THE CHALLENGES AND ECONOMIC BENEFITS OF UTILISING CIRCULAR ECONOMY IN THE PRODUCTION OF TEXTILES

Lappeenranta–Lahti University of Technology LUT

Bachelor's thesis in Business Administration

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Examiner: Postdoctoral researcher Roman Teplov

ABSTRACT

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The challenges and economic benefits of utilising circular economy in the production of textiles

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Keywords: circular economy, textile production, textiles, textile waste, recycling and sustainability

The textile production resource use is reaching its breaking point at a cracking pace. There is a limited resource of raw materials, clean water, soil for growing natural fibres and food as well as landfills for waste. Due to this, there is a need to shift from a linear economy towards a more circular economy to guarantee that future generations do not need to compromise in meeting their needs. With circularity, resources may be optimised, which advances sustainability and sustainable development in textile production. The utilisation of a circular economy can create various new opportunities and many economic benefits for companies through resource optimisation and sustainability. However, there are challenges that must be solved to make the implementation of a circular economy more cost-efficient and profitable.

The thesis explores how to make the production of textiles more sustainable by utilising a circular economy. The economic benefits and challenges of the matter are also investigated and summarised. To answer the main research question and two sub-question, secondary data from secondary sources and primary data collected from two semi-structured interviews were analysed. The secondary sources consisted mainly of peer-reviewed journals, and the interviews were held with two experts working with new fibre technologies.

The results of the thesis are revealed in the findings and discussion section. There were altogether 14 solutions identified to make textile production more sustainable by utilising a circular economy. In addition, several economic benefits and challenges related to the utilisation of a circular economy in the production of textiles were found. The thesis provides a great understanding of the topic and beneficial insights into a circular economy.

TIIVISTELMÄ

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Kauppatieteet

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Kiertotalouden hyödyntämisen taloudelliset hyödyt ja haasteet tekstiilien tuotannossa

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Tekstiilituotannon resurssien käyttö saavuttaa kovaa vauhtia kriittisiä rajojaan. Raaka-aineita, puhdasta vettä, maaperää luonnonkuitujen ja ruoan kasvattamiseen sekä kaatopaikkoja jätteelle on rajallinen määrä maapallollamme. Tämän vuoksi, on tarpeen siirtyä lineaarisesta taloudesta kiertotalouteen, jotta tulevien sukupolvien ei tarvitse tehdä kompromisseja tarpeidensa täyttämiseksi. Kiertotalouden avulla, resursseja voidaan optimoida, mikä edistää kestävyyttä ja kestävää kehitystä tekstiilituotannossa. Kiertotalouden hyödyntäminen tuottaa yrityksille uusia mahdollisuuksia ja monia taloudellisia etuja uusien mahdollisuuksien, resurssien optimoinnin sekä kestävyyden kautta. Kiertotalouden hyödyntämiseen tekstiilien tuotannossa liittyy kuitenkin haasteita, jotka on selätettävä, jotta kiertotalouden hyödyntäminen olisi kustannustehokkaampaa ja kannattavampaa.

Tutkielmassa pohditaan, miten tekstiilien tuotantoa voidaan saada kestävämmäksi kiertotaloutta hyödyntäen. Lisäksi taloudellisia hyötyjä ja haasteita aiheeseen liittyen käydään läpi ja lopuksi kootaan yhteen. Jotta tutkimuksen pääkysymykseen ja kahteen alakysymykseen löydettiin vastaukset, sekundaaridataa sekä kahdesta puolistrukturoidusta haastattelusta kerättyä primääridataa analysoitiin. Sekundääridata koostui pääosin vertaisarvioiduista julkaisuista. Primääridata koostui kahdelle uusien kuituteknologioiden parissa työskenteleville asiantuntijoille pidetyistä puolistrukturoiduista haastatteluista.

Tutkielman tulokset käydään läpi lopuksi kohdassa neljä. Tekstiilituotannon kestävyyden parantamiseksi kiertotaloutta hyödyntäen tunnistettiin kaikkiaan 14 ratkaisua. Lisäksi löydettiin useita taloudellisia hyötyjä sekä haasteita, jotka liittyvät kiertotalouden hyödyntämiseen tekstiilien tuotannossa. Tutkielma tarjoaa laajan kokonaisvaltaisen käsityksen aiheesta sekä hyödyllisiä oivalluksia kiertotaloudesta.

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1 Introduction

Textile waste has become a severe problem for our planet. The textile and clothing industry is one of the most polluting industries in the world. The fast fashion cycles in the industry have led to over-consumption and large amounts of textile waste. (Pensupa, Leu, Hu, Du, Liu, Jing, Wang & Lin 2017, 1) Textiles, such as clothing, are not nowadays a basic need for individuals. Instead, textiles can be viewed as a form of self-expression and style. Due to this, textiles may be disposed of even if they are entirely usable. (Bartl 2011, 1) According to Martina Igni's article (2022) about fast fashion waste, 92 million tonnes of textile waste is produced yearly.

The textile and clothing industry needs more sustainable solutions for textile production because the resilience of the Earth is approaching its critical limits. With the help of sustainable solutions and circularity, economic advantages and new opportunities in textile production can be achieved. Sustainable solutions are being innovated, and technologies are being developed continuously. However, it is a challenge to implement all the actions of a circular economy in textile production while keeping the environmental impacts at the minimum and the production of textiles profitable. A relevant question is: Who will invent the innovation that makes the production of textiles sustainable, cost-efficient and profitable?

1.1 Background

In the 1960s, a simple idea of a circular economy was developed by an environmental economist, Professor Kenneth E. Boulding (George, Lin & Chen 2015, 2). At the time, Professor Kenneth E. Boulding described the Earth as "*a single spaceship without unlimited reservoirs of anything, either for extraction or pollution...*" (Boulding 1966, 7). With this, Professor Kenneth E. Boulding meant that a cyclical economy is needed in society to enable the continuous reproduction of material forms. However, inputs of energy cannot be escaped, according to him. (Boulding 1966, 8) There is a limited number of raw materials and resistance to pollution on the Earth. In addition, great soil worldwide is used for growing cotton. Instead, the ground could be used, for example, for food production. Having that said, it can be highly beneficial to implement a circular economy in the production of textiles.

In the last two decades, the textile industry has doubled its production. In addition, the annual consumption of textiles has increased from seven to thirteen kilograms per person. (Shirvanimoghaddam, Motamed, Ramakrishna & Naebe 2020, 1) These numbers are alarming and require action. There have been implementations of strategies that consider the sustainability and circularity of textiles. The United Nations Environment Programme (UNEP) created a report in 2020 about the actions needed to advance a sustainable and circular textile value chain. The UNEP report considers the textile industry's issues and visualises the required activities for a sustainable and circular textile sector by 2040. (UNEP 2020, 1, 9, 45). In addition, the European Union (EU) has created a plan that "…*proposes actions for the entire lifecycle of textile products while supporting the ecosystem in the green and digital transitions*" (European Commission 2022).

Textile waste has become a more concerning topic. The global fibre production in 2013 was approximately 85.5 million tonnes. In 2025 global fibre production is expected to grow to 130 million tonnes in a year. There is constantly more textile waste produced as the production of textiles keeps growing. (Dahlbo, Aalto, Eskelinen & Salmenperä. 2017, 45) However, as mentioned earlier, there is a limited number of raw materials and resistance to pollution on the Earth. Due to this, the importance of implementing a circular economy to ensure the sustainable production of textiles in the future has become more relevant.

This thesis aims to explore and discuss more sustainable solutions for textile production. The author is highly interested in sustainable solutions in the textile industry because of its vast economic impact. In addition, the advantages that can be gained by implementing sustainability in the textile industry are a relevant topic for the companies operating in the textile industry through competitiveness, for instance. There are many frustrating topics related to responsible textile manufacturing for which reasonable solutions can be found with advanced technology and knowledge. It is hoped the thesis will give its readers insights into how to produce textiles more sustainably and what economic benefits they can achieve.

1.2 Research objectives

This thesis will explore the production of making textiles more sustainable by utilising circularity. The thesis will focus on the challenges and economic benefits of utilising the circular economy in the production of textiles. One of the thesis' targets is to find how different technologies, processes and solutions can make more sustainable textiles by implementing the circular economy. Therefore, the main question of the thesis will be:

> *Q1: How to make the production of textiles more sustainable by utilising the circular economy?*

In addition, as said before, the thesis will explore and discuss the economic benefits and challenges of utilising a circular economy in the production of textiles. Due to this, the two sub-questions of the thesis will be:

> *Q2: What are the economic benefits of utilising the circular economy in the production of textiles?*

> *Q4: What kind of challenges can be faced in the production of textiles when utilising the circular economy?*

The thesis will focus on circular textile production, especially at the beginning of textile production. The circular economy provides numerous opportunities at different stages of the textile production value chain. The reuse of materials and mechanical and chemical recycling will be, for instance, discussed as the actions of implementing the circular economy in textile production. The benefits are explored from a financial point of view because there is a significant relationship between corporate sustainability and financial performance. To answer the research question, data were collected from secondary sources and from two semi-structured interviews held with two professionals working with innovating new fibre technologies. The results of the research questions will be presented in section four.

1.3 Theoretical framework

The theoretical framework of this thesis will be a review of existing theories and insights that will help the author to develop the answers to the research questions together with the data collected from the interviews. The theoretical framework of the thesis revolves around the conceptual framework, which consists of the key concepts: circular economy, textiles, textile production, textile waste, recycling and sustainability. In the thesis, circular economy and textile production will be mainly discussed regarding textile waste, recycling and sustainability. The theoretical framework will be discussed more in section two.

1.4 Research methodology

The function of any research is to investigate answers to questions about a phenomenon through observation. Research may discover and explain new or different ways of understanding the changing world. (Jackson, Drummond, & Camara 2007, 21–22) Qualitative research aims to gain a deeper understanding of the researched objective and focus on answering questions: how? and why? (Maijanen-Kyläheiko 2022). Qualitative research methods view the research objective from a more holistic point of view and provide more information about the shared meanings, practices and experiences of groups such as a society or culture. The research of this thesis has been done by utilising qualitative research methods as they are applicable to answer the questions of this thesis. This study, conducted with multiple data sources, evaluates alternatives for sustainable textile production.

Two semi-structured interviews were held to gain supporting insights for the data collected from secondary sources. A semi-structured interview is a verbal interaction where the interviewer attempts to gather valuable information regarding the research objectives from another person by asking questions. Semi-structured interviews consist of predetermined questions the interviewee answers in one's own words. Semi-structured allow the interviewer and interviewee to discuss quite freely to get more comprehensive solutions to the questions (Gill, Stewart, Treasure & Chadwick 2008, 291; Longhurst 2003, 103). Semi-structured interviews can provide surprising insights into the topic. The two interviews of this thesis were held with two professionals that work with new textile production technologies. Both

interviews were held in Finnish and then translated. In the thesis, the names of these interviewees will not be mentioned, nor the companies' names they work in.

Secondary sources provide data that has already been collected, analysed, compiled and archived. Data provided by secondary sources are easily accessible because of the advanced technology. Due to this, various researchers use secondary sources to investigate a phenomenon and to create new insights into the topic that has not yet been learned. (Johnston 2014, 619–620) The secondary sources used for data collection in the thesis consist primarily of peer-reviewed journal articles, which provide more reliable researched knowledge and insights into the topic. In addition, reports about fibre and textile production were investigated to gain knowledge to answer the research questions.

The research methodology will be discussed more in section three. The section explains why specific research methods are chosen to collect data. The evaluation of the research methods will be, in addition, done in the methodology section.

1.5 Research structure

The thesis includes the introduction, theoretical framework, methodology, findings and discussion and lastly conclusions. In the introduction, the purpose of the research and research questions are presented. In addition, the introduction gives the reader a basic knowledge of the topic. The theoretical framework introduces the relevant theoretical frameworks, earlier literature and conceptual framework, which helps to understand the necessary more profound knowledge about the research topic. The research methods, data and data collection process are presented in the methodology section. Section four will introduce the main findings of the research and discuss them. The final section of the thesis is the conclusions which summarise the main results and topics of the thesis

2 Theoretical framework

This section introduces the key concepts that create the thesis's conceptual framework. In addition, earlier literature on the circular economy, sustainability, sustainable development and sustainable textile production are explored. The theoretical framework is supposed to give a literature review creating a basic understanding of the topic. The key concepts defined and earlier literature presented serves as a guide for the thesis, which supports answering the research questions. (Osanloo & Grant 2016, 12–13)

2.1 Conceptual framework

The most significant concepts of the thesis are circular economy, textile production, textile waste, recycling and sustainability. The five key concepts create the conceptual framework of the thesis. "*The conceptual framework offers a logical structure of connected concepts that help provide a picture or visual display of how ideas in a study relate to one another within the theoretical framework.*" (Osanloo & Grant 2016, 17) The visualisation of the interrelated concepts, defined next, can be seen in Figure 4.

A circular economy has various definitions. One is the spaceship definition by Kenneth E. Boulding, mentioned in the introduction. In short, the circular economy is formed when the resource flows' circularity is gained. The circular economy makes it possible to keep materials in the production cycle for as long as possible by adding small inputs, such as energy. The value of the materials should remain for as long as possible. The use of resources should be optimised, and the generated waste should be minimised.

In their article, Julian Kirchherr, Denise Reike and Marko Hekkert (2017) consider the 3R and 4R frameworks. It is mentioned that a circular economy is a combination of reduction, reuse and recycling activities. According to the authors, the words reduce, reuse, and recycle form the 3R framework, which is the most common conceptualisation of the circular economy in practice (Kirchherr et al. 2017, 229). The 4R framework includes the word recover as the fourth "R". Recover refers to the importance of recovering the used energy in a circular economy (Demestichas & Daskalakis 2020, 2). The 4R framework will be discussed more on page 13.

Textile production consists of various steps depending on the desired final products. However, all production begins with fibre production from raw materials. The raw material of fibres can be, for instance, crude oil and cotton. Fibres can be, in addition, produced from waste, which will be discussed later. If the desired final product is raw fibre, the finished product is achieved after the first step. The second step in production is to create yarn from raw fibre. The final product of the second step is dyed or undyed yarn. The third step is to make fabric from the yarn. The final product of the third step will be dyed or undyed fabric. The last step includes the production of clothes, carpets and other textiles from fabric. (Bartl 2011, 4) An illustration of a textile production value chain, with all the steps introduced, can be seen in Figure 1 below.

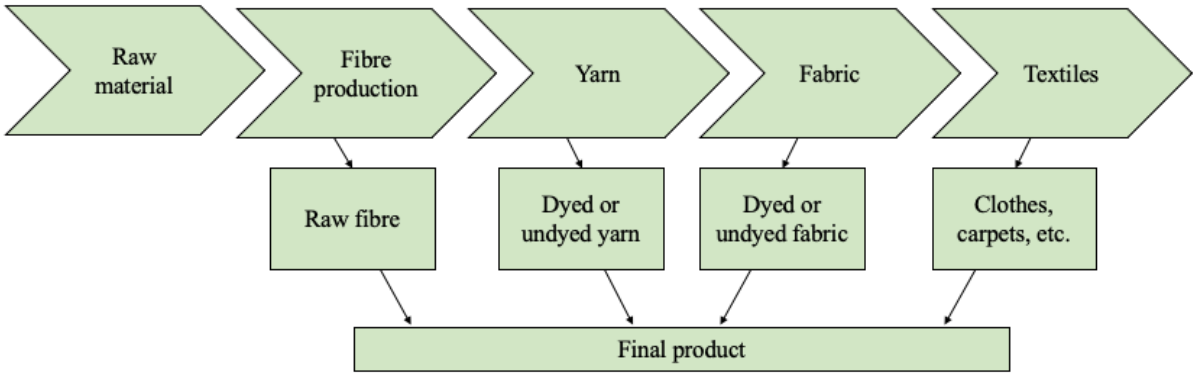

Figure 1: An example of a textile production value chain. (Bartl 2011, 4)

Textile production and consumption are expanding continuously. The global production of textiles has increased by almost 100 % from 2000 to 2015. The production is expected to grow 63 % from the current by 2030. Textile production uses many raw materials, water and land, making the production rather unsustainable. Less than 1 % of the textile waste is recycled and used for fibre production (Interreg Europe 2022). A vast number of textile waste is produced every year that could be reused with the help of a circular economy. In the thesis, new textile production technologies and processes will be explored because of the need to understand how to make production more sustainable.

Textiles are materials which consist of natural fibres or man-made fibres. Textiles are all around us. Textiles include, for instance, clothes, carpets, aeroplane seats and accessories, such as handbags. Some textiles contain both natural and man-made fibres. Natural fibres include animal and plant fibres. For example, silk, wool, animal hair, cotton, jute, and hemp are natural

fibres used to produce textiles. Man-made fibres, on the other hand, include synthetic polymers, natural polymers, and other fibres such as metal and ceramic. In the textile industry, widely used polyester is, for instance, a man-made fibre. In addition, viscose, rubber, and acrylic are all man-made fibres. (Kiron 2021; Bartl 2011, 2) An example of the classification of textile fibres can be seen in Figure 2 below.

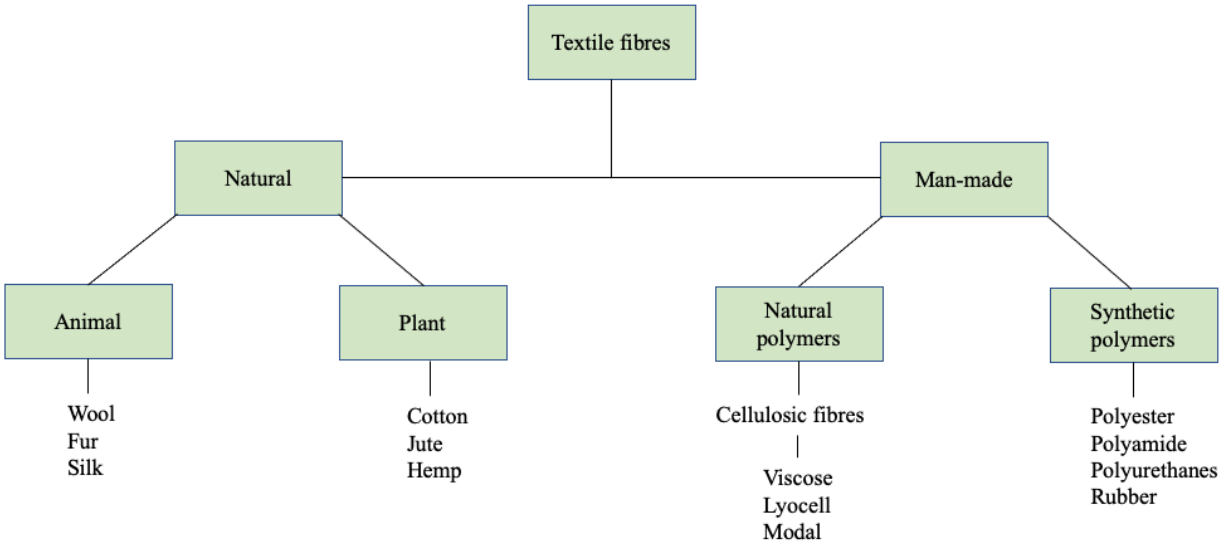

Figure 2: An example of the classification of textiles fibres. (Kiron 2021)

Fibres define the characteristics and performance of the textile material. The fibres are chosen based on the end-usage of the material. For instance, technical textiles, such as medical textiles, are produced primarily for technical and performance features (Choudri et al. 2017, 1424). Technical textiles require specific fibres that the desired characteristic and performance are achieved.

Textile waste, for instance, consists of clothing, furniture, carpets, tires and footwear disposed of. Textile waste can be concluded as goods that consist of textile fibres that are no longer utilised. As mentioned earlier in the thesis, 92 million tonnes of textile waste is produced every year worldwide that end up in landfills. Some textile waste is not biodegradable because the fibres contain fossil raw materials. Textile waste, in addition, ends up in nature. For instance, nearly 10 % of the oceans' microplastics are from textiles (Igni 2022).

Three-quarters of the world's textile waste is in landfills, and one-quarter is recycled or reused (Juanga-Labayen, Labayen & Yuan 2022, 174). Textile waste can be used, for instance, for

fibre production. However, utilising textile waste in the production of textiles can be challenging and needs a lot of resources. The waste consists of complex combinations of fibres and accessories, such as zippers, which must be torn up before being used again for textile production (Beall 2020). Some of the textile waste is chemically treated after tearing. Due to this, certain technologies are needed to utilise textile waste in the production of textiles.

Recycling is one of the key concepts of the circular economy. Recycling can be defined as a process of turning waste into new materials and products. If a material cannot be reused, it can be recycled and created into a new product. The increase in reusing and recycling textiles could save resources and positively impact the environment (Sandin & Peters 2018, 354–355).

As textile waste increases globally, new technologies can be used to reduce new material waste (Damayanti, Wulandari, Bagaskoro, Rianjanu & Wu 2021, 4). Recycling can be classified into mechanical and chemical recycling technologies (Figure 3). Mechanical recycling consists mainly of shredding textiles and creating yarn to manufacture new textiles. Mechanical recycling can be utilised with a low-cost budget, but shredded textile materials define the characteristics of the final products. The shredded fibres lose their quality in the mechanical process, which is why the fibres are often combined with virgin fibres to improve the quality of the final product (Damayanti et al. 2021, 9).

The chemicals make it possible to produce fibres that have particular characteristics. In chemical recycling, textile waste is chemically treated to create smaller polymer molecules. The smaller polymer molecules are used to make new textile fibres that can be utilised for textile manufacturing. (Damayanti et. al. 2021, 11) In chemical recycling, it is possible to create fibres that perform in a specific way, unlike in technical recycling. For instance, fibres can be used for making technical textiles that have certain characteristics.

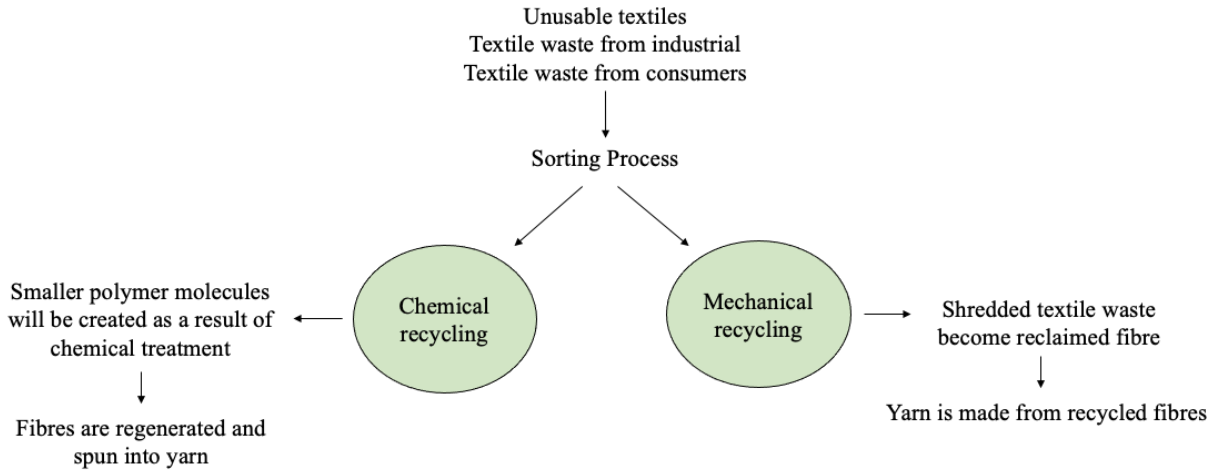

Figure 3: Possible textile waste recycling routes. (Damayanti et al. 2021, 7)

Recycling textiles is a more sustainable alternative to managing textile waste than incineration and landfilling (Juanga-Labayen et al. 2022, 179). Recycling creates circularity and reduces the need for raw materials and landfilling. With recycling, it is possible to maximise the utilisation of resources, such as materials and minimise the environmental impact. However, the most beneficial form of utilising the circular economy to reduce textile waste would be reusing the materials as such. (Juanga-Labayen et. al. 2022, 180) Although, it is not always possible. The materials might have flaws which makes them not suitable for reuse.

Sustainability is a broad concept that covers many issues regarding the environment, society and economy. The concept does not have a universal definition. Instead, it has many definitions that consider different sustainability aspects. The concept is considered on various occasions, from consumer behaviour in a grocery store to international organisations' strategies.

Sustainability significantly considers the sufficiency of resources. Concern about the population growing faster than the resources on the Earth has been acknowledged for hundreds of years. In 1798, Thomas Malthus wrote a book about the topic, which considers the impact of a constantly growing population and living conditions (Malthus 1798/1998, 6–11). However, as it is used and understood nowadays, the concept of sustainability was introduced in the 1980's century by a report entitled "Our Common Future", also called the Brundtland report. Doctor Gro Harlem Brundtland and the commission she led prepared the report for United Nations. In the report, sustainability is defined as meeting "…*the needs of the present without compromising the ability of future generations to meet their own needs*." (Brundtland

1987). The Brundtland report's definition can be considered one of the most famous definitions of sustainability. This thesis will primarily discuss sustainability as defined in Brundtland's report.

More recent definitions of sustainability can be found in numerous sources. For instance, Dr Michael Ben-Eli (2018, 139) has defined sustainability as "*a specific kind of dynamic equilibrium in the interaction of a population and the carrying capacity of its environment.*" According to Ben-Eli, this applies to any population and environment, from amoebas in a petri dish to humans on the planet. The definitions vary depending on the context in which they are used. Sustainability and sustainable development, as well as theories related to the concepts, will be discussed later in the theoretical framework.

The key concepts defined in this section form the conceptual framework of the thesis. Textile production and circular economy are the two main concepts discussed. The textile waste produced from textile production and recycling of the waste will be discussed considering the implementation of a circular economy. In addition, the sustainability of utilising a circular economy will be explored, as well as the economic benefits and challenges it creates. The visual illustration can be seen in Figure 4 below.

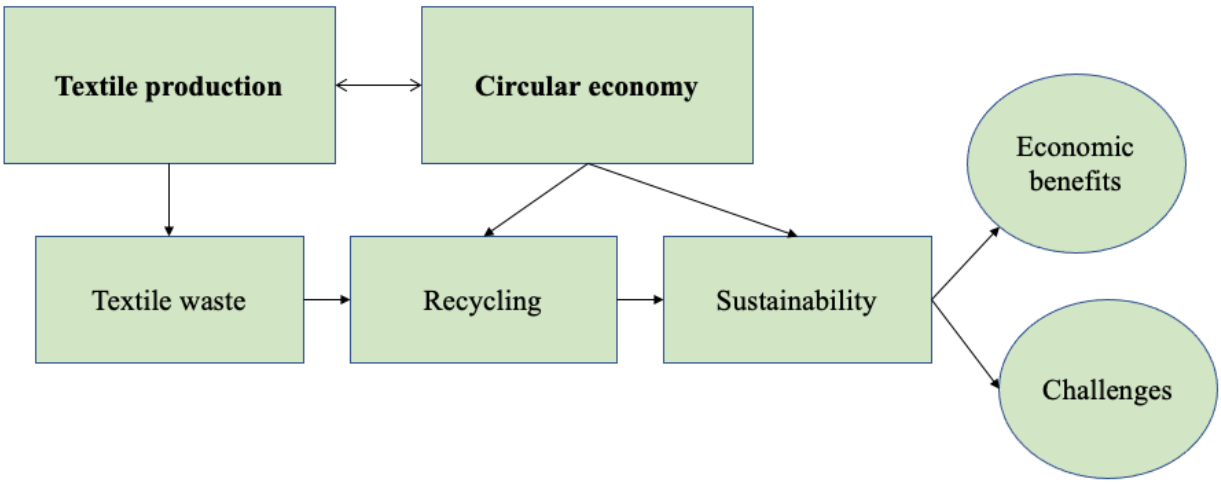

Figure 4: Conceptual framework.

2.2 Circular economy

The concept of circular economy, which provides an alternative to the traditional economic development thought of "take-make-waste", has gained attention worldwide over the last decade (Ghisellini, Cialani & Ulgiati 2015, 1; Geng & Doberstein 2008, 232). A circular economy was conceptualised considering that economic growth will reduce the Earth's resilience (Merli, Preziosi, & Acampora 2018, 704). At a theoretical level, circular economy has many similarities with ecological modernisation theory, which considers the relationship between industrial development and the environment (Geng & Doberstein 2008, 232).

The circular economy is briefly driven by three primary activities in production, circulation and consumption: reduction, reuse and recycling. In addition, recovering every resource back to the circular economy is seen as a part of the closed loop. It has been argued that reducing the circularity would be a poor decision since it may affect economic growth. (Kirchherr et. al. 2017, 226–227) However, the reduction is seen as a principle of the circular economy since there are limits for raw materials and waste on the Earth.

The 4R framework creates a closed loop with the resource flows maintained as part of the economy for as long as possible (Figure 5). **Reduce** mainly focuses on reducing the resources used, such as raw materials, energy consumption and water consumption, in manufacturing products. In addition, it refers to a reduction of emissions, waste and negative impact on the environment. **Reuse**, in the loop, refers to reusing materials or the components of materials as such. Reusing materials and components reduces the use of virgin materials and energy and water consumption. **Recycling** is the process where waste is turned into new materials, components and products. **Recover** means recovering every resource to the loop of the circular economy to optimise resource use. For instance, recovering the wastewater and energy back to production or making by-products from the waste flows generated from circular economy activities. (Kirchherr et. al. 2017 224–226; Jawahir & Bradley 2016, 105–106) There are plenty of different variations of the 4R framework. Some frameworks are called 6R or 9R frameworks because there are more factors in the closed loop, such as remanufacturing, rethinking and redesigning.

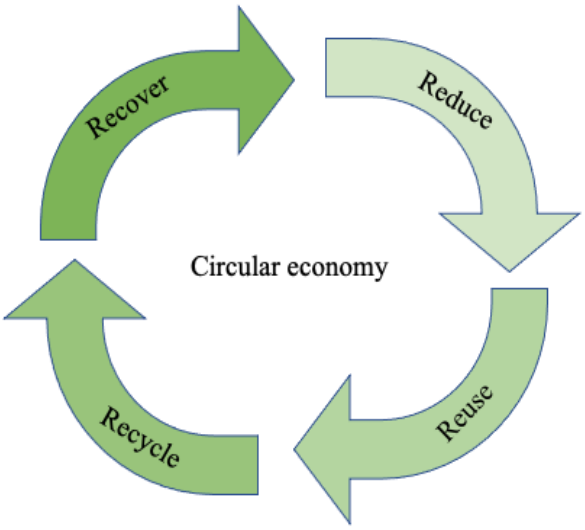

Figure 5: 4R framework.

The circular economy aims for sustainable development while creating environmental quality, economic prosperity and social equity (Kirchherr et al. 2017, 229). Various countries worldwide promote a circular economy to progress towards sustainability (George et al. 2015, 60, 63). The circular economy is seen as a global goal to strive towards. For instance, the European Commission adopted the new circular economy action plan in March 2020, which invites the European Union's institutions and bodies to actively endorse and contribute to implementing the action plan. In addition, the commission encourages the European Union member states to promote a circular economy in their national strategies. In the action plan, there is, for instance, a strategy for improving the circulation of the textile industry in the EU by reusing and recycling textiles. (European Commission 2020)

2.2.1 Circular economy in textile production

The current production of textiles is mainly driven by the linear economy, also known as the "take-make-waste" economy (Shirvanimoghaddam et al. 2020, 4). The linear economy consists of sourcing raw materials and manufacturing them into utilised products until they are wasted (Figure 6). The linear economy produces an unreasonable amount of waste output, and the resources of textile production are continuously wasted. Environmentally and economically,

the linear economy has reached its limits. Due to this, "*…the natural environment seems to be unable to tolerate the current level of resource exploitation*" (Sariatli 2017, 34).

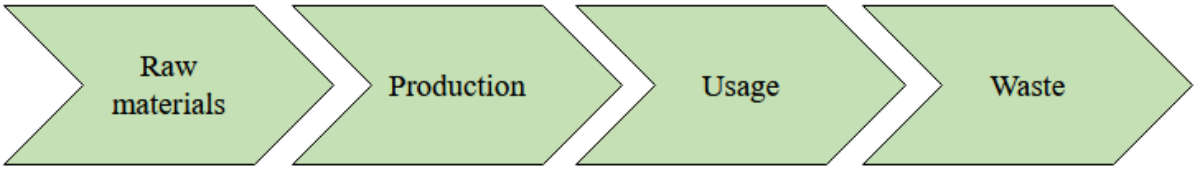

Figure 6: An example of a linear economy. (Shirvanimoghaddam et al. 2020, 4)

Implementing a circular economy could reduce the environmentally negative impact of textile production (Dahlbo et al. 2017, 44). By implementing a circular economy in textile production, the value of products, materials and resources can be maintained for as long as possible, optimising resource use (Roberto, Preziosi & Acampora 2018, 1). It is even required that companies in the textile industry must implement circularity shortly. For instance, the European Union aims to be climate-neutral by 2050. For textile products and other everyday items, it is required that the products must be durable, reused, repaired, recycled or contain recycled materials to gain access to the European Union market. (European Commission 2020)

Implementing a circular economy in textile production is crucial. However, it can be challenging. All the actions, from sorting waste through separation to recovering the materials, energy and water while optimising the operations in textile production, consume lots of resources. It is a complicated process that must be done efficiently to achieve sustainability and benefit economically. Implementing a circular economy in textile production requires engagement and significant changes to the "take-make-waste" approach. (Dahlbo et al. 2017, 44; Heshmati 2017, 16–19)

A circular economy can make the production of textiles more sustainable and advance sustainable development (Ki, Chong & Ha-Brookshire 2020, 2401–2402). Developing new technologies have a significant advance in making implementing circularity more efficient and attractive for companies. Currently, textile production technologies have challenges, such as know-how to separate fibres from mixed blends and costly recovery processes, that must be solved to make implementing circularity profitable and attractive. If the technologies developed can overcome these challenges, it will positively impact profitability, sustainability and sustainable development. (Damayanti et al. 2021, 2)

2.3 Sustainability theories and sustainable development

Sustainability has been a relevant concept worldwide in business since the Brundtland report in 1987. Chang, Zuo, Zhao, Zillante, Gan & Soebarto (2017, 48) state in their article, "*Sustainability of firms has become an important research area since firms are the productive resources of the economy.*" Since sustainability has been a relevant concept for various businesses, it has been desired to understand more deeply and even universally. Due to this, theories have begun to develop around the concept of sustainability. Theories are created to produce valuable knowledge and understanding of the observed or experienced phenomenon (Goia & Pitre 1990, 584, 587). This section will introduce three theories related to companies' sustainability.

Sustainability is a key concept of business strategies since the resources of the Earth is approaching its critical limits. Sustainability in business can be defined as "… *meeting the needs of a firm's direct and indirect stakeholders without compromising its ability to meet the needs of the future stakeholder.*" (Schrettle, Hinz, Scherrer-Rathje & Friedli 2014, 73). Various stakeholders demand sustainability from companies, which makes it a concept that cannot be ignored (Wu & Pagell 2011, 577). Implementing sustainability in the companies' strategies and operations can embrace a company's economic, environmental and social impacts, resulting in improved resilience, growth and success (Balugani, Butturi, Chevers, Parker & Rimini 2020, 2).

Many of the diverse definitions of sustainability relate to sustainable development. Sustainability actions will be realised in the future and can be seen as the sustainable development of a company, an industry or a nation. The two concepts are often used as synonyms. Although the definitions share many similarities, sustainability and sustainable development should be considered two different concepts. Sustainable development refers to positive growth, while sustainability can be associated with negative growth (Ruggerio 2021, 2–3).

2.3.1 Theories about sustainability and sustainable development

The theory of corporate social responsibility was one of the first theories regarding sustainability. Social corporate responsibility can be seen as evolved from "social responsibilities of businessmen", a term created by Howard Bowen in 1953. (Lee 2008, 56–57) Howard Bowen considered the relationship between a company and society regarding how a company's strategies and actions affect the citizens (Chang et al. 2017, 50). Since the theory has been evolving to the point where it can be seen affecting "*…all the activities a company engages in while doing business.*" (Porter & Kramer 2006, 8)

The stakeholder and corporate sustainability theories have evolved alongside the corporate social responsibility theory (Chang et al. 2017, 49). Philosopher Robert Edward Freeman introduced the stakeholder theory. Stakeholder theory explains the connections between a company and its stakeholders. Stakeholders refer to everyone involved in the company's success or failure. The stakeholder theory's main aspects are value creation, trade and managing a business effectively. Managing a business effectively can be seen as creating as much value as possible for the stakeholders. (Freeman & Harrison 2010, 9) "*Businesses are actors in the social environment and should respond to pressures and demands from their stakeholders in order to attain their overall strategic objectives*." (Linnenluecke & Griffiths 2013, 51). Due to this, it is crucial, according to stakeholder theory, to consider stakeholders' demands, such as sustainability, in the strategy and actions of a company.

Corporate sustainability has been increasingly taken into consideration since Brundtland's report. The theory of corporate sustainability is usually operationalised through the social, environmental and financial dimensions also called the "triple bottom line". Sustainable business models can be seen as promoting corporate sustainability (Chang et al. 2017, 51). Sustainable business models consider a wide range of stakeholder interests through the "triple bottom line" approach. Companies can gain competitiveness by promoting sustainability in their business processes and operations with the help of sustainable business models (Bocken, Short, Rana & Evan 2014, 42). Corporate sustainability theory's main idea can be seen as organisations improving their competitive advantage by focusing on the social, environmental and financial dimensions. In addition, integrating corporate sustainability into the company's actions advances sustainable development. (Jamali 2006, 816 817)

Sustainable development goals can only be fully achieved if companies worldwide engage with them. "*Firms play a crucial role in facilitating sustainable development*." (Chang et al. 2017, 48) Therefore, sustainable actions, such as circularity, should be implemented in industries. There are 17 sustainable development goals determined by the United Nations in 2015 (Table 1). The sustainable development goals have been created to be universal goals that respond to political, economic and environmental challenges faced now and in the future (United Nations 2022). The goals can be seen as a solution and guidance for businesses to implement sustainability as well as gain opportunities in the long term. Pedersen (2018, 21) has described the goals as "*...a crystal ball to look into the future...*" for businesses. There is a relationship between companies operating responsibly and financial benefits. A responsible company, which considers sustainable development goals in its strategies and operations, can benefit from its improved reputation publicly, thereby enhancing its financial performance and favour. (Orlitzky, Schmidt & Rynes 2003, 427; Chang et al. 2017, 50)

Table 1: The 17 Sustainable development goals (United Nations 2015).

1. No poverty	9. Industry, innovation and infrastructure
2. Zero hunger	10. Reduced inequalities
3. Good health and well-being	11. Sustainable cities and communities
4. Quality education	12. Responsible concumption and production
5. Gender equality	13. Climate action
6. Clean water and sanitation	14. Life below water
7. Affordable and clean energy	15. Life on land
8. Decent work and economic growth	16. Peace, justice and strong institutions
	17. Partnerships for the goals

2.4 Sustainable fibre and textile production

Sustainable fibre and textile production can be defined as "*…one that is resource-efficient and renewable resource-based, producing non-toxic, high quality and affordable...products, while*

providing safe and secure livelihoods." (UNEP 2020, 45). Governments, businesses and consumers should rethink the current linear economy to achieve sustainability in production. Sustainable fibre and textile production should operate within the planetary boundaries (Whiteman, Walker & Perego 2013, 317). In addition, materials values should be kept at their highest for as long as possible, and resources should be recovered as well as possible.

The Circle Economy (2017) estimates in their report, according to "Sustainable Textiles for Apparel: Fact, Fiction and Future Prospects" report published in 2014, that an 84 % increase in demand for textile fibres over the next 20 years will lead to a breaking point of resources. There are various activities to make fibre and textile production more sustainable. Implementing circularity is a crucial approach towards sustainable fibre and textile production (Dahlbo et al. 2017, 45; Shirvanimoghaddam et al. 2020, 9; Okafor, Madu, Ajaero, Ibekwe & Nzkwe 2021, 73). Circularity as rethinking the use of materials, designs, and manufacturing along with reducing and reusing materials, has a significant impact on advancing the life cycle of textile products and the sustainability of fibre and textile production (Kazancoglu, Kazancoglu, Yarimoglu & Kahraman 2020, 1478–1479).

Different fibres, places of manufactures and textiles designs are more sustainable than others. Natural fibres rely on renewable resources instead of limited and highly polluting fibres made of fossil raw materials such as crude oil. In addition, natural fibres often have a lower environmental footprint. Nevertheless, cultivating natural fibres requires a lot of land use, which often leads to deforestation and reduces the land that could be utilised, for instance, for food production. On the other hand, synthetic fibres neither require as much land use as natural fibre nor animals involved in the production. However, producing synthetic fibres requires a lot of energy and raw fossil materials, which are both issues for the environment and society. On top of that, fibre and textile production uses a lot of water and energy, so the manufacturing locations should be optimised to mitigate environmental hazards. (Muthu, Li, Hu & Mok 2012, 67–73)

With sustainable fibre and textile production, sustainable development goals can be advanced, leading to environmental, social and economic benefits (Tobler-Rohr 2011, 2). Sustainable fibre and textile production contribute directly to goals 9, 12 and 15 (Table 1) (de Oliveira Neto, Ferreira Correia, Silva, de Oliveira Sanches & Lucato 2019, 1524). Sustainable fibre and

textile production actions can also advance other sustainable development goals, such as 2, 6, 7, 8, 13, 15 and 17 (Table 1).

Although sustainable textile production creates many benefits, developing processes and strategies that result in a sustainable and profitable outcome is challenging. The low-price tag of virgin fossil-based artificial fibres makes them more attractive for fibre producers regardless of the impacts on sustainability and sustainable development. Polyester has the highest market share of any fibre at 54 %, of which a small percentage of 14.8 % is recycled because of the competitively low costs of fossil-based polyester. (Textile Exchange 2022) However, emerging technologies that enable the more practical and diverse implementation of fibre and textile production's sustainability could be a solution because it would bring cost-efficiency and profitability (Nieminen, Linke, Tobler & Beke 2007, 1268).

3 Methodology

The research methods, data and the process of data collecting will be introduced in this section. The research methodology consists of the methods used for collecting data and the logic behind the methods. The section explains why the specific methods used are appropriate to answer the determined research questions. The methodology discusses the data collection, introduces the data and evaluates the research methods. Using appropriate research methods can help to gather more reliable data. (Kothari 2004, 7–8)

3.1 Research methods

This thesis is a qualitative study using multiple sources to observe more sustainable alternatives for textile production by utilising a circular economy. In addition, the economic benefits and challenges of implementing a circular economy in textile production will be considered and discussed. To gather data, the most suitable research methods for the thesis seemed to be semi-structured interviews and secondary sources. These research methods can provide the knowledge to answer the research questions comprehensively in the two months timeframe.

3.1.1 Semi-structured interviews

The two semi-structured interviews were held for experts working with new fibre technologies that advance the utilisation of circularity in fibre production and the textile industry. The interviewees are called Expert 1 and Expert 2. The interviewees and the companies they work for will remain anonymous in the thesis. Semi-structured interviews may be resource-consuming as the long process of contacting participants, conducting the interview, transcribing the data and using it must go through (Alsaawi 2014,154). Due to this, two semi-structured interviews were ideal for the thesis. Suppose there had been a more extensive time frame. In that case, more interviews could have been conducted with experts working on implementing circularity in textile production to increase the knowledge on the topic in business and real life.

The interviews were held remotely on Teams in October and November 2022. Both interviews were held in Finnish and then translated for the thesis. The interviews consisted of six predetermined questions that guided the interviewer and interviewee's discussion. According to Koskinen, Alasuutari & Peltonen (2005, 109), a functional interview frame should have five to twelve questions. The six questions of both interviews provided a good number of insights to help answer the research questions. There were some differences between the questions asked from Expert 1 and Expert 2. By adapting the questions slightly for both interviews, the unique knowledge held by the experts was able to be gained. The questions asked from Expert 1 can be observed in appendix 1, and the questions asked from Expert 2 can be observed in appendix 2.

The two experts were chosen to be interviewed because of their knowledge and experience related to the topic. Both experts provided significant insights about the matter, considering the real-life implementation of circularity into the textile value chain. The interviews, together with earlier research, peer-reviewed journal articles and other secondary sources, presented excellent knowledge that helped create more comprehensive findings presented in section four.

3.1.2 Secondary sources

Various peer-reviewed journal articles, alongside other beneficial secondary sources, are easily accessible for a bachelor student in a university, which helps to create comprehensive findings. However, one must be critical when using secondary sources to support one's interpretations. Secondary sources may not provide all the information of interest and vary depending on the research question wording and preciseness. Nevertheless, various well-designed and peer-reviewed secondary sources consider the reliability and validity of the information and results provided. (Pederson, Vingilis, Wickens, Koval & Mann 2020, 59)

The secondary sources are used in the thesis to help gain knowledge about the solutions to making textile production more sustainable. In addition, a discussion about the benefits and challenges provided by the secondary sources is convenient for answering the sub-questions. The secondary sources were an excellent addition to the thesis because they have already been

collected, analysed and compiled. The secondary sources were a beneficial research method, considering the timely manner of conducting this research.

3.2 Data

The research question of the thesis will be answered with the help of theory and qualitative research where data is collected from multiple sources. The data consist of the interviews and knowledge provided by secondary sources. Secondary sources are primarily used to support the interpretations from the interviews as well as to gain more profound findings on the topic. The interview data were transcribed, so it is easier to manage and gather valuable insights.

Content analysis involves comparing, contrasting and categorising collected data in order to gain a deeper understanding of specific themes and approaches of a researched phenomenon or issue (Gerbic & Stacey 2005, 46). The collected data is analysed with content analysis framework methods. The content analysis summarises the collected data while maintaining all the valuable information and creating findings about the researched matter (Vaismoradi, Jones, Turunen & Snelgrove 2016, 101). The purpose of using content analysis as the method for data analysis is to gather extensive information from data collected into a compact and informative package.

The interview data were written, including the most relevant information, to compare, contrast and categorise the information to find solutions for the research questions more easily. The data was processed multiple times in order to gain the most valuable information. After that, findings from secondary sources were compared, contrasted, and categorised according to the data provided by the interviews. This allowed to gain and summarise the findings of the thesis regarding more sustainable solutions for textile production utilising circular economy and the benefits and challenges that may be faced when utilising circular economy in the more sustainable production of textiles.

The similarities in data will be mainly focused on answering the research questions. In addition, the differences in data will be discussed to think critically about the findings. The findings will be categorised to have a compact and informative form of the main findings for each question. The visualisations of the data's categorisation are presented in the next section.

4 Findings and discussion

This section presents the answers to the main research question, "*How to make the production of textiles more sustainable by utilising the circular economy?*" and the two sub-questions "*What are the economic benefits of utilising the circular economy in the production of textiles?*" and "*What kind of challenges can be faced in the production of textiles when utilising the circular economy?*". The findings from interviews and secondary sources' insights presented in the theoretical framework will be analysed and categorised to find the answers to the research questions. The categories will be determined based on the similarities between the interviews and secondary sources.

4.1 Producing textiles more sustainably by utilising a circular economy

This section will answer the main research question. The answers gathered and categorised from the two semi-structured interviews and secondary sources are illustrated in Figure 7. The main categories of the solutions are more circular product design and development, development of technologies advancing circularity and resource optimisation.

There are various solutions to advance the sustainability of textile production, and implementing circularity in the processes can be seen as one solution. As explained and stated in the theoretical framework, a circular economy can make the production of textiles more sustainable. Circularity will promote the sustainability of textile production, and it can create opportunities for differentiation leading to economic advantages, which will be discussed more in the next section.

Implementing a circular economy in the production of textiles means reusing, recycling and recovering materials and resources. In addition, reducing resource use can be a solution to make the production of textiles more sustainable. However, the material flows will remain even if there is a reduction in resource use. As Expert 1 stated: "*The reuse of products and raw materials is inevitable*." Therefore, implementing a circular economy in textile production as well as in other areas is crucial for protecting our "spaceship" with limited resources of everything.

Kircher et al. (2017, 224) suggest that circularity, which leads to the more sustainable production of textiles, can be increased by optimising material and resource use, extending the lifespan of products and their parts with more innovative product use and manufacture. According to Kircher et al. (2017, 224) and Shirvanimoghaddam et al. (2020, 6), the increasing circularity consists of strategies that involve reducing, reusing, recycling and recovering as rethinking, repairing, repurposing and remanufacturing. Expert 1 also suggested that with "*Rethinking of processes and products with sustainability-driven perspective…"* and recycling, for example, waste flows from other processes, making textile production more sustainable by utilising a circular economy is possible. It is crucial to utilise every resource, including waste flows from other processes, to maximise resource use.

Both experts mentioned reducing fossil-based raw materials in the production of textiles to make the production more sustainable. At the moment, polyester, made of non-renewable fossil fuels, ranks as the most popular fibre because of its low price and desired features. Fibre production requires significant energy and crude oil inputs leading to significant environmental hazards. In addition, the fibre is not biodegradable and takes a long time to decompose. (Koszewska 2018, 3, 7)

Often natural fibres, such as cotton, are considered more sustainable than, for instance, polyester. However, "*The environmental footprint of cotton, the second biggest textile fibre… is significant.*" Cotton requires a lot of water and land to grow. It is a biodegradable fibre, but when disposed of it negatively affects the quality of soil and groundwater. (Koszewska 2018, 3) Both Experts, in addition, brought up the environmental hazards of cotton. It was discussed that growing cotton reduces the land used for food production and the availability of clean water. These negatively affect achieving goals two and six of sustainable development (Table 1). In conclusion, some fibres, technologies and solutions may appear sustainable, but the environmental footprint may be surprisingly significant when researched deeper.

Both Experts suggested that the sustainability of the textile industry can be advanced by developing production processes and technologies, for instance, for cellulose fibres as well as recycled fibres. However, it is challenging to discover which fibres have the smallest environmental footprint because many factors affect the comparison. Some fibres are easier to recycle, some are more durable, some release more oxygen as they grow, and some do not need

that many resources to manufacture (Muthu et al. 2012 68–71; Sandin, Roos, & Johansson 2019, 8). However, smarter fibre compositions, the rethinking of materials, as well as innovative and sustainable product designs can significantly advance the sustainability of textile production by utilising a circular economy.

The circular economy can considerably decrease the negative impact of textile production on sustainability and sustainable development. Expert 2 expressed that a significant question at the moment is: "*Who will invent the technologies and find the know-how to implement a circular economy that is cost-effective and sustainable enough*?" In addition, Expert 2 stated that "*The right parameters must be found in order to achieve cost-effectiveness and positive environmental impact*." However, Expert 1 said: "*Technologies in this field have taken a huge leap in recent years, and I believe the development will continue.*" It is crucial to find the solutions to make the utilisation of a circular economy attractive, profitable and especially sustainable with all processes included.

There are various benefits, but also challenges, to implementing a circular economy in textile production. Both the Experts and many researchers have stated that the benefits and possibilities created by utilising circular economy in textile production are remarkable. Due to this, the research and development of the utilisation of circular economy in processes have accelerated. The economic benefits and business area possibilities have made utilising a circular economy in the production of textiles a hot topic.

Altogether 14 solutions were identified to advance the sustainability of textile production by utilising the circular economy (Figure 7). The solutions were categorised into three categories: more circular product design and development, development of technologies advancing circularity and resource optimisation. There are various stages in the textile production value chain in which utilising a circular economy can promote the sustainability of the production of textiles. The development of efficient recycling infrastructure, innovating of new fibre technologies, making implementing circularity more attractive with new technologies, reusing, recycling and recovering acts, minimisation of waste, maximisation of the lifespan of products and sustainability-driven products, such as by-products and more sustainable fibre compositions were the most significant solutions identified in the thesis to make the production of textiles more sustainable by utilising the circular economy.

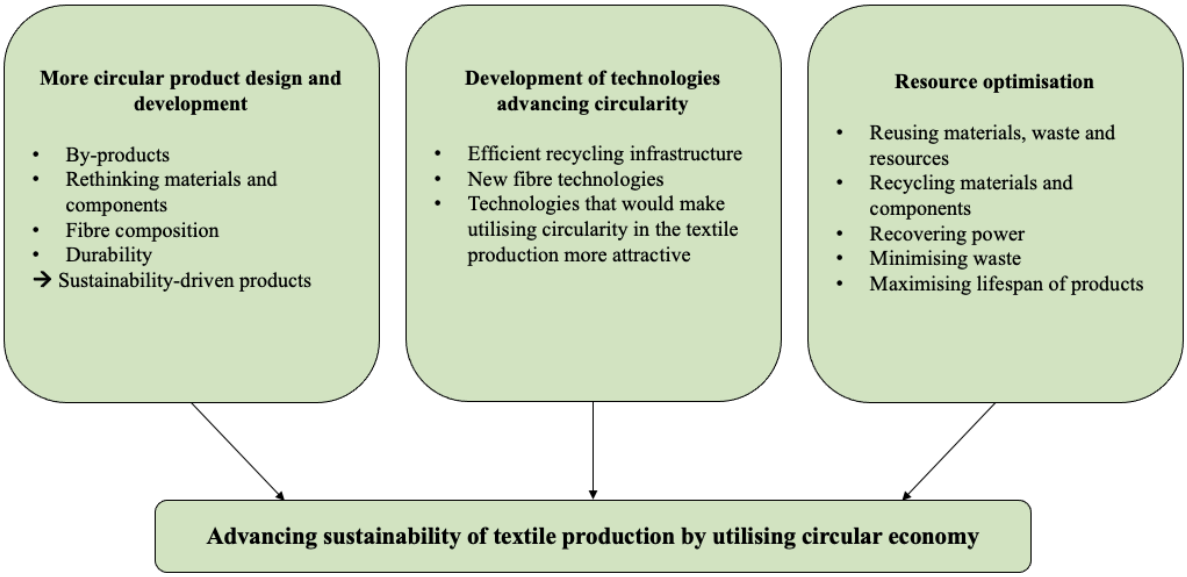

Figure 7: Solutions to advance the sustainability of textile production by utilising circularity.

4.2 Economic benefits of utilising circular economy in the production of textiles

Implementing circularity creates several benefits. Economic benefits, such as an increase in the company's net income and revenue, can be achieved by utilising a circular economy in textile production (Kumar, Ihsan, Garza-Reyes, Gonzalez & AL-Shboul 2019, 1073). The circular economy can also be seen "*…as an opportunity for companies and the development of processes to curb the sustainability crisis*." as Expert 1 mentioned. Expert 1, in addition, stated that: "*When processes and products are designed primarily with the sustainability aspect in mind, the economic benefit also follows from that.*"

The economic benefits may be achieved through life cycle assessment, reduction of waste generation, lower input prices and mitigation of environmental penalties when utilising circularity in textile production. (Park, Sarkis & Wu 2010, 1496; Geng, Fu, Sarkis & Xue 2012, 221–222; MacArthur 2013, 8). In addition, according to Kumar et al. (2019, 1073) and the Experts interviewed, the circular economy provides new business areas for recycling and remanufacturing products from reused and repaired parts. New business areas and markets may boost net income and revenues. Implementing circularity can also benefit a company's brand image, making it a more desirable alternative among stakeholders.

Expert 1 and Expert 2 mentioned that consumers now demand more sustainable products, such as textiles made of recycled materials. This is an excellent opportunity for companies to make their product more attractive to consumers by utilising a circular economy in the production of textiles, for instance. As circularity allows companies to use recycled materials in their products, many consumers' interests towards the more sustainable product may arise. Expert 2 said that by using recycled materials, the company might increase their brand benefit, which leads to competitive advantage and economic benefits. However, he also mentioned that it must be kept in mind that various companies are labelling their products as circular even though they may not be.

Chang et al. (2017, 48) stated in their article that companies are the productive resource of the economy. Due to this, the financial benefit of companies will lead to economic growth, which is essential for development, especially sustainable development. As mentioned in the theoretical framework, a company's sustainable performance significantly affects its financial performance. Companies must respond to the customers' demand, which nowadays consists of sustainable products, services and acts. By implementing circularity in the production of textiles, it is possible to create a more sustainable brand image, have lower input prices, mitigate environmental penalties and seek new business opportunities. As companies go towards sustainability, under the demand of consumers and policymakers, it creates new business areas, opportunities and increases in revenues, which creates economic benefits for the company and society as well as advances sustainable development. Expert 1 mentioned that there are various opportunities for companies to grow their businesses in this field.

The answers for the first sub-question were also categorised into the same three categories as the solutions for the main research question (Figure 8). It was noticed that both Experts and researchers thought that technologies advancing circularity create new opportunities and competitive advantage, which results in economic benefits. In addition, implementing circularity in the production of textiles lowers the input prices, mitigates environmental penalties, and allows resource efficiency through life cycle assessment resulting in economic benefits. Companies may also gain financial benefits by promoting their brand image using recycled materials and designing sustainable-driven products. It may even harm companies' financial performance if they do not implement circularity because the stakeholders will most likely demand it.

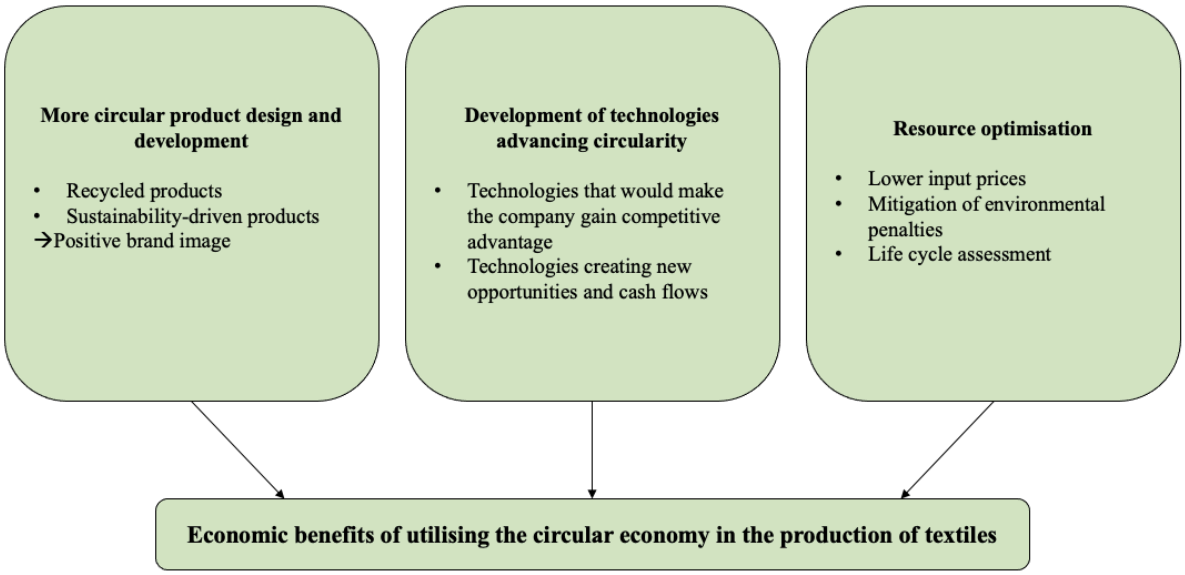

Figure 8: Economic benefits of utilising the circular economy in the production of textiles.

4.3 Challenges of utilising circular economy in the production of textiles

There has been a lot of discussion of challenges when implementing a circular economy in the production of textiles. It is an important aspect to investigate to find the solutions to overcome the challenges and make the utilisation of a circular economy more attractive and economically and environmentally beneficial. This section will give a comprehensive answer to the second sub-question.

If the utilisation of a circular economy in the production of textiles was easy, it most likely would have been implemented more than it has been. The challenges consist primarily of a lack of solutions and resources, such as time and money. For instance, textiles' separation and recycling processes are complicated and require a lot of resources and knowledge to develop. "*The invention of new technologies requires a lot of resources, such as research and development, which consumes time and money*." – Expert 2. The textiles are mixed blends of different fibres and often include accessories that must be appropriately separated. "*The waste needs to be collected, sorted and categorised correctly to maximise the use of it.*" – Expert 1.

Even though the technologies have evolved vastly, there is yet much to do. The technologies must enable sustainability so that environmental hazard is minimised. Implementing circularity can be thought of from a perspective where it consumes too many resources and causes

ecological issues. Separation, recycling, manufacturing and all the processes in the textile production value chain must be done carefully to maximise the benefits and minimise the negative impacts, such as emissions, pollution and damage to human health, that may form from the production.

Damayanti et al. (2021, 2) state in their article that there are five problems in recycling technologies currently. The five problems Damayanti et al. (2021, 2) mentioned in their article summarise well the challenges the two Experts brought up. The five problems that emerged are "*lack of commercially viable recycling technologies…, lack of mainstreamed… processes and know-how to separate fibre types from the mixed blends and composite structures, the costly recovery process, the fact that recycling end-market is dominated by low-quality materials and blends, costly logistics and the low availability of textile recycling plants on local and regional levels."* (Damayanti et al. 2021, 2). Expert 2 mentioned that the availability of textile waste for the processes is a challenge because there are specific quality requirements, and new operators in the business area will need a considerable amount of textile waste that meets the requirements. Because of this, textile recycling plants, for instance, are much needed to advance circularity in the production of textiles. (Figure 9)

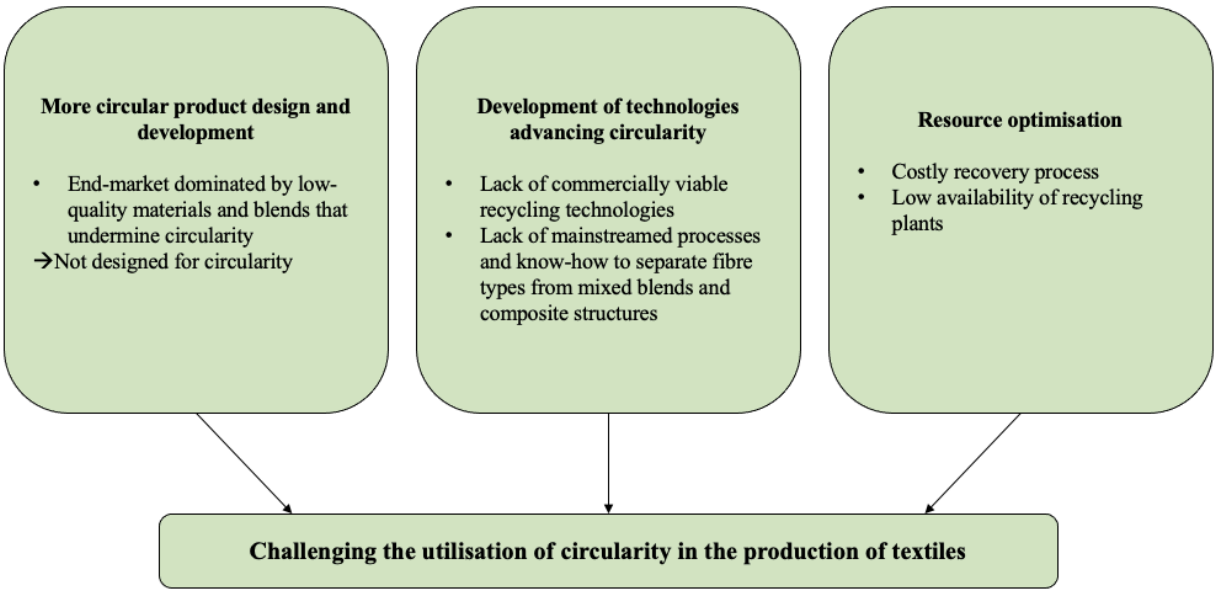

Figure 9: Challenges of utilising the circular economy in the production of textiles.

5 Conclusions

The unsustainability of textile production is reaching its critical limits, and there is a need for solutions, such as new, more sustainable, efficient innovations and technologies. This thesis aims to find solutions for making the production of textiles more sustainable. In addition, the economic benefits and current challenges of implementing a circular economy in the production of textiles were explored and discussed.

The textile industry cannot keep using resources as it is currently. Due to this, implementing a circular economy in production could be a great solution. A circular economy would create circularity among the resource flows in the textile production value chain. It can be stated that a circular economy can make the production of textiles more sustainable by optimising resource use. It must be kept in mind that there are limited resources for everything on our planet, which is why circularity and sustainable choices must be implemented to ensure that the next generations do not need to compromise in meeting their needs.

The thesis is qualitative research that uses multiple sources to answer the three research questions. The answers to the questions were gathered by analysing two semi-structured interviews held for experts working with new fibre technologies and secondary sources primarily consisting of peer-reviewed journal articles.

The results revealed various ways of making textile production more sustainable by utilising a circular economy. For instance, designing by-products of waste flows, recycling materials and components, recovering power and maintaining the value of materials for as long as possible were solutions to make textile production more sustainable with circularity. The implementation of circularity in textile production also creates several economic benefits. The sustainable performance of a company remarkably affects the net income and revenue of the company. It may be harmful to companies in the future not to implement circularity because it most likely will be demanded by the stakeholders.

However, significant challenges must be solved to make the utilisation of a circular economy in producing textiles cost-efficient, profitable and as sustainable as possible. The challenges primarily relate to the question: Who will invent the technologies that make the utilisation of

circular economy commercially viable in textile production? It can be stated that the technologies must be researched and developed to overcome the challenges. At the moment, there is a lack of know-how. The proper parameters must be found to make all the processes efficient and profitable and minimise the environmental hazard. In addition, a shift in business models is much needed to have a more circular economy instead of a linear one, which leads to the over-consumption of resources.

5.1 Reliability of the research

This thesis has followed the logical patterns of research: introduction, theoretical framework, methodology, findings and discussion and lastly conclusions. Dependability is one of reliability's four areas, and it determines if the research's structure has been logical. The three other areas determining reliability are credibility, transferability and conformability. (Anney 2014, 272).

The thesis's section has been structured carefully with the help of secondary data from secondary sources and primary data from the interviews. While searching results for the research questions, many similarities were found between earlier literature. In addition, new insights about the implementation of circularity in textile production in real-life were discovered by analysing and colliding all the data collected with the content analysis method.

The content analysis method worked well to gather the most valuable information from the multiple sources used. The analysation was performed logically and carefully not to lose any valuable data. This study could be replicable because of the anonymity of the experts, precise research methodology explanation, theoretical framework and carefully operated data (Eriksson & Kovalainen 2008, 294). However, it must be kept in mind that implementing circularity in textile production includes various complex processes, steps and aspects, making evaluating its sustainability by qualitative methods challenging.

5.2 Future research suggestions

As said, there is a need for a shift in business models towards circularity. Research about new business models for utilising circular economy in the production of textiles could be beneficial. The shift towards a more circular economy in the business models would help businesses to understand how and why one should go from a linear economy to utilising a circular economy. Expert 1 suggested that it could be highly beneficial to research and create new circularity-driven business models. The topic would be interesting for future research and the continuation of this research.

A remarkable topic of research now is to find solutions to overcome the challenges slowing the implementation of a circular economy in the production of textiles. As said, the right parameters must be found to optimise the utilisation of circular economy in textile production making it cost-efficient, profitable and as sustainable as possible. The matter needs further research.

In addition, quantitative research could be done to test or confirm the economic benefits and sustainability of implementing circularity in textile production. The quantitative analysis could be used to establish generalisable facts about the topic. Quantitative research would provide more specific information with quantitative data about the economic benefits and sustainability.

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Appendix 1: The interview questions for Expert 1

1. What position are you in?

2. Do you think the circular economy will be in a key position for the textile industry?

3. From your point of view, how is it possible to make the textile industry more sustainable?

4. What kind of role does the company you work in play in textile recycling, and why is this role?

5. What is the company looking for in this business?

6. What challenges can be faced in manufacturing when utilising the circular economy?

Appendix 2: The interview questions for Expert 2

1. How are you working with the circular economy in business?

2. From your point of view, how is it possible to make the textile industry more sustainable?

3. Which kind of fibres are better for making textiles from, and why?

4. What are the differences between mechanical and chemical recycling, and which could be more sustainable?

5. What kind of benefits can be sought by utilising the circular economy in the production of textiles?

6. What challenges can be faced in manufacturing when utilising the circular economy?