ecosystem integration for value creation from products/ services, by-products and useful waste flows through prolonged life cycles that improve the economic, social and environmental sustainability of organizations" (Batista et al., 2018a:446). The key message for circular design is to examine every step in the entire supply chain, and produce a product that can enter material loops over and over again (Ellen MacArthur, n.d.).



(fig 3: Circular design process, EMF, nd)

2.2.7 business models and servitization

The Ellen MacArthur Foundation touches upon the world's business models in their CE definition. Seamless little attention to the matter does not mirror the concept's true importance. Because is society is to transform from a linear to a circular economy, business has to fundamentally rethink their operations. Yet, according to the EU commission, CE brings several economic benefits that make CE interesting for corporations: "A circular economy encourages sustainability and competitiveness in the long term. It can also help to:

- preserve resources – including some which are increasingly scarce or subject to price fluctuations
- Saving costs for European industries
- Unlock new business opportunities
- build a new generation of innovative, resource-efficient European businesses – making and exporting clean products and services around the globe
- create local low and high-skilled jobs

- create opportunities for social integration and cohesion”

For a business to transform into a circular business model, according to Jonker et. al. (2017) it has to undergo a five step process. The first is aimed at ‘in-house circularity’. This includes closing your own heat, energy and waste loops. The second phase is a shift from your own organization to suppliers. It is a ‘partial-chain integration’ which becomes a small part of the total supply chain. The next step is called a ‘material mono-flow cycle’ which focuses on closing the simple cycle of a specific material. In the fourth step refurbishing and repairing become a crucial part in minimizing resource extraction and the reuse of materials without losing value. Involved business models become more connected and start to develop an ecology. In the final stage further inter-weaving and interlocking of cycle-ladders should result in an organizational-economic system (Jonker et. al., 2017).

Today many businesses have ties all over the world. Yet for circularity to root into society, it should be organized locally. The most obvious reason is that less transport means less fuel. The same accounts for the amount of transport vehicles, distribution centers, petrol stations, airports needed, and so on (Larsson, 2018). Lovins and Baumgart (2014) present five principles to a more local circular economy:

1. “The smaller the loop (activity-wise and geographically), the more profitable and resource efficient it is.
2. Loops have no beginning and no end; value maintained replaces value added.
3. The speed of circular flows is crucial; the efficiency of managing stock in the circular economy increases with decreasing flow speed.
4. Continued ownership is cost efficient; re-use, repair, and remanufacture without a change of ownership save double transaction costs.
5. A circular economy needs functioning markets.”

(Lovins & Braungart, 2014)

Closing and narrowing loops are the opposite of the footloose strategies that have been deployed by many multinational corporations over the last decades. Banning those and starting from scratch with smaller local businesses yet, the demand for local products and services is increasing (Larsson, 2018; Zhang et al., 2019). The principles of the circular economy enable more locality by keeping the resources in a loop instead of them needed to be extracted from other continents.

Another key business approach in favor of CE is the servitization of business. Presenting products as a service does not only change the traditional end-of-life phase, but also makes consumer products more efficient. For instance, a car is usually parked over 90% of the time and a drill is only used 20 minutes per year (Jonker et. al., 2017). The multinational Philips, famous for the production of lightbulbs has realized this and now sells lightning as a service instead of a product. In with their programme, the ‘circular lighting’ business no longer has to buy lights, but lightning. This way the lights remain the property of Philips and are they repaired when needed. In order to perform repairs, lights have been designed in a completely different way that would enhance maintenance on the lights (philips n.d.). Another movement in the area of servitization comes from the sharing economy. The sharing economy encompasses new peer-to-peer platforms such as AirBnB, ridesharing apps like BlaBlaCar and even car-sharing apps like GreenWheels. Although the effects of such innovations are still unclear, there seems to be an increase in innovations that disrupt the market (Martin, 2016).

2.3 Waste

2.3.1 Waste management

"Waste management can be generally considered as the entire treatment or handling process from waste collection via recycling/treatment to final disposal" (Yu et. al., 2014:31). The main driver of waste-management before the Industrial Revolution was that not many resources were available at the time, cleaning the streets from hosredung to sell as fertilizer and scavenging broken parts and repairing them could provide income (Woodward, 1985). The idea that products were derived from repairing and reusing changed during the industrial revolution of the 19th century when products and resources became abundant. Waste-management at the time was mostly driven by public health issues and therefore mainly focussed on hygiene (Wilson, 2007). In the late sixties and early seventies, there was an apparent shift to environmentally driven policies concerning waste-management. This shift may arguably be accredited to the publishing of several academic works such as Silent Spring and Limits to Growth that changed the public perspective on environmental issues (Wilson, 2007). Contemporary waste-management strategies are driven by a mixture of all the aforementioned and strengthened by the economic perspective that resources are becoming more scarce and therefore less affordable (Wilson, 2007; Yu et. al., 2014). The main distinction between CE and waste-management is that the latter only involves handling the left-over materials. Where it also involves design, waste-management does not.

In the last decade especially, CE has influenced waste-management significantly. In most EU countries, CE has become an important part of national waste-management strategies (Gopinat, 2020; Luga, 2016; Neless et al., 2016; Skorupskaitė & Junevičius, 2017). What all of the waste-management strategies have implemented is a desirability 'scale', or pyramid. This means that some ways of dealing with waste are more desired than others. The order, from most to least desired is: (1) Prevention of waste, (2) Preparing waste for reuse, (3) Recycling, (4) Other recovery, (5) disposal (Neless at al., 2016). A similar desirability scale was presented by Yu et al., (2014). Here too, waste prevention is most desired and landfill least desired. Yet, even though all waste management strategies accept the notion that preventing waste is the most desired practice, altering design that enables this prevention falls out of most waste-management scopes. CE has therefore become an essential concept that listens closely to the waste-management approach when it comes to resource recovery. This is where, in turn, waste-management strategies heavily depend on CE for future improvements in waste prevention.

2.3.2 Factors in generating waste

To find out what factors influence the minimization of waste, it could be useful to examine what factors contribute to generation waste. Waste, of course, comes in many forms and differs across countries, regions, households and businesses (UNEP, 2014). A study on waste generation in the EU described the factors that contribute to the amount of waste, as well as the composition of waste, as regional factors. Included in these regional factors are socioeconomic status, climate consumption rate, presence (or absence) of tourist and the amount of gardens per household (Halkos & Petrou, 2018). Hoang et al., (2017) state that "Rapid urbanisation and industrialisation in developing countries have led to a dramatic increase in the volumes of municipal solid waste" (Hoang et al., 2017:385). Moreover they confirm that gardens, as well as property size are factors that influence generation of waste. They add that household income, a person's age, property size and whether it is located in a rural or urban area are also factors that need to be considered.

Bruvol and Ivenhold (1997) argue that technological progress influences the amount of materials that are used and hence the generation of waste. This technology does not concern the technologies that are involved with processing waste, but is described as technological progress in manufacturing products. Their argument is that when technological progress makes the manufacturing products more efficient, the material input would decrease. Therefore, the material output (i.e. waste) will also decrease (Bruvol and Ivenhold, 1997). Others have found evidence that technological advancement leads to an increase of waste. Mazzanti et al., (2008) argue that an increase in income and other economic drivers like population size and technology tend to increase the generation of waste. They continue by introducing a Kuznets curve that confirms their first statement but also shows that from a certain level of technological maturity the amount of waste is decoupling from the economic factors. Therefore only a few rich countries (or area's) experience these advantages of technological advancement (Mazzanti et al., 2008).

Legal factors are also considered a part in the generation of waste. Taxes, subsidies and legal definitions influence waste management practices (Epifanov, 2018). Defining what is considered waste or not plays a big role in how to handle it. Solid waste is considered a fuel or resource for some businesses, yet it is often labelled as waste by law. This has implications on how it can be transported or sold to other businesses (Longo & Wagner, 2011). Moreover, the Royal Dutch Association for Waste and Cleaning Management (NVRD) confirms that by law waste is neither a product nor resource. Exports, trade and transport are therefore limited. This is considered a threshold in the transition to a circular economy (NVRD, 2018). Dutch law requires that all businesses should separate paper and residual waste. Dutch law describes waste as any substance or object which the holder discards or is required to discard under applicable national provisions (Wet milieubeheer, 2014). The same law also states all waste has to be reported before being transported. If one fails to report this, it will lead to a financial disciplinary measure (LMA, n.d.) in the EU, where companies are obligated to take back electronic devices from customers when they buy new devices. This way electronic waste gets separated and recycled. This is a positive contribution to the transitions toward a circular economy as (rare) metals can be harvested from the devices and be recycled into new electronic devices (Hong & Ke, 2011).

Legal factors often involve economic instruments. High taxes on landfills could be a way to discourage transport of waste to landfill sites (Slavík et al., 2017). Although they do not per se influence the amount of waste that is generated, it does affect the amount of waste being processed in less desirable ways. Taxes might increase the real cost of waste processing and therefore presents a negative incentive for less desired ways of handling waste. Subsidies in their turn are a decrease of the real cost in order to stimulate more desired ways of handling ways. Slavik et al., (2017) state: "As a market-based instrument, subsidies change the relative prices of alternative waste treatment methods, and they should therefore provide incentives for the effective treatment of Biodegradable Municipal Waste" (Slavik et al., 2017:1) Moreover subsidies on recycling. Besides lowering the cost of processing waste in alternative ways, it also increases the value of scrap metals. Where processing costs would normally be higher than the residual value of metals, subsidies could make it profitable to recycle specific materials (Kaffine, 2014). In a study by Hockett et al., (1995) they argue that although demographic and structural factors are of influence, the biggest determinant in generating waste is the economic factor. Their study on MSW shows that the fees that need the be paid for handling and processing the waste are most significant (Hockett et al., 1995).

The line between factors that generate waste and factors that minimize waste can be vague. Often factors can influence waste generation in both ways. When demographic factors like population increase, the amount of waste also increases, but when the population density declines, it becomes a factor on minimizing waste. Another thing that is involved in this ambiguity is the production process.

2.3.3 Factors on waste minimization

So far, the theories discussed have shed light on what is considered sustainable. Attempted to define the circular economy and described what factors generate waste. This final section will discuss what factors influence the minimization of waste. In a way, reversing the factors that generate waste will minimize waste. Where high density of postal codes is a factor that increases the generation of waste, a low density will be a factor that decreases the amount of waste. Yet there are some factors specifically aimed at minimizing waste that are discussed here.

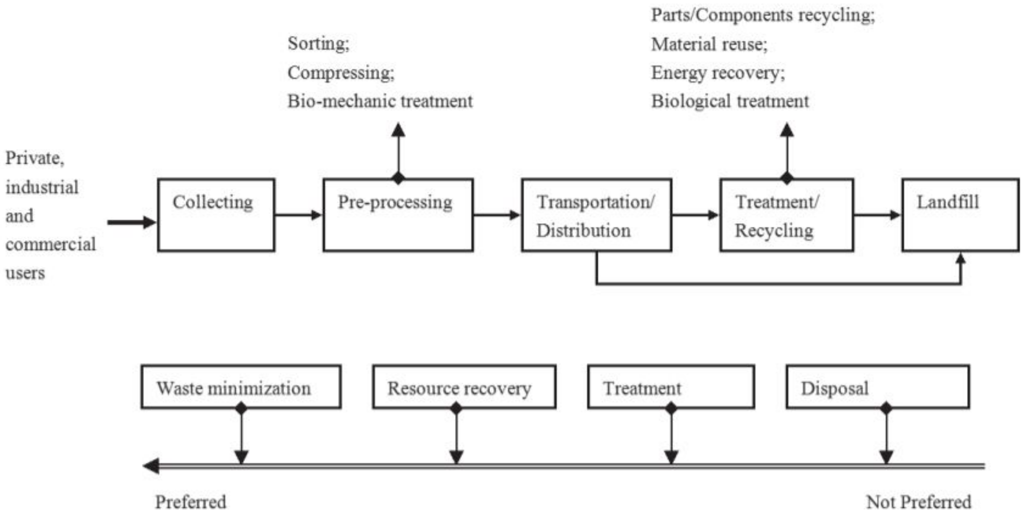
Evidence from the Asia-Pacific has shown that the decentralization of waste collecting has a positive effect on waste minimization (Story et al., 2013). The theory advocates that in regions where there are limited facilities to process waste, waste is less likely to be picked up by waste-haulers and people are less willing to transport their waste to potential waste processing facilities (Story et al., 2013). Data from the Dutch Central Statistics Bureau (CBS) show that the more urbanized an area is, the less waste is produced per capita. It has to be taken into consideration that some less urbanized areas are popular tourist destinations, such as Zeeland or the Waddeneilanden, yet there is significant evidence that the less populated the area, the more waste is produced (CBS, 2019).

A problem with decentralized waste facilities is monitoring when waste facilities are full. When containers for separating plastic are full, people are more likely to dump the plastic that does not fit in the plastic container, into the residual waste container. As a result, less materials are being recycled. New technology enables bins and containers to become ‘smart’. Containers that are almost full send out a signal to the waste-haulers to let them know their capacity has almost reached a limit. This makes it more efficient for waste-haulers to empty the full container instead of driving all the way to half empty containers (Ramos et al., 2018).

Tanskanen et al., (2018) state that cooperation throughout the entire supply-chain is required in order to implement the circular economy in the telecom and ICT industry. European standardization organizations are currently working on common definitions and terminology that should increase the implementation of circular practices. The authors state that aluminium and steel are by far the most used materials. Applying circular practices throughout the supply chain should therefore accommodate the reuse or recycling of this metal. Another significant aspect to cooperation is sharing the network, or parts of the network with other operators. In this way less materials are needed to provide the same service (Tanskanen et al., 2018). Although their research focuses mainly on the manufacturing process of cellular phones, the importance of collaboration throughout the entire chain has been the result of many studies (Leising et al., 2018; Onur, 2020)

2.4 Theoretical Framework

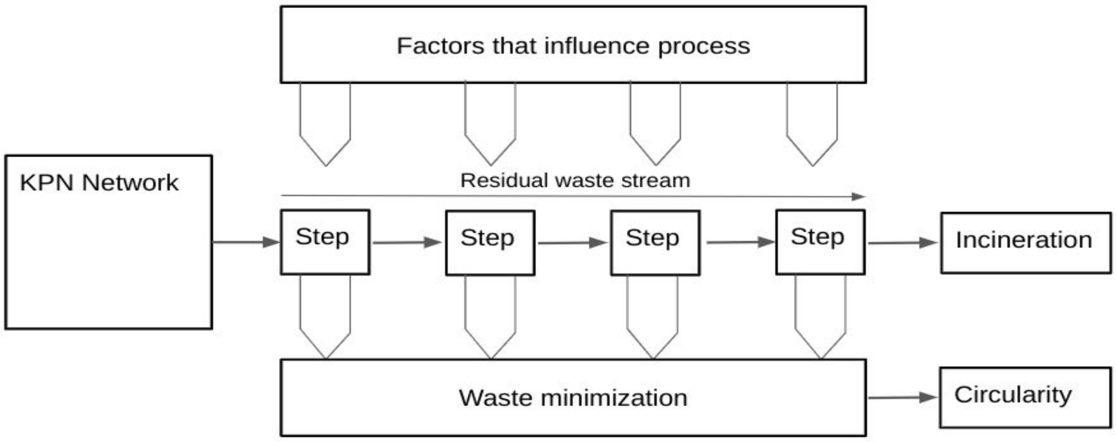
The theoretical framework of this research consists mainly of the above described concept of the circular economy in combination with the theory of sustainable waste-management provided by Yu et al. (2014). This theory is described by Yu et. al., (2014) and visualized in their model as shown in figure 4. They describe it as "a decision aided system based upon a multi-objective dynamics waste management model.. ..for emphasizing and optimally managing the interactions between system efficiency and potential risks as well as sustainability (Yu et. al., 2014:31) The model visualizes the potential steps in handling waste and implements a preference ladder that is in line with the CE philosophy of waste minimization. it shows that the process starts with the collection of waste, after which it is being pre-processed. This preprocessing constitutes sorting, compressing or bio-mechanic treatment. After pre-processing, waste gets transported to either a recycling, reuse, energy recovery or biological treatment facility. The last and least sustainable and therefore least desired way of dealing with waste is a landfill.



(*Figure 4: Theoretical model for Sustainable Waste-management*; *Yu et. al.*, 2014).

The bottom half of the model, shown in figure 4, shows the attitude to what is a preferred or less preferred way of dealing with waste. According to the authors prevention is the most desired way of dealing with waste. They state: “To achieve this goal, vigorous promotion in collaboration with incentive, policies and regulations is necessary, and patience also plays an important role in this process because the time needed for the majority people to adopt the concept of sustainable waste management may be of significant difference in different regions and is also hard to be accurately predicted (Yu et. al., 2014:31). The second best way to deal with waste is resource reuse/ remanufacturing/ recycling. The authors make no specific distinction between the three, which could arguably be a flaw in this theory. They continue by stating that energy recovery from solid waste is the third-best option in dealing with waste. As aforementioned, landfill or ‘disposal’ are the last resort in dealing with waste flows. Yu et. al., identifies four steps in the waste-flowchart these are (1) waste collection (2) pre-processing / distribution (3) incineration/recycling (4) landfill (Yu et al., 2014).

An analytical framework has been constructed in order to guide this research (Figure 5). The framework visualizes a process that starts with the KPN network. Therefore, processes before materials are being released from the KPN network, such as the design, are not included in the analysis. From the network, materials are released. Through several steps these materials finally get incinerated or recycled/reused. The model presumes that with each step, there are factors involved that steer materials from the incineration stream into other streams in which the materials enter a loop. The idea is that if at a step (or steps) the factors get altered, less waste will end up at the incineration facilities. Therefore, if factor X influences what stream the waste ends up in, then altering factor X is expected to influence the waste process and lead to less waste being incinerated.



(Figure 5: Analytical model of the research, own design, n.d.)

The factors that are considered to have potential to influence the process of materials becoming waste are derived from the literature discussed above. Legal factors have the potential to influence the process. This is because materials have to be transported from the maintenance site to the place where they eventually be discarded. According to the NRVD, transportation of waste is often limited by legal factors (NVRD, 2018). Another factor that is expected to be of significance is that of the economics of waste. Whether it will be tax-cuts, subsidies or corporate incentives is still unclear, yet that financial incentives play a significant role in minimizing waste has become clear in the work of Slavik et al., (2017). It must be stated that legal and economic factors are therefore often related. Geographical factors, like population density and socio-economic status are undoubtedly the prime contributors to the generation of waste. Yet, the literature described how this mainly influences solid municipal waste. The bigger a garder, the bigger a household, the more people in a small area all influence the amount of waste that is generated (Halkos & Petrou, 2018; UNEP, 2014). For this research, these aspects are all considered exogenous influences that KPN can not change. The only aspect from the geographical factor that has potential of influencing the KPN residual waste stream is that of centralized waste collecting. Finally, cooperation and collaboration is a factor that is considered significant in the process of materials becoming waste. Simply put, KPN works with Allinq, Suez, Renewi and many other parties in order to optimize their reuse and recycling rates. Another aspect to the factor cooperation was described by Tanskanen et al., (2018). In their theory, cooperation between the entire supply-chain is an important factor. Yet again, supply-chain integration is beyond the scope of this research. Nonetheless, cooperation occurs on every level on which KPN operates and can therefore still lead to interesting findings. The final factor that could potentially influence waste minimization is that of technology. Smart bins or machines that can process specific materials could make the difference between materials being recycled, reused or incinerated (Mazzanti et al., 2008).

3. Methodology and methods

3.1 Research Design

The research design of this thesis is that of a case-study. Case-studies come in many shapes and in the process of doing thesis the shapes have in fact changed in order to fully facilitate the research questions to an maximum. Yin (1989) defines a case study as:

"*A case study is an empirical inquiry that investigates a contemporary phenomenon within its real-life context; when the boundaries between phenomenon and context are not clearly evident; and in which multiple sources of evidence are used*"
(Yin, 1989:23).

The case of this study, as described in the introduction, is the outflow of waste from the KPN network through Allinq. The empirical inquiry is obtained by gaining access at KPN through an internship and doing interviews and making observations. The contemporary phenomenon that the case revolves around is the transition towards a circular economy. The real-life context is the collaboration between KPN and Allinq in reducing residual waste. In order to examine circularity through factors of waste minimization at KPN, multiple sources of evidence are used. The sources of evidence, as discussed further down this chapter, were limited due to the COVID-19 Pandemic.

The shape of this case study has shifted from an ethnographic case-study to a causal exploratory single case-study as described by Gerring (2006) and Yin (1981). Translated into this research, this means that this case explores a causal relationship between not yet identified factors and the generation of waste in the hope of constructing a hypothesis (Gerring 2006; Yin, 1981). The type of case-study had shifted because first I had the intention to fully participate in everyday business activities whilst researching how to decrease the outflow of waste. On forehand I thoroughly described a well-known pitfall in ethnographic case-study design which is that of going native. This occurs when a researcher becomes too close to his research subject. This phenomenon, that can also be a research strategy, becomes a pitfall when the researcher becomes too involved in the community of what is being researched. Bryman discusses this and states:

"*Going native is a potential problem for several reasons but especially because the ethnographer can lose sight of his or her position as a researcher and therefore find it difficult to develop a social scientific angle in the collection and analysis of data*"
(Bryman, 2015:445).

In the early stages of the internship the focus was mainly aimed at constructing a solid research proposal. A stiff relationship between KPN and Allinq made it difficult to obtain preliminary inquiries about the case. Awaiting a formal introduction with Allinq led to an increase in involvement in business activities that clearly did not contribute to the research. Moreover, the research instruments that I was developing, seemed to have been in vain after the first contact with the Allinq contact. This contributed to a growing personal clash between me as a researcher and me as an employee of KPN. After consulting my supervisor I decided to withdraw from all non-essential activities in order to resolve the involved ambiguity.

Whenever one conducts a case-study, there are several hurdles that ought to be overcome. The first is to gain access into an organization. There are many ways to achieve this. Academic literature has formulated clear distinctions on how a position is obtained, to what extent access is granted and more. The following actions were taken to obtain the position as an intern researcher. The first is that KPN is considered a: Closed non-public setting. It means that one needs special authorization to enter the KPN office facilities. Therefore it is essential to get this authorization. Through a personal contact, who has been with KPN for several years, I got in touch with the head of the Network team involved with circularity. This resulted in a meeting in which I got interviewed for the position as a research intern for the circular economy at KPN. After a successful job interview, I had to go through a screening in which I had to present documents such as my Bachelor's degree and a term statement of conduct. This then resulted in me becoming an 'Overt full-member'. In other words, I would try and become part of the team as much as possible whilst not hiding the fact that I am a researcher who is conducting research (Bryman, 2015). This position was altered later as the 'ethnographical' way of researching seemed to cause undesirable effects. This alteration has led to a more precise description given by Adler and Adler (1987). They describe an Overt-full member as being an 'active member researcher'. This entails a researcher that becomes involved with the central activities of the group without fully committing themselves to the members' values and goals (Adler and Adler, 1987). It might seem like a difference without distinction yet, the ethnographic case study implies full engagement with the team, whereas the latter does not. Something that both case-studies have in common is that both give researchers a certain amount of legitimacy and/or stigma (Adler & Adler, 1987; Bryman, 2015). Dwyer (2009) adds that insider roles may contribute to the debt from which data can be gathered, he argues:

"*This insider role status frequently allows researchers more rapid and more complete acceptance by their participants. Therefore, participants are typically more open with researchers so that there may be a greater depth to the data gathered.*"
(Dwyer, 2009:58).

3.2 Research Strategy

The strategy and instruments used to conduct this case study are of qualitative nature. Case studies are often, yet not exclusively, of a qualitative nature (Bryman, 2015). As the bulk of case-studies on waste flows are of quantitative nature, this study will exclusively use qualitative data. A minor exemption is the quantitative data derived from the waste reporting sheets concerning the waste-streams from the KPN network.

As with most qualitative research, this study does not follow a tightly woven plan. External factors such as the collaboration of third-parties, the attributed importance of the subject by managers (Eriksson & Kovalainen, 2008). Lillis (2002) identifies three roles in qualitative research that are (1) Reporter (2) Interpreter (3) Advisor. The success of qualitative research in a market-based setting often depends on the researchers skills of mediating, communicating, thinking and managing the research project. Lillis (2002) further argues:

"*To fulfil the roles and fully exercise the skills to produce results that are useful and usable, qualitative researchers need to operate in a context of trust. If the recipient of qualitative research output does not trust it, for whatever reason, it is useless*"
(Lillis, 2002:28)

Moreover qualitative strategies, according to Bryman (2015) they usually differ from quantitative strategies in approach. Where most quantitative research is considered deductive, qualitative research is more often characterized by an inductive approach. The latter means that a theory is generated from research, where the former works the other way around (Bryman, 2015). This research distinctively uses an inductive approach. The explanatory nature of this case study is examining data in order to identify a causal mechanism. The idea is that some factors might influence waste minimization. The primary data collected for this research is, to an extent, aimed at generating a theory concerning the factors influencing waste minimization in this specific research context. As with most qualitative case-studies, open-ended interviews, narratives and observations are renowned instruments on collecting data. This will be discussed more in-depth in the sections below.

3.2.1 Research philosophy

This thesis is conducted from a constructivist (or constructionist) perspective. According to Guba and Lincoln (1994) constructionists state, concerning the ontology that: "C*onstructions are not more or less "true", in any absolute sense, but simply more or less informed and/or sophisticated. Constructions are alterable, as are their associated "realities" (Guba and Lincoln, 1994:110).* This position is in line with the epistemological choices of this research as narratives are used to inquire knowledge. This knowledge is probably presented by the research subject as their constructed truth. Whilst accumulating this knowledge a new reality is constructed. This is considered a temporal reality as in the future again more knowledge will construct more sophisticated forms of reality (Guba & Lincoln, 1994). As knowledge is acquired mainly through vocal processes, the voice of the inquirer is expected to be that of an "passionate participant" who attempt to reconstruct a multi-voice truth. Besides that this philosophy mirrors the researchers' personal ways of thought, is constructivism ought to be the favorable philosophy in a case-study (Guba & Lincoln, 1994).

3.3 Data collection

The collection of data was limited by the external pressure of the COVID-19 pandemic. The Dutch government strongly advised me to follow the instructions given by the National Institute for Public Health and Environment (Dutch: Rijksinstituut voor Volksgezondheid en Milieu, RIVM). These instructions are to stay at home as much as possible and if in proximity of others, keep 1,5 meter distance (Rijksoverheid, 2020). Moreover, the government had put penalties of 400 euros on meetings with more than 2 persons. This situation was a reality from March 13 until May KPN closed its offices remain closed from March 13th until the end of the research

Besides the first couple of weeks, doing research was changed completely. Alternative research methods have been discussed with the thesis supervisor from Radboud as well as information about sources provided by the lead professor of the Advanced Research Methods course Pascal Becker. The use of information and communication technologies (ICT) became an important part of the research. Skype, Whatsapp and Microsoft Teams were often used to communicate with the research participants. Doing so is not uncommon in qualitative studies. Sometimes referred to as 'Netnography', the use of the internet in doing research is not uncommon (Kozinets, 2009). Ahlin and Li (2019) have shown that the internet enables researchers to create a research field. Doing research through digital communication makes that 'field event' become possible. The construction of a research field through a physical and digital/virtual collection of events (Ahlin & Li, 2019).

3.3.1 Literature research

A literature reviews help with setting a framework and therefore the stage of the research (Lichtman, 2013). The method for exercising the literature desk research based on a method advocated by Bryman (2015), it goes as follows: Search for a topic that you want to research. Read the abstract and collect the articles that seem of interest to the topic. When no new information or possibly interesting articles present themselves, you are saturated when it comes to collecting academic literature. What follows is a period in which one reads all the articles. This process gets repeated until no new information becomes available (Bryman, 2015). A typology of literature reviews from the encyclopedia of research designs (2010) refers to this process as coverage literature review (Salkind, 2010). Besides academic literature will what Salkin (2010) refers to as organizational literature review be a method that will be used in order to analyse internal processes from the case. The literature is used as a source to gain insight on what circularity entails and what factors influence the generation of waste. The necessary documents are derived from the KPN drive for internal use. If gatekeepers or restrictions make it clear that access is not directly permitted, superiors will be asked to grant permission to use the files.

3.3.2 Sampling methods

In order to get respondents that are willing to participate in the research project a diverse set of actors are approached in several different ways. First, key actors involved in handling the KPN network waste will be identified. The project relies on internal contacts to establish a connection between me and these actors (or gatekeepers if you will). After a connection is established a request will be sent in order to get in touch with employees engaged in the handling materials in their process of becoming waste. It is a mix of what can be described as purposive sampling, wherein purposely key actors are approached that then lead to snowball sampling depending on their willingness to cooperate (Bryman, 2015). The purposive sampling methods was later altered to whomever had some potentially interesting insights on how to handle waste from network operations. This was done because the Corona restrictions made it extremely difficult to get in touch with sufficient research participants.

Besides gathering literature, interviewing and observing the obvious, I will also encounter unforeseen situations wherein relevant information will present itself. This opportunistic sampling method will help me gather information during informal moments. These will form the main source of input for the mental- and jotted notes as described in the following section.

3.3.3 Observations

In the first six weeks of the research many mental and jotted notes have been gathered. During meetings that were attended, informal conversations and communication between team members. After the 17th of March this data source of data dried up because all offices closed. These Daily notes that were taken are categorized by Bryman (2015) into 3 types:

- **Mental notes**—particularly useful when it is inappropriate to be seen taking notes. This can be informal conversations with colleagues, as well as coffee breaks or drinks on Friday. In my case, mental notes are mainly used as food for thought, which might develop into jotted notes once they seem to be interesting.
- **Jotted notes** —very brief notes that I will write down in my paper notebook. about events that could be written up later or used later. (Lofland and Lofland, 1995:90) refer to these as being made up of 'little phrases, quotes, keywords, and the like'. They need to be jotted down inconspicuously. I will use this method as soon as a conversation or event has ended.
- **Full-field notes—** Detailed notes that are made as soon as possible after relevant observations took place. These will be added as appendices and ultimately form the basis of the data obtained through observation.

On rare occasions visual data is sourced from those participants willing to share it. These pictures replace on-site visits to get an impression of what a location looks like. Addition is a google maps satellite image used. This image is less reliant, as it usually dates back several years because of privacy laws. Although not uncommon as a data source, one must take into account that the use of photographs in research always manipulates the real world to a certain extent. It never shows what is behind the lens, or what has happened before the picture was taken (Stanczak, 2007).

3.3.4 Interviews

Besides the literature, notes and photographs, interviews will be a prime source of data for this research. As face-to-face interviewing is potentially harmful to participants, interviews will only be conducted from a distance. Digital and phone interviews are a solid substitution in times of pandemics. Moreover, Skype is supposed to encourage participation in times when mobility - in this case by government restrictions - is limited (Janghorban et al., 2014).

The interviews will be semi-structured, unstructured and open-ended. This leaves room for the interview to flow in many directions whilst not losing track of the topic at the same time (Bryman, 2015). The interview-as-data method is described by Seale (2004) as a proven qualitative research instrument (Seale, 2004). The interviews are distinguished into two categories: the un- and semistructured interviews. The semi-structured interviews make use of a horizontal pyramid model in order to keep focus on what is researched. This method is elaborated on in section 3.6. The interviews eventually became unstructured. Again, because of Corona, anyone who could provide relevant data was welcome. Because many companies involved in waste and network activities were requested an interview, it was uncertain who would reply and how much time would be willing to spend on an interview. In other words, it would not be efficient to outline a 30 minute interview, if the participant would only have five or ten minutes of time available. This uncertainty caused the interviews to be conducted as unstructured narratives.

Another significant distinction was made in my role as interviewer. Some interviews are held from the role as intern employer from KPN, others are interviews held from the role as a student researcher. This difference has been made in order to not let potential economic factors get in the way of true information. I would argue that when approaching organizations or businesses as a KPN intern might seem like a business opportunity for some of them. Therefore the information obtained through these interviews could be tailored to fit the needs of KPN instead of just being information on factors influencing waste. This dual role has two benefits. The first being that business interests are not involved. When I conduct interviews as a KPN employee, a business might present themselves differently than when I come there as a student. Secondly, when I interview e.g., the waste company that KPN is involved with, I want to be able to ask more critical questions without potentially harming the relation between KPN and their contractors.

3.5 Validity and Reliability

Constructivist research does not lend itself for generalization. Especially because constructivist research involves constructs of truth of the research subject, making the results unique to this case. Yet, the results, derived from research at Allinq, could very well be implemented at Volker-Wessel Telecom (VWT), a company very similar to Allinq. VWT does exactly the same work as Allinq for KPN. Because this research involves a case-study, it is important to recognize a similar context when discussing external validity. Moreover validity, due to the natural setting of the research, the ecological validity (which refers to the naturalness of the research) is considered high. This is the case with most case-studies as the a conducted in 'real' settings (Bryman, 2015).

Due to the constructionist philosophy in this research, replicability is considered low. The researcher as well as the research subjects will gather new knowledge that constructs a new reality. Therefore, when replicating this research, the subjects are expected to give different or new information. Besides the former, is the personality of the researcher considered to much of an influence on the process (Verschuren, 2004). Moreover, the situation at KPN might change after this research making it impossible to replicate.

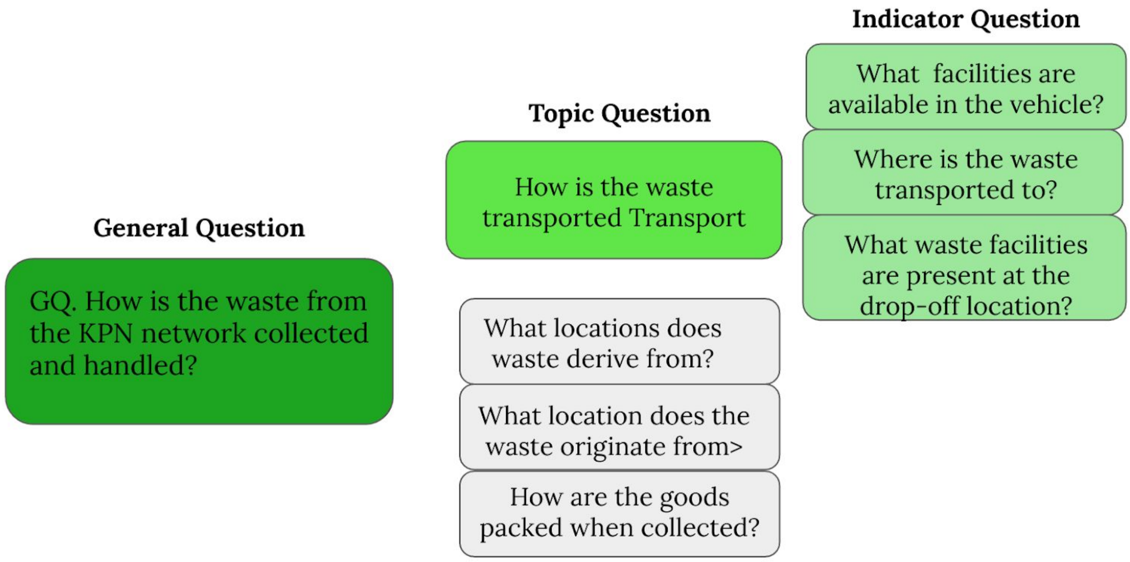
Finally, the internal reliability (consistency) will be moderately high concerning the fact that it involves a case-study performed by only one researcher. The progress of the research is clearly and transparently communicated to peers to enable them to monitor every step of this research.

3.6 Operationalizing the theoretical framework

Within the theoretical framework, four questions need to be answered. The first is to what extent the KPN network can be considered circular. To answer this subquestion, observations and an analysis of internal documents, are held against Jonkers (2017) 5 stages theory. By submerging into the KPN sustainability team, evidence of what circular practices KPN is involved in, as well as how far they are in the process, will give a clear insight to what extent the KPN network activities are considered circular.

The conceptual model is based on the assumption that there is more than one step in the materials journey of becoming waste. Through interviewing, this assumption is tested. By inquiring mechanics and their manager on what an average day looks like, where they encounter, how they transport and discard waste gives an idea of the steps that the materials go through. Additional interviews are held with other companies involved in infrastructure networks, in order to find out whether or not they involve additional, or less steps.

Finally, factors on generating waste should be a good indicator on the factors to minimize waste. As the literature review showed, many indicators on waste generation could be factors of waste minimization when they get reversed. Uncovering relevant factors to the KPN waste generation is done through interviewing. Indicators are based on the factors described in the literature review. Some indicators have been set out in an interview strategy using the horizontal pyramid model of semi-structured interviews. Figure 6 shows an example of the operationalisation of the horizontal pyramid. An example of one indicator here is coloured green.



(Figure 6: horizontal pyramid interview guide, own source, n.d.)

When looking at this horizontal pyramid, one must realize that the interviews are held as narratives. For instance, a mechanic is asked to describe a day of work. Where does he start, go to and finish? During the description of a typical day, the indicators often present themselves in one way or another. At the end of the interview (or sometimes during) I could ask for additional information in order to fuel missing indicator questions. The same accounts for examining potential factors. In some cases the topic questions are aimed at unravelling the influence some factors have on the process of generating or minimizing waste. The factors: Legal, Economic, Co-operation and Geography are the main suspects influencing the process. Therefore special effort has been put in weaving indications of the effect of the factors into the interview questions. Even though the horizontal pyramid framework was originally used for interviewing, it can be applied to examine internal documents. For instance subquestion A; To what extent are the waste-management practices of the KPN network considered circular? A topic question could be: What amount of waste does not re-enter a material cycle? Eventually all three sub questions present a narrative through which the main research question can be answered.

For clarification, the analysis will consist of what KPN can do by itself. Processes before network maintenance such as design are not included in the analysis. The analysis starts when a material, product or equipment is delivered at KPN. Moreover, the analysis stops whenever a material enters its final waste stream. This means that after Suez or Renewi collects the waste, the analysis ends.

3.7 Ethical considerations

Throughout the entire research, ethical questions pop up. Diener and Crandall (1978) argue that ethical considerations can be broken down into four areas. These are (1) harm to participants. (2) whether there is a lack of informed consent. (3) If there is an invasion of privacy. (4) whether deception is involved. These four areas mainly concern the wellbeing of those involved in the research. Another perspective on ethics is about whether or not a researcher can exercise in the research in freedom. i.e., without being influenced by externalities such as sponsors (Wiles, 2012).

Harming research participants is considered to be off limit by the academic community. Bryman (2015) advocates to "*anticipate, and to guard against, consequences for research participants which can be predicted to be harmful*" (*Bryman, 2015:136*). (*Hammersley & Traianou,* 2012) described ethics in qualitative methods extensively. In their work they argue that at the early stages of the research it is more difficult to oversee the direction that is headed and whether or not this could collide with interests of external actors. Hammersley & Traianou (2012) have created a list of what harm potentially entails:

1. "*Pain, physical injury, and permanent disability.*
2. *Psychological damage, for instance emotional distress, erosion of self-confidence, stress related illness, and so on.*
3. *Material damage of some kind, for example loss of one's freedom through imprisonment, dismissal from one's job, reduction in income or wealth, damage to property, and so on.*
4. *Damage to reputation or status, or to relations with significant others, for example through the disclosure of information that was previously unknown to some relevant audience.*
5. *Damage to a project in which people are engaged, to some group or organisation to which they belong, perhaps even to some institution or occupation in which they participate*"

(Hammersley & Traianou, 2012:19).

For this research all of the above factors have been considered whilst conducting the research. Although the first type of harm 'pain and physical injury' seemed unlikely to occur in this research, external factors have increased this potential significantly. In March Europe - and with it the Netherlands - got struck by a pandemic caused by the COVID-19 virus. As mentioned earlier in this chapter, this pandemic altered the stage to such an extent that all methods of data collection had to be revised. Where meeting network mechanics for interviews or tagging along with them to visit houses seemed harmless, they now pose a direct threat to participants' health. To cope with this situation according to the 'do not harm participants' principles, no physical meetings were held during the entire research. To protect research participants and myself, only digital communication was used.

Psychological damage is usually more of an issue to be considered in psychological research (Bryman, 2015). Nonetheless, would any possible occurrence of this kind of damage be dealt with appropriately.

Material damage as described by Hammersley & Traianou (2012) could potentially occur during this research. I was engaged in interviewing network mechanics on the way they work with/handle waste could - although unlikely - lead to dismissal by their superiors. This is difficult to predict, but in order to ensure that this harm would not be inflicted the managers were informed about the inquiries on forehand and the participants received an informed consent message in which they were thoroughly informed in the research. Damage to relationships and projects was something to take extra care of. The relationship between KPN and Allinq, for instance, was fragile. To make sure no harm was brought upon the relationship communication was only allowed after approval of KPN gatekeepers and after they had knowledge of what would be communicated.

Informed consent is another critical aspect of doing research (Bryman, 2015). Participants of research should never be deceived, therefore, it is important for them to give informed consent (Wiles, 2012). With an informed consent form, research participants are made aware of what the research is about, who is funding it and that participation is voluntary. By thoroughly informing the participants the risks of inflicting harm are reduced (Marzano, 2007). Even when gatekeepers give permission for people that they employ to participate, they should also be given the chance to give informed consent (Wiles, 2012). In the case of this research would that entail if a manager gave permission to interview a network mechanic, I would still ask for his permission through informed consent. The form, which I developed with one of the team members, can be found in appendix 4. The content of the message is based on a checklist presented by Bryman (2015). The message is formulated with the aim to be small and informal to appeal to the audience more. Because the research could only take place from the living room due to COVID-19, signatures on informed consent forms were impossible to receive. For this reason the informed consent forms became an informative message that was attached to the email in which participants were invited to participate in the research. In some cases, there was no email contact between me and the participants, but instead just a phone call took place. In such a case I always asked participants whether or not they would like to receive the informed consent message after the conversation.

The issues of invasion of privacy or deception were not apparent in this research. This research uses the full names of mechanics. Because their contact information was obtained after inquiry with superiors and the data is easily linked to the area they operated in, it would have been an illusion to ensure them anonymity. Therefore, this issue has not been addressed in the informed consent form. Instead, participants are given the opportunity for a full-withdrawal from the research when desired.

4. Results

The analysis consists of four sections. The first is aimed at examining internal KPN policies and documents on order to find out how KPN approaches sustainability and the circular economy. This part of the analysis therefore will consist of a close examination of internal documents, projects and communication to the public. The second part of the analysis will discuss relevant results from the interviews. This is followed by a brief summary of findings through observations. Finally this chapter will conclude by linking the results with the literature. Before going into detail on the results, a clear description on how the process on handling network waste from KPN/Allinq is executed.

Table 1: Description of a mechanics workday/ handling waste	
A)	Mechanics start the workday from home. - If the right equipment is already in the van, the mechanic skips '**B**'
B)	Collect the right tools/ equipment for work that day at Service Warehouse. Discard 'waste' from previous day.
C)	Drive to the maintenance site.
D)	Perform maintenance/ exercise work.
E)	Drive to Service Warehouse. - Occasionally a mechanic drives straight home, in that case '**B**' can usually not be skipped the next day.
F)	Discard waste and collect tools/ equipment for the next day
G)	Suez and Renewi collect containers from the service warehouse and process the materials in their own facilities.
Note:	Mechanics do not visit the location in Harderwijk often, but only incidentally.

(Table 1: description of waste its journey, source: interviews)

Collecting and handling waste goes roughly as described in table 1. In this scenario it is assumed that the tools/ equipment for the day is present in the service warehouse and no extra rides are needed in order to start maintenance activities. If mechanics work on project locations, equipment is usually available on-site. These are temporary locations where, for instance, optical fiber is installed in a neighborhood. In these locations, facilities to separate waste differ per project. Depending on the work being performed, different containers are placed (e.g. Debris, Plastic, Paper, Residual). Moreover, these project locations in section 4.2.2.

4.1 Sustainability and KPN

For it being one of the top 3 greenest telecom businesses in the world, it does not come as a surprise that KPN has set ambitious targets concerning sustainability. KPN has been voted one of the greenest telecom companies in the world by the Dow Jones Sustainability Index and was voted the most sustainable Telecom business in the Netherlands by the Sustainable Brand Index of may 2020. It must be stated that the latter is an award on customer perception of a brand's sustainability (SBI, 2020).

What is it that makes KPN score so well on sustainability? In the overall sustainability approach by KPN, their efforts reach beyond the targets that are set by the board. KPN participates in a number of side projects that are aimed at increasing sustainability. One of these is Groene Netten (Green Networks). Groene Netten is a collaboration of organisations that own a lot of assets throughout the Netherlands. This collaboration consists of Stedin, Alliander, Rijkswaterstaat, ProRail and more. The three main goals of the collaboration are to: (1) Reduce energy use (2) Make energy greener (3) Accelerate the transition to the Circular Economy (Groene Netten, n.d.). The project originates from the increasing demand for more sustainable forms of entrepreneurship. The Netherlands is a small and densely populated country, infrastructure companies therefore play an important role as together they possess a significant amount of land. The Groene Netten collaboration facilitates the transition to a more sustainable world with adjustments to infrastructure. On the other hand, the activities also have a negative impact due to the emissions and the purchase of non-renewable raw materials essential to the infrastructural networks. Joint responsibility for making society more sustainable is a challenge that fits in perfectly with the activities of these infrastructural activities. Together they can potentially accelerate sustainable development from their own chain position by consciously dealing with emission reduction and accelerating the migration to circular material use, in collaboration with suppliers. The participating companies each conform to the following responsibilities:

- Implementation of at least one icon project in the field of energy saving, greening or circular use of materials. These projects are characterized by a sector-renewing character and increase the knowledge base and support base for policy adjustment.
- Announcing progress on the icon projects, as well as its progress on the total social impact of the managed infrastructure. Studies conducted and results by parties are shared to make maximum use of each other's insights.
- Taking joint responsibility for the proper functioning of the platform Green Nets and its ambitions.

Besides saving energy and resources, Groene Netten also aims to improve biodiversity. As Rijkswaterstaat and Prorail possess vast amounts of land, they try to plant specific flora alongside the roads and railways to attract insects, then in turn attract birds and so on. The same is done by the Electra companies that plant seeds under the cable carriers throughout the country. KPN is also involved in this biodiversity project and it aims to do so with the 'buurt battery' (Neighborhood battery).

The Neighborhood battery is a project from the KPN sustainability department wherein all aspects of sustainability seem to come together. The idea is that the old and outdated batteries that KPN uses to keep its network running get replaced. These batteries are usually housed in unidentifiable buildings without any further purpose and are not being used for the majority of the time. The idea is that new, modular batteries take the place of the old batteries. Besides keeping the network running during a power fail, these new batteries are supposed to store excessive energy that is produced by local solar or wind power generators. When it gets cloudy and there is not much wind, households can withdraw the energy that was previously stored. This way renewable energy is used as efficiently as possible.

The modular batteries that have been selected are non ion-lithium and do not consist of any rare metals and besides a new interior. This was a circular contribution to the project. Moreover it is going to play a significant role in Groene Netten's ambition to improve biodiversity, as KPN wants to place plants on the roof and wall. This way the battery also becomes a hub for insects and birds.

4.1.1 Sustainability report and waste figures

Before discussing the figures concerning waste, the general environmental impact of KPN is discussed. As shown in figures 7 and 8 the figures are derived from the KPN annual report 2019, found on the KPN website. The electricity consumption of KPN has declined steadily over the last nine years. The KPN network consumes 117GWh less energy compared to the base year in 2010. Moreover the roughly 2.7 PetaJoules of electricity that was consumed in 2019 was 100% green energy. Moreover, in the period from 2016 to 2019, natural gas consumption has decreased by 30%. The same can be said about the use of diesel. Finally the fuel consumption decreased by 50%. The same figure is that, although energy consumption is declining, KPN has zero CO2 emissions. This is arguably considered odd. KPN itself states that is has zero co2 emission while in reality they contribute tons of emissions but compensate this with Gold Standard Certificates (KPN, n.d.). The Gold Standard Certificates help reduce CO2 emissions worldwide. Whether this is done by providing solar energy to developing communities in Kenya or planting trees in Peru, this Swiss company ensures that the CO2 that KPN emits is being compensated elsewhere (Gold Standard, n.d.). This is an important detail because having zero co2 emission seems contradictory with their goal of reducing 50% CO2 emissions by 2040.

Table 2: Electricity consumption (in GWh)

	Target 2030 compared to base year		Target 2022 compared to base year		2019[1]		2018		2017		2016		2010 (base year)	
	NL	KPN Group	NL	KPN Group	NL	KPN Group	NL	KPN Group	NL	KPN Group	NL	KPN Group	NL	KPN Group
Network					580	580	595	595	581	583	606	608	694	697
Offices and shops					37	37	36	36	33	34	39	42	70	72
KPN Group (excluding NL|DC)	**-33%**		**-27%**		**617**	**617**	**631**	**631**	**614**	**617**	**645**	**650**	**764**	**769**
NL|DC (sold in 2019)					83	83	107	107	109	109	111	111	99	99
Total					**700**	**700**	**738**	**738**	**723**	**726**	**756**	**761**	**863**	**868**

1 KPN Group electricity consumption decreased by 20% versus base year

Table 3: Fuel consumption, lease vehicle fleet (petrol, diesel and LPG)

	Unit	target as from 2025	target 2020	target 2019[1]	2019	2018	2017	2016	2010 (baseyear)
KPN The Netherlands (excluding NL|DC)	1,000 liter	100% inflow of CO_2e neutral cars	–50%	-49%	8,457	9,347	9,429	10,126	16,597
NL|DC (sold in 2019)	1,000 liter				66	65	63	65	119
Total	**1,000 liter**				**8,523**	**9,412**	**9,492**	**10,191**	**16,716**

1 KPN The Netherlands fuel consumption decreased by 49% versus base year

(Figure 7: Table 2 and 3 on energy consumption, KPN, 2020)

Table 4: Other Energy consumption KPN Group

	Unit	2019	2018	2017	2016
Natural gas					
KPN Group (excluding NL|DC)	1,000 m3	2,580	3,424	4,390	3,774
NL|DC (sold in 2019)	1,000 m3	49	74	79	82
Total natural gas		**2,629**	**3,498**	**4,469**	**3,856**
Heating purchased	GJ	27,618	29,653	32,279	39,594
Cooling purchased	GJ	92,891	94,571	95,139	102,980
Diesel for emergency power generators					
KPN Group (excluding NL|DC)	1,000 liter	116	103	129	119
NL|DC (sold in 2019)	1,000 liter	56	81	63	122
Total diesel for emergency power generators		**172**	**184**	**192**	**241**

Table 5: CO_2e emissions own operations Scope 1 and 2 (in kTon)[1]

	target 2050	2019	2018	2017	2016	2010 base year
Scope 1 NL	0.0	0.0	0.0	0.0	0.0	58.8
Scope 2 NL	0.0	0.0	0.0	0.0	0.0	35.9
KPN Group (excluding NL|DC)	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**94.7**
KPN non-NL entities	0.0	0.0	0.0	0.0	0.0	25.0
NL|DC (sold in 2019)	0.0	0.0	0.0	0.0	0.0	44.0
Total	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**163.7**

1 The reported emissions in the table are net scope 1 and scope 2 market based. In the table on page 50 both net and gross scope 1 emissions are reported as well as the location and market based scope 2 emissions.

(Figure 8: Table 4 and 5 on energy consumption, KPN, 2020)

4.1.2 Analysis of the waste figures.

Table 2 shows the waste streams from the KPN network that are from the Allinq FieldForce. What stands out is that the residual waste stream, labelled here as 'bedrijfsafval', has a deviant incineration percentage compared to all other waste streams. An interesting detail is that although 100% of the residual waste gets incinerated, 10% is counted as recycling, as this is ash that is used as debris to support roads. Another interesting finding related to these numbers comes from the interviews conducted with Ronnie and Saskia. Ronnie, being a Field Force mechanic, and Saskia, who manages the waste figures from Allinq both questioned these waste figures. The mechanic argued that he does not encounter much waste at all. Network components that he uses are collected from the service warehouse, replaced in the network and old components. The boxes from the new components are then used to return the old components to Leidsche Rijn where they are separated and prepared to be reused or recycled. The residual waste from the service warehouse in Heerenveen consists of one small bin per month.

Table 2: Waste figures from KPN Network reported by Allinq

Allinq FF	Reuse (%)	Recycling (%)	Incineration (%)	Landfill %
Waste stream				
Batteries Dry	0.0%	85.0%	15.0%	0.0%
Lead Acid Batteries	0.0%	80.0%	20.0%	0.0%
Small Hazardous Waste	0.0%	75.0%	25.0%	0.0%
Archive Paper	0.0%	100.0%	0.0%	0.0%
Asphalt debris	0.0%	100.0%	0.0%	0.0%
Residual waste	0.0%	10.0%	89.3%	0.7%
(De)- construction waste	0.0%	90.0%	10.0%	0.0%
HDPE	0.0%	100.0%	0.0%	0.0%
Wood B	0.0%	90.0%	10.0%	0.0%
Cables	0.0%	100.0%	0.0%	0.0%
Lightbulbs (onsorted)	0.0%	100.0%	0.0%	0.0%
Metal (non ferro)	0.0%	96.0%	2.0%	2.0%
Old Iron (grinded)	0.0%	96.0%	2.0%	2.0%
Paper/Cardbox	0.0%	100.0%	0.0%	0.0%
Debris	0.0%	99.0%	0.0%	1.0%
PVC pipes	0.0%	100.0%	0.0%	0.0%

(Table 2: waste figures from KPN network, Internal source)

This is because these waste numbers, labelled fieldforce, can be linked to an older system that has been used by KPN. Today most of the Allinq waste, including FTTH and FTTB are also included in these figures. It does not change much about the amount of waste that is processed, but it does give a wrong impression to the efforts made by the Field Force to increase the reuse of materials.

Because of the sensitivity of the information, only percentages are presented in table 2. Company compliance did not allow all details to become public. Yet the - by far - most voluminous stream from this table is debris (50%). This comes as no surprise as the waste is measured by weight. The second biggest waste stream is residual waste accounting for 25% of the total amount of waste. Debris is fairly easily recyclable. It consists of concrete, bricks and other materials that emerge from demolition. Partly because of the weight of the material, it alters the reuse and recycling numbers significantly. The total amount of waste that is being incinerated now is around 23%. Yet if the debris waste stream would be left out from the total (because of its volume), about 50% of all waste from the KPN network would be incinerated. Evidence from an examination of this residual waste performed by waste company Suez showed that at least half of the residual waste stream could be recycled without much trouble.

4.1.3 The circular strategy

On their general website, KPN has published their road to sustainability. This strategy rests on three pillars:

(1) Being close to 100%
    - From 2025 being almost waste-less and have up to 20 iconic products with circular designs.
(2) Having zero percent CO2
    - From 2025 all new vehicles will be emission free.
(3) Emitting 50 percent less.
    - By 2040 the KPN CO2 emission are reduced 50% throughout the whole chain

Figure 9 shows how this is communicated to the outside world.

(Figure 9: Road to sustainability, KPN, *n.d.)*

In order to really get this strategy going, the board has decided to include components of the circular economy such as Key Performance Indicator (KPI) in the KPN sustainability strategy. The amount of materials that are not incinerated form the foundation of the KPI. For instance; if the KPI of 2020 is 85, then only 15% of the materials are to be incinerated. This KPI in turn is linked to a financial incentive for the top 200 managers at KPN. This is ought to contribute to managers actively engaging in reaching this goal. This circularity target is focussed solely on the output of materials and not the input. The target on circularity has not been set on inflow, instead it solely focuses on the outflow of materials. Before diving deeper into the circular world of KPN, first the corporate definition used by the board:

"The circular economy is a generic term for an industrial economy that is producing no waste and pollution and in which material flows are of two types: biological nutrients, designed to re-enter the biosphere safely, and technical nutrients, which are designed to circulate at high quality in the production system without entering the biosphere."
(*Annual Report 2019*, 2020:201)

AS mentioned above, the KPN goal on circularity is to accomplish 'virtually' zero waste. The KPI set on outflow ought to accelerate this achievement. Yet the overall approach is broader than just focussing on outflows. In order to achieve waste minimization reduction of materials as well as extending product life are ongoing developments. Several KPN interns research new packaging potentials and some staff actively tries to alter the manufacturing process of network products.

(*Figure 10: circular economy approach*, KPN, 2020)

Overall it can be stated that KPN is making great efforts in becoming more sustainable. Non-profit side-projects are the strongest evidence of their commitment to being sustainable. At the same time KPN is investing a lot in having a 'green reputation'. This sometimes leads to targets set on scores in international rankings. This is not a bad thing per se, KPN is proud of their green angle and wants to show this to the world. It has become a chicken or egg situation. Whether KPN aims to be green in order to boost their reputation, or that their mission on sustainability inevitably boosts their green reputation is unclear. At the same time this is insignificant because whatever the angle, the result is a more sustainable KPN.

4.2.1 Interview results

Both of the mechanics from interview 3 & 10 were surprised that they were to give an interview about KPN network waste. Joey Ritmeester (Respondent 3, R3) told me during a short phone call that he barely encounters any waste. When he was confronted with the waste numbers, he could not place where those would come from. It seemed there was not much to talk about, but I still asked him for a visual tour through the service warehouse in Heerenveen as it was impossible to observe first handed. The results were interesting. This Whatsapp interview included some photos (Appendix X). The photos revealed that the service warehouse was very well organised. It shows that many network parts are stored in their original packaging. The picture further shows that boxes are stored neatly in order to return materials back to Leidsche Rijn. The waste barrel that is used to collect their waste looks like the same barrel as described by R11. Picture 5 from R3 also showed that only a paper container and residual waste container were found outside. According to R3, they are mainly used by FTTH mechanics.

The interview with the mechanic Ronnie Horstman at R10 revealed similar results. First of all he was surprised that he was the subject in an examination of KPN network waste. This mechanic specializes in creating custom solutions where default maintenance falls short. On some occasions he could leave the waste at a customer's house. Yet most of the waste ended up in his waste barrel that got emptied at a KPN/Allinq location. When he was asked if he ever separated this waste at the facility in Harderwijk he gave a negative answer. The only reason that he, or other mechanics would visit the headquarters in Harderwijk, is when he has to conduct training or collect some administration.

Interviews concerning KPN real estate are labeled interview 1 (M. van Slooten, R1) interview 2 & 5 (Saskia van 't Veen, R2). R1 is the brains behind the spare-part management warehouse in Leidsche Rijn. From this location network- and spare parts are distributed

throughout the country. R1 said that the locations used by Allinq are property of KPN. Yet Allinq is responsible for the waste facilities on these premises.
The first interview with R2 was aimed at inquiring what Allinq does and how the organisation is structured. The interview reveals that Allinq has six other ‘office’ locations besides that in Harderwijk. Yet R2 stated that Fieldforce mechanics rarely visit the site in Harderwijk. Although the question was preliminary, she was asked what she thought was the main factor that contributed to waste generation. Her answer was laziness. To a certain degree laziness is very understandable. After a long, hard day's work it is just easier to throw the excess materials into the residual waste container, yet no empirical data has been found to back up this statement.

The second interview with Saskia (R5) was aimed at examining possible factors to influence waste minimization. This was broken down into legal, administrative, type of maintenance activity, type of location, internal perspectives. On the first topic, legal factors seemed to be irrelevant. Allinq does not get any subsidies. The only relevant legislation is that they are obligated to collect paper and residual waste at any site. the second topic administrative factors were addressed because no one seemed to able to clarify where the large amounts of waste originate from. According to R5, the waste figures that FieldForce was accountable for were named incorrectly. This waste is not just from FieldForce, but also from the FTTH team. Another interesting fact is that the amount of waste from the milieustraat in Harderwijk that is assigned to KPN, is measured by revenue. This comes down to the percentage of the total revenue from Allinq that is paid by KPN, which is used to calculate its share. For example, if the Allinq yearly revenue is one million Euro, and 700.000 is paid by KPN, then 70% of the waste from the milieustraat is from KPN. The types of locations differ from fixed locations of which there are three, the rest are temporary locations. These are streets or neighborhoods. These locations are similar to any maintenance activities one would recognize from electricity, water or sewage companies. It entails a small container for residual waste as well as a container for Debris. The final question of the interview concerned internal incentives as a factor. But a bonus system of some sort was not present at Allinq.

Interview 6 was conducted in order to find out more about legal factors in handling waste. Jacomij is a relatively big player in the field of recycling ferrous and nonferrous materials. Apparently legislation concerning waste differs an awful lot within the EU. The main reason is that the internal market is aimed at goods and resources. As waste is neither a waste of resources, it has to be dealt with differently. Moreover, when products contain batteries, they have to be treated as ‘hazardous waste’ and become more difficult to process efficiently. Contemporary designs of most mobile devices incorporate batteries in such a way that they cannot be taken out. This ‘non-modular design’ makes it very difficult for Jacomij to process. R6 did also not have special legal benefits for contributing to the circular economy, in fact, R6 feels that the government is working against instead of with him.

Interview 7, 8, 9 and 11 were conducted with representatives of other companies that are involved in maintaining infrastructural networks of some kind. To examine factors that minimize the generation of waste, it was considered interesting to see how companies from other industries handle this. These include two interviews with a water company. Brabantwater (R7) WMD Drenthe (R8). As well as two electricity infrastructure companies Stedin (R9) and Alliander (R10). The data derived from the water companies did not present much interesting information. The infrastructure of water companies is much more simplistic than that of a telecom business. Their drinking water network does not need updating as frequently as that of the telecom industry. The materials that are encountered during these activities are also much less diverse.

Interviews R9 and R11 did reveal some interesting information. The respondents from these interviews had detailed information on their waste streams (unlike those of R7 & R8). Both companies score better on recycling and reuse than KPN does. Where KPN has about 23% incineration of waste, Stedin has 13% and Alliander around 9%. At Stedin they do encounter a high rate of landfill. Yet this is inevitable as this number derives from asbestos. Legislation concerning asbestos means that it is not allowed to be processed any other way. For this reason, Alliander does not include landfill in their recycling scope. This could be a reason for their relatively high percentage of recycling. Alliander, on the other hand, is the only company that has a milieustraat on most sites around the country. In the areas where Alliander operates, they have about twelve locations where they have a small milieustraat. This entails using at least five different containers to collect materials.

A final interview was conducted with Saskia 't Veen (R12) to discuss earlier results and fill in some of the knowledge gaps. From the interview it became clear that one other location besides Harderwijk has a small milieustraat. In Abcoude there are around four containers available in which materials can be separated. When Saskia was asked if Allinq deals with temporary project locations in a similar way to the companies from interview 7,8,9, and 11 she acknowledged that similar methods were applied by Allinq. Furthermore, internal documents have described an assessment of what amount of waste from residual waste could potentially be recycled. The container that was used for this investigation was a residual container from the Allinq location in Harderwijk. This means that in the most optimal circumstances. where 16 different waste streams can be separated, still 50% of the waste that enters the residual waste stream should have entered a different stream. When asked if it is then realistic that the percentage of recyclable materials in the residual waste stream is higher at any other location, the answer was positive.

4.3 Analysis of observations

The observation consists of mainly formal and informal meetings with KPN staff. One of the earliest observations was that although the team has great ambitions and knowledge concerning the circular economy, they do not always seem to practice what is preached. The reason for this is that corporate decides what direction to set course. Even though eliminating waste, or upcycling of materials should be preferred, corporate governs on recycling numbers. In their world recycling a material is just as valuable as the reuse of materials.

In the early stages of the research, it was more or less unclear how network mechanics exercise their profession and how it is possible that vast amounts of material end up in residual waste streams. The general idea was that the mechanics were facilitated properly with a sixteen stream strong waste facility in Harderwijk. The low recycling rate therefore was expected to be a product of their attitude when disposing the materials. From this, the idea emerged to really help the mechanics in an as nice as possible way. The first week of May was supposed to be 'the residual waste week' at Allinq. This week, the circularity team will be present at the milieustraat in Harderwijk with a coffee stand and gloves to help the mechanics separate their materials. This would at the same time be a great way to speak to all the mechanics and listen to what obstacles they encounter during a day of work. The circularity team really liked the idea. It could be combined with a VLOG, signs on the side of the containers it would truly be an event in which the team shows their support and solidarity for the cause of separating waste. Due to COVID-19 this all could not take place. Yet, what is interesting is that later interviews show that barely any mechanic ever visits the milieustraat in Harderwijk. So if their would have been an event, there would barely be a mechanic. It is interesting that nobody from the KPN circularity team concerning the network has any clue on how the network is maintained.

Another remarkable observation is the separation of the teams involved with circularity within KPN. The main circularity team is based in Den Haag. Jeroen Cox leads the team together with circularity consultant Edwin Rutte, who is responsible for the reporting of the recycling and reuse figures to audit. The circularity department in the Hague is involved in overall circularity within KPN. (Where the Amersfoort team is only involved in the network). The team in the Hague has five interns doing research on corporate social responsibility (CRS), design and more circular implementation. The team at Amersfoort does more or less exactly the same, yet here they try to manage circularity within the network. This has led to some miscommunications. This became evident when discussing the numbers of incineration or recycling. Edwin stated: after incineration, about 10% of residue (ash) is left over and recycled. Therefore if 100 kilograms of materials get incinerated 10% of this gets recycled. It seems like a distinction without a difference, but for appearances it makes sense to report it in this manner, simply because at the end it shows better numbers. At the same time, the team at Amersfoort is arguably more critical. Accounting 10% of this material for recycling instead of incineration is not the way things should be recycled. (for instance: if one burns a chair, only ashes and only ashes are leftover, it is at least peculiar to say 'Oh well, we recycled 10% of the chair'). This is just an example of how the two teams do not cooperate efficiently towards their joint goal of achieving circularity. The teams have no weekly meetings, information is scattered between several online folders and ideas remain either in the Hague or Amersfoort.

During a meeting with two KPN sustainability team members and a TNO 'waste'-consultant, it became clear that KPN had created a financial incentive on achieving circularity (read: zero incineration). In itself a positive stimulus, yet it could be the reason that the teams do not always practice what they preach, as discussed above. When the KPN board only makes a distinction between' incineration' and 'anything else' it is understandable that it becomes more difficult for the team to steer towards much more difficult waste reduction instead of just less incineration. Simply put; reuse or minimization through design requires collaboration throughout the entire chain. For a manufacturer in China to change the production process or design, takes a lot more effort than recycling excess materials.

The results from both the interviews and observation present an image showing a clear gap in knowledge. Without a doubt both KPN and Allinq make efforts in managing waste streams more efficiently. A collaborative goal has been set on reducing incineration to a virtual minimum. Yet a clear starting point and understanding of how and where this waste is generated is missing. Waste figures that are accounted for by fieldforce, whilst being generated by other Allinq branches, seem to be creating extra confusion and unclarity. Mechanics were even surprised when they were questioned about waste, whilst they stated they rarely encountered any waste at all. In addition to the total waste figures, it is unclear what amount of waste went through the milieustraat at Harderwijk and what amount of waste went through the service warehouses, or originated at project locations. A more detailed overview of these figures would benefit policy creation on this topic.

4.4 Linking the results to factors

4.4.1 Technological Factors

The results presented an image of waste being collected with regular waste-containers. Technological advancements in this field, like the smart bins described by Ramos et al., (2018), would not benefit waste minimization in this situation. There has not been any evidence that full containers, or inefficient waste hauling leads to an increase of volume of the residual waste stream. Smart bins on more than ten locations would therefore be an exorbitrary investment that would lead to extremely limited results. Another approach to technological advancement is in fact a great contributor to the generation of waste. As the Telecom industry is ever developing, adjustments and maintenance to the network is an ongoing process, The current 5G network employment is a great example of this. Yet, stopping this development would not benefit the circular economy according to Tanskanen et al., (2018). The authors state that digitalization of society gives room for business opportunities like those in the sharing economy or servitization (Tanskanen et al., 2018). Therefore, continuous technological development would in the long-run make material use more efficient. This process is in line with the assumption from Mazzanti et al., (2008) who state that through technological development, the amount of waste tends to increase until a certain level of societal maturity (Mazzanti et al., 2008).

4.4.2 Legal and economic factors

Legal factors often involve economic factors. This is because states, national or supra-regional, can stimulate certain processes with taxes or subsidies. Therefore both are combined in this paragraph. First, the non-economic legal factors, such as legal standards and juridical terminology, are discussed. An important finding has been that on all but two Allinq locations where waste is collected, only two waste streams are facilitated. This has come forth from the fact that legally every company should have facilities to separate paper and residual waste. Hazardous waste, like asbestos and chemicals, is another type of waste that is collected separately. The waste figures from table 1 have shown that KPN does separate their hazardous waste. Moreover, as the residual wastestream gets incinerated, it is unlikely that hazardous waste has frequently (or ever) ended up in the wrong waste stream. The restrictions on exporting and transporting waste that were described by the NRVD (2018) are not considered significant in reducing waste from the KPN network. Indeed, materials are transported from the maintenance site to the waste containers at the service warehouses, but no restrictions or limitations on this process have emerged during this research. It is only after the waste is collected and sold to third tire parties such as Jacomij that legal factors linked to transportation and export seem to gain importance. This is far beyond the direct influence of KPN and therefore out of the scope of this research.

Economic factors: The most obvious financial factor is that of the KPI on circularity, leading to a bonus for the top-200. The financial incentive set by the company's board has pushed circularity higher on the agenda. Upper management now seems more involved in reaching the goals of waste minimization. Again, the missing distinction between reuse and recycling being reduced by design makes all three seem to fall into the same category of 'zero-incineration'. The financial incentives as described by Slavik et al (2017), taxes and subsidies, do not seem to play a significant role in the circular transition of KPN. On the contrary, KPN would not even hesitate to spend extra money in order to improve waste minimization.

4.4.3 Geographical factors

Geographical factors as described by Halkos & Pertou (2008) or Hoang et al., (2017) primarily focus on solid waste from households. Comparing the KPN case, that involves a big corporation that does not have solid waste coming from its network is therefore considered irrelevant. Besides, KPN cannot alter population density or socioeconomic status in certain neighborhoods. Nevertheless, has there been work by Story et al (2013). Again, this study concerned municipal solid waste, yet their angle is one that can be applied by KPN. The authors describe how decentralization of waste facilities lowers the threshold for people who want to discard waste. Again, this is about solid waste yet, the mechanics that work on the KPN network, did not seem to be unwilling to separate waste. A problem that was presented in the interviews is that none of the service warehouses have sufficient waste facilities and the one centralized facility in Harderwijk was rarely used by either of the mechanics. Just as with the research by Story et al (2013), does distance to these facilities present a threshold for separating waste.

4.4.4 Cooperation factors

The literature has described the importance of collaboration throughout the supply chain (Tanskanen et al., 2018). This is not only the case in telecom, but in virtually any other sector (Leising et al., 2018; Onur, 2020). Without cooperation between manufacturers, suppliers and end-users, creating circularity is virtually impossible. For KPN to use products that are manufactured with second-hand materials only, they have to rely on others. As described in the results above, KPN goes through great lengths in order to drive collaboration through the chain. Circular manifestos and intensive contact with Huawei and businesses in between show that KPN understands the need for collaboration. This collaboration was described by Jonker et al. (2017) as the second step in the transition towards becoming a circular business. As the intensity of the collaboration between KPN and partners has only recently started to grow, the results are not yet incoming. Whoever, the benefits from collaboration described by Tanskanen et al. (2018), which are aimed at standardization of terms and legislation, is also applicable to KPN internally. The collaboration between the decentralized circularity and sustainability teams could benefit from better collaboration. Another improvement in cooperation is that between Allinq and KPN on reporting as well as shared targets. There clearly is a lack of understanding between the two organisations on how they function. Evidence of this can be found in the observations, where the circularity team in Amersfoort had no idea on how Allinq operates. The other way around, could Allinq definitely improve the way data on waste is gathered and communicated to KPN.

In general is the majority of the literature concerning factors on waste generation not applicable to the case of KPN. Most literature is focussed either on municipal solid waste or production/ manufacturing processes (Halkos and Pertou, 2008; Haong et al., 2017; Tanskanen et al., 2018). Servitization is described as a great contributor to the circular economy (Martin, 2016). KPN is a service provider. Although some literature describes how to use services as a way of achieving circularity, little is written on how service-oriented industries, like that of the telecom, can stimulate partners in their supply-chain on producing circular products. This makes it difficult to compare these results with most literature on the topic. When it comes to the waste-management strategy by Yu et al., (2014), KPN staff members acknowledge the scale of desirability that is included in Yu et al. (2014) their model (figure 4). Yet the KPN board, makes just two distinctions (1) not desired (2) desired. The latter includes recycling, reuse and waste prevention. The former includes everything else. This means that according to the KPN board, recycling is just as desired as reuse. The main reason is that whether reuse or recycling is reported, both accomplish the same goal: zero incineration.

Technological advancement could, in this case, be translated to ‘network maintenance’. This would, in the case of KPN, be a main factor to generating waste. As IT-development is essential to KPN its core-business in order to provide their services to customers, altering this factor is not an option. Therefore, technological advancement is indeed considered the main factor that generates waste, yet not one that will benefit minimization of the residual waste stream. It has become clear that the factor cooperation internally at KPN, as well as that with Allinq has potential to improve. Geographically it seems too that progress is still to be made in making the waste collection process more efficient.

5. Answering the research questions

5.1 Sub-questions

To what extent are the KPN network activities considered circular?
To answer this first sub-question, the KPN waste-management practices are aligned to the Ellen MacArthur Foundation's definition of the circular economy.

“an industrial system that is restorative or regenerative by intention and design. It replaces the ‘end-of-life’ concept with restoration, shifts towards the use of renewable energy, eliminates the use of toxic chemicals, which impair reuse, and aims for the elimination of waste through the superior design of materials, products, systems, and, within this, business models.”

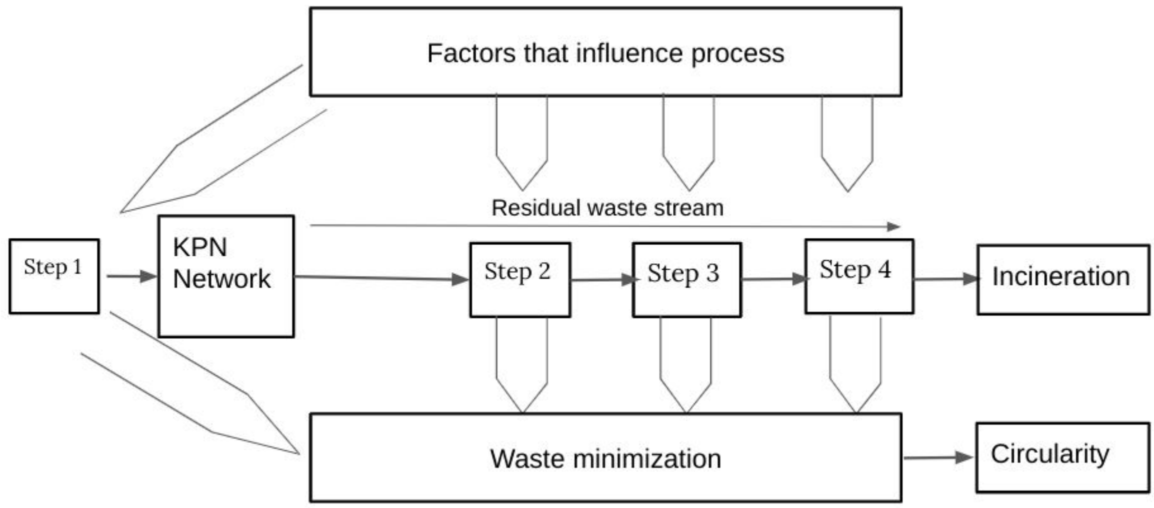
At KPN real efforts are being made to replace the ‘end-of-life’ concepts with restoration. The first evidence is the assignment for this thesis itself. The aim is to increase the amount of waste being recycled or reused. The KPN ambition is to become virtually waste-free by 2025. Therefore, the waste management practices have put the emphasis on the output of materials. The KPI on reuse and recycling makes that becoming waste-free is now also in the interest of the top 200 managers of the company, as they get a financial incentive for achieving higher reuse and recycling scores. Besides the financial incentive for the managers, the location in Leidsche Rijn is designed to facilitate reuse for as many materials as possible. The interior of the compound is designed to enable reuse as much as possible. All incoming materials are separated and sorted according to type. Interviews with Allinq have shown that at their location in Harderwijk, Allinq attempts to facilitate waste separation as much as possible. At their flagship location 16 different waste streams facilitate material recovery. On the part of waste elimination through design, the first steps are being made. So far, no clear progress has come from these efforts.

According to Jonker, the transformation to become a circular business consists of five phases (Jonker et al., 2017). KPN is working on three of them at the same time. Although involved in three steps has KPN has not yet closed its own heat, energy and waste loops, which is the first step in the transition. However, KPN aims to fulfill this first step by 2025. This goal does seem reachable when it comes to managing residual waste. Yet, no evidence on attempts to close the in-house energy loops has been found. Although KPN states in the sustainability factsheet to have a net emissions of zero CO_2, does the same factsheet show that large amounts of gas and diesel are consumed annually. Moreover, on their website KPN states that the total emissions of CO_2 should be down by 50% by 2040. This ambition is contradictory with the statement of being virtually 100% circular by 2025. Burning fossil fuels is simply not part of a circular economy. The second phase described by Jonker, a shift from one's own organisation to suppliers, has started. The ‘home-boxes’ that customers receive when they become customers do not contain any plastic. The packaging is completely modular and made from a cardbox. Moreover, the new KPN plastics will be coloured black instead of white, as white plastics can only be created with virgin plastics. The network team is also making great efforts in trying to alter the production process from Huawei. The third step, which focuses on closing the loop of one single material, is extremely difficult for a service oriented business like KPN. No effort has yet been made to achieve this. Yet, evidence from Jacomij and current legislation show that it is extremely difficult to process specific materials internally. Special permits for transportation and the definition of what is waste and what is a resource make that even specialized companies face difficulties in processing all materials to make them re-enter the material flow. Technical innovation and new legislation are needed to accommodate this phase in the transition to circularity. The fourth phase has also started. The Leidsche Rijn Spare-part warehouse saves and repairs a lot of network items. Although this process is limited to small parts, it is in fact a great example of how materials can be reused. In the final stage further inter-weaving and interlocking of cycle-ladders should result in an organizational-economic system. As KPN just started integrating circularity into their business model recently, it may come as no surprise that no evidence of this final phase has yet been found.

Therefore, although being engaged in more than one phase, KPN has not even come close to completing stage one in the transition of becoming a circular business. KPN is currently working on three stages simultaneously. The effort has had limited results so far. The KPN network activities circular to a limited extent.

What steps can be identified in the materials journey of becoming waste?

As the analytical framework in figure 5 showed, there are several steps that can be identified in the process of turning materials into waste. There are four phases that can be identified along the line of the materials its journey to become waste. Yet a slight alteration has placed the first step at a different position in the framework. Four different steps have been identified. These are:



(Figure 11: revised analytical model, own source)

Step 1: Arrival of goods at KPN locations.

Before any network maintenance takes place new- or spare parts need to become available in the service-warehouse. A mechanic can not replace an item if it does not have an item to replace it with. Step one therefore entails the way that materials are transported and collected at the service warehouse.

Step 2: Network maintenance.

Once the maintenance mechanic has been given an assignment for the day, he has collected his necessary materials at the service warehouse and has to perform maintenance. This can take place in larger project locations, such as placing glass fiber cables on new housing estates, or at smaller locations such as customer homes.

Step 3: Transport from maintenance locations to waste disposal locations.

Once maintenance has taken place, old materials might have been removed from the network and new materials have been stripped of their possible packaging and added to the network. These excess materials then need to be transported to the location of disposal. In some cases there are on-site disposal facilities. In that case the transport would entail walking to this container. In most cases transport is concerned with placing excess material in a transport vehicle and drive back to the service warehouse.

Step 4: Disposing of waste.

After transportation to the waste disposal locations, the waste gets placed into the available waste containers before being picked up by the waste haulers Suez and Renewi. After they have collected the container, the influence of KPN on the process has ended and therefore further steps have not been included in the model.

What factors influence the generation of residual waste from the network?

The factors that generate waste, have been accessed per step from the previous subquestion. The first step is the arrival of goods at KPN sites and the way they are collected by the mechanics. Some products, like the KPN router, are packed modularly with only cardboard materials. These are usually sent to customers' houses before mechanics come to install them. Yet, most network parts are sent to the warehouses, like that in Leidsche Rijn. Here the goods get sorted and distributed to the regional service warehouses. Many materials get unpacked in the main warehouse, where packing materials are separated and recycled. Materials that arrive at the smaller service warehouses also get stored and the boxes in which the materials arrive are saved. These materials are used again to return old network equipment to the Main service Warehouse. It can therefore be said that virtually no waste is generated in this process. Packing materials either remain on the product, or get recycled and in many cases even reused.

The second step is network maintenance. What happens in the majority of the maintenance activities is an extension of the network. This could include extending glass fibre to new areas, adding new housing estates to the existing network, or connecting a house to the grid available on the street it is located on. Factors that generate waste here are limited. In principle, materials that are taken out of the networks are considered 'old materials' and not yet wasted. The equipment can be considered conglomerates of materials that are still to be reused. According to interview 3, most mechanics do not encounter much packaging during maintenance activities. Even if they would, in this step the packaging would still be excess materials and not waste. Yet, in some locations there are waste disposal facilities present. In a way, all plastic entering a plastic recycling container equals waste being averted as the material enters a material loop instead of being incinerated. Therefore waste is generated once it ends up in a 'residual waste container'. The absence of containers that collect materials, make them discard materials in residual waste containers and then become waste. The reason that the network is being maintained and upgraded, stem from the factor technological advancement. The growing demand for data to support the Internet of Things, and its devices, make that the network is constantly needs maintenance. This inevitably leads to the generation of waste.

The third step is the transportation of the network materials to a waste disposal location. In most cases it is not possible to place a wide range of containers, if any, in the maintenance van. Because of this mechanics have a 60 liter barrel in their vehicle. The problem is that there is just one barrel in a vehicle. Interview 10 showed that only on rare occasions a second barrel is added. As this barrel is a 'residual waste barrel' the generation of waste here is considered temporary. The materials in the barrel face two possible faiths. They either get separated at waste disposal location and thereby change from waste into materials that enter a new loop. Or the barrel gets emptied into residual waste containers and incinerated.

The fourth and final step is the disposal of materials at KPN locations. It seems that this phase is the most significant as these locations all facilitate an entry into the residual wastestream and not present entries to other waste streams. This is not problematic per se, it is required by law to accommodate the residual wastestream, as well as paper separation. It is in these locations that most materials either end up in their final stream, or re-enter a material cycle. When network mechanics visit the location to collect tools and materials in step one, they usually discard the waste collected in their barrels. If this happens in any location that is not the Allinq headquarters in Harderwijk, all materials that are not paper are therefore destined to become waste. The factor here that generates waste is the absence of facilities to collect materials.

The short answer to this subquestion, is that materials become waste, once they have entered the residual waste stream. Plastic from packaging is plastic and can be recycled or reused as long as it does not end up in the residual waste container but in the container for plastic materials. Yet the absence of these containers from all but one location makes it clear that plastic and other materials are almost always destined to become waste. The factor geography, and more specifically centralized waste collecting, generates the most waste (Story et al., 2013). Indeed, as discussed, technological advancement is the driver to network maintenance performed by KPN/ Allinq. These activities therefore are considered a significant factor in generating waste.

5.2 Main research question

What factors influence the minimization of waste in the process of handling the residual waste-stream from the KPN network?

An interesting factor to take into consideration is cooperation. In this case not specifically throughout the entire chain as described by Tanskanen et al. (2018), but between the teams at KPN internally, as well as their ties with Allinq. A better understanding of KPN's demand could stimulate more precise and detailed waste reporting by Allinq. The scattered sustainability/ CE knowledge throughout multiple KPN departments definitely does not stimulate cooperation. Yet, it is not the main factor for minimizing KPN network-waste handled by Allinq. Nonetheless could the factor cooperation contribute to address the main factor; Geography. By answering the subquestions, this prime factor to the main research question has prevailed itself: The lack of available opportunities to separate materials leads to the generation of waste. Therefore, altering the geography of waste-collection is expected to influence minimization of the residual waste stream from the KPN network handled by Allinq the most.

Efforts to optimize material collection at the Allinq headquarter in Harderwijk, seem to be an effort that will not translate to significant results in efforts to minimize residual waste. Interviews with mechanics showed that they rarely visit the location in Harderwijk and if they do, it is usually for administrative tasks and not for waste disposal. At all other locations only the bare minimum, legally required, paper and residual waste containers are present. The work by Story et al. (2013) described how centralization of waste collecting influences the process its efficiency negatively. The interview with Alliander also showed that they are a company that is committed to minimizing waste. Of the materials that emerge from their network maintenance activities, less than 10% end up in the residual waste stream. Small 'milieustraten', that hold at least five different material containers throughout their operating area, contribute to their low amount of residual waste.

In order to minimize the residual wastestream, the entry to other waste streams should become more accessible and therefore dispersed. One can assume that when 50% of the residual waste container in Harderwijk could potentially be recycled, the percentage would be higher at any other location. This is based on the fact that in Harderwijk there are opportunities to separate a wider range of materials than in any other location. Moreover, when the locations from where mechanics work, do not facilitate more waste streams, efforts to improve material collection in their vehicle are useless. Because what is the point in pre-separating materials in a van, when at the service warehouse there are no opportunities to dispose of these materials in the right containers? Yet, when more waste streams would be facilitated at more locations, this should translate into the facilities available in the vehicles. Little space is needed to provide a vehicle with space to separate: Cardbox, which can be made flat and held against the side along with cables that are held tight by an elastic band. Plastic, which can go in a see-through bag in the back of a vehicle. Finally, a smaller residual waste barrel could stimulate better separation of materials.

6. Conclusion and Discussion

6.1 Conclusion

The collected data had delivered sufficient new information with which it was possible to thoroughly provide answers to the research questions. This research has shown that the KPN sustainability ambitions are indeed sincere. When it comes to the reduction of the residual waste stream from the KPN network, or in other words 'less incineration of materials', does this seem to be a realistic and achievable goal for the near future. More dispersed, and therefore more accessible, waste facilities are essential in accomplishing this goal. Better communication and collaboration throughout all teams and parties that are involved with sustainability would definitely benefit the transition of becoming a truly circular business. For the remainder of this thesis, the results, limitations and recommendations are discussed below.

6.2 Reflection of the results and theories

The results of the interviews have presented valuable insights into waste management practices at KPN. In line with the first step of Jonker et al., (2017) KPN and Allinq are actively seeking ways of closing material loops. Besides this first step, have the results shown that KPN is involved with many more side-projects, some without a profit motive, in order to improve the natural environment. The Groene Netten initiative is a great example of how KPN selflessly invests time and money to improve, amongst other things, biodiversity. As the numbers from the 2019 report have shown, are the efforts to reduce environmental impact paying off. The engagement with the Gold standard certificates is a solid temporary solution to mitigate the CO2 emissions that are currently present. The engagement with second and third line parties makes it clear that KPN is actively attempting to address most of the steps described by Jonker et al (2017). The future strategy, with its approach being aimed at increasing reuse and recycling, is in line with the most desired way of managing waste as described by Yu et al. (2014).

The theory of Story et al. (2013), that revolves around decentralized waste collecting seems most applicable to the situation at KPN. By facilitating material collection, an entry is created for materials to enter a loop. Although the KPN network materials can be discarded in various locations throughout the country, are entries to material loops other than paper and residual-waste not available. Moreover, contrary to the great efforts that KPN puts into being sustainable, is the collection of waste stuck at a bare minimum. Besides the Harderwijk location, are all sites equipped with the bare minimum, legally obligated paper and residual waste containers. This is similar to the way KPN deals with the CO2 emissions that it emits. Legally speaking, indeed, KPN is 'Carbon-neutral'. On the other hand, KPN uses significant amounts of natural gas and diesel, which is not in line with both the sustainable and circular ambitions the company stands for. Data has shown that again, in line with the first step of achieving circularity, KPN is not actively seeking methods to bring fossil fuel consumption to a minimum. On the other hand, this task is designated to the 'energy team' which operates separately from the circularity team. This independent method of working also prevails within the circularity teams spread out within KPN. The team in the Hague, and that in Amersfoort, are sometimes engaged in similar projects, and sometimes head in completely different directions. The absence of weekly meetings and engaging with the energy team in achieving this first step of in-house circularity seem to present a threshold for really making progress towards being a circular business.

To me it seems like the KPN ambitions are approached in a relatively unstructured manner. It is illogical that there are two teams involved in circularity that work separately without weekly meetings, not getting their noses in the same direction. The sustainability team at Amersfoort, both the people involved in energy as well as circularity, are genuinely driven to reduce the amount of resources KPN consumes. Yet at times they seem sometimes to be misdirected by the boxes that need to be ticked that earn the highest rankings in international indexes, as well as the bonus of the top 200. A collective goal seems to be missing. The first phase in the transition of becoming a circular business is all about making energy loops circular. This first phase presents an incredible opportunity for the energy and circularity teams to collaborate towards a clear collective goal. Being 'virtually circular by 2025', whilst not aiming for 'zero-emissions' or, being 'fossil fuel-free', to me, seems irreconcilable.

The theoretical framework consisting of Yu et al. (2014) and Jonker et al (2017) worked complementary to each other. Jonker's five phase transition helped frame where KPN stands in the transition. More importantly, it helped organise what is - and is not - being addressed internally at KPN. The waste-management theory by Yu et al. (2014), helped assess whether or not the KPN waste-management practice was desired compared to what the literature described. Yu et al., (2014) make a clear distinction between all sorts of ways in which waste can be handled. KPN, on the other hand, unfortunately makes no distinction between recycling, reuse or design. Yet without the theory of Yu et al. (2014), I might have thought the same concerning desirability as KPN. When it comes to the factors on generating and minimizing waste, the literature presented some valuable insights into factors influencing waste. While the majority of the literature was focussed on municipal and household waste, did it help assess what direction to look into in the case-study. Overall I am convinced that the literature that has been assessed for this thesis has been plentiful and relevant.

6.3 Limitations

The limitations of the thesis are significant. If this research had been conducted in a 'corona-free world' I would not be satisfied with the amount of data collected. Or at least, had definitely attempted to collect more data by visiting sites and speaking to people. In early March I was planning an event named 'The Residual Waste Week' (Appendix 4). This week I would have visited KPN locations, done observations and interviewed multiple network mechanics. Field trips to other KPN partners should have painted an even brighter picture of how the KPN waste-management practices function. Sampling interview subjects became completely random and fully reliant on cooperation of third parties or persons. At times it took three to four weeks before a request to speak to someone resulted in an actual interview. This extremely slow process meant that I had to reach out to any company involved in infrastructure projects to fuel me with ideas and insight on factors that contribute to the minimization of network waste streams. Another attempt to add data was to use ArcGIS to make spatial analysis of the available KPN locations that could facilitate material recovery. Yet obtaining an ArcGIS license from the university took a lot of time. After finally gaining access to the software, I spent ten days trying to geocode the addresses only to find out that it was not possible with the student license. After a month of consulting the ESRI helpdesk and three KPN employees (sometimes formerly) involved with GIS to grant me access to the essential features of doing the analysis the effort turned out to be in vain.

But this thesis has not been conducted in a normal world. COVID-19 limited my mobility and placed many research subjects out of my reach. Initiatives to organize data collection events had to be cancelled. Therefore I am satisfied that under the circumstances enough data has been collected to thoroughly describe relevant aspects waste management processes. On the 18th of May I decided to stop collecting data in order to start the analysis. This decision was made because it would have been an utter guess when and who would return a request for an interview. Waiting an additional two weeks for one extra fifteen minute interview is simply not worth it. Another limitation to the research is the role of attitude amongst mechanics. Although clear evidence of a lack of willingness amongst mechanics was absent, could this still potentially influence the extent to which waste is separated. On the other hand, as no facilities to separate waste are currently available is it more interesting to measure the attitude after facilities for waste separation have been applied on all the service warehouse sites.

6.4 Recommendations

The recommendation to KPN for minimizing the residual waste stream is twofold. The first is that I would opt for one area from which all circularity and sustainability/ energy teams work together. A space that is designed to live and breathe sustainability. This company 'hub' would definitely stimulate cooperation. I expect weekly meetings on what is going on in each team, could present handles that the other teams can grasp onto in order to create a synergy. This is especially true for completing the first phase of circularity 'closing in-house energy-loops'. Without engaging the staff involved with sustainable energy in circularity, closing the energy loops is expected to be much more difficult. The second and most feasible recommendation is that containers that collect materials should be placed at every service warehouse. Creating one big milieustraat in Harderwijk is of course also a good idea. This can function as a testing ground. At the same time can this facility function as a training center for mechanics. Therefore the big milieustraat can be used to educate the mechanics and give off a clear signal about the importance of waste separation. At the same time it is the big milieustraat hardly ever used by most mechanics. As the mechanics mainly work from the service warehouses, facilities to collect different materials should be present at those locations. Placing these facilities should be the main priority in the mission of minimizing residual waste. Once these facilities have been put in place, new research could shed more light on the direct results, attitudes and whether or not pre-separation in vehicles is desired.

For further research, it is important to investigate what materials end up in the residual waste containers that are present in all KPN/Allinq locations. With this information, new waste facilities need to become present at sites throughout the country. Once the new facilities are in place, a deductive study on the effects of decentralized waste collection should establish the results. Since estimates showed that over 50% of all residual waste has the potential of being recycled, entries to the material loops should lead to a significant decrease of incineration.

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= **References**

Adler, P., & Adler, P. (1987). Membership roles in field research. Newbury Park, CA: Sage.

Ahlin A., Li F., (2019) From field sites to field events.Creating the field with information and communication technologies (ICTs)

Angelis, R. D., & De Angelis, R. (2018). Business Models in the Circular Economy. https://doi.org/10.1007/978-3-319-75127-6

Antink, R., Bakker P., and twenty others (2019) The Circularity Gap Report.

Bailey, I., & Wilson, G. A. (2009). Theorising Transitional Pathways in Response to Climate Change: Technocentrism, Ecocentrism, and the Carbon Economy. In Environment and Planning A: Economy and Space (Vol. 41, Issue 10, pp. 2324–2341). https://doi.org/10.1068/a40342

Barca, S. (2019). The Labor(s) of Degrowth. In Capitalism Nature Socialism (Vol. 30, Issue 2, pp. 207–216). https://doi.org/10.1080/10455752.2017.1373300

Batista, L. Bourlakis, M. Smart, P. Maull, R. (2018) In search of a circular supply chain archetype–a content-analysis-based literature review Prod. Plann. Contr., 29 (6) (2018), pp. 438-451

Bhaskar, R. (1989). Reclaiming Reality: A Critical Introduction to Contemporary Philosophy. London: Verso

Birkeland, J. (2007) Ecological Waste: Rethinking the Nature of Waste Environment Design Guide Gen 6: (August 2007), pp. 1-9 (10 pages) Published by: Royal Australian Institute of Architects

Boulding, K. (1966) THe economics of spaceship Earth. Environmental Quality in a Growing Economy, pp. 3-14. Baltimore, MD: Resources for the Future/Johns Hopkins University Press

Brindis D., (2014) Illegal timber from the Brazilian Amazon sold all over the world. Retrieved February 18, 2020 from https://www.greenpeace.org/usa/new-greenpeace-investigation-illegal-timber-brazilian-amazon-sold-world-legal-paperwork/

Bryman A., (2015) Social Research Methods. Routledge

Campbell A. (2019) Mass timber in the circular economy: paradigm in practice? Engineering Sustainable, ICE Publishing

Centraal Bureau voor Statistiek (2019) Afval per inwoner in minst stedelijk gebied. https://www.cbs.nl/nl-nl/nieuws/2019/44/meeste-afval-per-inwoner-in-minst-stedelijke-gemeenten

Chertow M. R. (2000) INDUSTRIAL SYMBIOSIS: Literature and Taxonomy. Annu. Rev. Energy Environ. 2000. 25:313–37 Copyright °c 2000 by Annual Reviews. All rights reserved.

Cole, R. J. (2012). Regenerative design and development: current theory and practice. In Building Research & Information (Vol. 40, Issue 1, pp. 1–6). https://doi.org/10.1080/09613218.2012.617516

Guba, E. and Lincoln, Y. (1994) "Competing paradigms in qualitative research" from N/A, Handbook of qualitative research pp.105-117, Thousand Oaks, Calif.: Sage Publication

Cramer, J. (2014). Moving towards a circular economy in the Netherlands: challenges and directions. Utrecht University. [Retrieved on april 20th 2020] from: http://docplayer.net/5055129-Moving-towards-acircular-economy-in-the-netherlands-challenges-and-directions.html

Dwyer S., C. (2009) The Space Between: On Being an Insider-Outsider in Qualitative Research. International Journal of Qualitative Methods 2009, 8(1)

Ellen MacArthur Foundation (2013) Towards The Circular Economy. Economic and business

Ellen MacArthur Foundation (n.d.) Case-studies on effective Industrial Symbiosis. [Retrieved April 29th 2020] from: https://www.ellenmacarthurfoundation.org/case-studies/effective-industrial-symbiosis

Ellen MacArthur Foundation (n.d.) Circular design. retrieved May 12th 2020 from: https://www.ellenmacarthurfoundation.org/explore/circular-design

Energy Information Administration (2016) Industrial sector energy consumption. https://www.eia.gov/outlooks/ieo/pdf/industrial.pdf

European Commission (n.d.) Internal Market, Industry Entrepreneurship and SMEs. Retrieved on March 2nd from: https://ec.europa.eu/growth/industry/sustainability/circular-economy_en

European Economic and Social Committee (2019) Circular economy strategies and roadmaps in Europe: Identifying synergies and the potential for cooperation and alliance building. Published by: "Visits and Publications" Unit EESC-2019-51-EN www.eesc.europa.eu

Eurostat (2019) Circular economy in the EU. Record recycling rates and use of recycled materials in the EU.

Farooque, M., Zhang, A., Thürer, M., Qu, T., & Huisingh, D. (2019). Circular supply chain management: A definition and structured literature review. In Journal of Cleaner Production (Vol. 228, pp. 882–900). https://doi.org/10.1016/j.jclepro.2019.04.303

Fincher, M. (2015). Impact of Shortening International Product Life Cycle. In Proceedings of the 1996 Multicultural Marketing Conference (pp. 73–76). https://doi.org/10.1007/978-3-319-17395-5_16

Finnveden, G., & Ekvall, T. (1998). Life-cycle assessment as a decision-support tool: The case of recycling versus incineration of paper. Resources, Conservation and Recycling, 24(3–4), 235–256. doi:10.1016/S0921-3449(98)00039-00031

Geary C., (2014) Sustainable Connections: Linking Sustainability and Economic Development Strategies. National League of Cities.

Geissdoerfer, M., Savaget, P., Bocken, N. M. P., & Hultink, E. J. (2017). The Circular Economy – A new sustainability paradigm? In Journal of Cleaner Production (Vol. 143, pp. 757–768). https://doi.org/10.1016/j.jclepro.2016.12.048

Gerring, J. (2006). Case Study Research: Principles and Practices. Cambridge University Press.

Girardet, H. (2014). Creating Regenerative Cities. https://doi.org/10.4324/9781315764375

Gold Standard (n.d.) About us; initiatives and innovations [Retrieved 20th May 2020 from: https://www.goldstandard.org/about-us/initiatives-innovations]

Gopinat D. (2020) Waste management in England and the 'circular economy' model. Geography 105, no. 1, (2020): 39-46

Hammersley, M., & Traianou, A. (2012). Ethics in Qualitative Research: Controversies and Contexts. https://doi.org/10.4135/9781473957619

Hoang, M. Pham Phu, S. Nguyen, K., Fujiwara, T. (2017) Predicting waste generation using Bayesian model averaging, 10.22034/GJESM.2017.03.04.005. Global Journal of Environmental Science and Management

Hockett, D., Lober, D. J., & Pilgrim, K. (1995). Determinants of Per Capita Municipal Solid Waste Generation in the Southeastern United States. In Journal of Environmental Management (Vol. 45, Issue 3, pp. 205–217). https://doi.org/10.1006/jema.1995.0069

Hoffman, A. J., & Sandelands, L. E. (2005). Getting Right with Nature. In Organization & Environment (Vol. 18, Issue 2, pp. 141–162). https://doi.org/10.1177/1086026605276197

Hong, I.-H., & Ke, J.-S. (2011). Determining advanced recycling fees and subsidies in "E-scrap" reverse supply chains. In Journal of Environmental Management (Vol. 92, Issue 6, pp. 1495–1502). https://doi.org/10.1016/j.jenvman.2010.12.004

International Panel on Climate Change (2019) Special report on climate change and land-use.

Jonker, J., Stegeman, H. and Faber, N. (2017). The Circular Economy, Backgrounds, developments, concepts, and the search for matching business models. White Paper, Nijmegen School of Management, Radboud University (the Netherlands).

Kahuthu, A. (2006). Economic Growth and Environmental Degradation in a Global Context. In Environment, Development and Sustainability (Vol. 8, Issue 1, pp. 55–68). https://doi.org/10.1007/s10668-005-0785-3

Kovacic, Z., Strand, R., & Völker, T. (2019). The Circular Economy in Europe: Critical Perspectives on Policies and Imaginaries. Routledge.

KPN (2020) Jaarverslag 2018. [Retrieved 24th May 2020 from https://jaarverslag2019.kpn/]

KPN (n.d.) Over ons; Duurzaamheid. [Retrieved 24the May 2020 from: https://www.overons.kpn/nl/kpn-voor-nederland/duurzaamheid/kpn-is-milieubewust]

Krrishnamohan, K., & Herat, S. (2000). Industrial ecology and sustainable development—a viewpoint. In International Journal of Environmental Studies (Vol. 57, Issue 4, pp. 387–400). https://doi.org/10.1080/00207230008711283

Lambert, A. J. D., & Boons, F. A. (2002). Eco-industrial parks: stimulating sustainable development in mixed industrial parks. In Technovation (Vol. 22, Issue 8, pp. 471–484). https://doi.org/10.1016/s0166-4972(01)00040-2

Landelijk Meldpunt Afvalstoffen (n.d.) Landelijk Meldpunt Afvalstoffen: Bron van inzicht. [retrieved 9 April 2020 from: https://www.lma.nl/]

Larsson, M. (2018). Circular Business Models: Developing a Sustainable Future. Springer.

Leising, E., Quist, J., & Bocken, N. (2018). Circular Economy in the building sector: Three cases and a collaboration tool. In *Journal of Cleaner Production* (Vol. 176, pp. 976–989). https://doi.org/10.1016/j.jclepro.2017.12.010

Levitt, T. (1965) Exploit the Product Life Cycle. Harvard Business Review, 43, 81-94.

Lichtman, M. (2013). Qualitative Research in Education.

Lillis, G. (2002). Delivering Results in Qualitative Market Research. https://doi.org/10.4135/9781849208819

Lofland J., Lofland L., (1995) Analyzing Social Settings: A Guide to Qualitative Observation and Analysis.

Lovins, A., & Braungart, M. (2014). A New Dynamic - Effective Business in a Circular Economy.

Iuga, A. N. (2016). Waste Management in the Circular Economy. The Case of Romania. In *IOP Conference Series: Materials Science and Engineering* (Vol. 161, p. 012086). https://doi.org/10.1088/1757-899x/161/1/012086

Mair, C., & Stern, T. (2017). Cascading Utilization of Wood: a Matter of Circular Economy? In Current Forestry Reports (Vol. 3, Issue 4, pp. 281–295). https://doi.org/10.1007/s40725-017-0067-y

Mang, P. & Reed, B. (2012). Regenerative Development and Design. Encyclopedia Sustainability Science & Technology. I. 8855. 10.1007/978-1-4614-5828-9_303.

Martin, C. J. (2016). The sharing economy: A pathway to sustainability or a nightmarish form of neoliberal capitalism? In Ecological Economics (Vol. 121, pp. 149–159). https://doi.org/10.1016/j.ecolecon.2015.11.027

Meadows, D. H., Meadows, D. L., Randers, J., & Behrens, W. W. (1972). Limits to Growth: A Report for the Club of Rome's Projects on the Predicament of Mankind. Washington, DC: Potomac Associates Book

Mestre, A., & Cooper, T. (2017). Circular Product Design. A Multiple Loops Life Cycle Design Approach for the Circular Economy. In The Design Journal (Vol. 20, Issue sup1, pp. S1620–S1635). https://doi.org/10.1080/14606925.2017.1352686

Miller, R. E., & Blair, P. D. (2009). Input-Output Analysis: Foundations and Extensions. Cambridge University Press.

Morris, J. (1996). Recycling versus incineration: An energy conservation analysis. Journal of Hazardous Materials, 47(1–3), 277–293. doi:10.1016/0304–3894(95)00116–00116

Mud jean (n.d.) Circular Jeans [retrieved 23 April 2020 from: https://mudjeans.eu/?lang=nl]

Mulrow, J., Derrible, S., Ashton S., Chopra S. (2017) Industrial Symbiosis at facility scale.

Nellesa, M, Grünesa J., Morschecka G. (2016) Waste Management in Germany – Development to a Sustainable Circular Economy? International Conference on Solid Waste Management, 5IconSWM 2015. Procedia Environmental Sciences 35 (2016) 6 – 14

Netter, S., Pedersen, E., Lüdeke-Freund, F. (2019). Sharing economy revisited: Towards a new framework for understanding sharing models. In Journal of Cleaner Production (Vol. 221, pp. 224–233). https://doi.org/10.1016/j.jclepro.2019.02.225

Nikitenko, S. Goosen, E. and Kontorovich, A. (2018) Shift of the world energy sector development paradigm: consequences for Russia Published 1 November 2018 • Published under licence by IOP Publishing Ltd

NRVD (2018) Literatuuronderzoek Trends & Ontwikkelingen t.b.v. scenarioverkenning NVRD.

Onur, D. A. (2020). Integrating Circular Economy, Collaboration and Craft Practice in Fashion Design Education in Developing Countries: A Case from Turkey. In *Fashion Practice* (Vol. 12, Issue 1, pp. 55–77). https://doi.org/10.1080/17569370.2020.1716547

Oxford dictionary (n.d.) Definition retrieved 15th may 2020 from: https://www.oxfordlearnersdictionaries.com/definition/american_english/restorative_1

Philips. (n.d.). Circular lighting | Philips. Retrieved May 6, 2020, from https://www.lighting.philips.nl/systemen/circular-lighting

Rockström, J. & Steffen, Will & Noone, Kevin & Persson, Åsa & Chapin, F.S.I. & Lambin, E.F. & Lenton, T.M. & Scheffer, M. & Folke, Carl & Schellnhuber, Hans. (2009). Planetary Boundaries: Exploring the Safe Operating Space for Humanity [Internet]. Ecol Soc. 14.

Plessis du, J. Anil, H. and Bagaric M. (2011) Principles of contemporary Corporate Governance, Cambridge: Cambridge University Press

Raworth, K. (2017). A Doughnut for the Anthropocene: humanity's compass in the 21st century. The Lancet. Planetary Health, 1(2), e48–e49.

Repetto, R. (1989) Renewable Resources and Population Growth: Past Experiences and Future Prospects.

Ridder, de M. (2013) The Geopolitics of Mineral Resources for Renewable Energy Technologies. The Hague Centre for Strategic Studies.

Riekhof, M., Regnier, E., Quaas, M. F. (2018) Economic growth, international trade, and the depletion or conservation of renewable natural resources. Journal of Environmental Economics and Management.

Robertson, T. (2012) The Malthusian Moment: Global Population Growth and the Birth of American Environmentalism. Rutgers University Press, 2012.

Rosa, A. da, & da Rosa, A. (2013). Storage of Energy. In Fundamentals of Renewable Energy Processes (pp. 821–862). https://doi.org/10.1016/b978-0-12-397219-4.00018-7

Sachs, J. & Warner, D. (2001) The curse of natural resources. European Economic Review (volume 45, issues 4-6, May 2001, page 827-838

Seale, C. (2004) Interviews, in: Qualitative Research Methods. Online ISBN: 9781848608191

Sillanpaa, M., & Necibi, C. (2019). The Circular Economy: Case Studies about the Transition from the Linear Economy. Academic Press.

Skorupskaitė, K., & Junevičius, A. (2017). Waste Management Policy Development in Lithuania Applying Circular Economy Model. In *Public Policy And Administration* (Vol. 16, Issue 1). https://doi.org/10.5755/j01.ppaa.16.1.18016

Slavík, J. Potluka, O. & Rybova, K. (2017). Subsidies in waste management: Effective instruments or a cul-de-sac of European structural policies?. Waste Management. 65. 1-2. 10.1016/j.wasman.2017.05.040.

Stanczak, E. (2009). Visual Research Methods: Image, Society, and Representation. SAGE Publications (CA).

Storey, D. Santucci, L. Aleluia, J. and Varghese, T. (2013) Decentralized and Integrated Resource Recovery Centers in Developing Countries: Lessons Learnt from Asia-Pacific, ISWA Congress, 7-11 October 2013

Stern, D. I., Common, M. S., & Barbier, E. B. (1996). Economic growth and environmental degradation: The environmental Kuznets curve and sustainable development. In World Development (Vol. 24, Issue 7, pp. 1151–1160). https://doi.org/10.1016/0305-750x(96)00032-0

Tanskanen, Pia & Kallio, Susanna & Scheck, Hans-Otto. (2018). Circular Economy in telecommunications- Closing the loop.

Treloar, G. J., Gupta, H., Love, P. E. D., & Nguyen, B. (2003). An analysis of factors influencing waste minimisation and use of recycled materials for the construction of residential buildings. In Management of Environmental Quality: An International Journal (Vol. 14, Issue 1, pp. 134–145). https://doi.org/10.1108/14777830310460432

UNESCO (2014) Inclusive Wealth Report 2014: Measuring Progress Toward Sustainability, Cambridge University Press: Cambridge.

United Nations (2015) Global Sustainable Development Report. Industrial symbiosis: powerful mechanisms for sustainable use of environmental resources https://sustainabledevelopment.un.org/content/documents/635486-Kusch-Industrial%20symbiosis_powerful%20mechanisms%20for%20sustainable%20use%20of%20environmental%20resources.pdf

United Nations (2018) Circular Economy for the SDGs: From Concept to Practice. General Assembly and ECOSOC Joint Meeting.

van Loon, P., & Van Wassenhove, L. N. (2020). Transition to the circular economy: the story of four case companies. In International Journal of Production Research (pp. 1–8). https://doi.org/10.1080/00207543.2020.1748907

Verburg, R. M., Wiegel V. (1997) on the Compatibility of sustainability and Economic Growth. Environmental Ethics, vol. 19 issue 13, 1997. pages 247-265.

Verschure, P. (2003) Case Study as a Research Strategy: Some Ambiguities and Opportunities, International Journal of Social Research Methodology, 6:2, 121-139.

Vries B. J. M., Petersen A. C., (2008) Conceptualizing sustainable development: An assessment methodology connecting values, knowledge, worldviews and scenarios. Ecological Economics Volume 68, Issue 4, 15 February 2009, Pages 1006-1019

Wautelet T. (2018) The Concept of Circular Economy: its Origins and its Evolution.

Woodward, D. (1985) Swords into Ploughshares': Recycling in pre-industrial UK. Economic History Review, 2nd series, 38, 175–191.

Yin R. K., (1989) Case Study Research, Design and Methods. Newbury Park, London: New Delhi: sage.

Zhang, T., Chen, J., & Hu, B. (2019). Authenticity, Quality, and Loyalty: Local Food and Sustainable Tourism Experience. In Sustainability (Vol. 11, Issue 12, p. 3437). https://doi.org/10.3390/su11123437