CIRCULAR SUPPLY CHAINS IN FINLAND:

Drivers, enablers, and barriers

Lappeenranta–Lahti University of Technology LUT

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ABSTRACT

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Circular supply chains in Finland: Drivers, enablers, and barriers

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93 pages, 10 figures, 22 tables and 6 appendices

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Keywords: circular economy, circular supply chain management, circular supply chain, drivers, barriers, enablers

Sustainability and circular economy have grown as important research topics in the last few years. Climate change has pushed companies towards more sustainable choices and as supply chains cause substantial amounts of emissions sustainable, green, and circular supply chains have grown popular. The aim of this study is to find the factors that affect the implementation of circular supply chains and circular supply chain management in Finland. Through examining the drivers, enablers, and barriers for circular supply chains, the most key factors are researched.

The study was conducted as a mixed method study, and it combined both quantitative and qualitative methods. The data was collected by using a questionnaire and semi-structured interviews. The questionnaire collected 62 responses and four interviews were held. Data was analysed using factor analysis, variance analysis (ANOVA), and theory driven content analysis. The findings show that there are many factors affecting the implementation of circular supply chains in Finland. The biggest drivers include customer demand, effects on brand, and environmental values. The biggest barriers include concern about customers' willingness to pay higher price, uncertainty in demand, and financial aspects. The biggest enablers include financial resources, technological solutions, and top management commitment.

TIIVISTELMÄ

Lappeenrannan–Lahden teknillinen yliopisto LUT

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Kauppatieteet

Sanni Lehtonen

Kiertotalouteen perustuvat toimitusketjut Suomessa: Motivaattorit, mahdollistajat ja estävät tekijät

Kauppatieteiden pro gradu -tutkielma

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Avainsanat: Kiertotalous, kiertoihin perustuvan toimitusketjun hallinta, kiertoihin perustuvat toimitusketjut, ajurit, mahdollistajat, haasteet

Kestävä kehitys ja kiertotalous ovat kasvaneet tärkeiksi tutkimusaiheiksi viimeisten vuosien aikana. Ilmastonmuutos on kannustanut yrityksiä kohti kestävämpiä valintoja ja kun toimitusketjut tuottavat suuria määriä päästöjä, kestävät, vihreät ja kiertotalouden mukaiset toimitusketjut ovat kasvattaneet suosiotaan. Tämän tutkimuksen tavoite on löytää tekijöitä, jotka vaikuttavat kiertotalouden mukaisten toimitusketjujen ja toimitusketjun hallinnan implementointiin Suomessa. Tärkeimpiä tekijöitä tutkitaan ajurien, mahdollistajien ja haasteiden kautta.

Tutkimus toteutettiin sekatutkimusmenetelmällä ja siinä yhdistettiin sekä kvantitatiivisia että kvalitatiivisia menetelmiä. Tutkimusdata kerättiin kyselyllä sekä puolistrukturoiduilla haastatteluilla. Kyselytutkimus sai 62 vastausta ja tämän lisäksi pidettiin neljä haastattelua. Tutkimusdataa analysoitiin hyödyntämällä faktorianalyysia, varianssianalyysia (ANOVA) ja sisällönanalyysia. Tulokset osoittavat, että on monia tekijöitä, jotka vaikuttavat kiertotalouden mukaisten toimitusketjujen implementointiin Suomessa. Suurimmat ajurit ovat asiakkaiden vaatimukset ja kysyntä, vaikutukset brändiin ja ympäristöystävälliset arvot. Suurimmat haasteet ovat asiakkaiden valmius maksaa korkeampaa hintaa, kysynnän epävarmuus ja taloudelliset tekijät. Suurimmat mahdollistajat ovat taloudelliset valmiudet, teknologiset ratkaisut sekä ylimmän johdon sitoutuneisuus.

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Lastly, I want to give special thanks to two people who I spent countless hours with while working on this thesis. One of them wrote their master's thesis during the Fall of 2023 with me and one of them wrote their bachelor's thesis during the Spring of 2024 with me. Peer support is important, and I could have not done it without your support.

In Espoo, April 3rd, 2024

Sanni Lehtonen

ABBREVIATIONS

CE	Circular Economy
CSC	Circular Supply Chain
CSCM	Circular Supply Chain Management
LE	Linear Economy
SCM	Supply Chain Management
SSCM	Sustainable Supply Chain Management

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1 Introduction

Climate change and environmental sustainability can be seen as possibly the biggest megatrend of 2020s. According to Finnish Innovation Fund Sitra (2023), one of the key megatrends of 2023 is the collapse of nature's carrying capacity. On the other hand, according to VTT Technical Research Centre of Finland (2023) one of seven global megatrends in 2023 is profound sustainability.

It is more important than ever to aim to mitigate the impacts of climate change. According to Romm (2018, 32-34) some of the effects of climate change include extreme weather conditions, global warming, loss of biodiversity, and rise of sea level. Stopping the climate change is ambitious and possibly impossible goal. However, there are ways to try to achieve that goal.

In 2020 European Commission introduced an action plan for the implementation of circular economy. According to the World Bank (2018) annual waste generation will increase by 70% by 2050. The basic concept of circular economy relies on theory of 3Rs. These are reuse, reduce, and recycle (Kirccher et al. 2017). Hence, circular economy can be seen as a potential answer to the issue of climate change.

This study discusses several factors affecting the adoption of circular supply chain management (CSCM) and circular supply chains (CSC). Supply chain sustainability is more important than ever as European Union (2023) has been planning new directive which has obligations related to supply chain sustainability.

1.1 Background of the study

Green and sustainable supply chain management have become big trends in the world due to climate change, global warming, and other drivers. According to Saeed & Kersten (2019) there are many different pressures that drive companies to adopt sustainable and green

supply chain management. There are societal, regulatory, and market pressures that drive companies towards sustainability in their supply chain management.

One sustainable concept is circular economy. As a concept circular economy is not a new one. There is not a clear answer to who introduced the concept for the first time. Already in the mid-1960s Boulding (1966) described in an article earth as a closed and circular system. Boulding's article has influenced some later ideas of circular economy, for example an article by Pearce & Turner (1989).

Circular economy has risen to important research topic as it is one of the possible concepts related to stopping the climate change or mitigating its effects. Circular economy can present many benefits to companies such as reduced raw material use, reduced waste, and reduced emissions (Korhonen et al. 2018; Kumar et al. 2019; Lahane et al. 2022; Nag et al. 2022; Sehnem et al. 2019). The problem with circular economy is that it has mostly been developed by policymakers, businesses, and other kinds of practitioners whereas academic literature and research has been lacking (Korhonen et al. 2018).

Even though, there has been increasing amounts of studies related to circular economy adoption, circular supply chains, and circular supply chain management, there is a research gap. Literature review showed that even though there are studies conducted in Finland related to circular supply chains, they have been mostly focusing on specific fields of Finland. This thesis on the other hand focuses on one country as a market and not only one field of business. It is also important to research the drivers, enablers, and barriers in many different contexts. For example, the barriers can be different depending on the region or field the business is practiced in (Wei 2015). In addition, the previous research has been widely focusing on the barriers for circular supply chains and circular supply chain management. Drivers or enablers are not as much studied. Implementation of circular practices to supply chains is not easy. Hence, the barriers have been studied a lot. However, it is also important to know which factors enable the implementation.

1.2 Research questions and aim of the study.

This thesis aims to find out the most common drivers, enablers, and barriers for circular supply chain management and circular supply chains in Finnish market. In addition, this study has a goal of finding the most important drivers, enablers, and barriers. These are all factor affecting the circular supply chains. There is also a goal of finding relationships between different drivers, enablers, and barriers and to find out whether other factors such as size of the company affect the implementation. Based on the aim of the study, the main research question has been identified as following:

MRQ: What are the key factors affecting the adoption of circular supply chain management and circular supply chains in Finland?

To support the main research question and to help to answer it, three sub-questions have been identified:

Q1: What are the most important drivers for circular supply chain management and circular supply chains?

Q2: What are the most important enablers for circular supply chain management and circular supply chains?

Q3. What are the most important barriers for circular supply chain management and circular supply chains?

1.3 Literature review

This sub-chapter aims to present a brief overview on the existing academic literature related to the topic of this study. Circular supply chain management as well as circular economy in general have been growingly increasing topics in academic research in the last decade. Table

2 summarizes articles about drivers, enablers, and barriers used in this study. They work as the basis for this study and are supported by a wide range of other articles.

Key word search was performed by using LUT Primo library database. The key words used were circular, supply chain and either driver or barrier as the search tool did not allow anymore terms. The search was otherwise limited by showing only peer-reviewed articles from 2014 to 2023. This search gave 659 results. Most of these results were not relevant for this study. From the key word search 33 articles were picked as relevant for the study. Also, other searches were utilized and overall based on the titles and abstracts 43 articles were chosen. Figure 1. shows how the amount of the relevant articles has grown. The search gave no relevant articles from years 2014 to 2017. This does not mean they do not exist, but the same trend has been seen in the previous literature. Lahane et al. 2020 utilized 125 articles in their literature review and 104 of them had been published after 2017. The increasing number of articles made on drivers, barriers, and enablers for circular supply management and circular supply chains emphases the thought that the topic is current and important. Most of the articles are from supply chain point of view, but also couple that discuss circular economy in general or circular business models were also taken into the research.

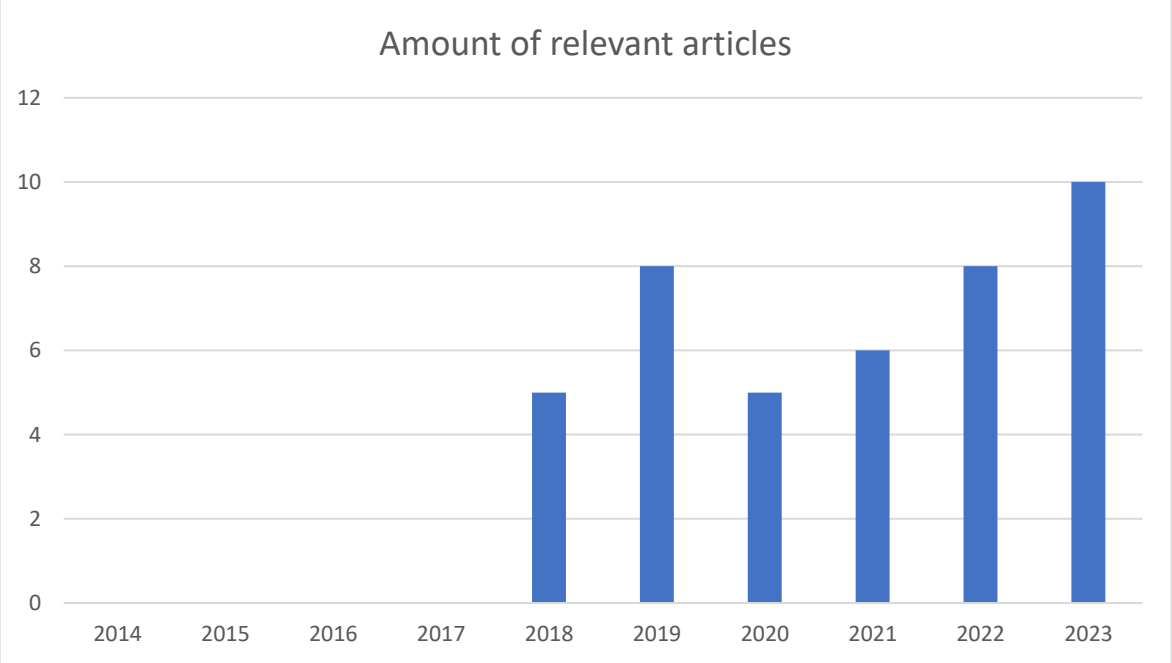


Figure 1. Number of relevant articles

42 selected articles are from different academic journals. In total they are from 20 journals. The journal with the most selected articles is Journal of Cleaner Production where 13 of the

selected articles were published. Hence, the keyword search was also performed specifically for articles from that journal. Otherwise, the number of journals was not limited as circular supply chains is still a rare topic for research. Table 1. presents how many articles were selected from each journal. The selected articles represent the topic well as they are from various parts of the world and from different industries. However, especially food and textile supply chains were a topic for many studies. In addition, geographically Europe and Asia were most presented.

Table 1. Number of articles per journal

Journal	**Number of selected articles**
Journal of Cleaner Production	13
Production planning & control	5
Business strategy and environment	3
Management decision	3
Business strategy and development	2
Environment, development, and sustainability	2
International journal of production research	2
The international journal of logistics management	2
Computers & industrial engineering	1
Industrial marketing management	1
International journal of environmental science and technology	1
International journal of productivity and performance management	1
Journal of engineering management	1
Journal of fashion marketing and management	1
Journal of industrial and production engineering	1
Management of environmental quality	1
Revista de gestão	1
Supply chain management	1
Sustainable development	1

According to previous literature the academic research in circular supply chains and circular supply chain management is lacking especially on the practical side of the issue (De Angelis et al. 2018; Korhonen et al. 2018). Literature review, also, showed that there exist several studies on the barriers for circular economy and circular supply chain adoption. However, drivers and enablers are much less studied. Also, for these reasons there is a need for studies regarding this topic. Table 2 presents some studies of drivers, barriers, and enablers for

circular economy, circular supply chains, and circular supply chain management. These articles have also been used as a part of the theoretical background in this study.

Table 2. Summary of articles about drivers, enablers, and barriers

Author(s) & year	Aim of the research	Methodology	Main findings
Tura et al. 2019	Creating a framework for drivers and barriers for circular business	Qualitative, Semi-structured interviews, case study	Both drivers and barriers include several environmental, economic, social, political, and institutional, technological, supply chain, and organizational factors.
Mehmood et al. 2021	Examining the drivers and barriers for circular economy in agri-food supply chain	Systematic literature review	Drivers include policies and laws, financial, health, and social benefits, environmental protection, and product development. Barriers include financial and economic factors, knowledge and skill related factors, technological, operational, and logistical and infrastructural factors.
Farooq et al. 2019	Examining the barriers for circular food supply chains in China	Quantitative, DEMATEL	Most significant barriers include lack of strong environmental legislation, lack of pressure from the customers, and lack of support from other actors in the supply chain.
Bhattacharya & Kalakbandi 2023	Discussing the role of unorganized sector in the adoption of circular economy and the barriers for circular tire supply chain in India	Qualitative, grounded theory, semi-structured interviews	Some of the barriers include lack of skilled labor, uncertainties related to customer knowledge and demand, poor implementation of standards, and increasing cost of raw materials.
Khan & Ali 2022	Creating a model to help managers in pharmaceutical industry to implement circular supply chain management	Quantitative, MCDM, F-FUCOM, FQFD	Barriers and enablers were analyzed, and the most significant barriers were lack of financial resources, market challengers, and lack of collaboration within the supply chain network. Most significant enablers were industrial symbiosis, RL infrastructure, and blockchain technology.
Khan et al. 2020	Identifying and analyzing significant enablers to implementing circular initiatives in supply chains	Quantitative, Grey DEMATEL	10 enablers were identified and analyzed. The most important were creating a demand for circular products, top management commitment, reversed logistical infrastructure, circular business model, and consumer attitudes,
Mangla et al. 2018	Analyzing barriers for effective circular supply chain management in a developing country	Systematic literature review, ISM-MISMAC	Several barriers were identified and analyzed. These barriers include lack of immediate economic benefits, lack of training of employees, lack of customer awareness, and poor demand.
Govindan & Hasanagic 2018	Analyzing drivers, barriers, and practices on implementation of circular economy from a supply chain point of view.	Systematic literature review	Several drivers and barriers for circular economy were identified. Some of these drivers include policies and laws, job creation, economic growth, and climate change. Barriers include governmental and economic issues.

Sandvik & Stubbs 2019	Analyzing and identifying drivers, barriers, and enablers of creating a textile-to-textile recycle system in fashion industry and systemic changes required for circular supply chains.	Qualitative, semi-structured interviews	Several drivers, barriers, and enablers are identified and analyzed in the context of the fashion industry and Scandinavian market. Some of the drivers include global trends, competitiveness, and brand image. Barriers include policies and quality. Enablers include technological, design, and product solutions as well as collaboration.
Calzolari et al. 2021	Assessing practices inspired by circular economy in the context of European Multi-National Enterprises.	Secondary data from corporate sustainability reports, data coding	Findings include degree of implementation, drivers for implementation, and the role of collaboration throughout the supply chain and role of partners.

1.4 Conceptual framework

Conceptual framework describes the topic of the thesis and combines the key concepts in a one picture. The framework shows how concepts of circular economy and supply chain management together create circular supply chain management. All three of these concepts are briefly defined in sub-chapter 1.5. In addition, the framework includes barriers, drivers, and enablers for circular supply chain management. In the bottom there is the core of this thesis which is circular supply chains in the Finnish market.

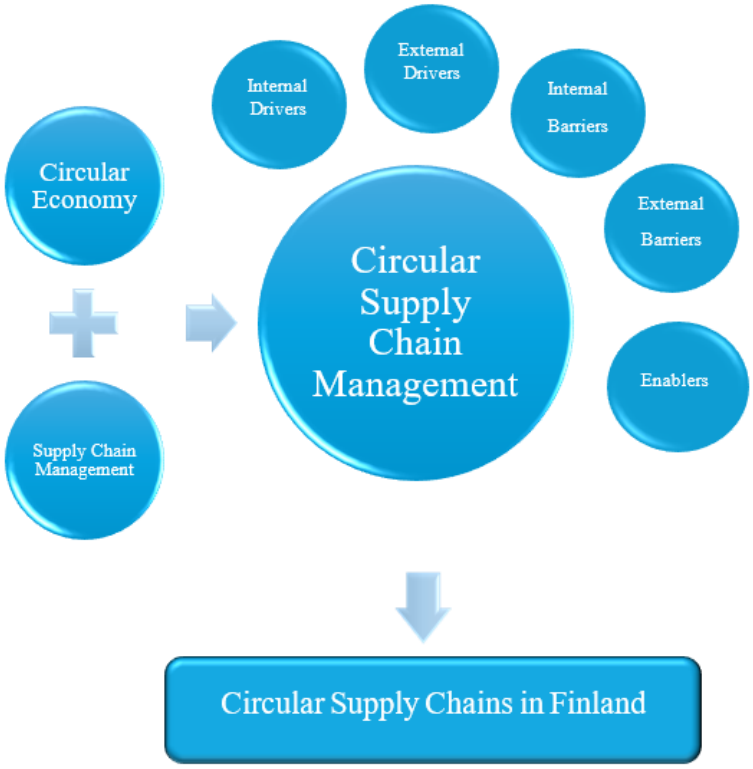


Figure 2. Conceptual Framework

1.5 Definitions of key concepts

This section aims to define the key concepts used frequently in this study. These concepts are circular economy, supply chain management, circular supply chain management, and circular supply chain. All of these have several definitions and hence it is difficult to build a definition for them.

Circular economy

Circular economy can be seen as an alternative system for more common linear economy. According to Korhonen et al. (2018) circular economy as a concept has traditionally been defined mostly by practitioners. However, there are scientific definitions. Circular economy can be defined as closed-loop resource system based on recycling (Figge et al. 2023). According to a study conducted by using 114 definitions of circular economy, the key concepts of circular economy are reuse, reduce, and recycle (Kirchherr et al. 2017).

Supply chain management

Supply chain management has many different definitions and as concept it is old. It has been first introduced in the beginning of 1980s by practitioners (Oliver & Webber 1982). One commonly cited definition for supply chain management is:

"Systemic, strategic coordination of the traditional business functions and the tactics across these business functions within a particular company and across businesses within the supply chain, for the purposes of improving the long-term performance of the individual companies and the supply chain as a whole." (Mentzer et al. 2001)

Circular supply chain management

Circular supply chain management combines the previously defined circular economy and supply chain management. It can be defined as combining circular concepts and thinking into the management of supply chains. It aims to create a system based on zero-waste involving all stakeholders in the life cycle of the product. (Farooque et al. 2019b)

Circular supply chain

Circular supply chains can have many different definitions. They are reverse supply chains that can improve different sustainability aspects of an organization (Batista et al. 2018). Structure of a circular supply chain can be described as short and closed loop (De Angelis et al. 2018).

1.6 Limitations and validity

This study contains some limitations. The companies selected for the data collection need to operate in Finland. The company does not need to be completely Finnish. However, it needs to have operations in Finland. In that case the respondent is asked to answer especially from the point of view of the Finnish branch, not the parent company or concern. This choice is made to limit the respondents and to get data from Finnish market as that is part of the research gap. Another limitation is excluding companies that offer only services. These kinds of companies do not fit as well to the aim of the study, as circular economy is based on recycling and waste management.

Chosen research method portrays some limitations. Quantitative research requires a big data sample. Otherwise, the results may not be reliable, and the findings cannot be generalized on a larger scale. Getting respondents for a questionnaire is not easy and that is a big challenge. Quantitative research, also, fails to give deep thoughts on topics. It focuses on numeric facts. To increase the reliability of the study, also qualitative portion is included. Qualitative research also provides some limitations.

This study also has some reliability threats. Some of the threats may be either participant error or participant bias or researcher error or researcher bias. These all lead to errors in the

data or in researcher's case error in the analysis of the data (Saunders et al. 2016, 203). As this study is conducted with a single researcher it must be considered that the views presented in this have been written by only one person. The questionnaire also requires some expertise from the respondents. Circular economy can be a difficult term to fully understand. Hence, there is an elevated risk of respondents misunderstanding questionnaire questions. Interviews provide less of a risk of misunderstanding as the questions can be clarified.

This thesis and its results can be valid for organisations aiming to implement circularity in their supply chain and supply chain management. It is important to acknowledge different barriers and enablers to be able to overcome the barriers and implement the enablers. The drivers can help for example policymakers to understand what aspects motivate companies to implement circularity.

1.7 Research methodology & data collection

The research was conducted as a mixed method study. This increases the validity of the study as not only one method is used. Quantitative method is also good for analysing relationships between several factors. (Saunders et al. 2016, 496) Quantitative method was also chosen because it works better for a large sample of data. However, even though the response rate of the quantitative study was good, the overall number of responses remained low. Hence, qualitative study was included to give more perspectives on the topic and to increase reliability.

Data for the empirical portion was collected with a questionnaire made with a program Qualtrics. The questionnaire was sent to 150 companies in hopes to get at least 50 responses. Potential respondents were searched through LinkedIn, and they hold a position related to either sustainability or procurement in their company. The emails were targeted to the respondents specifically. The reason for this was to get more answers and as the questionnaire required specific expertise to complete, the respondents had to be selected carefully to ensure they have the needed expertise.

The aim of the quantitative study is to find links between drivers, barriers, and enablers and how various aspects relate to them. Analysis of variance (ANOVA) is used as a tool for that.

ANOVA can be used to study whether there are differences in the means of two or more groups (Kaakinen & Ellonen 2021). The null hypothesis of variance analysis is that there is no difference in the means. The data collected can be also analysed by background factors such as the company size and fields of business and find relations from that. ANOVA was chosen as the method, as the main research question is what kind of factors affect the implementation. With ANOVA, it is possibly to find correlations between the statements of the questionnaire and the background questions.

The challenge of questionnaires is lack of respondents. Hence, four semi structured interviews were conducted in addition to the questionnaire. The upside of qualitative study is getting more detailed and deep thoughts on the subject.

1.8 Structure of the study

This study consists of six portions. First is introduction which introduces the topic of the thesis, aim, research question, background of the study, previous literature, conceptual framework, limitations, and research methodology and plan for data collection. From introduction the thesis moves on to the literature review. First the theory portion discusses the background of sustainability in supply chains. From there the review proceeds to circular economy and circular business and from there to circular supply chain management and circular supply chains. Next, the review proceeds to internal and external drivers, enablers, and to internal and external barriers. The last part of literature review describes Finland as an economic area and its characteristics.

In the third chapter methods and data collection of the study are described. It is followed by empirical part where the results of the tests made with questionnaire answers are presented as well as the results of the interviews. This is followed by discussion where these results are analysed more in depth. Last part of the study is conclusion which includes also managerial implications, limitations, and ideas for future research. Figure 2 shows the structure of the thesis.

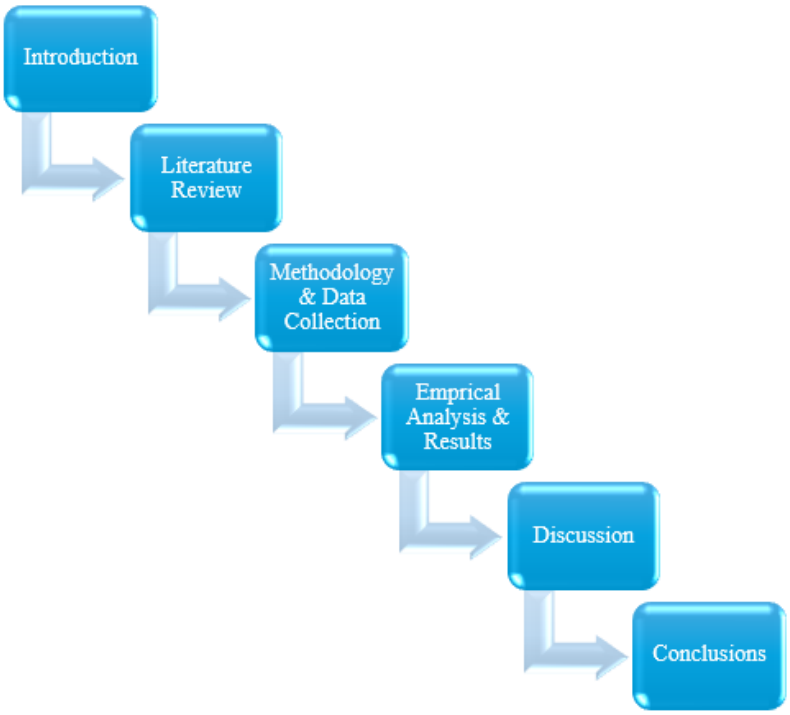


Figure 3. Structure of the study

2 Literature review

This chapter provides an overview of the existing academic literature. Key concepts of green supply management, circular economy, circular supply chain management, and circular supply chains are explained in more depth. Literature review provides a theoretical basis for the empirical part of the study. In addition to purely academic literature, some practitioner documents are used. Reason for this is that the concept of circular economy has been mostly defined by practitioners in the past and the existing academic literature lacks research on the actual implementation of circular economy or circular supply chains.

2.1 Background of sustainability and sustainable supply chain management

Sustainability as a concept started to emerge in the 1980s. IUCN's 1980 World Conservation Strategy used possibly for the first-time term "sustainable development". Arguably the most popular definition for sustainability is the definition by the World Commission on Environment and Development from 1987. In a report *Our Common Future* sustainable development was defined in the following way: "Development that meets the needs of the present without compromising the ability of future generations to meet their own needs."

As a term sustainability is wide. After the previously mentioned so called Brundlandt Commission many different definitions have been proposed. However, one thing these definitions have in common is that they are based on the theory of triple bottom line or three pillars. Sustainability has traditionally been divided into three different pillars of sustainability: environmental, social, and economic sustainability. (Pope et al. 2004) Already the 1980 World Conservation Strategy stated the following: "for development to be sustainable it must take account of social and ecological factors, as well as economic ones". This study focuses on the environmental aspect of the three aspects of sustainability. However, it touches upon the other two as well as these three are intricately connected and environmental sustainability attempts affect also social and economic sustainability.

Sustainability affects supply chains and supply chain management. Sustainable supply chains are a crucial part of mitigating the effects of climate change. According to Crippa et

al. (2021) the global food supply chain causes one third of all emission caused by humans. This is only the food supply chain. Emissions related to global supply chain are high and thus sustainable supply chains are critical to climate change effect mitigation.

Green and sustainable supply chains have both many different definitions. The definition depends on many things. Lack of proper definition for green or sustainable supply chain management can lead into confusion and debates (Ahi & Searcy 2013). Ahi & Searcy analysed 22 existing definitions of sustainable supply chain management and 12 existing definitions of green supply chain management and based on them proposed a following definition:

"The creation of coordinated supply chains through the voluntary integration of economic, environmental, and social considerations with key inter-organizational business systems designed to efficiently and effectively manage the material, information, and capital flows associated with the procurement, production, and distribution of products or services in order to meet stakeholder requirements and improve the profitability, competitiveness, and resilience of the organization over the short- and long-term."

According to Pagell & Wu (2009) some characteristics of companies with sustainable supply chain management are that sustainability is incorporated in every part of the supply chain, company's financial and environmental goals are in line with each other, and company has found partners with new knowledge and value to the chain. Several studies have also researched critical success factors of green and sustainable supply chain management. Top management commitment, sustainability certifications and regulations, and pollution prevention have been seen as critical success factors (Prasad et al. 2018; Raut et al. 2017). Some SSCM practices adopted by companies include green manufacturing, purchasing, packaging, transportation, product design, process design, and warehousing, recycling of materials, reducing emissions and energy consumption, waste, water, and air management, supplier sustainability assessment, and reverse logistics (Zimon et al. 2020). Sustainability in supply chains affects the whole value chain from start to end and hence needs to be considered throughout the chain.

Circular economy is one of the key concepts for sustainable development and mitigating the effects of climate change. However, some researchers argue that in some cases circular economy is not even sustainable (Corvellec et al. 2022). Considering the triple bottom line,

circular economy lacks to consider the social aspects of sustainability. For example, Plan-Julian & Guevara (2019) researched circular economy from the viewpoint of care ethics and gender equality. Circular economy lacks these sustainability concerns.

2.2 From linear to circular economy

Transition to circular economy has been mentioned even in the United Nations Sustainable development goals. Traditionally the world has been described as a linear economy which is usually based on three principles: take, make, and dispose (Ellen MacArthur Foundation 2012). However, in recent decades this system has been questioned. As earths carrying capacity is surpassed every year and natural resources run dry, there needs to be new ways to support the economy to prevent food shortages, water shortages, climate refugees, and other affairs such as those.

The introduction chapter already introduced the concept of circular economy and mentioned it not being a new one even though studies on it have heavily increased in past few years. Circular economy is often based on the theory of 3Rs: reuse, reduce, and recycle. It is difficult to tell who introduced the concept for the first time. However, several researchers have used the theory as a basis for their studies (Kirchher et al. 2017; Ren 2007; Sakai et al. 2011). 3Rs is most common of the theories but there are also theories of 4Rs, 5Rs, 6Rs, and even 9Rs. 6Rs is very known theory as well. The theory includes in addition to the mentioned three Rs also recover, redesign, and remanufacture. The 6Rs were first proposed by Joshi in a conference in Brazil in 2006. 6Rs brings more to the theory as 3Rs have been argued by some to be too focused on waste management and not so much to developing new products

and to manufacturing new products (Ghisellini et al. 2015). 9Rs includes in addition to the six previously mentioned Rs also refuse, refurbish, rethink, and repurpose.

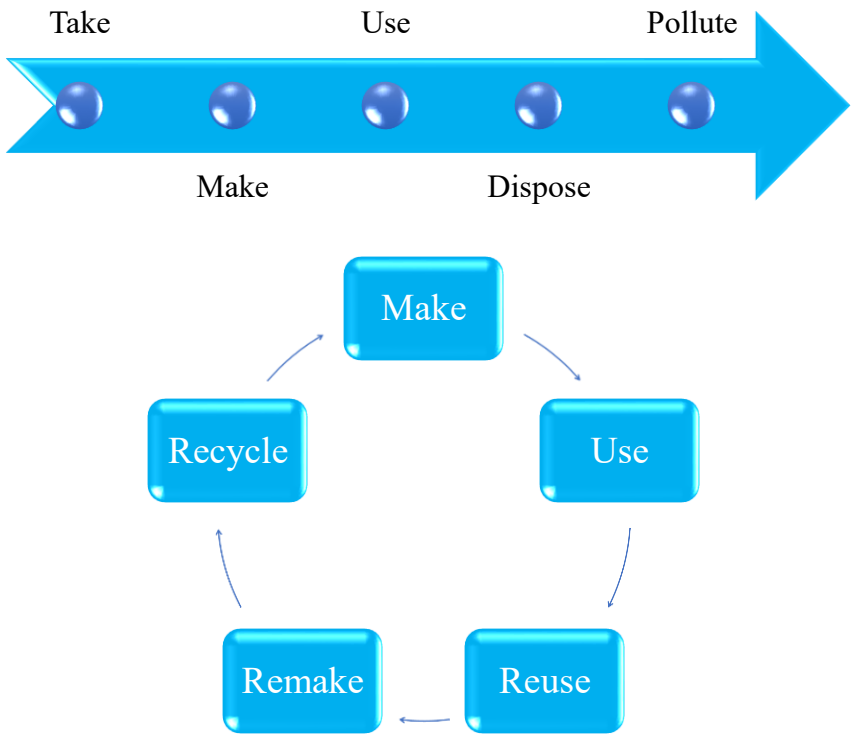


Figure 4. Difference between linear and circular economy
(adapted from a figure by Cathrine Weetman 2016)

The transition from linear economy to circular economy requires a lot. One of the most important things is that it requires systems thinking and not just concrete new products (Kopnina 2021). The transition requires collaboration in all stakeholder levels from regional level to international level (Gorokhova et al. 2023). Circular economy also requires new kind of infrastructure which on the other hand requires governmental support (Hailemariam & Erdiaw-Kwasie 2023). Some drivers for the transition from linear economy to circular economy include environmental awareness and environmental regulation. It has been studied that younger people are more aware and have more knowledge on the issue. Hence, there is a need for marketing and education for older generations. (Neves & Marques 2022) Khan et al. (2020) analysed several critical success factors for transition to circular economy.

They divided them into five dimensions: organizational, economical, technological, environmental, and social. It is important for managers to understand the importance of CSFs to them to able to implement them and therefore enable the transition to circular economy.

Some studies have proposed that there is not really a clear transition from linear economy to circular economy as the world has always been a mixture of LE and CE and will continue to be (Morseletto 2023). Hence, it may not be beneficial to aim for completely circular world

To be able to transition from linear economy to circular economy, companies must implement circular business models. Geissdoefer et al. (2020) defined circular business model innovation in a following way:

"Circular business model innovation can be defined as the conceptualisation and implementation of circular business models, which comprises the creation of circular start-ups, the diversification into circular business models, the acquisition of circular business models, or the transformation of a business model into a circular one. This can affect the entire business model or one or more of its elements, the interrelations between the elements, and the value network."

Practitioners have identified many different strategies for companies to build circular business models. According to Atasu et al. (2021) companies may adopt one of three strategies for circular business model. In the article by Atasu et al. (2021) the first circular strategy is retaining product ownership in which the business model is shifted from selling to leasing. The second one is product life extension. This strategy focuses on lengthening the product life cycle. The issue with this business model is that it leads to fewer purchases which is why it may not be seen as appealing by the manufacturers. The last one is design for recycling. The companies utilizing this one need to focus on the recycling part of their product and make sure recycling possibilities are maximised.

The Ellen McArthur Foundation (2013) has been able to prove that it is possible to create circular business values which hold also financial value. By adopting the CE principles there can even be financial benefits. Profitability has been a major challenge for efficient circular business models in the past.

2.3 Implementation of circular supply chain management and circular supply chains

Circular supply chain management and circular supply chains were defined in the sub-chapter 1.5. Implementation of circular supply chain management or circular supply chains are still not very well studied in practice, and they have not been implemented yet. For this reason, this chapter and its sub-chapter provides an overview of the drivers, enablers, and barriers for circular supply chains and circular supply chains management based on the articles found in the article search which was described in the sub-chapter 1.3. These identified drivers, enablers, and barriers are used as a basis for the empirical portion of this study.

Saroha et al. 2020 presented some benefits of CSCM adoption. These include savings both financially and in other resources. According to Malhotra (2023) those who adopt circular supply chains early may gain a competitive advantage from it. There are more benefits from implementation of CSCM and CSC than purely environmental benefits.

2.3.1 Identifying internal and external drivers for CSCM and CSC

Drivers can be described as something that drives and motivates companies to behave in a certain way. This sub-chapter discusses the internal and external drivers identified from previous literature. Drivers are divided into two categories: internal and external drivers. Internal drivers are motivators coming from inside the organisation. External drivers come from outside the organisation and the company has little to none say over them. Table 3 and Table 4 present the different drivers identified in the literature review.

There can be many types of drivers such as environmental, financial, and social drivers. There is a trend of mitigating the negative environmental effects which is one driver (Tura et al. 2019). Another environmental driver is resource scarcity (Moktadir et al. 2018; Tura et al. 2019). As the climate change as well as urbanization proceeds, there will be less resources in the future. Circular supply chains may provide a solution to this issue as the existing material is reused. Climate change is a major driver for circular supply chains as there is a lot of waste produced and it creates emissions (Govindan & Hasanagic 2018).

Financially circular supply chains can provide cost savings and other financial benefits. Waste disposal is expensive and circular supply chains reduce waste. Hence, there is a cost saving opportunity there and in addition waste can be utilized to bring additional value (Tura et al. 2019). Circular practices also provide a platform for new service models which on the other hand can lead to financial benefits (Tura et al. 2019; Sandvik & Stubbs, 2019). According to Agyemang et al. (2019) financial benefits and cost reduction were seen as most prominent factors driving towards circular supply chains. Prices of raw materials are increasing and disposal of product in the end of a life cycle is expensive. .

Regulation is widely seen as the most important external driver for circular supply chains. According to Calzolari et al. 2021 regulation is one of the major pressures for companies adopting circular practices. Regulation provides rules for companies that need to be obeyed. Sometimes there is also governmental support available for those who adapt regulatory practices.

Socially especially risen customer awareness is seen as a major driver (Jia et al. 2020; Tura et al. 2019). Customers are more aware than ever about sustainability and circularity. As a result, there is increased demand for sustainable and circular products from all kinds of stakeholders including customers.

Competitiveness can also be seen as a driver for CE adoption. Competitors may be already implementing sustainable, green, and circular implementation which drives also other companies competing for the same customers to do the same (Jia et al. 2020).

Table 3. Internal drivers identified in the literature review.

Internal drivers	**References**
Cost savings and financial benefits	Agyemang et al. 2019, Govindan & Hasanagic 2018, Tura et al. 2019,
New opportunities (for e.g., innovation)	Calzolari et al. 2021, Tura et al. 2019
Commitment of top management	Jia et al. 2020, Ostermann et al. 2021, Ouro-Salim et al. 2023
Expertise within the organization	Ostermann et al. 2021
Competitiveness and market share	Agyemang et al. 2019, Calzolari et al. 2021, Jia et al. 2020, Sandvik & Stubbs 2019
Brand image	Sandvik & Stubbs 2019
Circular value proposition	Amir 2023

Table 4. External drivers identified in the literature review.

External drivers	**References**
Policies, regulations, and law	Calzolari et al. 2021, Govindan & Hasanagic 2018, Jia et al. 2020, Mehmood et al. 2021, Ostermann et al. 2021
Climate change and environment	Govindan & Hasanagic 2018, Mehmood et al. 2021, Moktadir et al. 2018, Tura et al. 2019
Resource scarcity	Tura et al. 2019,
Increased awareness of customers, customer demand	Jia et al. 2020, Tura et al. 2019

2.3.2 Identifying enablers for CSCM and CSC

This sub-chapter discusses the enablers found in the literature review. These are the factors that are essential for the implementation of circular supply chain management and circular supply chains. Table 5 presents the enablers identified in the literature review.

The most common identified enabler is collaboration throughout the supply chain. Another important one is technological and digital solutions. Khan et al. (2020) researched for enablers for circular supply chain. The most effective enabler was customer's attitude towards recycled products. As there needs to be demand for circular products the customer attitudes are particularly important to be able implement circular supply chains.

The next most influential enabler according to Khan et al. (2020) is top management commitment. This is an important enabler because nothing happens in an organization without the support of top management. Other influential factors included legislation and regulation and forming a circular business model. Legislation is an important enabler as it forces companies to act. To be able to implement circular supply chains having a circular business model is a necessity.

Sandvik & Stubbs (2019) found digital solutions to be a major enabler for circular supply chain. Circular supply chains require a lot of new innovations and digitalisation enables them. Bressanelli et al. 2021 digitalization includes many industry 4.0 based solutions such as blockchain, 3D printing, and internet of things (IoT). These digital solutions help to enable the transition to circular economy. According to Khan & Ali (2022) efficient technological solutions need to be found for waste management. Chen et al. (2022) studied the effects of technology on the adoption of circular supply chain management in their paper. Technological solutions that improve the automation of processes can enable the adoption of circular supply chains and supply chain management. According to Andra et al. (2023) lack of experience in using technologies may influence the adoption of circular supply chains- Hence, in addition to having efficient digital and technological solutions available, it is important to have staff who know how to operate with them.

Collaboration throughout the supply chain is an enabler mentioned multiple times in existing academic literature. Mishra et al. (2021) studied collaboration as an enabler for circular economy. As supply chain redesign is seen as a crucial enabler for circular economy (Hazen et al. 2021; Hussain & Malik 2020; Mishra et al. 2021), the collaboration throughout the supply chain is an important factor. Collaboration overall is an important enabler. Industrial symbiosis which means different industries collaborating together has been seen as an enabler (Dohale et al. 2023; Khan & Ali 2022).

According to Andra et al. (2023) traceability is major enabler for circular supply chains. Previous literature has seen traceability as important for sustainable supply chain management and tracking the supply chains is a very current topic in the field of sustainability.

Table 5. Enablers identified in the literature review

Enablers	**References**
Technological and digital solutions	Andra et al. 2023, Bressanelli et al. 2021, Chen et al. 2022, Khan & Ali 2022, Sandvik & Stubbs 2019
Customer's attitude towards recycled products	Bressanelli et al. 2021, Khan et al. 2020
Collaboration throughout the supply chain	Hussain & Malik 2020, Khan et al. 2020 Mishra et al. 2021, Nag et al. 2021, Ouro-Salim et al. 2023, Sandvik & Stubbs 2019
Demand for circular products	Khan et al. 2020
Supply chain redesign	Batista et al. 2018, Hazen et al. 2021, Hussain & Malik 2020
Supply chain flexibility	De Angelis et al. 2018
Mandatory legislation and other regulations	Bressanelli et al. 2021, Khan et al. 2020, Moktadir et al. 2018
Awareness of potential revenue gains of CE	Dohale et al. 2023
Awareness of cost savings	Dohale et al. 2023
Availability of training	Dohale et al. 2023, Moktadir et al. 2018
Sustainability awareness	Dohale et al. 2023
Industrial symbiosis	Dohale et al. 2023, Khan & Ali 2022
Right kind of infrastructure	Mehmood et al. 2021,
Top management support / commitment	Khan et al. 2020, Kozancaglu et al. 2020
Supplier adaptability	Nag et al. 2021
Traceability	Andra et al. 2023

2.3.3 Identifying internal and external barriers for CSCM and CSC

Barriers can be described as challenges that are preventing companies from behaving in a certain way. This sub-chapter discusses the internal and external barriers identified from previous literature. Table 6 and Table 7 present the different barriers found in the literature review. The barriers have been more widely studied than drivers and enablers. There are more barriers for implementing circular supply chains that there are drivers or enablers.

The most common internal barriers found in the existing literature were cost of implementation, lack of financial resources, and lack of skilled labour. On the other hand, the most common external barriers were lack of customer awareness, lack of collaboration and support from suppliers, and weak legislation. The implementation is a very costly process and even though circular supply chains can bring financial benefits eventually, many especially small companies cannot think far ahead and high investment costs of the implementation is a major barrier (Tura et al. 2019). According to Mehmood et al. (2021) finance is the most prominent barrier and due to the high cost of implementation, there is a need for governmental support for enterprises. Mehmood et al. (2021) highlight companies being profit-oriented and that often profit comes before environment. Also according to Govindan & Hasanagic (2018) high cost of implementation is a major barrier for circular supply chains, and as governments are reluctant to offer financial aid for the implementation, also lack of governmental support can be identified as a barrier.

According to Farooque et al. (2019) lack of collaboration throughout the supply chain was found as the most prominent barrier. In the previous sub-chapter collaboration was found as an enabler for circular supply chains. For supply chain to be circular, all stakeholders need to collaborate.

Common external barrier is the customers' willingness to pay higher price. In some industries sustainability is not valued remarkably high. In these industries it may be unprofitable to make circular products.

Existing literature finds weak environmental legislation the most common barrier (Farooque et al. 2019). According to Tura et al. (2019) some regulations in Finland even prevent circular solutions. Some fields also lack laws for circular solutions for manufacturing for example (Jia et al. 2020).

One of the most common internal barriers is lack of knowledge (Mehmood et al. 2021). Circular solutions require a lot of expertise. Sometimes the barriers depend on the industry. For example, according to Bhattacharya & Kalakbandi (2018) circular solutions require skilled labour also for tasks that no one wants to do. This may be common, especially in manufacturing. As technology is a major enabler for circular supply chains, there must be employees that know how to use the technology. Lack of skills related to technological solutions is a barrier for circular supply chains (Andra et al. 2023).

Waste management is a crucial part of circular economy as the concept is based on recycling and waste. Hence, one important barrier for circular supply chains is lack of efficient policies for waste management. According to Mehmood et al. (2021) there is a lack of waste management facilities and relevant technology for efficient waste management is not available for all. Especially developing countries lack efficient system for waste management and that can be a big barrier and in some areas laws for waste management do not support circular economy adoption (Govindan & Hasanagic 2018).

There are a lot of different infrastructural barriers for circular supply chains. Logistical issues are one of them (Andra et al. 2023). There is a connection to the enablers. Supply chain redesign is one of the enablers, and it can bring even more logistical and infrastructural challenges.

Table 6. Internal barriers identified in the literature review.

Internal barriers	**References**
Lack of economic benefits in the short run	Mangla et al. 2018, Masi et al. 2018
Lack of training and education	Jia et al. 2020, Kumar et al. 2019, Mangla et al. 2018
Lack of skilled labour	Agrawal et al. 2023, Andra et al. 2023, Bhattacharya & Kalakbandi 2018, Kazancoglu et al. 2020
Lack of awareness, knowledge	Kazangoclu et al. 2020, Kumar et al. 2019, Ouro-Salim et al. 2023, Masi et al. 2018
Cost of implementation	Ayati et al. 2022, Cikmak et al. 2023, Kazangoclu et al. 2020, Kumar et al. 2019, Masi et al. 2018, Mehmood et al. 2021
Lack of financial resources	Jia et al. 2020, Khan & Ali 2022, Kumar et al. 2023, Ouro-Salim et al. 2023, Shaikh et al. 2022, Sonar et al. 2023
Quality of recycled product	Ayati et al. 2022, Sandvik & Stubbs 2019,
Lack of top management commitment	Ayati et al. 2022, Shaikh et al. 2022, Sonar et al. 2023
Lack of efficient policies for waste management	Govindan & Hasanagic 2018, Mangla et al. 2018, Mehmood et al. 2021
Lower productivity	Sharma et al. 2019
Design challenges	Kazancoglu et al. 2020

Table 7. External barriers identified in the literature review.

External barriers	References
Lack of customer awareness	Agarwal et al. 2023, Bhattacharya & Kalakbandi 2018, Kumar et al. 2019, Mangla et al. 2018, Masi et al. 2018, Sonar et al. 2023
Uncertainty in demand / lack of demand	Ayati et al. 2022, Bhattacharya & Kalakbandi 2018, Kumar et al. 2019 Mangla et al. 2018
Lack of supplier collaboration/support	Farooque et al. 2019, Khan & Ali 2022, Shaikh et al. 2022, Sharma et al. 2019, Vermunt et al. 2019, Werning & Spinler 2020
Weak environmental legislation, policies	Ayati et al. 2022, Cikmak et al. 2023, Farooque et al. 2019, Kazancoglu et al. 2020, Kumar et al. 2019, Sandvik & Stubbs 2019, Sharma et al. 2019, Sonar et al. 2023, van Keulen & Kirchherr 2021
Lack of market pressure	Farooque et al. 2019, Sonar et al. 2023
Lack of available suitable supplier partners	Bressanelli et al. 2019., Kumar et al. 2019, Vermunt et al. 2019
Customer's willingness to pay higher price or willingness to buy a circular product	Bressanelli et al. 2019, Kumar et al. 2019, Tura et al. 2019
Infrastructural issues (e.g., logistics)	Andra et al. 2023, Kumar et al. 2023, Sharma et al. 2019, Sonar et al. 2023

2.4 Characteristics of Finnish circular market

As an economic market Finland is a small one. In this chapter Finland is described as a market because circular economy depends on the culture and legislation a lot. The implementation is very dependent on the area according to existing literature. For example, the barriers can depend on the area (Wei 2015).

In this chapter Finland is described briefly as an economic market by using PESTEL framework. PEST framework was first introduced by Francis J. Aguilar in 1967. PESTEL adds environmental and legal factors to the model. PESTEL is used in this chapter to provide an overview of the characteristics of Finnish market.

The first letter of PESTEL model stands for political. According to Finnish government Finland is a parliamentary republic. Finland has a parliament of 200 representatives. The Finnish government consists of 12 ministries and is led by prime minister.

The second letter stands for economics. According to the data of World Bank the most recent value of GDP per capita of Finland is 50,871.9. This is 24th in the entire world. Hence, it could be stated that Finland is quite economically stable area. According to Bank of Finland, Finland is in 2024 in recession. The recovery has started as inflation slows down and interests are going down as well. The unemployment rate is estimated to rise to nearly 8% in 2024. Finland's bank estimates the recovery from recession to be slow. According to Finland's labour force survey, the unemployment rate in February 2024 was 7.7%. According to Statistics Finland the inflation rate in Finland in February 2024 was 3.0%. Both the amount Finland exported and imported in 2022 was around 90 billion (46th out of 226) (OEC 2022).

The third letter stands for social. Socially Finland is a small market with the population of 5.6 million (114th in the world). According to the forecast made by Statistics Finland, the population will start to decline in 2031. There may be a need for example for occupational immigration in the future.

The fourth letter stands for technological. Finland has traditionally held a lot of technology companies and for example, a technology company Nokia helped Finland overcome the economic depression of 1990s. According to Technology Finland the technology industry is the most important export industry of Finland. Technological solutions have been seen as a major enabler for circular supply chains (Andra et al. 2023; Bressanelli et al. 2021; Chen et

al. 2022; Khan & Ali 2022; Sandvik & Stubbs 2019). Hence, technology being the most important export industry in Finland, may also affect the implementation of circular economy.

The fifth and sixth letters environmental and legal are intricately connected to each other. According to the ministry of foreign affairs, in 2021 Finland ranked first in international sustainable development ranking. Finland can be seen as one of the front runners when it comes to environmental issues. Environmental legislation is mostly based on EU directives and other international obligations.

The new Climate Act was adopted in July 2022. The act includes for example a carbon neutrality goal, emission reduction targets, and a planning system for a climate change policy. According to this climate act Finland aims to be carbon neutral by 2035. There is a plan for a long-term climate plan to be taken into action in 2025. (Ministry of the Environment 2024)

Finland has national regulations related to climate change mitigation. However, they are mostly based on EU regulations or obligations from United Nations Climate Convention. (Ministry of the Environment 2024) Due to the regulation mostly coming from the European Union and United Nations Climate Convention, the environmental legislation related to circular economy does not differ much from the environmental legislation elsewhere in Europe.

According to the Finnish Ministry of Environment (2023) Finland has a strategic programme to change the economy to one based on circular economy by 2035. Previous literature saw governmental support (Bressanelli et al. 2021; Moktadir et al. 2018) as one of the enablers for circular economy. Finland's government has prepared many different incentives to promote circular economy. Finland is part of the European Union and according to Marjamaa et al. (2021) for especially ministries and regional councils following the EU legislation and environmental legislations in general are major motivators to implementing circular economy incentives.

Previous literature highlights the role of consumer attitudes (Bressanelli et al. 2021; Khan et al. 2020). According to a study made in Finland based on consumer attitudes, consumers may not work as an efficient driver to circularity. It was found that in Finland younger people

tend to be more open to responsible and circular products. However, there is the issue of self-responsibility. Younger generations are varying of that. (Mykkänen & Repo 2021)

One of the issues related to Finland specifically is the size of the market. Finland is such a small market, and the customer base is exceedingly small, and this results in a situation where the investments needed to implement circularity may be unprofitable (Tura et al. 2019).

Sitra has published a report called Leading the cycle: a Finnish roadmap to circular economy 2016-2025. Finland's government set a target of making Finland a leader in circular economy by 2025. In other words, Finland has ambitious goals related to circular economy implementation.

3 Methodology and data collection

The aim of this study is to research on what kind of drivers, enabler, and barriers there are to the implementation of circular supply chains in Finland. This chapter describes the chosen methodology as well as data collection process of this study. Lastly, the liability of this study is considered.

3.1 Research design and data collection

The topic of circular supply chains has been previously researched as shown in table 2 by both qualitative and quantitative methods. A lot of literature reviews have also been conducted. Qualitative methods have been more frequently used which led into primarily using quantitative methods. However, the study is not purely quantitative as it also contains qualitative methods. Hence, the study is conducted as a mixed methods study. According to Mertens (2023, 2) many researchers have found that using a single research method is not adequate. For that reason, mixed methods approach has gained popularity among researchers. The quantitative statistical testing is done by using a program STATA/SE 18.0.

Quantitative and qualitative methods have different characteristics. Quantitative data is numeric whereas qualitative data is based on either written or spoken text. Quantitative data is analysed by diagrams and statistical methods whereas qualitative data is analysed by conceptualisation (Saunders et al. 2016, 569). Questionnaire was chosen to collect new numeric data. Interviews were chosen as the data collection method for the qualitative research as the timeframe for conducting the data collection for qualitative research was tight.

As previously stated, this study consists of both quantitative and qualitative data. Hence, they must be analysed through different data analysis methods. Chosen methods are variance analysis (ANOVA) and content analysis.

Variance analysis is a statistical method. It is used to compare the means of two or more groups. The aim is to find whether there is a statistically significant difference in the means (Mattila 2021). There are four assumptions to be associated with variance analysis. These are random sampling, independence, homogeneity, and normality (Doncaster & Davey 2007, 14). As seen in the analysis of the statistical testing, not all these assumptions are valid in this study. This makes the results of this study more indicative that generalizable.

Content analysis has three distinct categories. The one utilized in this study is theory-driven content analysis. Theory-driven content analysis means that the data is first analysed in a way that answers to the research questions are found. Only after this the data is compared to an existing theory. (Tuomi & Sarajärvi 2018) In this study the data is first analysed and after that it is compared to existing academic literature in the discussion portion.

3.1.1 Questionnaire

The data collection for the quantitative analysis was made by a questionnaire. This questionnaire was made using a program Qualtrics. The respondents were carefully selected by criteria. The company had to be from an industry where circularity is possible to be implemented in the supply chains, the company must have operations in Finland, and the person answering the questionnaire must hold a position where they have enough information about the topic of the study. The respondents were searched via LinkedIn, company websites, and other public sources. To improve response rate the questionnaire was made as short as possible, any open answer questions were excluded, it was provided in both Finnish and English, and it was possible to take completely anonymously.

The questionnaire consisted of four sections. These were background information, drivers of circular supply chains, enablers of circular supply chains, and barriers of circular supply chains. Questions 1-5 were asked for descriptive purposes and to increase the liability of the research. In addition to the descriptive questions, the questionnaire had 43 statements which were divided into three categories: drivers, enablers, and barriers. The statements are based on the existing academic literature. References for the statements are provided in the tables 3, 4, 5, 6, and 7. These three questions were created in a matrix form, and they had a 7-point scale (1 = not at all, 7 = very much). The questionnaire in its English form is available in appendix 1.

The questionnaire was sent to 150 potential respondents via email. More companies were considered but relevant contact information could not be found. The questionnaire was accompanied by a cover letter explaining the purpose of the research. The questionnaire was opened in December 2023 and closed in January 2024. In total it was open for eight weeks to provide enough time to respond. The Holidays had to be taken into consideration and hence there was around two weeks where there were no new responses. Three reminder messages were sent during the eight-week period. In total 62 responses were received. All questions were made mandatory to answer. Hence, all 62 responses were usable. The response rate is 41.3%. The response rate is satisfactory. However, it must be noted that the statistical analysis is more reliable the more there are answers. Hence, qualitative data is also utilized in the study to improve the reliability.

3.1.2 Interviews

The qualitative part of this study was conducted by holding semi structured interviews. Semi structured means the questions were prepared in advance and the questions remained the same for all the interviewees. However, there is room for additional questions and comments and for example the order of the questions can be changed (Hirsjärvi & Hurme 2015). Semi structured interviews are possibly the most used qualitative method, as it allows for the researchers to change the order of the questions and ask more questions on specific details if needed (Alasuutari 2011).

The interviewee selection was done by contacting people who had answered the questionnaire and showed interest towards the study. They were familiar with the aim of the study as they had already answered the questionnaire.

The interviews were conducted as individual interviews through Microsoft Teams platform in January and February 2024 right after the questionnaire had been closed for responses. All interviewees were informed about the purpose of the interviews, recording the interview and transcription of the interview. The interviews were automatically transcribed by the transcription tool of Microsoft Teams.

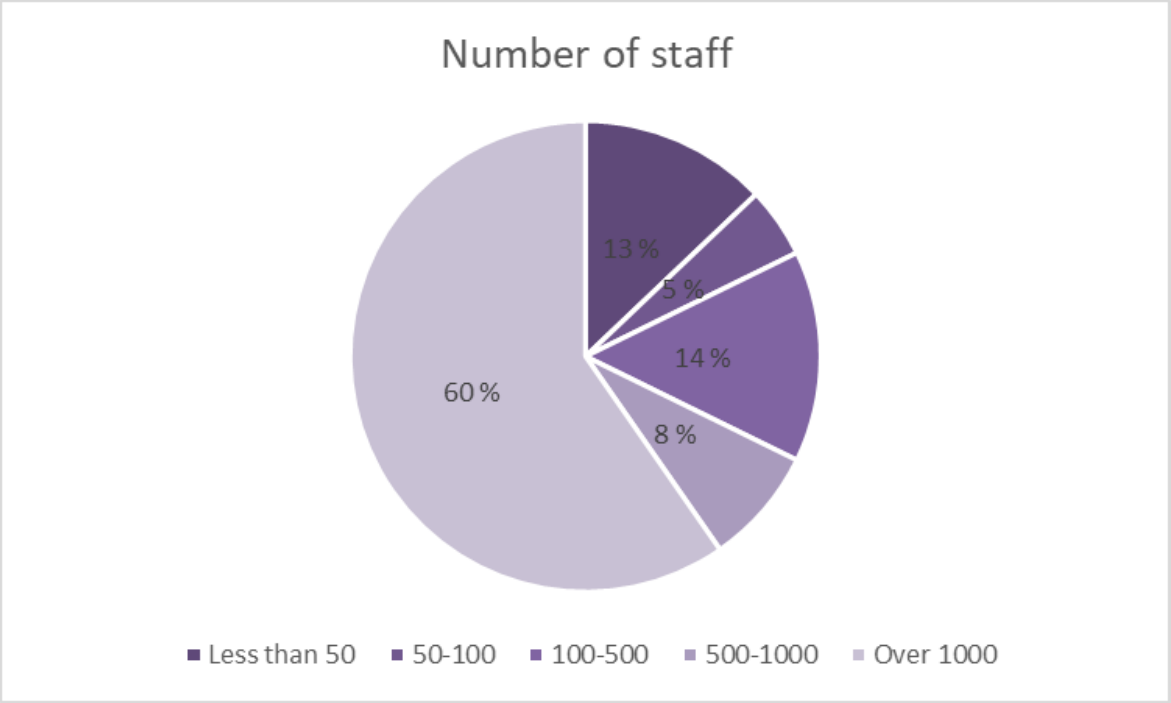
The interviews were kept short, and the length varied between 14 and 24 minutes. There were four interviewees who represented four different companies. The interviewees were

sustainability professionals or operational professionals. The interview questions were sent to the interviewees in advance to enable them preparing. The interviewees were prepared which also helped to keep the interviews short. Interviews were held in Finnish which was the first language of all the interviewees. Using foreign language can in interviews can lead into false responses and people are able to express their opinions better while using their first language (Welch & Piekkari 2006). Hence, the interviews were held in Finnish. All interview questions were asked in the order of the interview structure which is available in appendix 2.

In total four interviewees were interviewed. Table 9 describes the interviewees. One of the interviewees was top management level, one was middle management level, and two were specialists. The interview questionnaire consisted of the same four sections than the quantitative questionnaire. The first section consisted of descriptive questions and the second, third, and fourth sections consisted of questions of drivers, enablers, and barriers of circular supply chains. The interview questionnaire was built to support the quantitative questionnaire.

3.2 Overview of the data

This section gives an overview of the data collected for the study. As written before both quantitative and qualitative data was collected. These are described separately. First the quantitative data is described.



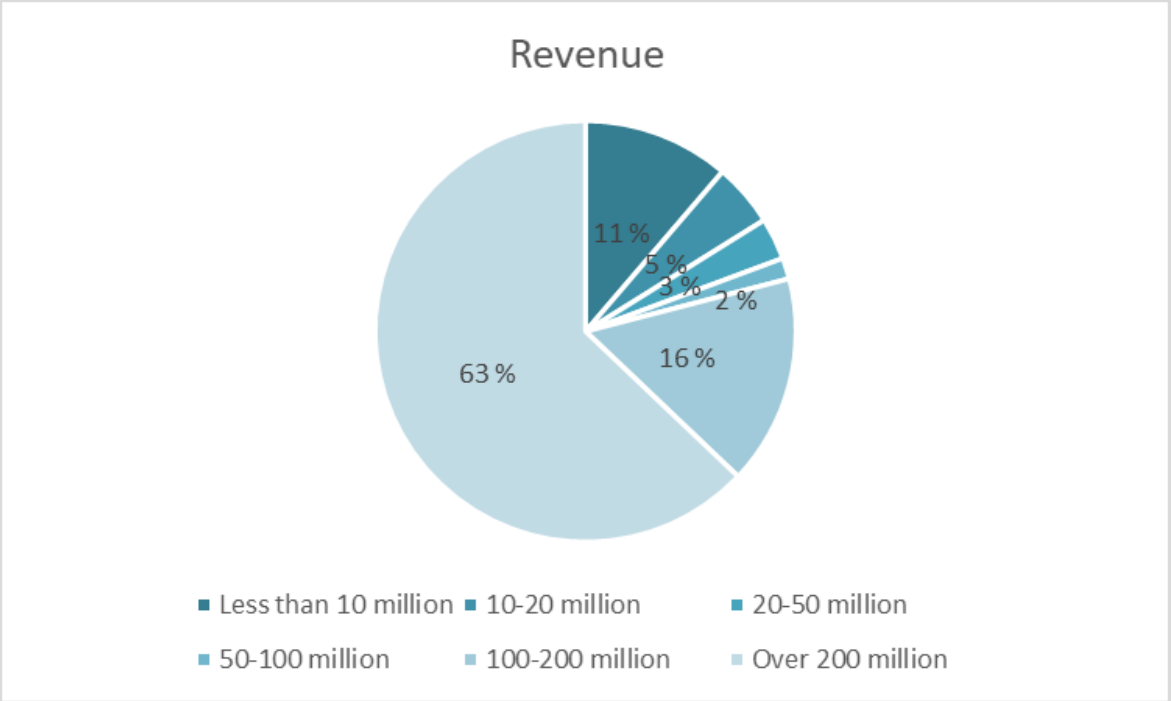


Figure 5. Number of staff and revenue.

Most of the respondents work in large companies. As seen in figure 5. 63% of the respondents work in a company that has a revenue of over 200 million euros and 60% of the respondents work in a company with a staff of over 1000 people. On the other hand, only 11% of the respondents work in a company that has a revenue of less than 10 million euros and only 13% of the respondents work in a company with a staff of less than 50 people. 56%

of the respondents work in a management level role. This gives reliability to the research. However, many of the respondents working in specialist roles have specific specialization in circular economy. Hence, they have a lot of knowledge related to the topic of the research.

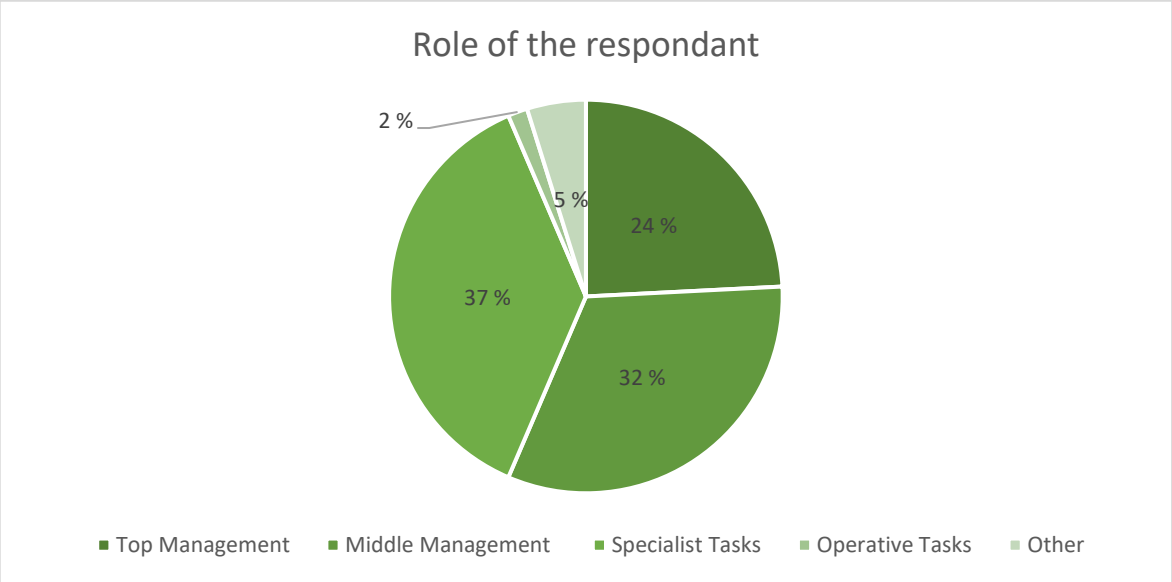


Figure 6. Role of the respondent.

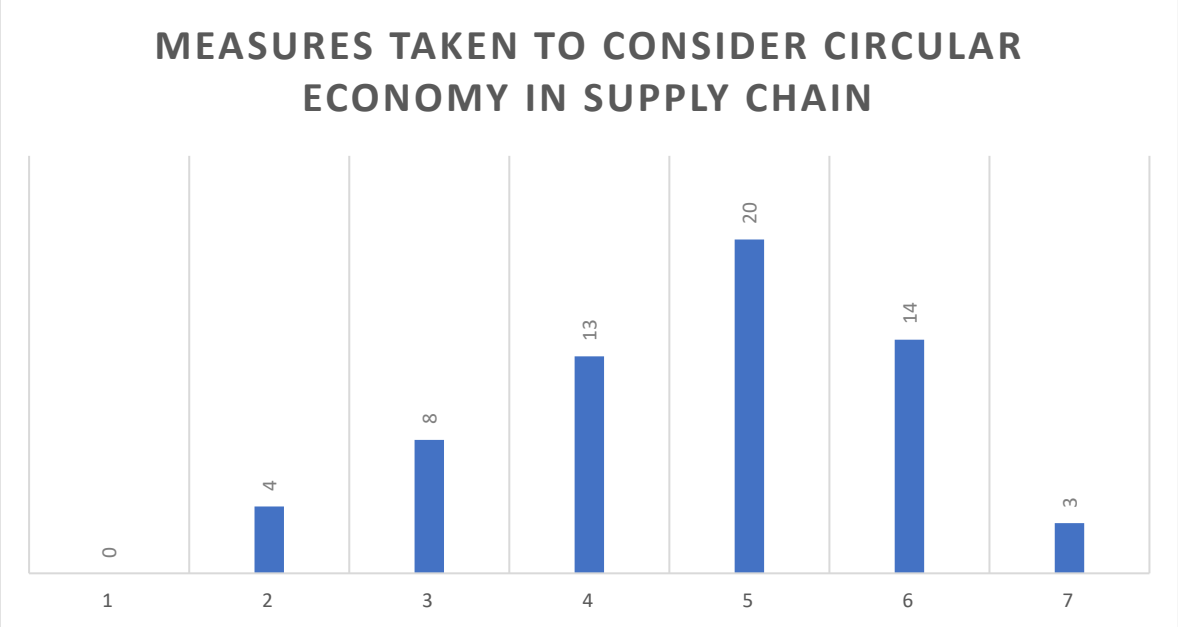


Figure 7. Measures taken to consider circular economy in supply chain.

The industry of the company was asked. It was asked in a very vague level to make sure the companies stay anonymous. This led into 58% of the respondents being from manufacturing companies and other industries had all less than 10% of the respondents. Hence,

manufacturing companies are compared to all other industries together. Last background question asked was whether the company has taken measures to consider the circular economy in their supply chain. This was asked in a 7-point scale where 1 meant not at all and 7 meant very much. The mean was 4.66. The minimum answer was 2 and the maximum 7. 60% of the respondents answered 5 or more. 19% answered 3 or less. In other words, significantly more of the respondents were from companies that have taken significant measures to consider the circular economy in their supply chain.

3.2.1 Variables

Next the variables used in the statistical analysis are presented. In total nine variables were created in factor analysis. To be able to create sum variables, the statements should have a loading of at least 0.5 (but when data size is this small, preferably above 0.7). The uniqueness level should also be below 0.5. (Mattila 2021). The eigenvalue of the factors created should be above 1. The eigenvalue tells how much the factor can explain the dispersion between variables. Communality tells how much of the dispersion of one variable is explained by the factors created. Cronbach's alpha is a measure for reliability and should be above 0.7. (Mattila 2021) Eigenvalues, communalities, and Cronbach's alphas of created factors can be found in appendix 4.

First two variables were created from drivers of circular supply chains. 11 statements were presented in the questionnaire on scale from 1 to 7. The figure 8. shows the distribution between the answers. The figure shows the most important driver with a mean of 5.84 was statement 11. This was effects on the brand. On the other hand, the driver found least important was statement 7 with a mean of 4.40. This statement was resource scarcity.

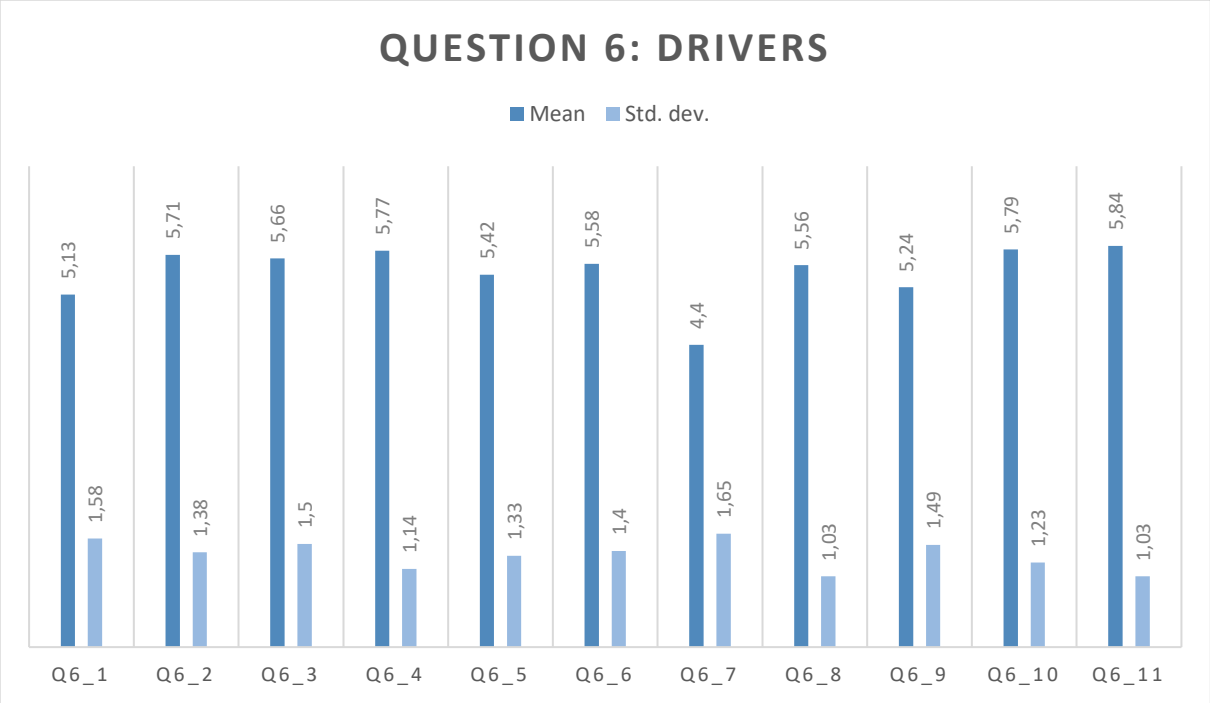


Figure 8. Means and standard deviation values of the statements of question 6

Factor analysis was performed for drivers and at first three factors were created. However, due to poor loading or double loading some of the statements had to be removed from the analysis. The removed statements had either loading below 0.5, they loaded for several factors, and it was not possible to tell which one they belonged to, or the uniqueness level was above 0.5. Due to the removing in the end only two factors were created. The first factor was named *organizational_drivers*. Cronbach's alpha for this factor is 0.82 which is quite good. The loadings of the statements varied between 0.68 and 0.85. They are all above the limit of 0.5. However, as this questionnaire had only 62 responses, the loadings should also be higher (above 0.7). All but one of the statements were above 0.7 and the one below it was close. The second factor for drivers was named *benefits_demand*. Cronbach's alpha for this factor is 0.75 which is lower than for the first one but still acceptable. Hence, the reliability of both factors is on an acceptable level. The loadings for this factor varied between 0.65 and 0.76. Again, all but one were above 0.7 and the one that was not was close. Both factors consist of four statements as three statements were removed from the review.

Next the factor analysis was performed for barriers and at first there were five factors. However, again statements had to be deleted due to poor loading or double loading and in

the end four factors were created. For barriers 18 statements were presented in the questionnaire again with a scale from 1 to 7. The figure 9 shows the distribution of the answers. The most important barrier with a mean of 5.03 was statement 14. This statement was uncertainty on customer's willingness to pay higher price for a circular product. On the other hand, statement 15 with a mean of 3.24 was found to be the least important barrier. This statement was lack of top management commitment.

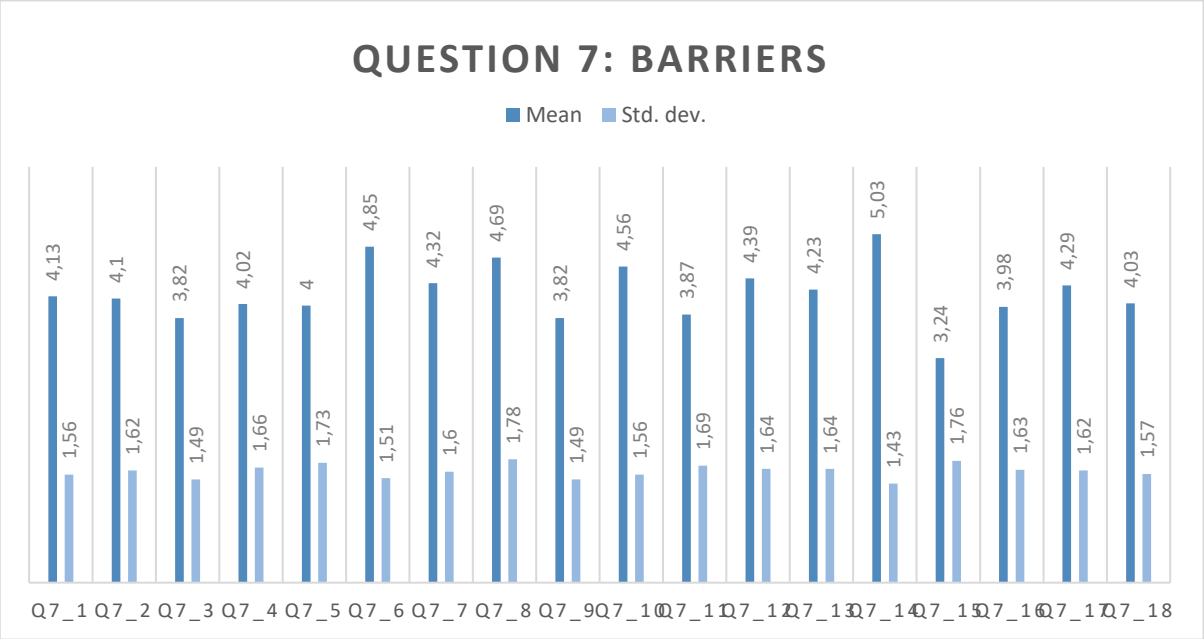


Figure 9. Means and deviation values of statements of question 7

The first factor was named *lacking_aspects* and it has a Cronbach's alpha of 0.91 which can be considered particularly good. The first factor consists of three statements and the loadings varied between 0.88 and 0.90. The second factor was named *financial_barriers*. It has a Cronbach's alpha of 0.81 which is quite good, and it consists of four statements. In this factor two statements had a loading below 0.7 but above 0.6. Removing them would not have affected Cronbach's alpha significantly. Hence, they were not removed. The third statement was named *supplier,* and it includes two statements. Originally a variable named *supplier_quality* was created, and it included also a third statement. However, by removing statement 8 the Cronbach's alpha was raised from 0.71 to 0.81 and the uniqueness of statement 8 was near the 0.5 limit. For these reasons statement 8 was removed from the review even though the initial plan was to keep it in. The last factor created from the barriers

was named *infrastructure_market.* This factor consists of three statements, and it has a Cronbach's alpha of 0.71. This is lower than the other factors have. However, it is still acceptable, and the reliability of the factors made of the barriers can be considered as acceptable.

Lastly the factor analysis was performed for the enablers. In the questionnaire 14 statements were presented and this portion had the scale from 1 to 7. Figure 10. shows the distribution of the answers. The most important enablers with a mean of 5.58 is statement 3 which is collaboration throughout the supply chain. The least important enabler is statement 10 with a mean of 4.32 which is trainings on the topic.

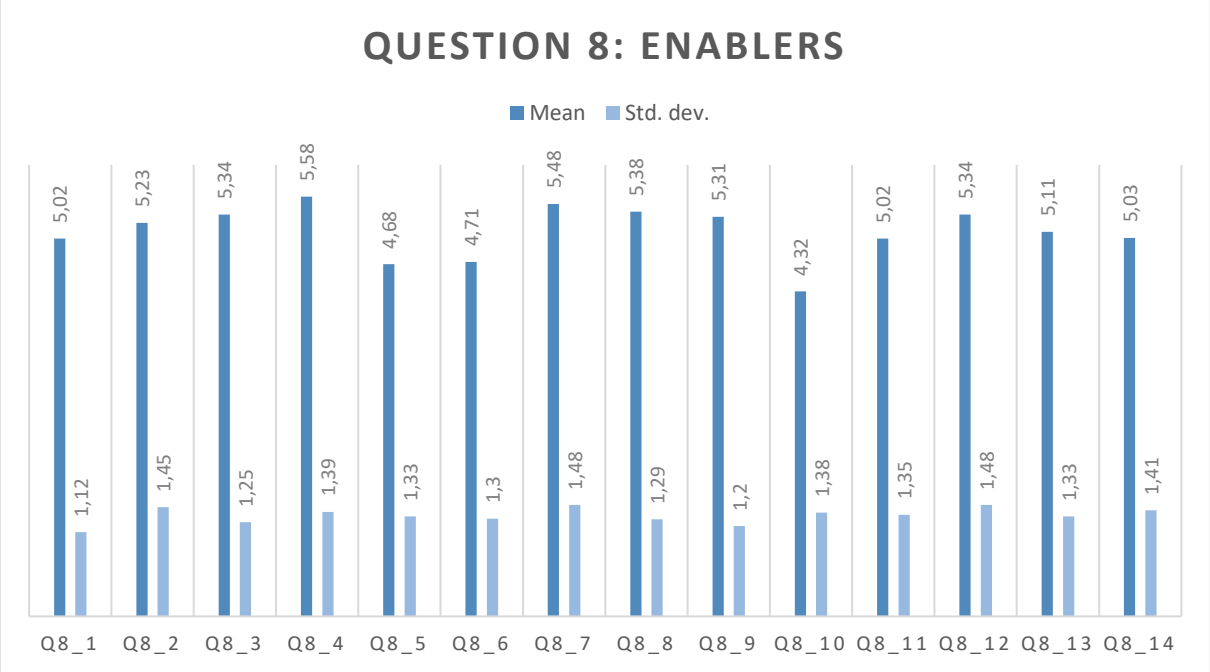


Figure 10. Means and deviation values of statements of question 8

In total three factors were created. The first one consists of four statements and was named *technology_supplychain.* It has a Cronbach's alpha of 0.86 which can be considered good. The second factor was named *awareness,* and it consists of four statements. This factor has a Cronbach's alpha of 0.78. The last factor created from the enabler statements was named *stakeholders*. It also consists of four statements and has a Cronbach's alpha of 0.77. Also, these factors can be considered reliable. Table 8 presents information about the variables. The full results of the factor analysis can be found in the appendix 4.

Table 8. Summary of the variables

Variable	SD	Mean	Min	Max	N
Organizational_drivers	.9576313	5.705645	3	7	62
Benefits_demand	1.130206	5.403226	2.5	7	62
Lacking_aspects	1.499476	4.350806	1	7	62
Financial_barriers	1.252424	4.129032	1	6.75	62
Supplier	1.530926	4.129032	1	7	62
Infrastructure_market	1.278359	4.102151	1	6.666667	62
Technology_supplychain	1.067927	4.854839	1.75	7	62
Awareness	1.041256	5.08871	1.75	7	62
Stakeholders	1.058914	5.290323	2.5	7	62

3.2.2 Interview data

The second part of the data in this study was collected by conducting interviews. There were four interviewees from four different companies. All interviewees had also answered the questionnaire. Hence, they were familiar with the other part of the study as well. Three of the companies were from manufacturing and one was import/wholesale company. They all hold positions related to operations, procurement, or sustainability. The information from companies is used in a way the company cannot be identified. Table 9. gives an overview of the interviewees.

Table 9. Interviewees

Interviewee	**Title**	**Field**	**Length of the interview**
Interviewee A	Sustainability Manager	Import, wholesale	18:54
Interviewee B	Operations Director	Healthcare equipment	16:58
Interviewee C	Development Manager, Sustainable Procurement	Manufacturing	14:11
Interviewee D	Chief Operating Officer (COO)	Construction industry	23:55

3.3 Reliability and validity

In this subchapter the reliability and validity of the study are briefly assessed. It is important to assess them as all studies have reliability and validity issues (Tuomi & Sarajärvi 2018). Reliability of quantitative study differs from the reliability of qualitative study. Reliability means accuracy of the results (Alasuutari 2011). Reliability of both parts of the study is good. Methods for analysing the data were carefully selected. Reliability of the quantitative analysis is lowered by the small number of respondents. It has been considered while analysing the results. Qualitative analysis relies on subjective opinions. Reliability of the qualitative analysis has been increased by using direct quotes from the interviewees. The interviews were also recorded and transcribed. This makes the study more trustworthy. The validity of the study improves from the usage of mixed method study. To make the results and data stronger, the data should be collected from different sources (Zohrabi 2013). In this case the data was collected through a questionnaire and interviews. Validity means that the conclusions made are accurate relating to the research (Tuomi & Sarajärvi 2018).

4 Results

This chapter presents the results of this study. The data collected is in this chapter analysed separately. First are presented the results of statistical testing. After that, the results of theory driven content analysis are presented. The results are analysed and discussed together in chapter 5 to be able to draw conclusions in chapter 6.

4.1 Results of one-way ANOVA

The quantitative data of the study was collected by questionnaire. In this sub-chapter the results of one-way ANOVA are ´presented. There is an issue with the data. One of the requirements for variance analysis is for the variables to be following normal distribution. However, the appendix 5. shows that not all the variables follow normal distribution. This is probably due to the small number of responses. There are only 62 responses which affect the normal distribution.,

In this thesis two different variations of ANOVA are used: Oneway ANOVA and two-way ANOVA. First, one-way ANOVA was used. The dependent variable was always one of the sum variables created for the factor analysis. The independent variable is in this case the measures companies have taken to consider circular economy in their supply chains. This was question 5 in the questionnaire and it had a scale from 1 to 7 with 1 being not at all and 7 very much. As none of the respondents answered 1, there are six categories in this variable.

Variance analysis aims to describe whether there is a statistically significant difference in the means of variable in correlation with the mean of another variable. First the one-way test was performed for the *organizational_drivers* sum variable. Table 10 shows the analysis of variance. As can be seen the f-test shows that Prob>F is 0.0000 which is below 0.05. This means there is a statistically significant association between the measures to consider circular economy in supply chains and the sum variable *organizational_drivers.* The null hypothesis of the equality of means can be rejected.

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Table 10. One-way ANOVA organizational_drivers

Analysis of variance

Source	SS	df	MS	F	Prob > F
Between groups	25.5798958	5	5.11597915	9.44	0.0000
Within groups	30.3606284	56	.542154079		
Total	55.9405242	61	.917057774		

Next the other driver-based sum variable *benefits_demand* was tested. As can be seen in table 11. the f-test gave a result of 0.0002. This also means this sum variable has a statistically significant association with the measures to consider circular economy in supply chains. Also in this case, the null hypothesis can be rejected.

Table 11. One-way ANOVA benefits_demand

Analysis of variance

Source	SS	df	MS	F	Prob > F
Between groups	27.0913672	5	5.41827344	5.97	0.0002
Within groups	50.8279876	56	.907642636		
Total	77.9193548	61	1.27736647		

As the barrier-based sum variables were tested, only one of them had a Prob>F that was below 0.05. This means that only one of the sum variables based on barriers had a statistically significant association with the measures to consider circular economy variable. Tables 12, 13, 14, and 15 show the results of the one-way tests performed for the barrier-based sum variables. Sum variable *lacking_aspects* has a p value of 0.0072 which is below 0.05. Hence, there is a statistically significant association, and the null hypothesis can be rejected. Otherwise, all the barrier-based sum variables have p values above 0.05. This means that there is no statistically significant association between those variables and the measures to

consider circular economy in supply chain variable. The null hypothesis of the equality of means remains valid.

Table 12. One-way ANOVA lacking_aspects

Analysis of variance

Source	SS	df	MS	F	Prob > F
Between groups	33.0966444	5	6.61932888	3.56	0.0072
Within groups	104.057477	56	1.85816923		
Total	137.154121	61	2.24842822		

Table 13. One-way ANOVA financial_barriers

Analysis of variance

Source	SS	df	MS	F	Prob > F
Between groups	11.6719228	5	2.33438456	1.56	0.1876
Within groups	84.0105369	56	1.50018816		
Total	95.6824597	61	1.56856491		

Table 14. One-way ANOVA supplier

Analysis of variance

Source	SS	df	MS	F	Prob > F
Between groups	18.0238088	5	3.60476176	1.62	0.1709
Within groups	124.943933	56	2.23114166		
Total	142.967742	61	2.34373347		

Table 15. One-way ANOVA infrastructure_market

Analysis of variance

Source	SS	df	MS	F	Prob > F
Between groups	13.9640458	5	2.79280917	1.82	0.1229
Within groups	85.7223332	56	1.53075595		
Total	99.686379	61	1.63420294		

Tables 16, 17, and 18 show the results for variance analysis for the enabler-based sum variables. *Technology_supplychain* has a p value of 0.0187. This means that there is a statistically significant association, and the null hypothesis can be rejected. On the other hand, sum variable *awareness* has a p value above 0.05. Hence, there is no statistically significant association, and the null hypothesis remains valid. The third sum variable *stakeholders* has a p value of 0.0072. This is below 0.05 and thus it does have a significant association with the variable, and the null hypothesis can be rejected.

Table 16. One-way ANOVA technology_supplychain

Analysis of variance

Source	SS	df	MS	F	Prob > F
Between groups	14.6177643	5	2.92355286	2.98	0.0187
Within groups	54.9507841	56	.981264002		
Total	69.5685484	61	1.14046801		

Table 17. One-way ANOVA awareness

Analysis of variance

Source	SS	df	MS	F	Prob > F
Between groups	9.29434265	5	1.85886853	1.83	0.1215
Within groups	56.8427541	56	1.01504918		
Total	66.1370968	61	1.0842147		

Table 18. One-way ANOVA stakeholders

Analysis of variance

Source	SS	df	MS	F	Prob > F
Between groups	16.5207251	5	3.30414503	3.57	0.0072
Within groups	51.8784684	56	.926401222		
Total	68.3991935	61	1.12129825		

4.2 Results of two-way ANOVA

Two-way ANOVA was performed using the other background information questions from the questionnaire. The background information questions in the questionnaire were questions 1-4. These asked the revenue, number of staff, role of the respondent, and the field of the company. First, two-way ANOVA was performed to all the sum variables using revenue and field of the company as exploratory variables. After that two-way ANOVA was performed to all the sum variables using number of staff and role of the respondent as exploratory variables. None of the two-way ANOVAs performed had a statistically significant p-value. This indicates that revenue, number of staff, role of the respondent or the field of the company do not have an association with drivers, enablers, or barriers for circular supply chains and all the null hypotheses related to these remain valid. Two-way ANOVAs performed are presented in the appendix 6.

However, it must be remembered that there are some limitations which may affect this result. The factors created do not follow the normal distribution. In addition, as previously mentioned in chapter x, most of the respondents were from large companies from the field of manufacturing. For example, the field variable has very few respondents in other categories than manufacturing. For these reasons, the statistical testing in this thesis gives only indicative results and they cannot be generalized.

4.3 Results of the content analysis

The qualitative data of the study was collected through four interviews. Table 9. describes the interviewees. At first the interviewees were asked whether their company takes circular economy or circularity into account in their supply chains. After that, the questions were divided into three themes: drivers, enablers, and barriers of circular supply chains.

4.3.1 Circular economy and the company

Interviewee from Company A started by describing their business model as it differs from the other interviewees who all work for manufacturing companies. Company A imports goods to Finland. Hence, a lot of responsibilities related to sustainability are in the hands of the manufacturers. They do also manufacture some of their products but only a small amount. The company still does consider sustainability and circular economy in their business. For example, sustainability is considered when choosing new products to import. Circularity is considered especially in packaging materials and recycling.

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"In the products we manufacture in Finland circular economy is quite directly considered for example in using recycled material in packaging." (Interviewee A)

Company B's interviewee said that the company has considered circular economy and sustainability overall. As did interviewee A also interviewee B highlighted recycling. They

also mentioned refreshening the products to lengthen the life cycle. Also, making the products recyclable to a new customer has been considered but there is no clear business model for it yet.

"In a small scale we have had refreshing where we by repairing try to make [a product] again usable. Possibly also for a new customer." (Interviewee B)

Company C's interviewee said that circular economy is considered in their own actions as well as in the supply chain in many ways. One way is using waste materials and branch currents from processes as materials. The topic is studied constantly and new ways to use waste are searched. Circular economy shows also in indirect purchasing, for example in working clothes. They mention collaboration in the supply chain as well.

"We obligate our suppliers to accept our code of conduct and it contains themes relating to circular economy." (Interviewee C)

Company D's interviewee tells that the company itself is based on circular economy. Their business model is based on using waste and branch currents as an alternative solution for a material that creates a lot of emissions.

"In the sense we take circularity into account that our solution is based exactly on waste and branch currents and utilizing them as a part of construction. "(Interviewee D)

4.3.2 Drivers of circular supply chains

The first theme of the interview was drivers of circular supply chains. The interviewees were asked what kind of aspects motivate and drive their company towards circular supply chains. After that they were asked to clarify which aspect they see as the biggest driver.

Every interviewee mentioned the environment, reducing emissions, and overall sustainability as a driver. However, none of the interviewees saw it as the biggest driver. Interviewees A, B, and D saw customer demand and demand for the products as the biggest driver. Interviewee C saw strategic vision as the biggest driver. In a way it is in line with the other answers as the vision is most likely based on the views of customers.

"Demand is where our focus is. If people do not buy, then we will not do it." (Interviewee A)

Interviewee C mentioned another particularly important driver legislation and regulation when asked about the most important driver. This driver was mentioned by half of the interviewees (interviewees A & C). Interviewee A spoke about regulation giving a platform to all sustainability activities the company does.

" Amount of legislation grows all the time and there are clear obligations relating to circular economy in the legislation which we must obey." (Interviewee C)

Another driver where interviewees A and C agreed was financial benefits. Interviewee A believes that circularity in the supply chain can bring cost savings. When there is less material used due to the possibility of reusing material it brings down not only material costs but also transportation costs. Table 19. summarizes the drivers found in the interviewees.

Table 19. Drivers found in the interviews.

Interviewee	Drivers	Main driver
A	• Overall sustainability • Customer demand • Cost savings • Regulation	• Customers and their wishes
B	• Environmental and emission reduction goals • Customer demand	• Customers and their wishes
C	• Environment friendliness and emission reduction • Financial benefits • Legislation • Strategic commercial choice	• Supporting strategic vision
D	• Environment • Customer demand	• Customers and their wishes

4.3.3 Enablers of circular supply chains

The second theme of the interview was enablers of circular supply chains. The interviewees were asked what kind of aspects enable the implementation of circular supply chains. After that they were asked to clarify which aspect they see as the biggest enabler.

The most mentioned enabler was regulation, mandates, and legislation which was mentioned by most of the interviewees (interviewees A, C & D). Interviewee D spoke about the importance of mandatory standards.

"There should be mandates because they are mandatory to implement. Because without them we are unable to develop technology. When there are mandates new operators and competition comes by force. Then greener solutions are considered and used. But as long as it is not mandatory, the existing and cheapest option is chosen." (Interviewee D)

Aside from regulation the answers varied. Interviewee A spoke about industrial symbiosis and collaboration throughout the supply chain. Circular economy needs work from each part of the supply chain. For example, it does not matter if the company manufactures a completely sustainable shampoo bottle if at the end of the chain some waste management company just burns all the waste. Also, interviewee B mentioned as an enabler that circular economy is considered from the very beginning of the chain.

"Circular economy is in a way interesting because it is a system. We cannot do anything alone." (Interviewee A)

Interviewee B emphasized top management support as the most important enabler. This is important to get money to invest in the implementation. Also, interviewee A raised money as one of the most important enablers.

"Even if you have the best idea, if you are unable to get the blessing from the top management it will stay as just an idea." (Interviewee B)

Interviewee C considered the development of technology and new innovations as the most important enabler of circular supply chains. They also spoke about how there are so many novel solutions related to circular economy. However, interviewee C especially considered it difficult to choose the most important enabler as there are so many enablers and they are in ways connected. Table 20. summarizes the enablers found in the interviews.

Table 20. Enablers found in the interviews.

Interviewee	Enablers	Main enabler
A	• Industrial symbiosis • Collaboration throughout the supply chain • Investments/money • Regulation	• Money
B	• Considering circular economy throughout the whole life cycle of the product • Demand • Top management support	• Top management support
C	• Development of technology • Innovations • New circular solutions • Regulation	• Development of technology, innovations
D	• Mandates, regulation • Open culture	• Mandates, regulation

4.3.4 Barriers of circular supply chains

The third and final theme of the interview was barriers of circular supply chains. The interviewees were asked what kind of aspects are challenging for the implementation of circular supply chains. After that they were asked to clarify what aspect, they see as the biggest barrier.

All four of the interviewees spoke about the financial challenges. Interviewee A highlighted the worry about customers' willingness to pay higher prices for more sustainable products.

"It is easy to say I want [a more sustainable product] and I like [sustainability] as a value but when the purchasing decision should be made it becomes more challenging." (Interviewee A)

Interviewee B also spoke about the need for demand and market for circular products. The market cannot be created from nothing. There must be a demand. Interviewee D, on the other hand, emphasized the current recession in Finland. It has a big effect on customers' liquidity.

"It is very challenging to sell a new concept and a new more expensive option, when companies are struggling every day with staying afloat." (Interviewee D)

Both interviewee A and C mentioned regulation as a barrier. Interviewee A spoke about the changes in regulation. As there are a lot of changes it may be difficult to estimate what kind of obligations are coming. Interviewee C spoke about there being specific obligations in manufacturing and sometimes there are no available solutions to be able to obey the requirements. Also, interviewee D spoke about the availability of solutions.

Interviewees B and C spoke about the knowledge and skills inside of the company. Interviewee B did not see it as that bad of a barrier as the staff can always be trained. Interviewee C considered it important that knowledge and knowhow relating to circular economy is raised inside the organization.

Interviewee C highlighted the uncertainty of supply chains and especially the global supply chain as a barrier. They also spoke about barriers varying depending on whether thinking about direct procurement or indirect procurement or downstream or upstream supply chain.

Interviewee B is from a company where circular economy is not considered as much yet as in the other interview companies. Hence, interviewee B spoke a lot about different barriers.

According to them the company's products' current design does not necessarily support circular thinking. As the main barrier they mention creating a circular business model that works. It is also difficult to create a green or sustainable culture inside the corporation.

"Still one can hear comments that it is more rational to sell a new one [product] than to repair an old one." (Interviewee B)

The barriers differed between the interviewees. One reason may be that the companies are at quite various levels on circular economy implementation. Table 21. summarizes the barriers found in the interviews.

Table 21. The barriers identified in the interviews.

Interviewee	**Barriers**	**Main barrier**
A	• Customers' willingness to pay higher price. • Lack of resources • Regulation	• Demand and customers' willingness to pay higher price
B	• Current design of the product • Profitability • Creating a working circular business model. • Lack of knowledge and skills	• Creating a working circular business model
C	• Uncertainty of the global supply chain • Regulation • Lack of financial resources • Lack of knowledge and skills	• Uncertainty of the global supply chain
D	• Recession / financial situation in Finland • Availability of solutions • Lack of financial resources	• Recession / financial situation in Finland

5 Discussion

In this chapter the research questions are answered. The results of statistical testing and content analysis are combined and analysed together. They are also reflected to existing academic literature. This study contains one main research question and three sub-questions. Each of these are answered based on the statistical results, content analysis results, and academic literature to ensure the questions have been answered thoroughly and carefully.

Companies value environmental values and as seen in figure 7. 60% of the questionnaire respondents answered on a 1 to 7 scale 5 or above when asked about the measures taken to consider circular economy in the supply chain of the company.

The main research question of the study is following:

What are the key factors affecting the adoption of circular supply chain management and circular supply chains in Finland?

The empirical analysis of this study revealed that there are several factors affecting the adoption of circular supply chain management and supply chains in Finland. There was a statistical correlation found in the means of the measures companies have taken to consider circular economy in their supply chain. Both driver factors, most enabler factors, and one of the barrier factors had a p value below the limit. Hence, it can be argued that the factors found important depend on the level of the current circular economy adoption. On the other hand, there was no statistically significant association between any of the background questions and the sum variables created. Two-way ANOVA was used to test whether the background information collected with the questionnaire has an association with the factors created. The null hypotheses remaining valid would mean that revenue, number of staff, role of the respondent, or field of the company are not factors affecting the implementation of circular supply chains. However, as stated previously the results of the statistical testing are only indicative and it may be that in more diverse

Based on the empirical analysis companies are driven to adopt circular supply chains especially by environmental values, brand image, opportunities, and customer demand. Barriers found in the empirical analysis relate mostly to cost of the implementation and customer demand. The analysis also found some enablers that enable the adoption of circular

supply chains. Enablers for circular supply chains in Finland include regulation, collaboration / industrial symbiosis, and financial resources.

Three sub-questions were defined to help answering the main research question. The first sub-question is following:

What are the most important drivers for circular supply chain management and circular supply chains?

Empirical analysis found many important drivers. The most important driver found in the empirical analysis was customer demand and customers' wish. Nearly all interviewees found it the most important driver. This driver is also supported by existing literature (Jia et al. 2020; Tura et al. 2019). The questionnaire found effects on the brand as the most important driver. Even though it is not completely same thing, it is closely related to customer demand and wishes of the customers. Another important driver that was found especially important in both questionnaire and interviews is environmental values and overall sustainability. Interesting point is that even though every interviewee mentioned it and it scored the second highest in the questionnaire results, it still was not anyone's first choice. This is supported by existing literature (Govindan & Hasanagic 2018; Mehmood et al. 2021; Moktadir et al. 2018; Tura et al. 2019). Companies and customers want to be sustainable and value it highly. However, in the end profitability rises higher.

Other important drivers found in the empirical analysis were top management commitment and regulation. The latter was more highlighted in the interviews and the first one was more highlighted in the questionnaire. Existing literature supports especially regulation as a major driver (Calzolari et al. 2021; Govindan & Hasanagic 2018; Jia et al. 2020; Mehmood et al. 2021; Ostermann et al. 2021). This is natural as mandatory regulation forces companies to act. Top management commitment is also supported by existing literature to be a major driver (Jia et al. 2020; Ostermann et al. 2021; Ouro-Salim et al. 2023).

In statistical testing it was found that there was no statistical significance that size of the company or field of the company had any relation to the drivers for circular supply chains or that some field or size drove companies more towards circular economy. This may also be because of the small sample size and the answers being mostly from large companies and mostly from manufacturing.

There was a statistical significance that the level of measures taken to consider circular economy in supply chains has effect in the drivers. If the company has already implemented circular economy into their supply chain, it is more likely that the drivers have affected the company.

The results of the analysis indicate that external drivers affect the implementation more than internal drivers. This observation is supported by existing literature. According to Walker et al. (2008) most of the times external drivers drive organizations more than internal ones.

The second sub-question is following:

What are the most important barriers for circular supply chain management and circular supply chains?

Empirical analysis was able to find many important barriers. The most important barrier found in both interviews and questionnaire was customer's willingness to pay higher price and uncertainty in demand. As written about drivers, people want to be sustainable but are not always willing to pay for it. Interviewee D highlighted the poor financial situation in Finland as a major barrier. In a poor financial situation, it is difficult to get the customers pay more for a product that is more sustainable. Uncertainty in demand or lack of demand is supported by existing literature as a barrier (Ayati et al. 2022; Bhattacharya & Kalakbandi 2018; Kumar et al. 2019; Mangla et al. 2018). Demand and supply must meet. For that reason, lack of demand is a major barrier. Customers' willingness to pay higher prices is also supported by existing literature (Bressanelli et al. 2019; Kumar et al. 2019; Tura et al. 2019).

Another important barrier is the financial risk. In the questionnaire cost of the implementation rose to score second highest and in the interviews profitability and costs were mentioned by nearly all interviewees. Also, this barrier is related to the poor financial situation in Finland. Many companies currently are struggling to stay afloat and hence prohibitive costs of implementation are not possible for many companies. Existing literature found multiple barriers related to finances. The most cited from the sample used for this study is lack of financial resources (Jia et al. 2020; Khan & Ali 2022; Kumar et al. 2023, Ouro-Salim et al. 2023; Shaikh et al. 2022; Sonar et al. 2023).

In statistical testing there were no statistical significance that size of the company or field of the company would have any correlation on the barriers. This may again be due to the small sample size and the answers being mostly from large manufacturing companies.

One of the barrier-based factors had a statistical significance that the level of measures taken to consider circular economy in supply chain matters. This was lacking_aspects. It is probably due to companies that have already implemented this not lacking these aspects. Other sum variables did not have statistical significance. In other words, it could be said that all kind of companies in Finland face barriers related to circular supply chains.

Barriers found the most important were both external and internal barriers. The most important barriers related either to customers or financial resources. Customer based barriers are external barriers. Financial resource-based barriers are internal.

The third and last sub-question is following:

What are the most important enablers for circular supply chain management and circular supply chains?

Empirical analysis found many enablers even though these are less studied than drivers and barriers. The interviewees also found these the most difficult to identify. Possibly due to this the answers varied a lot. Every interviewee found a different thing as the most important enabler. In addition to this, the most important enabler identified in the questionnaire did not align with the opinion of any of the interviewees. Enablers the interviewees found most important are financial resources, top management support, development of technology, and regulation and mandates. In the questionnaire the most important enabler was demand for circular products. The next most important enablers found in the questionnaire were awareness of potential revenue gains and mandatory regulations. These align with the interview responses bit better. The fourth highest scoring statement was top management commitment. In other words, even though all the interviewees have different most important enablers, they somewhat align with the statements found most important in the questionnaire. Existing literature found collaboration throughout the supply chain as the most important enabler (Hussain & Malik 2020; Khan et al. 2020; Mishra et al. 2021; Nag et al. 2021; Ouro-Salim et al. 2023; Sandvik & Stubbs 2019). Collaboration throughout the supply chain may affect the adoption of circular supply chains.

There were three enabler-based factors created. Two out of three had a p value of less than 0.05. This means the factor technology_supplychain and factor stakeholders had a statistical significance on the measures to consider circular economy in supply chain. Again, there were no statistical significance that the size of field of the company would affect the enablers found important.

6 Conclusions

The aim of this study was to identify factors that affect the implementation of circular supply chains and circular supply chain management in companies operating in Finland. The concept of circular economy is old, but it has really gained attention only in the last few years. Hence, it is a current topic for research. Even though the topic of circular supply chains has been studied in Finland, it has mostly been focused on specific industries. That provides a research gap for this thesis. As the study contains both qualitative and quantitative research methods, it is a mixed method study. This method has not been used very much. Interviews were conducted as the questionnaire gained only 62 responses. Even though this gives a response rate of 41.3% which is good, the statistical methods are made for large sample sizes. Hence, the results are mostly indicative. For example, factors created do not follow normal distribution. This is likely due to the small sample size.

To better understand the factors affecting the implementation, the factors were divided into three groups: drivers, enablers, and barriers. The data for the study was collected through an online questionnaire and semi-structured interviews. Both the questionnaire and the interview structure were divided into these groups. Table 22 summarizes the findings of the study.

Table 22. Summary of the main findings

<table>
<tr><th colspan="3">Factors affecting the CSC and CSCM</th></tr>
<tr><td colspan="3">Drivers:
Effects on brand
Customer demand / awareness
Environment and environmental values
Top management commitment
Regulation
Financial benefits and cost savings
Improved competitiveness
Barriers:
Customers' willingness to pay a higher price.
Uncertainty in demand
Cost of implementation
Financial risk
Poor economic situation
Profitability
Enablers:
Regulation
New technological solutions
Industrial symbiosis / collaboration throughout the supply chain
Investments and financial resources
Top management support
Demand for circular products</td></tr>
<tr><th>Most important drivers</th><th>Most important barriers</th><th>Most important enablers</th></tr>
<tr><td>Customer demand
Effects on the brand
Environmental values</td><td>Customers' willingness to pay higher price.
Uncertainty in demand
Financial barriers</td><td>Regulation
Top management support
Demand for circular products.
Collaboration</td></tr>
</table>

Most important driver found in the analysis is brand image and customer demand. The drivers found most important in the empirical study have been mentioned in the existing

literature as seen in the tables 3 and 4. However, from the sample of articles this study used as theoretical basis, it was not the most identified driver.

Most important barrier found in the analysis was clearly both in the qualitative and quantitative analysis customer's willingness to pay a higher price and uncertainty in customer demand. As seen in table 5. these are also supported well with existing literature.

There was no clear most important enabler. Existing literature found technological solutions as the most important enabler. Interviewee C mentioned this as the most important enabler. Otherwise, the answers varied. Interviewees mentioned that enablers were the most difficult to identify. This may be a reason for the lack of unity in the responses.

6.1 Managerial implications

It is important for the managers to understand the enabler for the circular supply chains to be able to implement the successfully. On the other hand, it is important to understand the barriers to be able to take them into account and to be able to overcome them. Drivers are important for the policymakers to understand as well as to organizations that drive towards a healthier planet.

As top management commitment and support is a major enabler for circular supply chains, managers should ensure they are supportive of this transition within the organization. Besides this manager should aim to have the financial and technological resources for the implementation. Awareness and knowledge are also important enablers. The employees as well as external stakeholders must be educated on the topic.

As regulation is seen as driver, enabler, and barrier, it grows to a critical position regarding to the implementation of circular supply chains. Policymakers should aim for content mandates that are easy to apply. The regulation does not solve any issues if it becomes a barrier for circular supply chains.

Customer demand is the biggest barrier. This can be overcome in many ways. Customer views can be found out, for example, with surveys. Spreading the awareness is also one way of increasing the customer demand.

6.2 Limitations and future research

This study had limitations. The study was limited to circular supply chains instead of for example circular economy or sustainable supply chains which would provide a wider topic for research. Also, the study was limited to only companies operating in Finland.

The chosen method also has its limitations. The questionnaire had only 62 responses which created difficulties with statistical testing. Generally, ANOVA requires the sum variables to follow normal distribution. However, the sum variables created for this study mostly did not follow normal distribution. This is most likely due to the small sample size. In addition to the quantitative also the qualitative portion has its limitations. There were only four interviewees. The reliability of the qualitative analysis could have been increased by increasing the number of interviewees. However, as this study was originally aimed for a purely quantitative study the time for conducting the interviews was limited.

Future research on the topic could focus on the key factors affecting the circular supply chains. For example, regulation was identified to be driver, enabler, and barrier. It would benefit the policymakers to conduct further research on topic. As qualitative and quantitative methods have their limitations, more mixed method research could be conducted in the future. Overall, the concept of circular supply chain management has not been very widely studied yet. Previous research highlighted that the concepts related to circular economy have mostly been developed by practitioners. There is also not much research made on the actual implementation process concretely. Research made on that could benefit a lot and find even more enablers and barriers.

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8 Appendices

Appendix 1. Questionnaire (in Finnish)

Company background

Q1. Company revenue

Less that 10 million

10-20 million

20-50 million

50-100 million

100-200 million

Over 200 million

Q2. Number of staff

Less than 50

50-100

100-500

500-1000

Over 1000

Q3. Role of the respondent

Top Management

Middle Management

Specialist tasks

Operative tasks

Other

Q4. Field of the company

Agriculture, forestry, and fishery

Mining

Manufacturing

Electricity, gas, and heating

Water supply, sewage, and waste management

Construction

Wholesale and retail

Transportation and warehousing

Accommodation and nutrition activity

Information and communication

Finance and insurance

Real estate

Occupational, scientific, and technical activities

Administrative and support services

Public administration and national defence

Education

Health and social services

Art, science, and recreation

Other

Q5. Circular supply chain

Evaluate at what level the company has taken measures to consider the circular economy in the supply chain
1 = not at all, 7 = fully implemented in the supply chain

Q6. Drivers

Evaluate how much these motivators would influence or have influenced the integration of the circular economy into the company's supply chain 1 = not at all, 7 = very much

	1	2	3	4	5	6	7
Cost savings and financial benefits							
Opportunities (e.g., for growth, innovation)							
Improved competitiveness							
Top management commitment							
Knowhow related to circular economy within the company							
Law and regulation							
Resource scarcity							
Customers' growing awareness of sustainability and circular economy							
Customer demand							
Concern about climate change and protecting the environment							
Effects on the brand							

Q7. Barriers

Assess how much these challenges/barriers would or have affected the integration of the circular economy into the company's supply chain 1 = not at all, 7 = very much

	1	2	3	4	5	6	7

Lack of short-term financial benefits							
Financial risk							
Lack of trainings related to circular economy							
Lack of awareness and knowledge							
Lack of knowhow and expertise							
Cost of the implementation							
Lack of financial resources							
Quality of recycled product							
Lack of customer awareness							
Uncertainty in demand / lack of demand							
Lack of supplier collaboration / support							
Lack of suitable suppliers							
Weak environmental legislation / policies							
Uncertainty on customer's willingness to pay higher price for a circular product							
Lack of top management commitment							

Lack of efficient waste management							
Infrastructural issues (e.g., logistical)							
Competitive market							

Q8. Enablers

Evaluate how much these enablers would affect or have affected the integration of the circular economy into the company's supply chain 1 = not at all, 7 = very much

	1	2	3	4	5	6	7
Technological or digital solutions							
Customers' attitudes towards recycled products							
Collaboration throughout the supply chain							
Demand for circular products							
Redesign of the supply chain							
Supply chain flexibility							
Mandatory legislation and other regulations							
Awareness of the possible revenue gains							
Awareness of sustainability							
Trainings on the topic							
Right kind of infrastructure							

Top management support and commitment							
Supplier adaptability							
Supply chain traceability							

Appendix 2. Interview questions.

Background
1. What is your role in the company? (title)
2. What is the field of your company?
3. Does your company consider circularity in the supply chain? If yes, how?

Drivers
4. What kind of things have driven your company towards circular supply chains?
5. What do you think is the biggest driver for implementing circularity into supply chains?

Enablers
6. What kind of things enable circularity in supply chains?
7. What do you think is the most important enabler for implanting circular supply chains?

Barriers
8. What kind of things have acted as barriers for circular supply chains in your company?
9. What do you think is the biggest barrier for circular supply chains?

General
10. Do you have something to add?

Appendix 3. Factors and statements

Question	Variable	Statement
Q6 (Drivers)	*Organizational_drivers*	Q6_4 Top management commitment

		Q6_5 Knowhow related to circular economy within the company
		Q6_10 Concern about climate change and protecting the environment
		Q6_11 Effects on the brand
	Benefits_demand	Q6_1 Cost savings and financial benefits
		Q6_3 Improved competitiveness
		Q6_6 Law and regulation
		Q6_9 Customer demand
	Removed due to poor / double loading	~~Q6_2 Opportunities (e. g., for growth, innovation)~~
		~~Q6_7 Resource scarcity~~
		~~Q6_8 Customers' growing awareness of sustainability and circular economy~~
Q7 (Barriers)	*Lacking_aspects*	Q7_3 Lack of trainings related to circular economy
		Q7_4 Lack of awareness and knowledge
		Q7_5 Lack of knowhow and expertise
	Financial_barriers	Q7_1 Lack of short-term financial benefits
		Q7_2 Financial risk
		Q7_6 Cost of the implementation
		Q7_7 Lack of financial resources
	Supplier	Q7_11 Lack of supplier collaboration / support
		Q7_12 Lack of suitable suppliers
	Infrastructure_market	Q7_16 Lack of efficient waste management
		Q7_17 Infrastructural issues (e.g., logistical)
		Q7_18 Competitive market

	Removed due to poor / double loading	~~Q7_8 Quality of the recycled product~~
		~~Q7_9 Lack of customer awareness~~
		~~Q7_10 Uncertainty in demand / lack of demand~~
		~~Q7_13 Weak environmental legislation / policies~~
		~~Q7_14 Uncertainty on customer's willingness to pay higher price for a circular product~~
		~~Q7_15 Lack of top management commitment~~
Q8 (Enablers)	*Technology_supplychain*	Q8_1 Technological or digital solutions
		Q8_5 Redesign of the supply chain
		Q8_6 Supply chain flexibility
		Q8_11 Right kind of infrastructure
	Awareness	Q8_8 Awareness of the possible revenue gains
		Q8_9 Awareness of sustainability
		Q8_10 Trainings on the topic
		Q8_12 Top management support and commitment
	Stakeholders	Q8_2 Customers' attitudes towards recycled products
		Q8_3 Collaboration throughout the supply chain
		Q8_7 Mandatory legislation and other regulations
		Q8_13 Supplier adaptability
	Removed due to poor / double loading	~~Q8_4 Demand for circular products~~
		~~Q8_14 Supply chain traceability~~

Appendix 4. Full results of the factor analysis

	Organizational_drivers	Benefits_demand	KMO	Uniqueness
Q6_4 Top management commitment	0.85		0.72	0.27
Q6_5 Knowhow related to circular economy within the company	0.77		0.82	0.31
Q6_10 Concern about climate change and protecting the environment	0.82		0.85	0.32
Q6_11 Effects on the brand	0.68		0.87	0.41
Q6_1 Cost savings and financial benefits		0.76	0.73	0.40
Q6_3 Improved competitiveness		0.65	0.84	0.33
Q6_6 Law and regulation		0.72	0.83	0.42
Q6_9 Customer demand		0.74	0.71	0.36
Eigenvalue	3.26	1.36		
Cumulative	0.46	0.66		
Cronpach's alpha	0.82	0.75		

	Lacking _aspects	Financial _barriers	Supplier	Infrastructure _market	KMO	Uniqueness

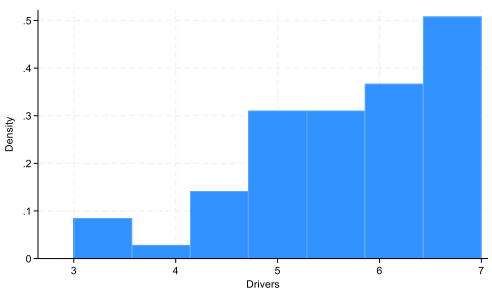
Q7_3 Lack of trainings related to circular economy	0.88				0.74	0.20
Q7_4 Lack of awareness and knowledge	0.90				0.70	0.10
Q7_5 Lack of knowhow and expertise	0.89				0.77	0.15
Q7_1 Lack of short-term financial benefits		0.83			0.77	0.25
Q7_2 Financial risk		0.82			0.75	0.26
Q7_6 Cost of the implementation		0.64			0.87	0.30
Q7_7 Lack of financial resources		0.62			0.82	0.38
Q7_11 Lack of supplier collaboration / support			0.77		0.82	0.25
Q7_12 Lack of suitable suppliers			0.89		0.74	0.18
Q7_16 Lack of efficient waste management				0.82	0.70	0.27
Q7_17 Infrastructural issues (e.g., logistical)				0.77	0.73	0.35
Q7_18 Competitive market				0.66	0.87	0.36
Eigenvalue	4.77	1.81	1.31	1.07		
Cumulative	0.40	0.55	0.66	0.75		
Cronpach's alpha	0.91	0.81	0.81	0.71		

	Technology_ supplychain	Awareness	Stakeholders	KMO	Uniqueness
Q8_1 Technological or digital solutions	0.64			0.82	0.46
Q8_5 Redesign of the supply chain	0.89			0.74	0.16
Q8_6 Supply chain flexibility	0.86			0.72	0.22

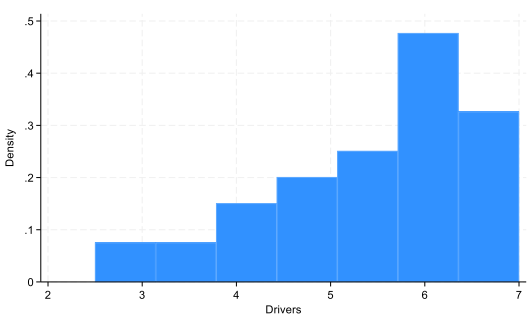
Q8_11 Right kind of infrastructure	0.61			0.87	0.32
Q8_8 Awareness of the possible revenue gains		0.77		0.78	0.36
Q8_9 Awareness of sustainability		0.78		0.81	0.35
Q8_10 Trainings on the topic		0.74		0.80	0.39
Q8_12 Top management support and commitment		0.63		0.85	0.34
Q8_2 Customers' attitudes towards recycled products			0.74	0.82	0.37
Q8_3 Collaboration throughout the supply chain			0.59	0.84	0.36
Q8_7 Mandatory legislation and other regulations			0.78	0.63	0.38
Q8_13 Supplier adaptability			0.66	0.80	0.37
Eigenvalue	5.34	1.40	1.19		
Cumulative	0.45	0.56	0.66		
Cronpach's alpha	0.86	0.78	0.77		

Appendix 5. Normal distributions of the variables

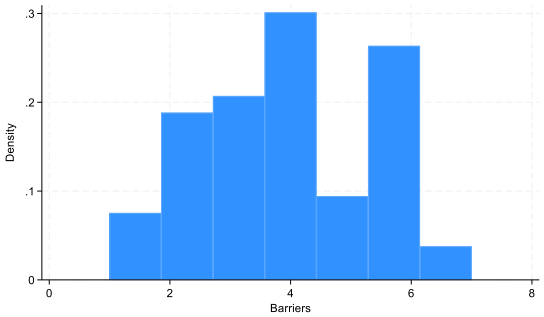
Organizational_drivers



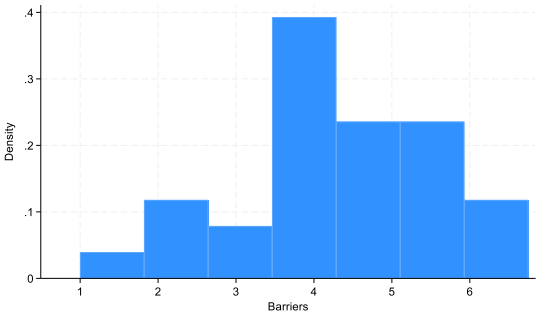
Benefits_demand



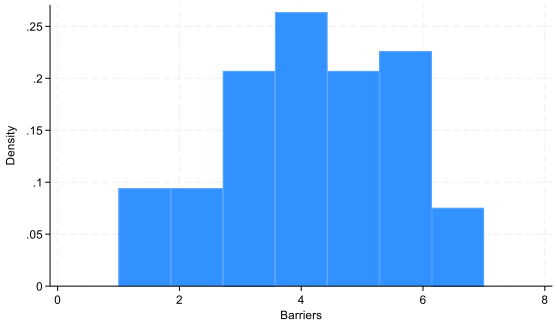
Lacking_aspects



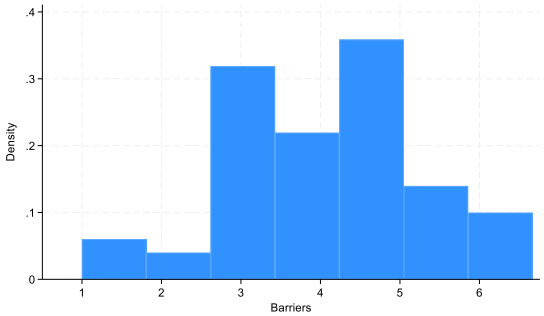
Financial_barriers



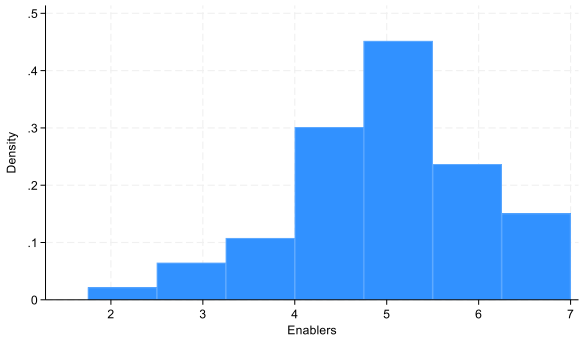
Supplier



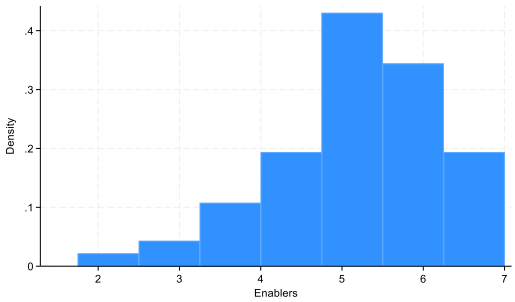
Infrastructure_market



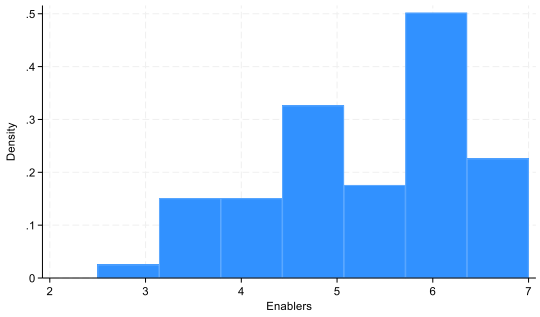
Technology_supplychain



Awareness



Stakeholders



Appendix 6. Two-way ANOVA

```
anova organizational_drivers companyrevenueeur companysfield
```

Number of obs =	62	R-squared =	0.3018
Root MSE =	.931645	Adj R-squared =	0.0535

Source	Partial SS	df	MS	F	Prob>F
Model	16.882252	16	1.0551407	1.22	0.2937
companyre~r	3.7104774	5	.74209549	0.85	0.5186
companysf~d	9.9113245	11	.9010295	1.04	0.4306
Residual	39.058273	45	.86796161		
Total	55.940524	61	.91705777		

```
anova benefits_demand companyrevenueeur companysfield
```

Number of obs =	62	R-squared =	0.2890
Root MSE =	1.10955	Adj R-squared =	0.0362

Source	Partial SS	df	MS	F	Prob>F
Model	22.520132	16	1.4075083	1.14	0.3478
companyre~r	1.9396665	5	.3879333	0.32	0.9013
companysf~d	20.096496	11	1.8269542	1.48	0.1711
Residual	55.399222	45	1.2310938		
Total	77.919355	61	1.2773665		

```
anova lacking_aspects companyrevenueeur companysfield
```

Number of obs =	62	R-squared =	0.2784
Root MSE =	1.483	Adj R-squared =	0.0219

Source	Partial SS	df	MS	F	Prob>F
Model	38.186597	16	2.3866623	1.09	0.3960
companyre~r	7.1256871	5	1.4251374	0.65	0.6644
companysf~d	29.099428	11	2.6454025	1.20	0.3128
Residual	98.967524	45	2.1992783		
Total	137.15412	61	2.2484282		

```
anova financial_barriers companyrevenueeur companysfield
```

Number of obs =	62	R-squared =	0.1914
Root MSE =	1.31125	Adj R-squared =	-0.0961

Source	Partial SS	df	MS	F	Prob>F
Model	18.31037	16	1.1443981	0.67	0.8110
companyre~r	4.5949244	5	.91898488	0.53	0.7490
companysf~d	14.420951	11	1.3109955	0.76	0.6741
Residual	77.372089	45	1.7193798		
Total	95.68246	61	1.5685649		

```
anova supplier companyrevenueeur companysfield
```

Number of obs =	62	R-squared =	0.2444
Root MSE =	1.54937	Adj R-squared =	-0.0242

Source	Partial SS	df	MS	F	Prob>F
Model	34.943125	16	2.1839453	0.91	0.5637
companyre~r	6.7128829	5	1.3425766	0.56	0.7305
companysf~d	29.856518	11	2.7142289	1.13	0.3612
Residual	108.02462	45	2.400547		
Total	142.96774	61	2.3437335		

```
anova infrastructure_market companyrevenueeur companysfield
```

Number of obs =	62	R-squared =	0.2888
Root MSE =	1.25516	Adj R-squared =	0.0360

Source	Partial SS	df	MS	F	Prob>F
Model	28.791621	16	1.7994763	1.14	0.3487
companyre~r	8.655242	5	1.7310484	1.10	0.3744
companysf~d	17.458394	11	1.5871268	1.01	0.4553
Residual	70.894759	45	1.5754391		
Total	99.686379	61	1.6342029		

```
anova technology_supplychain companyrevenueeur companysfield
```

Number of obs =	62	R-squared =	0.2337
Root MSE =	1.08845	Adj R-squared =	-0.0388

Source	Partial SS	df	MS	F	Prob>F
Model	16.256386	16	1.0160241	0.86	0.6177
companyre~r	4.9027685	5	.98055369	0.83	0.5368
companysf~d	10.466524	11	.95150216	0.80	0.6363
Residual	53.312162	45	1.1847147		
Total	69.568548	61	1.140468		

```
anova awareness companyrevenueeur companysfield
```

Number of obs =	62	R-squared =	0.2437
Root MSE =	1.05431	Adj R-squared =	-0.0252

Source	Partial SS	df	MS	F	Prob>F
Model	16.116344	16	1.0072715	0.91	0.5674
companyre~r	1.3181362	5	.26362723	0.24	0.9440
companysf~d	14.040076	11	1.2763705	1.15	0.3489
Residual	50.020753	45	1.1115723		
Total	66.137097	61	1.0842147		

anova stakeholders companyrevenueeur companysfield

Number of obs =	62	R-squared =	0.3135		
Root MSE =	1.02147	Adj R-squared =	0.0695		
Source	Partial SS	df	MS	F	Prob>F
Model	21.44628	16	1.3403925	1.28	0.2482
companyre~r	10.100559	5	2.0201117	1.94	0.1070
companysf~d	13.037517	11	1.1852288	1.14	0.3575
Residual	46.952914	45	1.0433981		
Total	68.399194	61	1.1212983		

anova organizational_drivers numberofstaff roleoftherespondentinthecompany

Number of obs =	62	R-squared =	0.2162		
Root MSE =	.909552	Adj R-squared =	0.0979		
Source	Partial SS	df	MS	F	Prob>F
Model	12.0944	8	1.5118	1.83	0.0923
numberofs~f	8.8179613	4	2.2044903	2.66	0.0423
roleofthe~y	4.4205991	4	1.1051498	1.34	0.2688
Residual	43.846124	53	.82728536		
Total	55.940524	61	.91705777		

anova benefits_demand numberofstaff roleoftherespondentinthecompany

Number of obs =	62	R-squared =	0.1465		
Root MSE =	1.1202	Adj R-squared =	0.0176		
Source	Partial SS	df	MS	F	Prob>F
Model	11.412368	8	1.4265459	1.14	0.3547
numberofs~f	1.8831848	4	.47079621	0.38	0.8253
roleofthe~y	9.599075	4	2.3997688	1.91	0.1219
Residual	66.506987	53	1.2548488		
Total	77.919355	61	1.2773665		

anova benefits_demand numberofstaff roleoftherespondentinthecompany

Number of obs =	62	R-squared =	0.1465		
Root MSE =	1.1202	Adj R-squared =	0.0176		
Source	Partial SS	df	MS	F	Prob>F
Model	11.412368	8	1.4265459	1.14	0.3547
numberofs~f	1.8831848	4	.47079621	0.38	0.8253
roleofthe~y	9.599075	4	2.3997688	1.91	0.1219
Residual	66.506987	53	1.2548488		
Total	77.919355	61	1.2773665		

anova lacking_aspects numberofstaff roleoftherespondentinthecompany

Number of obs =	62	R-squared =	0.0843		
Root MSE =	1.53938	Adj R-squared =	-0.0539		
Source	Partial SS	df	MS	F	Prob>F
Model	11.561276	8	1.4451595	0.61	0.7655
numberofs~f	7.0473311	4	1.7618328	0.74	0.5667
roleofthe~y	3.7825214	4	.94563036	0.40	0.8084
Residual	125.59285	53	2.3696763		
Total	137.15412	61	2.2484282		

anova financial_barriers numberofstaff roleoftherespondentinthecompany

Number of obs =	62	R-squared =	0.1289		
Root MSE =	1.25402	Adj R-squared =	-0.0026		
Source	Partial SS	df	MS	F	Prob>F
Model	12.336296	8	1.5420371	0.98	0.4614
numberofs~f	3.3226321	4	.83065802	0.53	0.7155
roleofthe~y	8.4296626	4	2.1074157	1.34	0.2673
Residual	83.346163	53	1.5725691		
Total	95.68246	61	1.5685649		

anova supplier numberofstaff roleoftherespondentinthecompany

Number of obs =	62	R-squared =	0.0992		
Root MSE =	1.55883	Adj R-squared =	-0.0368		
Source	Partial SS	df	MS	F	Prob>F
Model	14.179907	8	1.7724884	0.73	0.6649
numberofs~f	6.1483968	4	1.5370992	0.63	0.6415
roleofthe~y	8.6689217	4	2.1672304	0.89	0.4753
Residual	128.78784	53	2.4299592		
Total	142.96774	61	2.3437335		

anova infrastructure_market numberofstaff roleoftherespondentinthecompany

Number of obs =	62	R-squared =	0.1706		
Root MSE =	1.24903	Adj R-squared =	0.0454		
Source	Partial SS	df	MS	F	Prob>F
Model	17.002693	8	2.1253366	1.36	0.2345
numberofs~f	10.95013	4	2.7375324	1.75	0.1518
roleofthe~y	3.4023665	4	.85059162	0.55	0.7032
Residual	82.683686	53	1.5600696		
Total	99.686379	61	1.6342029		

anova technology_supplychain numberofstaff roleoftherespondentinthecompany

Number of obs =	62	R-squared =	0.1092		
Root MSE =	1.08133	Adj R-squared =	-0.0253		
Source	Partial SS	df	MS	F	Prob>F
Model	7.5971047	8	.94963809	0.81	0.5950
numberofs~f	3.3469893	4	.83674733	0.72	0.5850
roleofthe~y	4.1952042	4	1.0488011	0.90	0.4724
Residual	61.971444	53	1.1692725		
Total	69.568548	61	1.140468		

anova awareness numberofstaff roleoftherespondentinthecompany

Number of obs =	62	R-squared =	0.1720		
Root MSE =	1.0165	Adj R-squared =	0.0470		
Source	Partial SS	df	MS	F	Prob>F
Model	11.373414	8	1.4216767	1.38	0.2285
numberofs~f	1.1605469	4	.29013674	0.28	0.8891
roleofthe~y	9.6693077	4	2.4173269	2.34	0.0669
Residual	54.763683	53	1.033277		
Total	66.137097	61	1.0842147		

anova stakeholders numberofstaff roleoftherespondentinthecompany

Number of obs =	62	R-squared =	0.2149		
Root MSE =	1.00655	Adj R-squared =	0.0964		
Source	Partial SS	df	MS	F	Prob>F
Model	14.702239	8	1.8377799	1.81	0.0950
numberofs~f	7.7714783	4	1.9428696	1.92	0.1210
roleofthe~y	8.198874	4	2.0497185	2.02	0.1044
Residual	53.696955	53	1.0131501		
Total	68.399194	61	1.1212983		