FACULTY OF ECONOMICS AND BUSINESS ADMINISTRATION

TOWARDS A MORE CIRCULAR ECONOMY: THE ROLE OF CIRCULAR ECONOMY INDICATORS

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Hannah Mestdagh

FOREWORD

This master dissertation marks the end of my Master of Science in Business Engineering at the University of Ghent. Throughout these two years, I gained knowledge, explored new things, spoke with interesting people and broadened my horizon. Writing this master dissertation opened my eyes regarding the limitations of the current linear economy. More importantly, it made me see the opportunities of a circular economy and the role that CE indicators can play in this story.

In particular, I would like to thank prof. dr. Katrien Verleye for her guidance and contagious enthusiasm throughout this journey. Her interest in the subject of circular economy and her open-mindedness created the ideal circumstances for my research to emerge. Furthermore, I would like to thank all my respondents. During the interviews, these passionate and inspiring people revealed their innovative ideas and shared their view on sustainability and indicators regarding a circular economy.

I would also like to thank my parents for their encouragement every step of the way, for the insightful and enlightening discussions, but especially for their critical eye that made me go the extra mile.

Hannah Mestdagh

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LIST OF USED ABBREVIATIONS

OECD: Organisation for Economic Co-operation and Development
EEA: European Environment Agency
WCED: World Commission on Environment and Development
SDG: Sustainable Development Goal
UN: United Nations
EMF: Ellen MacArthur Foundation
EC: European Commission
CE: Circular Economy
EEA: European Environment Agency
EU: European Union
EASAC: European Academies' Science Advisory Council

1 INTRODUCTION

Despite the widely explored research of the circular economy paradigm, deep research on CE measurement and indicators is still lacking. The interest of companies in the CE paradigm is increasing since it is seen as a possible path to increase the sustainability of our economy. However, the lack of indicators and methodologies for measuring the application level of CE strategies, in particular on the micro level, makes it difficult to move towards a circular solution. In the past, only a few studies focused on how to effectively measure the circularity level of a product or service. (Elia, Gnoni & Tornese, 2017).

This master dissertation has three main purposes. The first purpose is to scrutinize the existing circular economy indicators and their theoretical background. Although CE indicators can be applied on the different levels: micro, meso and macro level, this master dissertation focuses solely on the micro level. Different authors emphasized the need for micro level indicators due to their underdevelopment in regard to the meso and macro level (Elia et al., 2017; Ghisellini, Cialani & Ulgiati, 2016; Kristensen & Mosgaard, 2019; Linder, Sarasini & van Loon, 2017). To close this research gap, a literature review is performed. In this literature review, the possible advantages of indicators regarding a circular economy are investigated in order to identify the opportunities of CE indicators. Furthermore, a table of existing indicators was created with an analysis of some of their characteristics. This extensive overview of existing circular economy indicators helps reveal the challenges of the existing circular economy indicators, but also the opportunities for growth.

For the second purpose, the focus is mainly on practice. In this qualitative research, the relevance and the importance of circular economy indicators in the fashion industry were researched. The three main reasons for this choice are (1) the fact that the fashion industry is worldwide an extremely wasteful and polluting industry (EMF, 2017), (2) the lack of scalable circular fashion research, which is a hurdle for the further adoption of a truly circular economy (Ki, Park & Ha-Brookshire, 2020) and (3) Cayzer et al. (2017) mentioned that sectors with middle and long-lived products, such as the clothing and textile industry, are the most suitable environments to develop CE indicators.

The advantages of circular economy indicators in the fashion industry are underestimated due to the lack of research, which restrains the improvement of the CE paradigm in the clothing sector. Different fashion retailers are interviewed as different cases in the case study approach. These interviews help to answer our research questions in order to provide an insight into the relevance of CE indicators in the fashion industry. The research questions are “How is the circularity currently measured in the fashion industry?” and “How can the way in which the fashion industry measures the circularity be improved?”. The semi-structured interviews created the ideal environment to ask ‘how’ and ‘why’ questions to provide us with answers to those research questions. The information gathered from the interviews lead to guidelines for a CE indicator specific for the fashion industry.

The third purpose of this master dissertation was to build a bridge between the theory and practice, and thus to create a proof-of-concept of a CE indicator. Based on the knowledge gathered from the analysis of existing CE indicators and the guidelines provided by the in-depth interviews with the fashion retailers, a first proposal was made for a circular economy indicator for the fashion industry.

The master dissertation is organized as follows. The literature review is presented in chapter 2. The literature review tackles the challenges and opportunities of the existing circular economies. In chapter 3, the methodology is explained in detail, including the case selection and data collection. Chapter 4 presents the results of the case study and chapter 5 presents a recommendation. The conclusion is stated in chapter 6. Lastly, limitations and ideas for future research are discussed in chapter 7.

2 LITERATURE REVIEW

The literature review is structured as follows. First, the definition of an indicator is explained together with its functionalities. Secondly, the principles of sustainability and circular economy are illustrated. Next, the circular economy initiatives in Europe, Belgium and Flanders are explored. In the fourth section, the need for CE indicators is discussed and the characteristics of a good CE indicator were elaborated upon. Furthermore, a table with the existing CE indicators is presented. In the last section, the point of view of policymakers was scrutinized.

2.1 What are indicators?

The term 'metric' can be used as a general term, meaning a quantitative measure of a phenomenon. This includes CE assessments, indicators, scoreboards, assessment tools and more. Although there might be slight semantic differences, most of these terms are used interchangeably by most researchers. They can be seen as suitable synonyms. In this dissertation, preference is given for the term indicator because of its generality.

The concept of an indicator is probably intuitively clear. However, from a theoretical perspective, it is useful to give a clear description of an indicator because definitions vary considerably. There is not one widely agreed-upon definition for an indicator. An integrative definition that includes a system and technical perspective is preferred. The main goal of an indicator is to show performance as a measurement of distance-to-target. Hence, the following integrative definition of an indicator was conducted (Waas et al., 2014):

"An indicator is the operational representation of an attribute (quality, characteristic, property) of a given system, by a quantitative or qualitative variable (for example numbers, graphics, colours, symbols) (or function of variables), including its value, related to a reference value."

A definition that is more focused on the goals of an indicator is the definition of the OECD (2014):

"An indicator is a quantitative or qualitative factor or variable that provides a simple and reliable means to measure achievement, to reflect changes connected to an intervention, or to help assess the performance of a development actor"

When indicators are condensed and aggregated into a single metric, the term 'index' is used (Waas et al., 2014). When aggregating CE indicators into a composite index, careful attention should be paid to the weights that are used (Di Maio & Rem, 2015).

Saidani, Yannou, Leroy, Cluzel & Kendall (2019) describe some of the functionalities of indicators:

(1) the potentiality of relaying complex information in a simplified and useful manner (Wisse, 2016)
(2) the capability to communicate, raise public awareness on important issues and to indicate whether or not targets will be met (European Environment Agency, 1999)
(3) managerial and policymaking instruments; the contribution on the need for short cuts and rules of thumb to support decision-making (Waas et al., 2014)

Brown (2009) stated that the purpose of the indicator needs to be established in advance. Based on the functionalities mentioned above, Saidani et al. (2019) indicated four different purposes: (i) information purpose, (ii) decision-making purposes, (iii) communication and (iv) learning, such as education of the workforce. Azevedo et al. (2017) also confirmed that the index could be used as a support for managers to assess their circularity and thus improve the performance of the company regarding the circular economy.

After defining an indicator in general, a distinction should be made between good and bad indicators based on their characteristics. Some instances already made a list of characteristics of a good indicator. Even managers and consultancy companies came up with lists of criteria. The proposed characteristics can be useful to define good indicators, in specific good circular economy indicators. Subsequently, a summary is given of these different characteristics.

The EEA (2003) focused on communication as the main function of indicators. Indicators should ease the information exchange regarding the concept they measure. Moreover, the EEA (2003) made a list of criteria that define a good indicator, namely:

(1) communicate in a sound way a simplified reality;
(2) match the interest of the target audience;
(3) be attractive to the eye and accessible;
(4) be easy to interpret;
(5) be representative of the issue or area being considered;
(6) show developments over a relevant time interval;
(7) go with a reference value for comparing changes over time;
(8) go with an explanation of causes behind the trends;
(9) be comparable with other indicators that describe similar areas, sectors or activities;
(10) be scientifically well-founded;
(11) be based on sound statistic.

Deloitte, a consulting agency, recommended the use of RACER criteria (relevant, acceptable, credible, easy, robust) to evaluate the suitability of indicators (Eisenmenger et al., 2016). Other commonly used criteria in companies for performance indicators are inspired by managerial best practices such as SMART (specific, measurable, achievable, relevant, timed) or CREAM (clear, relevant, economic, adequate, monitorable).

These acronyms provide ‘rule of thumb’ guidance to managers to select the most relevant and suitable indicators (Saidani et al., 2019).

2.2 Sustainability & Circular Economy

2.2.1 Sustainability

Sustainability is increasingly gaining traction with policymakers and academia (Geissdoerfer, Savaget, Bocken & Hultink, 2017). Moreover, it is more and more incorporated into the strategies of companies. The term originates in the French verb *soutenir*, which means “to hold up or support” (Brown, Hanson, Liverman & Merideth, 1987). A written statement of this conceptualization dates already from the 18th century. Only in 2015, the concept changed meaning, namely the principle of respecting the ability of nature to regenerate itself. With the appearance of the Brundtland Report (1987), the most prominent understanding of sustainable development was created.

Sustainable development has many definitions. However, one of the most commonly used is the definition of the Brundtland Commission, namely:

> *“Sustainable development is the development that meets the needs of the present without compromising the ability of future generations to meet their needs*” (WCED, 1987).

The pressing need to transition to more sustainable systems is caused by the increasing evidence on global scale environmental problems, such as ozone depletion, climate change, biodiversity loss or the alteration of the nitrogen cycle (Rockström et al., 2009). The rise of fast pace production and consumption, leading to short life cycle products, causes a rapid depletion of natural resources. Consequently, it jeopardises the earth’s life-support system since the planet is not able to replenish itself at this fast pace of production and consumption.

The focus is often on the environmental part of sustainability, as mentioned above. However, Elkington (1997) introduced the concept of the ‘triple-bottom-line’ of sustainability. He mentions that sustainable development should be understood as balancing the three dimensions: economic prosperity, environmental quality and social justice. These dimensions of sustainability are highlighted by the 2030 Agenda for Sustainable Development (UN, 2015), which was adopted by all United Nations Member states in 2015. At its core are the 17 Sustainable Development Goals (SDGs), which form a blueprint to achieve a better and more sustainable future for all. The different SDGs are interconnected.

Goal 1: No Poverty
Goal 2: Zero Hunger
Goal 3: Good Health and Well-being
Goal 4: Quality Education
Goal 5: Gender Equality
Goal 6: Clean Water and Sanitation
Goal 7: Affordable and Clean Energy
Goal 8: Decent Work and Economic Growth
Goal 9: Industry, Innovation and Infrastructure
Goal 10: Reduced Inequality
Goal 11: Sustainable Cities and Communities
Goal 12: Responsible Consumption & Production
Goal 13: Climate Action
Goal 14: Life Below Water
Goal 15: Life on Land
Goal 16: Peace and Justice Strong Institutions
Goal 17: Partnerships to Achieve the Goal

The key issue in global sustainable development is the linear throughput flow of materials and energy between nature and the human economy (Korhonen, Honkasalo & Seppälä, 2018). This causes three main problems: the exhaustion of resources, the complexity in accessing resources and the amount of waste produced. This is known as the 'take-make-waste' economic model (The Ellen MacArthur Foundation, 2015). A logical answer to the problem of this linear flow model is a circular model (Korhonen et al., 2018). Although energy can actually not be recycled, it can be cascaded on lower temperature and pressure levels for extended use. Hence, one can speak about materials and energy cycling for the purpose of simplification.

2.2.2 Circular Economy

Circular Economy (CE) is seen as a necessary step to achieve sustainable development (Geissdoerfer et al., 2017). The current 'take-make-waste' model is labelled as an unsustainable path (EMF & Granta design, 2015). The CE is seen as an approach that has the potential to break with the current linear economy. In the last couple of years, governments, scholars, companies and citizens devoted more attention to the CE concept as a potential solution to the current sustainability issues. This is denoted by recent EU policy (European Commission, 2015, 2018a, b), national and regional policy targets (e.g. Circular Flanders), business sectors reports (EMF & Granta design, 2015), and the increasing number of academic articles (Corona, Shen, Reike, Carreon & Worell, 2019).

Circular Economy became a generally known concept. However, some critics claim that it has different meanings to different people. There is no definition that is commonly accepted among scientists and other professionals. Kirchherr, Reike, & Hekkert (2017) analysed 114 circular economy definitions. Only four definitions were used more than once. Most of the definitions focus on economic prosperity. The social considerations are neglected most among the 114 definitions. The most used definition has been provided by the Ellen MacArthur Foundation (2012, p.7):

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

Geissdoerfer et al. (2017) claim that this is the most prominent definition. Although Kirchherr et al. (2017) propose a consensual and broad definition, they acknowledge that a CE understanding can be broader than the definitions presented with his study. Korhonen (2018) also emphasized the vagueness of the CE concept. He mentions that it seems as if CE is a collection of separate ideas from several fields and semi-scientific concepts. Moraga et al. (2019) propose the use of two definitions representing CE in sensu stricto and sensu latu. The sensu stricto, namely narrow focus, distinguishes CE from the linear economy by two characteristics: slowing and closing resource loops. On the other hand, the broader definition (sensu latu) pushes the focus to sustainability and the effects CE strategies have on the economy, environment, and society (Moraga et al., 2019). Since CE-based strategies have three areas of value: (a) environmental; (b) economic; and (c) social. (Elia et al., 2017), representing each pillar of sustainability (Rossi, Bertassini, dos Santos Ferreira, do Amaral & Ometto, 2020), the sensu latu definition might be the most valuable.

2.3 The initiatives for CE in Europe, Belgium and Flanders

As mentioned above, different initiatives were formed to guide companies and even countries to a circular economy. Below, the most important initiatives that have an impact on the region of Flanders are outlined.

2.3.1 The Ellen MacArthur Foundation

One of the most important authorities in the field of circular economy is the Ellen MacArthur Foundation (EMF). The EMF was launched in 2010 and its mission is to accelerate the transition to a circular economy. It is a registered charity that operates on a global level. The Foundation believes that a circular economy provides a coherent framework for systems-level redesign and it offers the world an opportunity to harness innovation and creativity to enable a positive, regenerative economy. The transition to this circular economy should be based on three principles:

(1) Design out waste and pollution
(2) Keep products and materials in use
(3) Regenerate natural systems

In 2015, the Ellen MacArthur Foundation wrote a report about circularity indicators together with Granta Design. This report is mainly focused on the company level. The lack of CE indicators is also highlighted in the report: "*Until now, there has been no established way of measuring how effective a company is in making*

the transition from 'linear' to 'circular' models, nor have there been any supporting tools". Furthermore, the report states "*The indicators can be used as a decision-making tool for designers, but might also be used for several other purposes including internal reporting, procurement decisions, and the rating or evaluation of companies"*.

In the same year, The Ellen MacArthur Foundation also published the report "Towards a circular economy: business rationale for an accelerated transition". This report lists the main challenges of a linear model, such as price and supply risks, natural system degradation and economic losses. Moreover, the report gives an overview of the opportunities for implementing a circular economy.

- ECONOMIC OPPORTUNITY: Improved economic growth, substantial net material cost savings, the creation of employment opportunities, and increased innovation
- ENVIRONMENTAL AND SYSTEM-WIDE OPPORTUNITIES: Reduced emissions and primary material consumption, preserved and improved land productivity, and a reduction in negative externalities
- OPPORTUNITY FOR COMPANIES: New and bigger profit pools, greater security in supply, and new demand for business services, building greater resilience as a result
- OPPORTUNITY FOR CITIZENS: Greater utility as a result of more choice, lower prices, and lower total cost of ownership

2.3.2 European Commission & Belgium

In 2015, the European Commission (EC) launched a first Circular Economy Action Plan. Five years later, in 2020, the EC has adopted a new Circular Economy Action Plan. This action plan is one of the main blocks of the European Green Deal. It entails different initiatives along the entire product life cycle.

Belgium has an ambitious framework to tackle the challenges of the 21st century. In 2013, the Federal Public Service Health (FOD Volksgezondheid) and the Federal Public Service Economy (FOD Economie) decided to combine their forces. Together they launched a proposal for a contribution to the objectives of the long-term vision and a basis for the development of a roadmap for more efficient use of resources. This document is called "Towards a Belgium as a pioneer of the circular economy". (FOD Economie & FOD Volksgezondheid, 2014)

2.3.3 Circular Flanders

Flanders is known as a pioneer in the management of resources for better recycling and reuse. Furthermore, the Government of Flanders takes great interest in the circular economy model. The government has set the circular economy as one of the seven transition priorities and appointed the OVAM (the Public Waste Agency of Flanders) as the initiator of Circular Flanders. Circular Flanders is the hub for the development of the circular economy in the Flemish region. It is a partnership of governments, companies, civil society, and the

knowledge community that will take action together. The partnership is the result of the merger of Plan C, the Flanders' Materials Programme and SuMMa. (Vlaanderen Circulair, 2017)

2.4 Circular economy indicators

For the literature review on circular economy indicators in specific, a desktop research of papers has been performed. A keyword search on the Web of science was deducted, combining the keywords "circular economy" with "indicator", "performance measurement", "index", "measuring" and "assessment". Only articles and reviews that clearly focus on indicators that measure the performance of CE strategies were considered. The literature review revealed that studies about CE indicators are not that common. However, the existing studies are dispersed over different fields.

2.4.1 Reasons for the need for (new) CE indicators

The traditional and existing indicators cannot express CE in its totality. They are not addressing all the predefined requirements. Most of them focus only on a few of the CE goals (Corona et al., 2019). At the moment, there is no generally accepted monitoring framework (Parchomenko, Nelen, Gillabel & Rechberger, 2019). Akerman mentions (2016) that the lack of academic and scientific knowledge on CE indicators is a barrier for further implementation. However, the increase of publications on indicators for CE is a result of the rising interest in this topic (Elia et al., 2017; Parchomenko et al., 2019; Saidani et al., 2019). With the rise of interest, the research area on CE indicators is also expanding. There is still a lack of in-depth investigation on the completeness, classification, possible complementary and applicability of CE indicators (Saidani et al., 2019). Due to the magnitude of the CE paradigm and the various definitions of the CE, indicators may lack clarity on what they measure and this might lead to many interpretations (Saidani et al., 2019). Hence, a clarification on these indicators could facilitate the dissemination and proper usages.

Different factors create this need for CE indicators. The most important ones are tracking the progress, raising awareness of the opportunities and legislation. The main advantage of CE indicators would be the ability to track the progress of CE and to monitor its implementation since a monitoring system is still lacking (Avdiushchenko & Zając, 2019). Monitoring circularity is essential to support progress towards CE (Cayzer et al., 2017; Saidani et al., 2019). Without indicators, we do not know whether we are moving in the right direction. It can be used as a measure of development and as an evaluation criterion (Su, Heshmati, Geng & Yu, 2013). Furthermore, it would help to analyse innovations brought by CE (Rossi et al., 2020). CE indicators can form a standardized language, which would simplify the understanding and the information change (Verberne, 2016). Subsequently, CE indicators can identify the varying weaknesses and search for applicable solutions (Linder et al., 2017).

Secondly, these CE indicators could make practitioners aware of the opportunities of a circular economy and its applications. This could increase the effective uptake by industry and the attention provided by policymakers. It can be seen as an alert to the need for a framework that promotes new patterns of consumption and production that supports sustainability (Azevedo, Godina & Matias, 2017). However, it is not only about creating awareness. These indicators can also influence the mindset of businesses and regulators about the CE (Parchomenko et al., 2019).

The circular economy paradigm should be accompanied by proper legislation to stimulate the movement away from a linear economy. The transition can lead to different risks such as price volatility and potential disruption to the supply chain (Di Maio & Rem, 2015). CE indicators will pave the way to a proper legal framework.

2.4.2 The different levels of CE indicators

Circular strategies and or interventions are commonly classified by the levels to which those strategies are applied: micro level (applied to products, companies or organizations), meso level (eco-industrial parks) and macro level (regions, cities, countries or the global economy) (Ghisellini et al., 2016). However, the definition of these implementation scales is neither consistently used nor clearly defined among different authors (Moraga et al., 2019). The same classification is used for circular economy metrics (Lonca, Muggéo, Imbeault-Tétreault, Bernard & Margni, 2018; Pauliuk, 2018; Saidani et al., 2017). Different authors emphasized the need for micro level indicators since these indicators are less developed (Elia et al., 2017; Ghisellini et al., 2016; Kristensen & Mosgaard, 2019; Linder et al., 2017). Therefore, this thesis will focus on this dimension specifically.

EEA (2016) noticed that CE initiatives are not sustained without an evaluation framework or support from the industry. The advantage of CE indicators on the micro level is two-sided (Kristensen & Mosgaard, 2019). On the one hand, it helps consumers who want to know how to compare products based on circularity. On the other hand, it guides producers to provide circular products and services. CE indicators help companies to identify areas with high importance and potential for improvement (Rossi et al., 2020). The lack of proper CE indicators decreases the verification and validity of CE, which in its turn hinders the implementation of CE in organizations (Kristensen & Mosgaard, 2019).

2.4.3 The characteristics of a good CE indicator

Indicators are very important for the development of a new concept, such as CE, since these measurements also shape the language within the concept and influence its development and perception (Valenzuela-Venegas, Salgado & Díaz-Alvarado, 2016). Hence, thorough research of the characteristics of a good indicator is necessary.

Current CE indicators do not address all the predefined requirements (Elia et al., 2017). This is a shortcoming. Thus, to avoid burden-shifting a good indicator should measure the progress of all the CE goals (Corona et al., 2019). Some of the possible dimensions of CE indicators are level of analysis (namely micro, meso and macro), input-output, resource utilisation intensity, longevity and value (Howard, Hopkinson & Miemczyk, 2018).

The importance of the three pillars of sustainability for the CE concept is already emphasized. Hence, to make sure that the CE indicators are complete and comprehensive enough, the indicators should address the three dimensions (Geissdoerfer et al., 2017). Only when including the environmental, economic and social impacts, it can successfully support sustainable development (Rossi et al., 2020). Kristensen & Mosgaard (2019) reviewed 30 indicators. This review showed that the majority of the already existing indicators focuses mainly on economic aspects. The favouring of economic aspects over environmental and social impacts can lead to sub-optimization (Kristensen & Mosgaard, 2019). More importantly, most of the positive impacts from a CE are presented in the social dimension. However, this dimension is difficult to measure, which leads to a lack of the social dimension in CE indicators (Korhonen et al., 2018; Murray, Skene & Haynes, 2017; Schröder et al., 2019).

Regardless of the advantages of simplicity and communication that a single indicator offers, a single indicator might not be sufficient due to the complexity of the Circular Economy. Of all the existing indicators, no single one encompasses all the requirements of the CE. Focusing on one single dimension forms a limitation in the assessment of CE (Elia et al., 2017). A set of multi-dimensional indicators is needed (Cayzer et al., 2017; Rossi et al., 2020). Different approaches were reached out to go from a single dimension to a multi-dimensional indicator. For example, Figge et al. (2018) proposed combining a circularity indicator with a longevity indicator in order to get a two-dimensional indicator. Further, Pauliuk (2018) mentioned that a circularity indicator can be accompanied by monetary indicators.

In specific, on a micro level, using a single indicator to measure CE might lead to an overly simplified measure of circularity. However, as micro level indicators for CE are largely targeted at companies the usability of the indicators may outweigh the desired CE coverage (Kristensen & Mosgaard, 2019). Hence, Kristensen & Mosgaard (2019) conclude that a trade-off between CE coverage and practical usability should be taken into consideration. Furthermore, to make sure that indicators are applicable, they should be transparent and trustworthy (Saidani et al., 2019).

2.4.4 Existing indicators

In the last couple of years, a wide variety of circular economy indicators has been developed (Saidani et al., 2019). CE indicators, in general, are still in the initial stage of development (Giurco, Littleboy, Boyle, Fyfe & White, 2014). Moraga et al. (2019) proved in a recent study that current CE metrics are not able to measure every CE strategy (Moraga et al., 2019). Furthermore, most of the published circularity metrics have been

criticized for not representing the systemic and multidisciplinary nature of CE (Saidani et al., 2019). Despite these pitfalls, there already exists a large range of measurement tools that aim to assess the progress towards a circular economy. According to Parchomenko et al. (2019), these existing tools cover different and varied aspects of the CE transition and are seemingly unrelated to each other (Parchomenko et al., 2019). However, different authors indicate the lack of specific standards and metrics (Avdiushchenko & Zając, 2019; Elia et al., 2017; Parchomenko et al., 2019; Saidani et al., 2019).

Corona et al. (2019) considered in total three major challenges of current circularity metrics: (1) difficulties in measuring the CE goals in all the sustainability dimensions, (2) evaluating the scarcity of used materials, and (3) underrepresenting the complexities of multiple cycles and the consequences of material downcycling (Corona et al., 2019).

The existing indicators can appear in different forms: single quantitative indicators, analytical tools, and composite indicator set. This demonstrates the existence of diverse approaches for measuring CE. Even the dimensionality of the indicators varies, ranging from a single dimension to multiple dimensions with a broad CE perspective (Kristensen & Mosgaard, 2019). In 2017, Elia et al. stated that no single existing indicator encompasses all the requirements of the CE concept. Hence, the fact that indicators focus on a single dimension is a current limitation (Elia et al., 2017).

Kristensen & Mosgaard (2019) studied the characteristics and dimensions of 30 circular indicators. One of the subdivisions they made is based on the three pillars of sustainability. In the research, the following criteria were used to measure the different dimensions:

(1) the economic dimension: cost and revenue;
(2) the environmental dimension: CO_2;
(3) the social dimension: job creation and safe working environment.

The study concluded that the most commonly included dimension is the economic dimension. The least occurring pillar is the social sustainability dimension. As mentioned above, the social dimension can be measured by job creation and a safe working environment. However, a general approach for the social dimension is lacking due to the small number of indicators that take this dimension into account (Kristensen & Mosgaard, 2019).

As mentioned before, research into CE indicators on the micro level is underdeveloped. Despite this knowledge gap, companies and industries in the private sector have demonstrated an increasing interest in a circular approach. At present, some CE indicators exist but still no commonly accepted way to measure CE in general at the micro level (Kristensen & Mosgaard, 2019). Howard et al. (2018) concluded that indicator focus is likely to be sector-specific. Hence, the focus does not have to be on a general approach. Some of

the already existing and general CE indicators at the micro level could serve as a suitable basis for the development of new more sector-specific indicators (Saidani et al., 2019).

A significant increase in publications can be seen since 2016 (Kristensen & Mosgaard, 2019), which is significantly later than the macro level indicators. The increase in publications of micro level indicators may be caused by the development of the material circularity indicator (MCI) (Ellen MacArthur Foundation and Granta Design, 2015). The MCI was one of the first CE indicators that received attention in academia, but also in practice. Moreover, there is an increasing interest from researchers in measuring micro level CE with fewer contributions from practice. This could be an indication of the difficulty for industries to develop and use such indicators (Kristensen & Mosgaard, 2019).

Kristensen & Mosgaard (2019) defined nine CE categories for the micro level indicators: recycling, end-of-life management, remanufacturing, resource-efficiency, disassembly, lifetime extension, waste management, reuse and multidimensional indicators. Recycling is the most common CE category.

2.4.5 Micro level indicators table

In the table below, a list of existing micro level indicators is presented. The table is subdivided into different columns which are important to indicate the relevance of the indicator. Firstly, a description of the indicator and the formula is given. To get a brief overview of what the indicator focuses on, columns four, five and six were added, namely duration, energy and value. Next, a subdivision between academic contributions (A) and practical contributions (P) was made.

As already mentioned, Elia et al. (2017) concluded that a single indicator might not be sufficient due to the complexity of the concept. Therefore, in the fifth column, it is indicated whether or not the indicator is represented by a single indicator (represented by the number 1 in the column). Further, another distinction is made between assessment tools (2) and composite indicator sets (3). The table shows that most of the assessment tools arise from practical contributions, although not all of them.

In the tenth column, the three pillars of sustainability are presented, namely the environmental, economic and social impact. Rossi et al. (2020) mentioned that a good indicator should include all of these dimensions. Hence, the ordering of the table is based on these aspects. As can be seen directly, only two of the indicators include all three pillars. It is clear that all of the indicators cover the environmental dimension. Further, the table reveals a lack of the social dimension in CE indicators. These conclusions emphasize the need for new and improved CE indicators.

In the following columns, a division is made between the 5 Rs, namely reduce, reuse, refurbish, repair and recycle. It is possible that indicators cover more than one of the 5 Rs. The column ‘Application level’ indicates

on what level the indicators are measured, whether this is done on the material, component or product/service level.

The following columns were added to check whether these indicators are already operationalized and what the main limitations are when operationalizing. It can be seen that only a minority of the indicators is already operationalized. Most of the indicators come from academic contributions in which it is made clear that further research is necessary before operationalizing. Although not operationalized, most of the studies discussed setting studies. In order to get a brief overview of which sectors are most investigated when trying to implement the indicator, the column ‘setting study’ is added. In this column, the evaluated sector is mentioned. The most prominent sector is manufacturing, in specific the manufacturing of electronics.

Lastly, the column ‘generalizable’ indicates whether the indicator can be generalized. However, being generalizable over all possible sectors might not be realistic. This column expresses whether the indicator can be generalised over different products and over one or more sectors. Although an interesting column, the column does not necessarily indicate the usefulness of the indicator. As mentioned before, Saidani et al. (2019) emphasized that the focus should not be on a general approach. Cayzer et al. (2017) concluded that the generic method needs to be accompanied by a more industry-specific approach.

At first sight, the table seems to include already a lot of CE indicators. However, when examining these indicators more in detail, many pitfalls are uncovered such as not covering all dimensions and not being operationalized.

Table 1: Existing CE indicators

Micro level Indicator	Description	Formula	Focus			Reference	A/P*	Type**	Sust. Dim.			5 Rs					App. level			Operationalized	Operational. - limitations	Setting study***	Generalizable
			Duration	Energy	Value				Env.	Economic	Social	Reduce	Reuse	Refurbish	Repair	Recycle	Material	Component	Prod./Serv.				
Eco-Efficient Value Ratio (EVR)	Ratio of environmental burden to economic value, to measure added customer value of a 'circular' product	The index is calculated by dividing eco-cost ('external costs' in environmental economics) by the customer perceived value			x	Scheepens et al. (2016)	A	1	x	x	x	x	x			x			x		To calculate the customer perceived value the price is used. However, this implies that the difference between the price and the value, namely the 'surplus value', is not taken into account.	Manufacturing - Food packaging	x
Value-based Resource Efficiency Indicator (VRE)	The ratio of added product value divided by the value of stressed resources used in production or a process thereof	The ratio of the output value (refers only to what is actually produced) divided by the weighted sum of the resources. The market price of the resources is used as weights.		x	x	Di Maio et al. (2017)	A	1	x	x	x	x							x		The metric is simpler to compute than the indicators based on lifecycle assessment or footprint analyses. Furthermore, the indicator is expected to show a smaller bandwidth than mass based indicators.	No setting study	x

Micro level Indicator	Description	Formula	Focus			Reference	A/P*	Type**	Sust. Dim.			5 Rs					App. level			Operationalized	Operational. - limitations	Setting study***	Generalizable
			Duration	Energy	Value				Env.	Economic	Social	Reduce	Reuse	Refurbish	Repair	Recycle	Material	Component	Prod./Serv.				
Circular Economy Index	The index provides a clear indication of how good a recycling company is in valorizing the materials	The ratio of the material value produced by the recycler (market value) by the material value entering the recycling facility.			x	Di Maio and Rem (2015)	A	1	x	x						x	x				CEI is easy to be computed and it uses data which are easily made available. Hence, easy to understand for managers. However, scientists argue that the relation with societal impacts is unclear. Moreover, it has low construct validity since it doesn't take into account other forms of recovering materials than recycling.	No setting study	
Longevity Indicator (LI)	It measures the contribution to material retention based on the amount of time a resource is kept in use. Hence, a measure of the average duration of product and material use.	LI is the sum of initial lifetime of the product, refurbished lifetime contribution and recycled lifetime contribution, measured in months.	x		x	Franklin-Johnson et al. (2016)	A	1	x				x	x			x				In an attempt to render the indicator manageable and practical, the assumed product life-cycle does not consider the complexities of refurbishment and recycling	Manufacturing - mobiles	x

Micro level Indicator	Description	Formula	Focus			Reference	A/P*	Type**	Sust. Dim.			5 Rs					App. level			Operationalized	Operational. - limitations	Setting study***	Generalizable
			Duration	Energy	Value				Env.	Economic	Social	Reduce	Reuse	Refurbish	Repair	Recycle	Material	Component	Prod./Serv.				
Product-Level Circularity Metric (PCM)	The ratio from the economic value from recirculated flows over the economic value of all flows	The ratio of the economic value of recirculated parts and the total economic product value. The circularity metric ranges between 0 and 1 (or 0% to 100% recirculated parts).			x	Linder et al. (2017)	A	1	x	x			x	x		x		x	x		The index allows value chain actors to share circularity data without sharing strategically sensitive marginal data. In practice, the specificity of the metric means that other indicators and metrics must be used to gauge other aspects of product quality.	Manufacturing - plastic toy & starter engines	x
Reuse Potential Indicator (RPI)	Measures how much a material is "resource-like" rather than "waste-like" according to the current available technologies. Hence, it expresses the usefulness of the material.	The index divides the economically reusable portion divided by the possible current level of generation based on the existing technologies. The ratio is represented by a real value between 0 and 1. It equals 0 when all materials are discarded and 1 when all materials can be reused.			x	Park and Chertow (2014)	A	1	x	x			x					x	x		The reuse potential increases as technological options increase, enabling more material recovery. Hence, this indicates that the concept of reuse potential is inherently time dependent.	Manufacturing- Coal combustion by-products	

Micro level Indicator	Description	Formula	Focus			Reference	A/P*	Type**	Sust. Dim.			5 Rs					App. level			Operationalized	Operational. - limitations	Setting study***	Generalizable
			Duration	Energy	Value				Env.	Economic	Social	Reduce	Reuse	Refurbish	Repair	Recycle	Material	Component	Prod./Serv.				
Remanufacturable Product Profiles (REPRO²)	The tool performs statistical analyses of different end-of-life (EoL) product scenarios based on a set of 82 criteria. It allows designers to compare their products with others.	The product is compared to one of the 11 different profiles, all having discriminating criteria, both internal and external. Each of the profiles exists of different external variables.			x	Gehin et al. 2008	A	2	x	x			x	x		x			x		For people who are not experts, it is not evident that the different criteria can be understood easily. Furthermore, it assumes that it is environmentally friendly and economically profitable, which is not always proved.	Manufacturing - Cement Mixer	x
Eco-efficiency Index (EEI)	Measures the value added and environmental impacts in terms of money, by combining LCA and LCC.	EEI is obtained by minimizing the weighted sum of economic (I1) and environmental (I2) impacts as follows: EEI = w(1)*I(1) - w(2)*I(2). I(1) is the value added and I(2) is the ReCIPE single score indicator, which represents the environmental damage in points.			x	Laso et al. (2018)	A	3	x	x										x	LCA systems are typically simplified as linear steady state models of physical flows. . If environmental and economic aspects are interdependent or even environmental impacts among them, non-linear programming would be required to account for the more complex, non-linear relations in the real system.	Manufacturing - Food packaging	x

Micro level Indicator	Description	Formula	Focus			Reference	A/P*	Type**	Sust. Dim.			5 Rs					App. level			Operationalized	Operational. - limitations	Setting study***	Generalizable
			Duration	Energy	Value				Env.	Economic	Social	Reduce	Reuse	Refurbish	Repair	Recycle	Material	Component	Prod./Serv.				
Circular Economy Performance Indicator (CEPI)	The indicator is capable of measuring the circular economy performance of plastic waste treatments	The ratio of the actual obtained environmental benefit over the ideal environmental benefit according to the quality for this flow. The ratio makes a distinction between four options: closed-loop, semi-closed loop, open-loop and incineration.		x		Huysman et al. (2017)	A	1	x							x		x			It is physically impossible (or economically not viable) to fully separate recycled polymers into their composing mono-streams. Hence, we need to predict this. quality based on the compatibility between the composing polymers in a mix.	(Re)manufacturing - Plastic Waste	
Circularity Index	The scale considers the loss of both material quantity and material quality. It is a combination of the combined effects of stock dynamics and dissipative losses and the quantity of energy required to recover material relative to the energy required for primary material production from virgin ore	The index consists of the multiplication of α (recovered EOL material divided by total material demand) and β (1- energy required to recover material divided by energy required for primary production)		x		Cullen (2017)	A	1	x					x		x	x	x	x		The estimates of α and β are only rough estimates. The ratio β is considered optimistic, given that most materials cannot be recycled indefinitely without degradation in the material quality, forcing downcycling.	No setting study	x

Micro level Indicator	Description	Formula	Focus			Reference	A/P*	Type**	Sust. Dim.			5 Rs					App. level			Operationalized	Operational. - limitations	Setting study***	Generalizable
			Duration	Energy	Value				Env.	Economic	Social	Reduce	Reuse	Refurbish	Repair	Recycle	Material	Component	Prod./Serv.				
Ease Of Disassembly Metric (eDIM)	The metric calculates the disassembly time given the sequence of actions and basic product information	Formula is not given	x			Vanegas et al. (2017)	A	1	x				x	x	x	x		x	x		It is transparent and easy to use thanks to the basic formulae employed for the time calculation, facilitating its implementation and verification. The calculation of the eDiM is unambiguous, thus avoiding any subjectivity during the verification by third parties.	Manufacturing	
Material Circularity Indicator (MCI)	It measures how restorative flows are maximized and linear flows are minimized, considering also the length and intensity of the product's use	It is constructed from a combination of three product characteristics: the mass of virgin raw material used in manufacture, the mass of unrecoverable waste that is attributed to the product, and a utility factor that accounts for the length and intensity of the product's use.	x	x	x	Ellen MacArthur Foundation and Granta (2015)	P	1	x	x		x	x	x	x	x	x	x	x	x	The index can create difficulties since it combines different materials and components into a single number. The utility factor is calculated based on estimated average product life spans, which might lead to optimistic outcomes.	No setting study	x

Micro level Indicator	Description	Formula	Focus			Reference	A/P*	Type**	Sust. Dim.			5 Rs					App. level			Operationalized	Operational. - limitations	Setting study***	Generalizable
			Duration	Energy	Value				Env.	Economic	Social	Reduce	Reuse	Refurbish	Repair	Recycle	Material	Component	Prod./Serv.				
Material Reutilization Score (MRS)	A score that indicates if products remain in perpetual cycles of use and reuse	Th sum of the percentage of the product considered recyclable or compostable x 2 and the percentage of the recycled or rapidly renewable content in the product. Next, this sum is divided by 3.			x	Cradle to Cradle Products Innovation Institute (2016)	P	1	x				x	x		x		x	x	x	Depending on the certification level of interest, gathering data on all homogeneous materials may not be necessary in order to achieve the required reutilization score. It has only 5 different materials as requirements.	Fashion - clothing	x
Recycling Desirability Index (RDI)	An integrated measure of the desirability of recycling end-of-life products. It can be used as an approach to prioritize the recycling of products.	The index is the sum of product complexity, recycling technology readiness level and the material security index.			x	Sultan et al., 2017)	A	1	x				x			x		x	x		For the index, it has been assumed that to recycle products, all materials have to be recovered and that the material security assessment is available and date stamped, which is not always the case.	Manufacturing - refrigerator	x

Micro level Indicator	Description	Formula	Focus			Reference	A/P*	Type**	Sust. Dim.			5 Rs					App. level			Operationalized	Operational. - limitations	Setting study***	Generalizable
			Duration	Energy	Value				Env.	Economic	Social	Reduce	Reuse	Refurbish	Repair	Recycle	Material	Component	Prod./Serv.				
BIM-based Whole-life Performance Estimator(BWPE)	The metric determines how much of recoverable materials from buildings are reusable and recyclable at the end of its useful life.	Index consists of identified factors that influence salvage performance and the concept of Weibull reliability distribution for manufactured products. The reliability of a product is described by hazard function or failure rate	x		x	Akanbi et al. (2017)	A	2	x			x	x			x	x	x		x	Different building components have different life expectancy and react differently to different environmental conditions. Hence, developing a holistic performance estimator for different group of these components is cumbersome and may not be practicable.	Construction - buildings	
Building Circularity Indicators	Indicators that measure the circularity of a building	The sum over the systems of the multiplication of the theoretical value System Circularity Indicator and the practical value for the System Circularity Indicator. This then divided by the factor for the system dependency		x	x	Verberne (2016)	A	2	x			x	x	x	x	x	x	x		x	The assessment model assumes access to a fair amount of technical data. This could include secret data, which might result into difficulties to gather this data	Construction - buildings	

Micro level Indicator	Description	Formula	Focus			Reference	A/P*	Type**	Sust. Dim.			5 Rs					App. level			Operationalized	Operational. - limitations	Setting study***	Generalizable
			Duration	Energy	Value				Env.	Economic	Social	Reduce	Reuse	Refurbish	Repair	Recycle	Material	Component	Prod./Serv.				
Circularity Design Guidelines (CDG)	Guidelines used to map companies' circular product design initiatives in the early stages of product design and development	No formula given	x			Bovea and Pérez-Belis (2018)	A	2	x			x	x		x	x			x		The Margin of improvement and Relevance need to be assessed by experienced technicians responsible for disassembling the sample, but even then certain subjectivity could appear when assessing each parameter	Manufacturing - Electronics	x
Circular Economy Indicator Prototype (CEIP)	The measurement of product performance with respect to circular economy principles	No formula given - index is based on a questionnaire	x	x		Cayzer et al., 2017	A	2	x			x	x	x	x	x			x		In practice it might lead to potentially misleading results. Another limitation is the reliance on context specific assumptions. Further, to create an appropriate outcome customization would be required, with a mix of 'generic' and specific questions.	Manufacturing and retail - Chemical processing industry	x
Circular Economy Toolkit (CET)	An assessment tool to identify potential improvement of products' circularity	Web-based tool - No formula given	x	x		Evans and Bocken (2013)	P	2	x	x		x	x	x	x	x			x	x	/	No setting study	x

Micro level Indicator	Description	Formula	Focus			Reference	A/P*	Type**	Sust. Dim.			5 Rs					App. level			Operationalized	Operational. - limitations	Setting study***	Generalizable
			Duration	Energy	Value				Env.	Economic	Social	Reduce	Reuse	Refurbish	Repair	Recycle	Material	Component	Prod./Serv.				
Circularity Calculator (CC)	A tool that helps designers to understand how strategic design decisions influence the degree of circularity of resource flows and potential value capture within the product-service-system	Web-based tool - No formula given	x		x	ResCom - Ideal&Co (2017b)	P	2	x	x		x	x	x		x			x	x	/	No setting study	x
Circular Pathfinder (CP)	A starting tool for companies interested in CE thinking, allowing them to explore and identify the most suitable circular pathways for their products by answering just a few questions	Web-based tool - No formula given	x		x	ResCom (2017a)	P	2	x			x	x	x	x	x			x	x	/	No setting study	x
Circularity Potential Indicator (CPI)	A guided questionnaire that aims at evaluating the circularity potential of industrial products	No formula given	x		x	Saidani et al. (2017)	A	2	x	x		x	x	x	x	x			x		The index uses available data and is modular and flexible. However, it lacks completeness of the indicators and consistency.	Manufacturing - component of motorized vehicle	x
Closed Loop Calculator (CLC)	A simple way to measure the 10 important credentials of circular products	No formula given - property of Kingfisher	x	x	x	Kingfisher (2014)	P	2	x			x	x	x	x	x			x	x	/	No setting study	x

Micro level Indicator	Description	Formula	Focus			Reference	A/P*	Type**	Sust. Dim.			5 Rs					App. level			Operationalized	Operational. - limitations	Setting study***	Generalizable
			Duration	Energy	Value				Env.	Economic	Social	Reduce	Reuse	Refurbish	Repair	Recycle	Material	Component	Prod./Serv.				
End-of-Life Index (EOLI)	An index for indicating, measuring and evaluating the forecasted performance of a product at the end of its life. There are three important aspects: disposal, recovery and disassembly	The sum of four components, namely the disassembly sub-index, the recovery sub-index, module overall EoL index and the components EoL index of the loose components attached to the module directly while dividing the last component by the number of modules. Each component has its own weighting factor.	x	x	x	Lee et al. (2014)	A	3				x	x	x		x	x	x	x		The index is flexible and the designer does not need to have a lot of data for the various values. However, there is one limitation: the lack of considerations for inter-dependency of the factors in some of the subindices.	Manufacturing - power tool	x
Multidimensional Indicator Set (MIS)	Four indicators to assess WEEE recycling in a context of sustainable materials management. It allows to quantitatively demonstrate recycling benefits.	Four indicators are used for the assessment: . weight recovery of material(s), recovery of scarce materials, closure of material cycles and avoided environmental burden. The MIS is calculated by taking the sum of these four indicators.		x	x	Nelen et al. (2014)	A	3	x				x			x	x				The operationality has been illustrated by the case study. However, calculating the indicators is only feasible when data can be obtained on the quantities and qualities of materials that leave the recycling system.	Manufacturing - televisions	x

Micro level Indicator	Description	Formula	Focus			Reference	A/P*	Type**	Sust. Dim.			5 Rs					App. level			Operationalized	Operational. - limitations	Setting study***	Generalizable
			Duration	Energy	Value				Env.	Economic	Social	Reduce	Reuse	Refurbish	Repair	Recycle	Material	Component	Prod./Serv.				
Recycling Indices (RIs)	An index that informs the customer about the recyclability of a product	The Material-RI expresses the recycling rate of individual elements for the processing flow sheet of a specific product or redesign - no specific formula given		x		van Schaik and Reuter (2016)	A	3	x							x		x	x		The index is very well suited to evaluate and quantitatively assess product and system redesigns simultaneously to optimize.	Manufacturing - LED lamps	

*A/P: academic contribution (A) or practical contribution (P);
**Type: (1) single quantitative indicator, (2) assessment tool, (3) composite indicator set;
*** Setting study: sector used in the setting study

2.5 Point of view of policymakers

After researching the academic literature, it is important to check how policymakers perceive the need for CE indicators. Different authorities at different levels wrote reports regarding this topic. Getting a grasp of what they assume to be important can be useful to get an overall view of CE indicators related to policymaking.

2.5.1 EU policy

The EU policy is based on different reports and has its own monitoring framework on the macro level created by Eurostat. The European Academies' Science Advisory Council (EASAC) published the report “Indicators for a circular economy” in 2016. The report emphasized that “Indicators are critical for economic assessment at all scales, from the micro- (business) level to macro- (regional and national) and global levels”. The report of the European Commission (2018) states “*In the transition to a more circular economy, monitoring the key trends and patterns is key to understand how the various elements of the circular economy are developing over time, to help identify success factors in the Member States and to assess whether sufficient action has been taken.”*. However, these reports mainly focus on the macro level indicators. Furthermore, this uncovers a lack of EU policy on the micro level.

2.5.2 National and regional policy targets

In the report of the Belgian Federal Public Service Health (FOD Volksgezondheid) and Federal Public Service Economy (FOD Economie), a whole chapter is dedicated to CE indicators, namely the section ‘Indicators for a policy aimed at an efficient resource use’. In this paragraph, the need for CE indicators is emphasized. For the Flemish region, in particular, SuMMa published two reports regarding the topic of indicators; “Towards a circular economy monitor for Flanders: a conceptual basis” and “Indicators for a Circular Economy”.

The report “Towards a circular economy monitor for Flanders: a conceptual basis” mentions clearly that “*for policymakers, it will become more and more important to have tools available that allow assessing the directions in which society is evolving”*. Further, the report explains that we need a monitor instead of an indicator since circular economy contains many dimensions: “*This monitor will be a scoreboard with indicators, and the activity of monitoring comes down to tracking the evolution of indicator scores throughout time”.*

The aim of the report “Indicators for a Circular Economy” is to make an inventory of indicators that are relevant to monitor the transition to a circular economy and to measure the effects of new policy and trends. The importance of indicators on the micro level is also emphasized in specific: “*Micro level indicators support the implementation of policies and decisions in areas such as product policies, energy efficiency, and integrated waste management.”* The proposed indicators are more general indicators that measure recyclability, repairability, energy recoverability and the environmental footprint. However, none of these indicators is sufficient to measure the circularity on its own.

3 METHODOLOGY

While the need for circular economy indicators in different sectors is emphasized in the literature review, the clothing industry was chosen as the focal industry for the qualitative research of this dissertation. The three main reasons for this choice are (1) the fact that the fashion industry is worldwide an extremely wasteful and polluting industry (EMF, 2017), (2) the lack of scalable circular fashion research, which is a hurdle for the further adoption of a truly circular economy (Ki, Park & Ha-Brookshire, 2020). Moreover, different researches indicated several gaps going from the lack of coordination, alignment and the deepening of the impact of existing initiatives (EMF, 2017) to the lack of reliable information and transparency for managing material circularity (Ki, Chong & Ha-Brookshire, 2020) and (3) Cayzer et al. (2017) mentioned the need for future work regarding CE indicators for different industry sectors. Moreover, in their research, sectors with middle and long-lived products, such as the clothing and textile industry, were proposed as the most suitable environments to develop CE indicators.

3.1 Circular Fashion

The textile and clothing industry is a big player in the European manufacturing industry. In 2019, 1.5 million people were employed in 160,000 textile and clothing companies in the EU-27. All these companies accounted for a turnover of €162 billion and they invested €5 billion. This resulted in a 5% share of employees and a 2% share of the value-added goods in the total manufacturing activities in Europe (Euratex, 2019). The appearance of the section about sustainability and circular economy in the report of Euratex also indicates the importance of a circular economy in this industry. The clothing industry in specific represents more than 60% of the textile and clothing industry and it will probably stay the most used application in the coming years. Above all, the production of clothing has almost doubled in the last 15 years (EMF, 2017).

In the clothing industry, the limits of the present ‘take-make-waste’ model are extremely apparent (Koszewska, 2018). Already in 2014, Choudhury (2014) mentioned that the textile and clothing industry is one of the most polluting industries in the world. He stated that this is due to the use of chemicals, the high consumption of water and energy, the huge fuel consumption for transportation and the use of non-biodegradable packaging materials (Choudhury, 2014). Six years later, textile and clothing production is still an important component in the world’s pollution (Ki, Chong & Ha-Brookshire, 2020). In the report ‘A new textiles economy: Redesigning fashion's future’ (2017) of the EMF, three reasons are mentioned why the current fashion industry is extremely wasteful: (1) clothing is massively underutilized, (2) less than 1% of the material used to produce clothing is recycled into new clothing and (3) the negative impact of the linear system on the environment and people.

Due to the adverse side effects, such as economic loss, environmental destruction, and threats to human well-being of the 'take-make-waste' model, a transition to a circular economy is necessary (Ki, Park & Ha-Brookshire, 2020). This transition will require significant changes in the production and consumption models (Koszewska, 2018). The EMF (2020) stated in its report "Vision of a circular economy for fashion" that all materials in the fashion industry should first be cycled through the technical cycle loops of reusing, repairing, remaking, and recycling.

When searching for research about circular indicators in the fashion industry, it is clear that there is almost no research about this topic. Moreover, in the report 'A new textiles economy: Redesigning fashion's future' (2017) of the EMF, there is a section about areas of action to move towards a new textiles economy. One of these key actions mentioned in this section is transparency. In this paragraph, the need for measurement tools is addressed. It is mentioned that measurement tools would be a good aid by assessing products' content and the negative impacts of individual actors within the textiles industry, as well as their ongoing efforts to transform their practices for a new textiles economy.

At the moment several initiatives are striving for slow and circular fashion, one of the best-known initiatives is Make Fashion Circular. In 2018, the Ellen MacArthur Foundation launched Make Fashion Circular at the Copenhagen Fashion Summit. This is actually the second phase of the Circular Fibres Initiative, which started in 2017. Make Fashion Circular is an initiative that emphasizes the need to radically redesign the current approach in order for the fashion industry to thrive. The initiative is meant to bring together leaders from across the fashion industry, but also to join forces between citizens, businesses and governments. Its main goal is to create a circular economy in the fashion industry by stopping waste and pollution and searching for recycled or renewable inputs. Their core partners are Burberry, Gap Inc., H&M Group, HSBC, Inditex, PVH and Stella McCartney. (EMF, 2020).

3.2 Research aim & design

The main objective of the qualitative research of this master dissertation is:

To provide an insight into the relevance of CE indicators in the fashion industry.

In regard to this research aim, this master dissertation will investigate the following research questions.

1) **How is the circularity currently measured in the fashion industry?**
    a. What specific aspects of circularity are important to retailers and how are they measured?
    b. Which role does circularity play in the search for a supplier?
2) **How can the way in which the fashion industry measures the circularity be improved?**
    a. What are the current limitations of labels?
    b. Why would the fashion industry need CE indicators?
    c. What are the current limitations and concerns?

Before the actual research design, a literature review was executed to get a profound understanding of the existence of circular economy indicators in general and what the current limitations are. The literature review consists of two different types of research. First, a desktop research of papers has been performed. A keyword search on the Web of science was deducted, combining the keywords “circular economy” with “indicator”, “performance measurement”, “index”, “measuring” and “assessment”. Only the works that were published in the last 5 years were beheld. Next, only articles and reviews that clearly focus on indicators that measure the performance of CE strategies were considered. In a later stage, only the articles that cover CE indicators on the micro level were retained. For the second part, I focused on grey and practical literature, namely reports and expertise of national and international governmental organizations and NGOs, such as the Ellen MacArthur Foundation related to CE indicators. Lastly, I created a table with the existing micro CE indicators, which can be a good guide when building a CE indicator for the fashion industry.

After obtaining this theoretical background, which gave insight into the core concepts of circular economy indicators, the concept of a CE indicator has been reviewed in practice. Several in-depth interviews were performed with different fashion retailers. Afterwards, the data was analysed with the aim to provide relevant information about the research aim. Lastly, in the section recommendations, the bridge between theory and practice was made. Throughout combining the concepts behind the existing CE indicators and the ideal targets for the fashion industry, according to the EMF, a proof-of-concept is given for a CE fashion indicator.

3.2.1 Case study

For the empirical part, the case study approach is chosen as the appropriate research approach. For this case study, interviews with SMEs and independent entrepreneurs are conducted. A case study is very useful when the research is mainly focused on ‘why’ and ‘how’ questions. Furthermore, the main advantage of a case study is that it allows gaining insight into complex contemporary phenomena in-depth (Verleye, 2019).

For the case study, fashion retailers were chosen as the subject of interest. The retailers can provide relevant information regarding the circularity of clothing on the micro level. Furthermore, their purchasing behavior and the criteria they use when searching for suppliers can provide insight into the purchase process. This might give an overview of which criteria are important on the micro level and how important sustainability is among these criteria. Above all, the retailers might give a profound view on how they perceive sustainability and whether information about the sustainability of clothing influences their decisions process.

Before collecting the data, the case selection needs to be performed. This is a small selection of 6 retailers and is based on a set of predetermined criteria. The predetermined set of criteria consists of three criteria. Firstly, the retailer should be active in the clothing sector. Hence, it needs to be a fashion retailer. The second criterium is about their relationship with the topic of a circular economy. The selected cases should be diverse in their relationship with sustainability. Lastly, all the retailers that are selected should have a shop located in Belgium. In the table below you can find the cases that were selected.

Table 2: Selected cases

Case	Company name	Company description[1]	Logo
1	Jbc	Jbc is a family enterprise that offers qualitative and affordable clothing. They have an extensive offer of children's clothing. Moreover, they are a member of the Fair Wear Foundation and strive to provide honest and sustainable clothing. (Company website)	
2	Jukebox	Jukebox is an emerging start-up that offers a shared wardrobe through a rental system. Their main goal is to become precursors of a change in the production of fashion and a reflex of consumption of quality clothing that respects both the ethics, the environment and the singularity of each. (Company website)	
3	Supergoods	Supergoods eco + fair fashion is a sustainable concept store with 3 stores in Belgium. These concept stores hope to provide you with the most exciting eco + fair brands. (Company website)	
4	Just Hazel	Just Hazel is a start-up of three friends, who noticed that finding sustainable clothing that they love is very difficult. They decide to provide their own sustainable closet. Their concept focuses on fair, ecological and sustainable clothing. (Company website)	
5	AO76	AO76 is a kids fashion brand. AO76 stands for cool clothing for boys and girls from 4 to 16 years old. They have been dreaming of being an eco-friendly business for a few years now, and meanwhile started their BeKind campaign. (Company website)	
6	Twiggy	Twiggy is a multibrand fashion store. They sell clothes for her, him and their home and are proud of their selection of designers and visionary thinkers. (Company website)	

[1] The list with the sources can be found in Appendix 2

3.3 Data collection

The data was collected in two ways: (1) semi-structured interviews and (2) web-based search. Table 3 gives an overview of the data per case.

Table 3: Data per case

Case	Company name	Interview Data		Data resulting from web based search[2]
		Name	Function	
1	Jbc	Valerie Geluykens	CSR manager	- Company website: 1 - Non-company website: 2
2	Jukebox	Catherine Detaille	Co-founder	- Company website: 2 - Non-company website: 1
3	Supergoods Gent	Olga Van Genechten	Owner	- Non-company website: 2 - Social media page: 1
4	Just Hazel	Nina Spooren	Co-founder	- Company website: 1 - Non-company website: 1
5	Ao76	Sebastien De Clercq	Managing Director	- Company website: 1 - Social media page: 1
6	Twiggy	Barbara Beernaert	Founder	/

The semi-structured interviews, which are interviews with one respondent at a time in which a blend of open- and closed-ended questions are asked, was chosen since it gives sufficient freedom to learn about unforeseen issues while still collecting data about the topics on the agenda. These interviews in general take less than one hour. (Adams, 2015, Chapter 19).

According to Adams (2015), the process of semi-structured interviews is done in three phases: (1) selecting and recruiting the respondents, (2) drafting the questions and interview guide and (3) analyzing the information gathered. For the semi-structured interviews, 6 respondents were interviewed. The companies that were selected for the case study are mentioned in table 2 (section 3.2.1). The interviews were held online in the months of March and April of 2021. The information of the respondents can be found in table 3.

The questions for the interview were drafted in advance which resulted in the creation of the interview guide. This interview guide is not the same as a questionnaire since the semi-structured interview method does not make use of fixed instruments. The interview guide should be a list of short questions and follow-on questions, grouped by the planned topics. The interview guide for the 45 minutes long semi-structured interviews can be found in Appendix 1.

The interview data were complemented with data resulting from a web-based search. The web-based search made use of publicly available sources such as websites and social media and was oriented towards

[2] The list with all the sources of secondary data can be found in Appendix 3

collecting extra information. Extra information via publicly available sources paved the way for triangulating the interview data.

3.4 Data coding & analysis

Lastly, the data, that was collected through the web-based search and the semi-structured interviews, are coded and analyzed making use of the software package NVivo (version 1.4). Before making use of the NVivo software, all the interviews were recorded and transcribed. For the analysis, an inductive strategy was utilized, namely the grounded theory. In the grounded theory, a theory is developed based on the collected data. The NVivo software was also utilized to do some data exploration and to create the necessary visualizations.

3.4.1 Case and source classification

For the data analysis, each of the cases is a fashion retailer. However, they each have different characteristics which might lead to different perspectives. Hence, I performed a case classification based on different attributes. The case classification can be found in table 4. In order to have a meaningful classification, the existence (in years) is grouped in three categories, namely, exists less than 5 years, between 5 and 15 years and more than 15 years. The number of shops is categorized in a similar way, namely 1 shop, between 2 and 5 shops and more than 5 shops.

Table 4: Case classification

Case	Company name	Existence (in years)	Number of shops	Concept	Focus Sustainability
1	Jbc	46	118	Selling	No
2	Jukebox	2	1	Renting	Yes
3	Supergoods	5	3	Selling	Yes
4	Just Hazel	5	1	Selling	Yes
5	AO76	45	5	Selling	No
6	Twiggy	42	1	Selling	No

The source classification exists of two different classes, namely interview and webpage. Both of the classes have the date as an attribute.

3.4.2 Code structure

Since the inductive approach was utilized, I did not start from a pre-made code structure based on the research question. After an iterative process in which all the interviews and webpages were coded, a code structure was created in NVivo. During the labeling and analyzing of the interviews and webpages, three

main themes were found: sustainability in the fashion industry, supplier criteria and the CE indicator. The code structures for each of the three main themes are represented in the figures below.

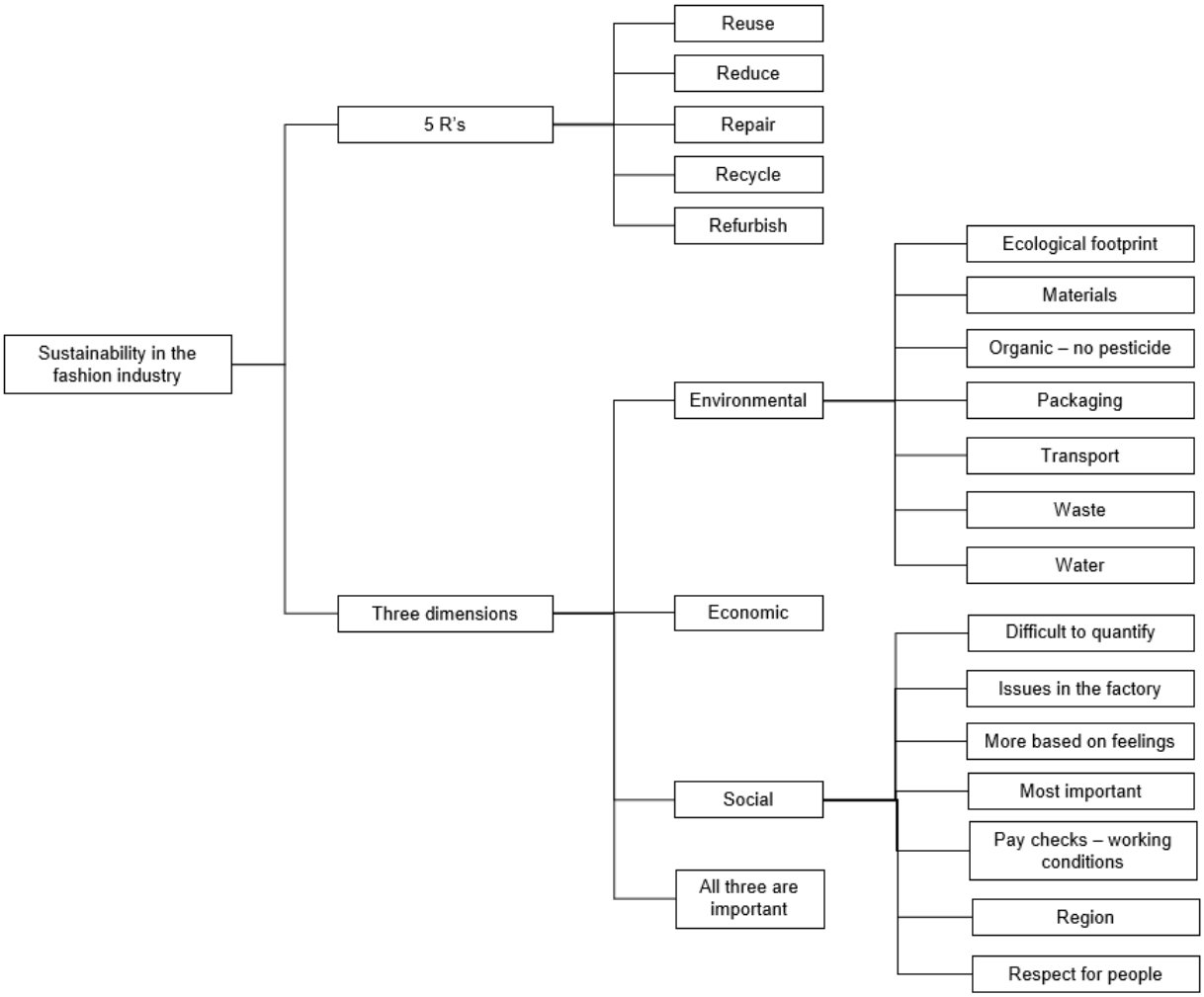

Figure 1: Code structure of sustainability in the fashion industry

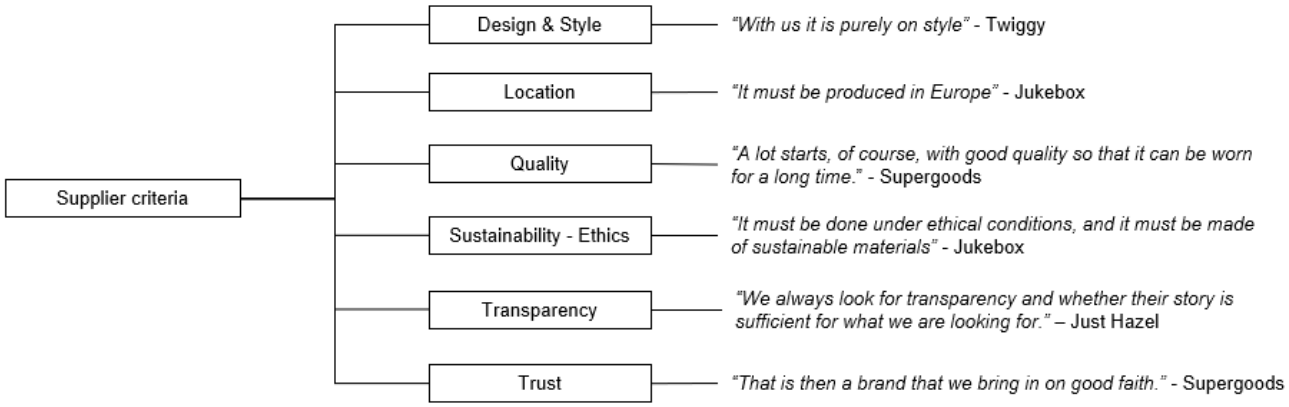

Figure 2: Code structure of supplier criteria

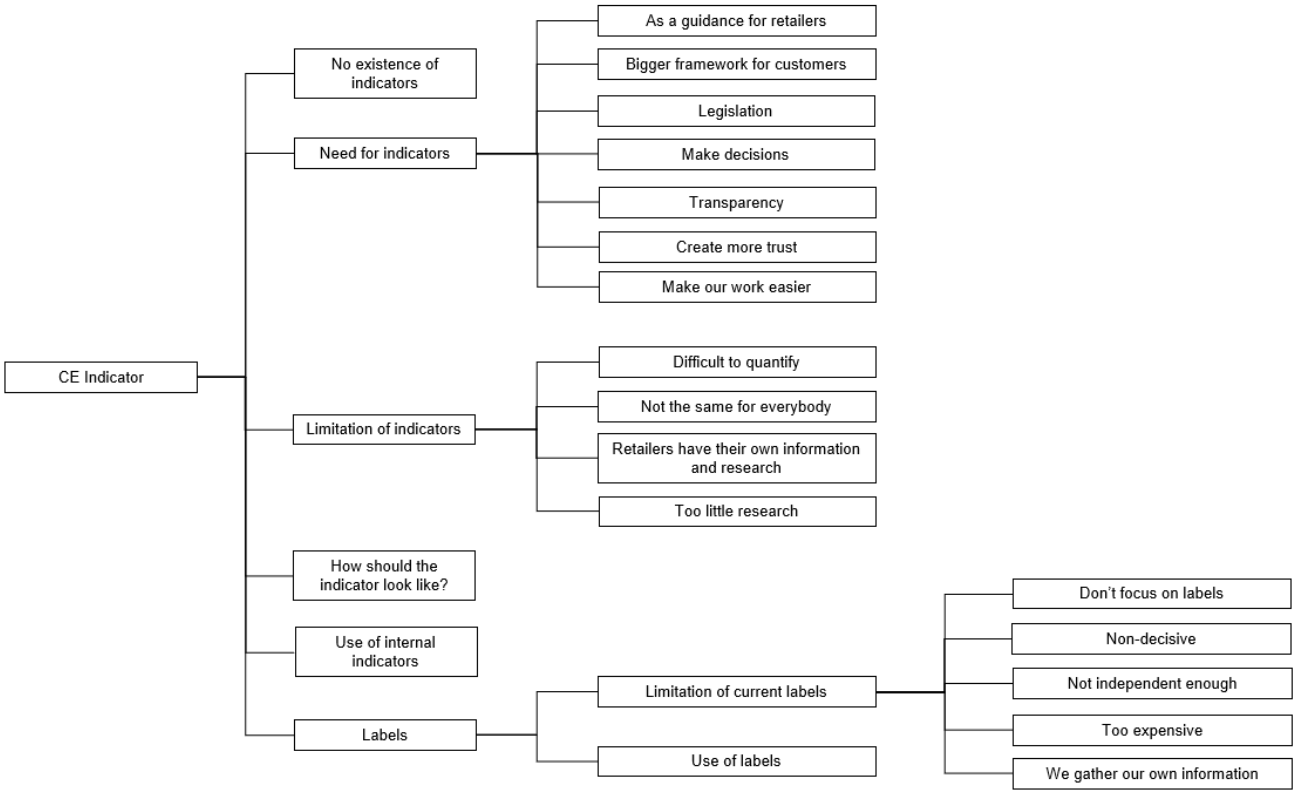

Figure 3: Code structure of the CE indicator

4 RESULTS

In this section, the results of the interviews are discussed in combination with the information that was gathered from the webpages. The goal of the interview and webpage analysis was to provide an insight into the relevance of CE indicators in the fashion industry. An important part of an indicator is knowing what we should measure. The literature review revealed that there are different definitions for sustainability and circular economy. Before reviewing the importance of a CE indicator in the fashion industry, it is necessary to get a profound view of how sustainability and circularity are defined in the fashion industry and how it is measured at the moment. Which aspects of sustainability are most important in practice? Answers to these questions will help us answer the research question. Moreover, since we are researching indicators on the micro level it is important to understand the role that sustainability plays when looking for a supplier. It is useful to know which parts of sustainability are seen as supplier criteria, and which are the other criteria that are implemented. Understanding the purchase behaviour of retailers can thus guide us in finding an indicator that might influence this process in the direction of a more circular approach.

During the interviews, the overall focus was on three main topics. The first two topics were, as indicated above, sustainability in the fashion industry and the criteria when searching for suppliers. Lastly, I focused on the existence of CE indicators in the fashion industry, and their relevance. This led to three types of exploratory questions, namely “How is sustainability perceived in the fashion industry and how is it measured?”, “What are the most important criteria when looking for a supplier and how is sustainability embedded in this purchasing process” and “What is the relevance of circular economy indicators in the fashion industry?”. All these questions help us to provide an all-encompassing answer to the research questions.

For the interviews, I contacted both retailers, whose concept is mainly focused on sustainability, and fashion retailers who do not focus on sustainability, but who might have started adapting a sustainable approach recently. Since these two groups of retailers have a totally different relationship with sustainability, they will often be analysed separately. By analysing the differences and similarities between these groups, it makes it possible to answer the question of whether there is a general need for circular economy indicators, and not only for a subsection of the sector. However, due to the limited number of retailers that were interviewed, we need to bear in mind that generalizing is difficult (see section 7).

In this section, I will discuss the questions related to the aspects of sustainability and supplier criteria together since both are intertwined. Next, the exploratory questions about CE indicators will be analysed in order to formulate an answer to the overall research question.

4.1 How is circularity currently measured in the fashion industry?

In order to provide an insight into how circularity is currently measured in the fashion industry, I reviewed which aspects of circularity are perceived to be important by fashion retailers and how they measure these aspects. Furthermore, I analysed which role circularity plays in the search for a supplier. Both parts are discussed in the sections below.

4.1.1 What specific aspects of circularity are important to retailers and how are they measured?

During the interviews, different statements (see table 5) endorsed that sustainability is a very broad concept, even in the fashion industry. Sustainability entails different aspects which are not strictly defined and cannot be easily ordered according to their importance. Based on the following statements of the interviews, it can be concluded that this is a challenge that also appears in practice, in specific in the fashion industry. The fact that sustainability is difficult to define is a first challenge for the CE indicator. On the other side, an indicator can tackle this challenge. A performant indicator could guide retailers through the principal aspects of sustainability in a transparent and well-arranged way.

Table 5: Quotes about sustainability

Cases	Quotes about the complexity of sustainability
Jbc	*"Now it is really just a search, because there are so many aspects to sustainability."*
Supergoods	*"What are the most important aspects for you when you talk about sustainability?" "It is a difficult story. It is not a black and white story. I'm not going to comment on that, because you can't. What is better than something else?"*
Jukebox	*"You have to know the fashion sector very well to be able to look at it critically. Because H&M now claims to have a sustainable collection, but what is sustainable, of course? That is always a difficult question."*

Sources: Interviews – translated from Dutch

To get a more detailed overview of the different aspects of sustainability that might be relevant in the fashion industry, more specific questions about the different components of a circular economy were asked. Intelligence was gathered about two specific topics of a circular economy, namely the three dimensions of sustainability (economic, environmental and social) and the 5 Rs (Reuse, Reduce, Repair, Refurbish and Recycle). If these circular economy concepts were not applied by the retailer itself, the question was raised whether they think it, nonetheless, is an important part of sustainability in the fashion industry. These were also principles that were assessed in the literature review on the existing indicators. Knowing which aspects are important for the fashion sector can help us build a bridge between practice and the existing research of current indicators.

The three dimensions of sustainability

The interviews were used to investigate whether the retailers acknowledge the importance of covering all three dimensions when talking about sustainability. In the figure below, the six cases are represented with different nodes for each of the sustainability dimensions. Also, the attribute level is shown to make a distinction between the retailers who focus on sustainability as the main concept and the retailers who do not. A difference between these two groups could indicate that sustainability is perceived differently among the members of the sector, and might lead to believe that having one general indicator will not be sufficient. However, figure 4 indicates that most of the cases indicated at least two dimensions. Only Twiggy did not link itself to the environmental dimension nor the social dimension, which is explainable since the owner mentioned that the focus is primarily on style and sustainability is seen to be mainly an add-on.

"For us, style always comes first. The story of sustainability is always a kind of extra for us." – Twiggy

The only clear difference is the fact that the economic dimension is only literally mentioned by the retailers who do not have a concept focused on sustainability. However, the economic dimension not being linked with the retailers who focus on sustainability is not a clear sign that this is not important for them. Each of the retailers aims at having a profitable business plan, even though this might not be the first dimension they think of when talking about sustainability.

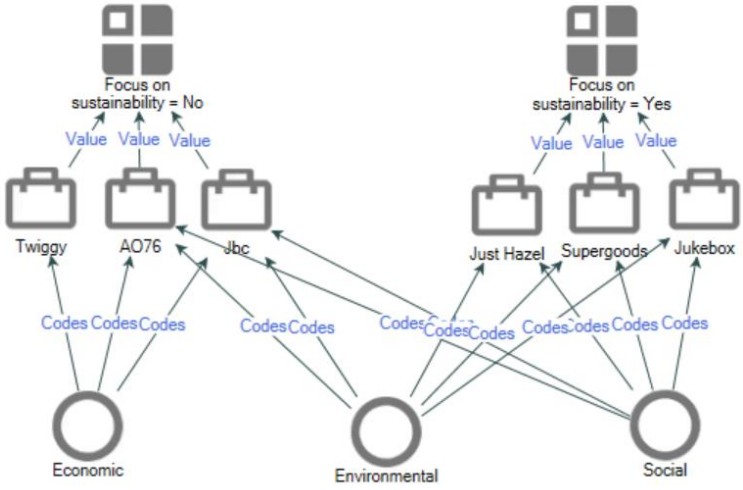

Figure 4: Three dimensions linked with the cases

The fashion retailers stated that the focus should be on multiple or all dimensions (see table 6). Some even pointed out that the dimensions are so intertwined, that it would be incorrect to pursue them separately.

Table 6: Quotes about the three dimensions

Cases	Quotes about the three dimensions of sustainability
AO76	*"The social of it is the most important thing for us at the moment, but you can hardly make an impact socially if you don't make a good impact as a company yourself."*
Jbc	*"We have also done a lot with 'planet', but more subconsciously. With the human aspect, we have always been much more conscious."*
Jukebox	*"It is certainly the intention of our project to include all three [dimensions]."*
Just Hazel	*"We let that [the three dimensions] weigh in just as much." "In general, of course, it's always somewhat related," "You can't make sustainable clothing that's made in social conditions but made in polluting conditions. That's not really true.*
Supergoods	*"You can't really take it [the three dimensions] apart. It is quite absurd to say that I am going to give a fair price to my cotton farmer, but then I am going to spray his field with pesticides. "*

Source: Interviews – translated from Dutch

Different aspects of the environmental dimension are recognized to be important. In the interviews and on the webpages, the following aspects were mentioned (see figure 5). Some nodes were even mentioned by multiple cases. The other components, although the relevance is clear, might be a hurdle to implement in the indicator. An interesting side note is the principle of circular packaging. Although this is not directly related to the sustainability of the clothes, this an important challenge that needs to be tackled in the transition to a circular economy. The majority of the retailers also denote to pay attention to packaging and are actively searching for circular alternatives.

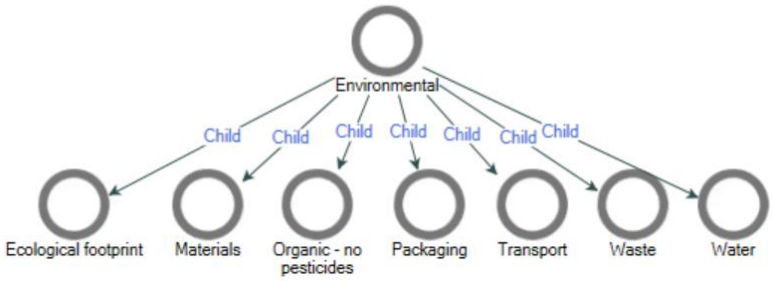

Figure 5: Environmental dimension with child nodes

Thereafter, the social dimension was discussed. During the interviews, several retailers indicated that measuring the social dimension is very difficult, and that this will probably remain so in the future.

Table 7: Quotes about the social dimension

Cases	Quotes about the quantification of the social dimension
AO76	*"To quantify that [the social dimension] is always going to be very difficult anyway."*
Jbc	*"…partly because it [the social dimension] is so difficult to quantify."*
Supergoods	*"It is already difficult to say socially what is the ultimate solution"*

Source: Interviews – translated from Dutch

The social dimension was mentioned in different forms during the interviews. The different subsections can be found in figure 6. These four topics are closely related to job creation and a safe working environment, which were both mentioned in the literature review as being possible ways of measuring the social dimension.

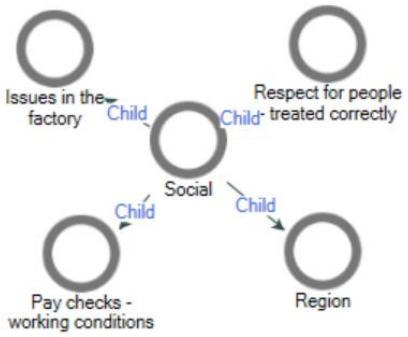

Figure 6: Social dimension with child nodes

5 Rs of a circular economy

For the current existing indicators, we also proposed an analysis based on the 5 Rs for a circular economy. Which Rs are included can have a big impact on how the indicator will look like. The interviews encompassed some questions related to the 5 Rs, such as which they implement themselves and which they perceive as important for the sector. It is clear that almost all of them are perceived to be important (see figure 7). However, not all of them can be easily implemented by the retailer. Repair and recycling came out as the most implemented Rs. This is not surprising, since in the literature review we also noticed that recycling was the R that is most covered by the existing CE indicators.

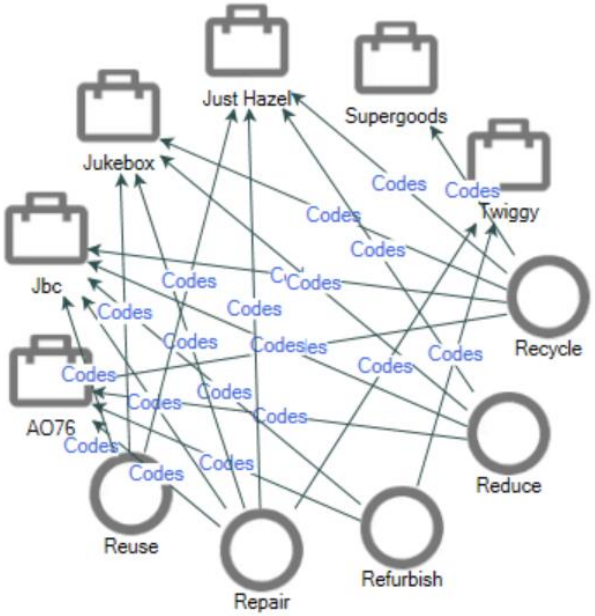

Figure 7: 5 Rs linked with the cases

4.1.2 Which role does sustainability paly in the search for a supplier?

Knowing which aspects of sustainability are apparent in the fashion sector, is not enough to get an idea of how a circular economy indicator on the micro level should look like in order for it to start a move towards a circular economy. The context in which the indicator would be put into practice should also be analysed. An assessment of which criteria are used in the purchasing process of retailers should be included as well. During the interviews, different criteria were mentioned that are taken into account in the search for a supplier. The different criteria can be seen in the visual representation below (see figure 8).

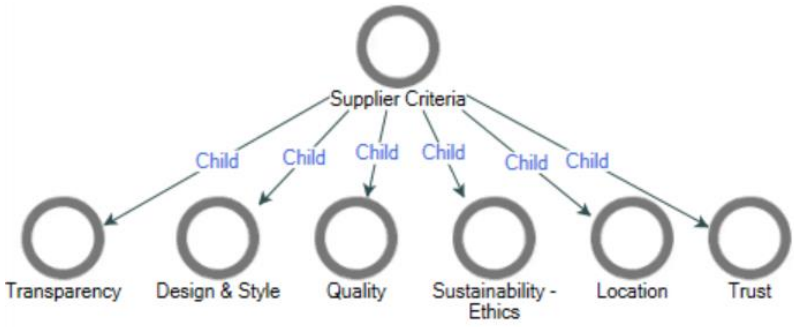

Figure 8: Supplier criteria with child nodes

Although it is clear that most of the shops include multiple criteria, it should be noticed that this is not the same for every retailer and thus cannot be generalized. Remarkable is the fact that Twiggy mentions to solely focus on style and design when buying clothes from a supplier. However, the owner of Twiggy mentioned that she assumes that in her price category the sustainability requirements are fulfilled anyway. The other stores, although not having a concept with the main focus on sustainability, also indicated the sustainability requirements as part of the supplier criteria. Quality is the only supplier criterium that is mentioned by all the cases. Multiple retailers also indicated that quality is the most important since this directly influences the durability of the clothing.

For the supplier criteria, there is no clear distinction between the two groups. Both of the groups indicated that all of the supplier criteria play a role. However, on the webpages and in the interviews of the retailers with a clear focus on sustainability, criteria such as transparency, location and sustainability are more emphasized than by the other retailers. But also the style is clearly mentioned on the webpages of these retailers as one of the main criteria for their clothing. This could be to promote the fact that sustainable clothing can also be very trendy and stylish.

The most important conclusion that can be made when looking at the criteria, is that sustainability plays a significant role when choosing a supplier. Thus, this is a first indication that there might be a need for CE indicators on the micro level in the fashion industry and that having such an indicator could have an influence on this decision process.

4.2 How can the way in which the fashion industry measures the circularity be improved?

How we can improve the way in which the fashion industry was measured was researched throughout different questions during the interviews. These questions covered the limitations of labels, the existence of CE indicators and their advantages and limitations. The answers to these questions are discussed in the sections below.

4.2.1 What are the current limitations of labels?

Before going deeper into the topic of indicators. Some exploratory questions were asked about the labels that are used to indicate the sustainability of clothing. Labels can give an indication of which aspects are focused on by the retailers and which aspects of sustainability are easily representable in an indicator. Also, questions related to why they use them and what the limitations are, are a good start to know their opinions about indicators. However, we need to bear in mind that these labels are not always clearly based on data or numbers.

Different cases indicated that they pay attention to the labels but most of the time the labels are non-decisive in their purchasing process. Reasons for not fully focusing on the labels are the fact that they are not perceived as independent enough and are often too expensive for the small brands they are working with. The most interesting limitation of labels, and which might be a limitation for the proper use of CE indicators, is the fact that retailers indicate to do their own research (see table 8). It is remarkable that this limitation is only touched upon by retailers with a concept that focuses on sustainability.

Table 8: Quotes about labels

Cases	Quotes about labels
Jukebox	*"We know themselves that they [the brands] are good, because we have met them ourselves. For us, labels are not important at our scale." "For our project, this [labels] is not going to make a difference. Those labels exist for the big brands, but the small brands we call regularly. So it has no added value for me."*
Just Hazel	*"But still, as I said earlier, we are going to look in much more detail at the story of the brand itself. "No, no, that's actually because when we buy a new brand we have to know a lot about it anyway. And we also want to know a lot about it."*
Supergoods	*"Yes, you have to be critical of that. That [the labels] is certainly not the true solution."*

Source: Interviews – translated from Dutch

4.2.2 Why would the fashion industry need CE indicators?

Firstly, the existence of CE indicators in the fashion industry was reviewed. The answers to the question of whether they know about the existence of a CE indicator on the micro level were quite dispersed. The

question was often doubtfully answered that they do not directly know such an indicator. Based on the answers to this question (see table 9), it can be concluded that if there even would be an indicator, then it is definitely not a generally known indicator. The co-founder of Jukebox made the link with labels, which confirms that labels might be the closest concept to indicators that exist at this moment in time in the fashion industry.

Table 9: Quotes about the existence of indicators

Cases	Quotes about the existence of indicators
AO76	*"Ugh, I don't know about that." "I am wondering what indicators you would mean, but I don't really know any of that that is a fixed indicator that I see in everyone."*
Jbc	*"We are actually members of the Bangladesh agreement and FairWear foundation, because there is no framework like that in Belgium."*
Jukebox	*"There are currently labels. The biggest one at the moment is GOTS, which goes the furthest in terms of both ethics and environment. There may be new labels in the meantime, but GOTS is the most developed."*
Just Hazel	*"That is difficult. No, I do not know that directly."*
Twiggy	*"You often have that when you buy a collection. You have an initial discussion. In general, we always do our preliminary research, we always visit the site. So that you already have a little bit more information about the brand."*

Source: Interviews – translated form Dutch

The retailers mentioned different reasons why CE indicators might be useful for them (see table 10). Jbc and Twiggy both indicated that a framework provided by an independent third party could help as a guidance for retailers. Jbc stated that they feel like they are really wandering for a good approach and that having an indicator might be a good push for retailers to start working in a more sustainable way. Twiggy was less resolute. The owner mentioned that it can definitely support the current way of working.

A second incentive that was mentioned by a lot of retailers was the influence it could have on the customers. Most of the retailers linked having more information for them as a retailer directly to having more information for their customers. A more transparent framework for customers is very important, even though this is not the subject of this research. I will not go into further detail but it is interesting to take into account that an indicator on the micro level might be translated into an indicator on the macro level.

The owner of Twiggy brought up that it would create more trust regarding the supplier. This was not affirmed by the other retailers. This could be caused by the fact that the retailers with sustainable concepts indicated that they keep close contact with the suppliers. The owner of Supergoods Gent, in contradiction, wants legislation and stated that indicators will probably be part of the solution to achieve this. In the literature review, Avdiushchenko & Zając (2019) also mentioned legislation to be one of the reasons we need CE

indicators. The other needs they indicated were tracking the progress and raising awareness of the opportunities. Related to these needs, Jbc indicated that they want the indicators to help make decisions.

The two most mentioned advantages are the fact that it would make the work of the retailers a lot easier and it would create a more transparent way of working. Nowadays, the retailers often have to do their own research, which can be very time-consuming and does not always reveal all the required information. The CE indicator would thus help to make the necessary information available in a transparent and easy to retrieve way.

Table 10: Need for indicators for each of the cases

Need for indicators	AO76	Jbc	Jukebox	Just Hazel	Supergoods	Twiggy
As a guidance for retailers		x				x
Bigger framework for customers	x	x	x		x	x
Create more trust						x
Legislation					x	
Make decisions		x			x	
Make our work easier			x	x	x	x
Transparency - More information	x	x	x	x		

Although it was said that there are no general CE indicators, the interviews revealed that some of the retailers internally use their own indicators to decide whether they think a product or material is sustainable. As mentioned before, some of the retailers do very extensive research themselves and thus can indicate what is better than something else.

"Yes, because now I have created a kind of nutrient score for different fibres myself." – Jbc

Just Hazel also indicated to have some internal guidelines on which they make their buying decisions. However, they indicated that this is not really written on paper.

"Yes, we actually have that. We don't have that on paper. All of us [the owners] just know." – Just Hazel

That the companies start creating their own indicators or guidelines is a good indication that there definitely is a need for CE indicators on the micro level in the fashion industry.

4.2.3 What are the current limitations and concerns?

The current limitations and concerns are only mentioned by Jbc and Jukebox. They indicated four limitations (see figure 9). The first limitation is that it will be difficult to quantify sustainability because some aspects of sustainability are difficult to represent in numbers. Jbc by example mentions the fact that some farmers in

the Far East simply do not register these numbers and information. It might be a challenge to capture this information when the owner himself does not keep a record of this. Secondly, the CSR manager of Jbc talks about gender-based violence, which could be part of the social dimension of the indicator.

"I think that there will always be indicators that are vague, especially since, for example, there are still farmers in the Far East who are not yet involved in technology and therefore do not quantify anything. And then there are issues such as gender-based violence which cannot be captured in indicators, or which you will miss out on. If you start doing that, you're actually going to hide part of the problem, because it's not quantifiable." – Jbc

For the second limitation, it is said that sustainability, and thus the indicator, might not be the same for everybody. Following on from this, it was also said that each retailer has its own information and knowledge. Thus, it might be questionable what needs to be included in the indicator to represent new information for the retailers. Above all, the question was raised whether a third party will have enough research to create an indicator that is completely synchronised with the academic field and complements practice.

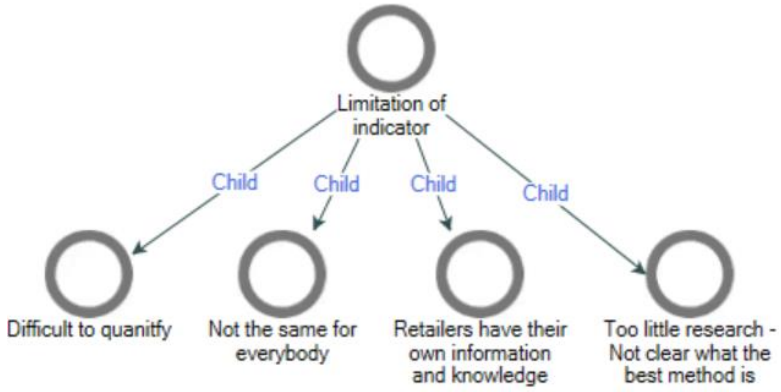

Figure 9: Limitation of CE indicator

5 RECOMMENDATION

In this recommendation section, the bridge is made between the literature review and practice as reflected in the qualitative study. Since the qualitative research indicated a clear need for CE indicators in the fashion industry, a proof-of-concept of a CE indicator in the fashion industry is proposed in this section. A design approach based on the design approach of Cayzer et al. (2017) was followed. In the initial phase, relevant and measurable variables were identified with their ideal targets. These variables are derived from the vision of EMF for a circular fashion (EMF, 2020) combined with the evidence from the qualitative study. In the second phase, a theoretical base for CE indicators in the fashion industry was constructed. Therefore, concepts of existing CE indicators from the literature review were analyzed and linked to the relevant variables that were indicated in the first phase. However, we need to bear in mind that this fusion of theory and practice is still in its infancy. The other limitations of this circular fashion indicator are discussed in the limitation and further research section (section 7).

5.1 Variable derivation & ideal targets

In the literature review, the different purposes of an indicator were scrutinized. Based on these different purposes, the aim of the CE indicator in the fashion industry can be made clear: 'a support mechanism that informs managers and stakeholders in the fashion industry so that they can make better decisions and can create more openness through communication'.

Before being able to select the useful indicators, we should be able to formulate an answer to Cayzer's et al. (2017) first question: "*What are the variables that should be measured?".* Hence, we need to know what the indicator should measure. Therefore, it is important to get a clear idea of the important variables when talking about CE in the fashion industry. In 2020, the EMF wrote a report that represents the vision of a circular economy for fashion. In this report, the different aspects/principles of the vision are mentioned. These goals are divided into three groups: (1) used more, (2) made to be made again and (3) safe and recycled or renewable inputs. These principles are used as a base, from which relevant variables in our search for a fashion CE indicator are derived. Moreover, the evidence from the qualitative research is also incorporated.

5.2 Indicator selection

First, a more general picture of how the CE indicator for fashion should look like is given. As already indicated in the introduction about circular fashion, Cayzer et al. (2017) indicated that there is a need for sector-specific indicators. The indicator is meant to be used on the level of the product, not the material, component, process or company. Based on the existing indicator table, it is clear that most of the existing CE indicators also focus

on the product level. Another finding based on the literature review was that different researchers indicated the need for CE indicators that cover all three sustainability dimensions: (i) the economic dimension, (ii) the environmental dimension and (iii) the social dimension. The qualitative research also confirmed the need for CE indicators that cover multiple dimensions. However, since table 1 (see 2.4.5) shows that only a minority of the existing indicators covers all three dimensions, it might be challenging to come up with an index that also covers all of them.

The selection and design of our indicator, which we will call the Circular Fashion Indicator (CFI), starts from the premise of covering all sustainability dimensions. Laso et al. (2018) started with a similar idea. They took a weighted sum of the economic impact and the environmental impact in order to build his Eco-Efficiency indicator (EEI): $EEI = I_{ec}.w_{ec} - I_{env}.w_{env}$. Since the goal of this study is to find an indicator that covers all dimensions, I extended the formula of EEI with the social dimension. Hence, we aim to build the Circular Fashion Indicator by this formula:

$$CFI = I_{ec}.w_{ec} + I_{env}.w_{env} + I_{soc}.w_{soc}$$

Notice that Laso et al. (2018) used a minus sign between the economic impact and the environmental impact. This is because they only measured the negative impact on the environment.

After stating this general view on our CE indicator, the formula will now undergo a hierarchical breakdown into sub-indexes. This method was used by Lee et al. (2014) in order to simplify the complex nature of EoL management. This modular approach is very useful for making the indicator simpler and easier to interpret the results because the sub-indexes are more measurable and easier to obtain (Lee et al., 2014). Although simplifying the indicator seems like a step back from reality, Nelen et al. (2014) already mentioned that in order to capture the complex reality into a single indicator, numerous simplifications and assumptions need to be done.

Based on the literature review it became clear that including all three might be challenging. In specific, the social dimension can be a hurdle. The challenge of measuring the social dimension was also touched upon during the in-depth interviews. At the moment, there is too little research done about circular economy indicators in the social dimension to extend this to the fashion industry. Hence, the following sections will solely focus on the economic and environmental dimension.

5.2.1 Economic dimension

Although the economic impact is not a separate section in the report of EMF, this is shown to be very important since almost half of the CE indicators in table 1 cover the economic dimension. Laso et al. (2018) used an extensive economic analysis based on the Life Cycle Costing (LCC) method. The LCC could help decision-makers to detect opportunities to reduce costs. In their research, they designed the life cycle costing

for the canning industry. However, with small changes, such as replacing the cost of pre-processing of raw materials with the cost of distribution, this can be generalised to the fashion industry as well.

$$LCC = C_{RM} + C_M + C_P + C_D + C_{WT}$$

In this formula, C_{RM} stands for the cost of raw materials, C_M are the costs of processing and manufacturing, C_P are the costs of the packaging, C_D are the costs of the distribution and C_{WT} are the costs of the waste treatment.

In the next step, the value added (VA) is calculated. The most logical formula for the value added, given the Life Cycle Costing, is presented by Rivera & Azapagic (2016). They stated that the value added is the difference between total incomes and costs of bought-in materials and services.

$$VA = WP - LCC$$

In this formula, WP is the wholesale price and LCC is the Life Cycle Cost calculated with the formula above. Therefore, this describes the profit margin for each product, and thus provides an insight into the value to the manufacturer and retailer, and the society at large when calculating the value added taxes. However, most of the time retail prices are used due to the lack of data about the wholesale prices (Laso et al., 2018). Next to Laso et al., Di Maio (2017) also used value added in his value-based resource efficiency indicator. Although the formula was a little bit different, the principle is the same: *VA = gross output (GO) – energy (E) – materials (M) – services (S)*. The aim of the Value-based resource efficiency indicator is to find products that use as few non-sustainable/stressed inputs as possible and creates jobs and a high value added (Di Maio, 2017). This is definitely part of the goal of the CFI and should thus be integrated into the indicator. Moreover, the use of economic value has the advantage of not like mass representing only quantity but also embodying the quality (Di Maio, 2017).

5.2.2 Environmental dimension

I. Used more

'Used more' is the first section in the vision of the EMF (2020) for a circular fashion. This section is mainly about the lengthening of product use. They divide this section into three possible options: (i) durability, (ii) reuse and (iii) repair. In the qualitative research, different retailers indicated to pay attention to each of these aspects. Although, some of them also indicated that second-hand clothing is a very crowded market with some big competitors, which leaves little room for them to compete in this market. The EMF points out the idea of rental services and recommerce, but they also emphasize the hurdle of the physical and emotional appeal of the product. This leads us to the concept of *timeless fashion*, although due to the subjectivity of

this concept this might be difficult to measure. In the following sections, we will look deeper into the three different options in order for clothing to be used more.

a. Durability

First, we will look at the durability of a product and how we can extend the life span. The EMF (2020) defines durability as *the ability of a physical product to remain functional and relevant over time when faced with the challenges of normal operation*. This also includes the lifetime after repair or the time of use of another user.

The durability can be divided into physical durability and emotional durability. The emotional durability is related to the concept of timeless fashion explained above. This means the products' ability to stay relevant and desirable to the user. However, this is very subjective and thus difficult to grasp in an indicator. Therefore, we will only focus on the physical durability. Adding a variable that measures the physical durability to our Circular Fashion Indicator, should create an incentive for manufacturers and retailers to design and buy clothing that can resist damage and wear.

One indicator compasses the idea of durability the best, and this is the Longevity Indicator of Franklin-Johnson et al. (2016). Franklin-Johnson et al. (2016) took into account three components when designing its indicator: initial lifetime (A), earned refurbished lifetime (B) and earned recycled lifetime (C). This led to the following formula:

$$Longevity = A + B + C$$

The longevity indicator is generic in nature since it is believed that use (A), reuse (B) and recycling (C) are what all product systems have in common. Hence, the longevity indicator can also be applied in the fashion industry.

Before considering repair, maintenance and recycling, the product should be designed in order to last as long as possible. This is comprised in A, as is to say the initial lifetime of the product expressed in the number of months. Azevedo (2017) even takes it to a higher level by multiplying the longevity with the utility during the use phase. To get a realistic ratio, he compares the lifetime and the intensity of the product used to an industry average product of a similar type. Azevedo (2017) uses the following formula in which he multiplies the longevity ratio with the utility ratio:

$$Util_{Use\ Phase} = \left(\frac{L}{L_{av}}\right) \times \left(\frac{U}{U_{av}}\right)$$

In this formula, U/U_{av} reflects the extent to which a product is used to its full capacity. This utility factor is also utilized by the EMF in their Material Circularity Indicator (EMF, 2019).

Using this formula for clothing can be challenging. Although, EMF (2019) indicates that companies are expected to have a reasonable understanding of the typical number of functional units (U) of their products,

for clothing this is not that easy. Normally, the industry average can often be assessed from warranty return rates and product testing, but clothing is usually not in constant active use such as a fridge. Unlike these electronic devices, clothing includes active and passive periods. Moreover, the purchase of one piece does not necessarily replace one of the pieces that were already part of the wardrobe, but rather extends the wardrobe (Klepp, Laitala & Wiedemann, 2020). Furthermore, the number of wears depends highly on the consumer preferences, whether the customers likes the garment, and on the number of clothes, the customer already has in his wardrobe (Klepp et al., 2020). Therefore, it might be better to mainly focus on the longevity of the clothing and to leave the utility factor out of the calculations due to its high correlation with the consumer's behavior.

That the formula of Longevity of Franklin-Johnson et al. (2016) might not cover the whole circularity concept is also indicated by Figge et al. (2018). To address the limitations of the LI, Figge et al. (2018) added the circularity metric. This circularity metric is composed out of three parts, the same as in the Longevity Indicator: (i) initial use, (ii) refurbishment and (iii) recycling. However, now the indicator represents the number of times a resource is used in a product system, according to the following formula:

$$Circularity = N^A + N^B + N^C$$

Since the material is only used once in the initial state, it is clear that $N^A = 1$. This formula represents the number of times a resource is used on average in a product system. Circularity can be between 1 and infinity. When the circularity is one it means a fully linear system, when infinity, it means a fully circular product system (Figge et al., 2018).

Since the variable B and C from the formulas of longevity and circularity relate to reuse and recycling, these will be discussed in the following paragraphs.

b. Reuse & Repair

Secondly, reusing products is another way for products to be used more. The reuse of products and how this can be measured will be discussed in this section. When talking about reusing clothing, this can be about buying second-hand clothing, but also about rental services. Cullen (2017) stated in his research that second-hand clothing is an approach in which little energy is required to reuse a discarded product. Additionally, Cayzer et al. (2017) advocated rental schemes since they enable customers to access higher quality products and materials without having to purchase the product themselves. However, reuse often goes hand-in-hand with repair. Due to the fact that these two concepts are very intertwined, I will analyse these together.

It is not surprising that Franklin-Johnson et al. (2016) and Figge et al. (2018) both combine these two principles into one variable. The variable B in the Longevity Indicator and the variable N^B both refer to products that are repaired, refurbished and reused. B measures the extended lifetime through refurbishing

and reusing the product. To measure B the formula exists of three components: w (the percentage of products returned), x (the percentage of these products refurbished) and U (the lifetime of a newly refurbished product). The following formula is used:

$$B_1 = w_1 \times x_1 \times U_1$$

The formula can be extended in the case that a product is refurbished twice, using the following formula:

$$B_2 = w_1 \times x_1 \times w_2 \times x_2 \times U_2$$

In order to get all the additional months, all of these sub-formulas are added to each other to get the value for B.

Furthermore, Figge et al. (2018) do not count the longevity of the goods that are reused or repaired, but take the sum of the products of the goods returned (a_j), and the proportion of those that are returned, which are then refurbished (b_j). This can be seen in the formula below.

$$N^B = \sum_{i=1}^{n} \left[\left(\prod_{j=1}^{i} a_j b_j \right) \right]$$

Vanegas et al. (2017) expressed the need for facilitated access to product components in order to be able to repair and reuse products. However, since we are talking about clothing, which does not need very complex ways to be disassembled in order to repair them, we will leave out a metric that measures the ease of disassembly for the sake of simplicity and comprehensibility of the Circular Fashion Indicator.

Although these concepts of reuse and remanufacturing are intertwined, and thus can be measured together, we need to take into account that some of these approaches are less circular or less environmentally friendly due to energy consumption than others.

II. Made to be made again

In this section, the next step in the cycle will be discussed. Namely, when products are not reused or repaired anymore but have to be recycled or remade. The results from the qualitative research indicated that all of the 5Rs are important. However, recycling is seen as the most important one. Hence, the aspect of recycling should definitely be included in our proof-of-concept. The EMF divided the made to be mad again section into four subsections, namely composting, design for disassembly, recycling and remaking. The paragraphs below follow the same division.

a. Composting

The EMF (2020) mentioned composting and biodegradable materials as part of the vision of CE in the fashion industry. However, meanwhile, they mention in their report (EMF & Granta, 2015) that hardly any clothes today are made purely from biodegradable or bio-benign materials. Moreover, they express that for a new textiles economy the focus should be on increasing the rates of clothing utilization and different levels of recycling. Nevertheless, they acknowledge that it is not unthinkable that, in the future, the use of biodegradable materials can become more prominent. As long as this is not a well-established method, it might be better to leave this out of any calculations in order to decrease the complexity of the metric.

b. Design for disassembly

As already discussed when talking about repair, integrating a metric that measures the ease of disassembly might be too complex when talking about clothing. And as also indicated by the EMF, this is something that mainly focuses on the design and should thus be integrated into the design guidelines instead of the Circular Fashion Indicator.

c. Recycling

Recycling is a very important principle when talking about circular economy in any sector. This can be seen from the table of existing CE indicators (see table 1). 22 out of 26 indicators integrate the principle of recycling into their indicator. Recycling is the most used approach from the 5 Rs in the existing micro indicators. This is not surprising since it is seen as a cornerstone of a broader vision for the sustainability of a closed-loop society (Di Maio & Rem, 2015).

Firstly, there already exists a practical contribution to an indicator about the recyclability of clothing, namely the Material Reutilization (MR) score (FashionForGood, 2017). This indicator is designed specifically for the fashion industry. This indicator is calculated as follows

$$\left(\frac{2y + x}{3}\right) \times 100$$

where y is the percentage of the product considered recyclable or compostable and x is the percentage of the recycled or rapidly renewable content in the product.

Secondly, in the academic world, there also done quite some research about circularity indicators in the field of recycling, although none of them is focused on the fashion industry. Through all these existing indicators that cover recycling proposed by different researchers, there is definitely a trend in the way these indicators are built. The indicators that are mentioned in the table are almost always presented as a ratio. In general, the denominator represents how much material is recycled or recovered, while the numerator represents the total amount of materials that is inputted or needed.

Cullen (2017) used a ratio of the recovered EOL material by the total material demand as part of his circularity indicator. Likewise, Di Maio and Rem (2015) proposed the ratio of the material value produced by the recycler by the material value entering the recycling facility, as his Circular Economy Index (CEI). Di Maio and Rem also indicated the difficulties when calculating this recycling index. One of the difficulties is the necessity to have detailed information about the materials contained at each end of life product entering the recycling facilities and what will be the output in order to compute the index. Remarkable is the use of an economic value, namely the material value, in the CEI instead of another unit such as mass or volume. Fregonara, Giordano, Ferrando & Pattono (2017) uses the formula $W_i/M_i \times 100\%$, with W_i being the amount of secondary raw materials used as input and M_i being the total amount of raw materials, in order to get an idea of how recycled a material is. Nelen et al. (2014) also applied similar ratios when designing their Recycling Index (RI). However, they went a step further in their research. The Recycling Index exists of a simple weighted sum model, existing of four different sub-indices. Each of these individual sub-indices consists of a similar ratio in which the denominator is a representation of the output value and the numerator is a representation of the input value.

I already touched upon the subject of recycling in the previous sections, when talking about the longevity indicator of Franklin-Johnson et al. (2016). Franklin-Johnson et al. also make use of the same type of ratio, which they then multiply with the number of months of initial use and the number of months after repair or remanufacturing. In order to calculate thus the recycled lifetime contribution the following formula is being used:

$$C = (A + B) \times \frac{w_1 y_1 z_1}{1 - w_1 y_1 z_1}$$

Where w is the percentage of products returned, y is the percentage of recycled products and z is the percentage of unrecovered materials from the product. Since it might be difficult to assess the number of wears (Klepp et al., 2020), it might be better to focus on the longevity than on the number of uses in the case of clothing.

d. Remaking

Remaking is defined as the operation by which a product is created from existing products or components (EMF, 2020). In terms of the indicator, there is no difference between the calculation of products that are recycled or remade. Hence, I will not devote a separate section to remaking. For the calculations of remaking, the calculations of recycling can be used by changing y, the percentage of recycled products, to the percentage of remade products.

III. The inputs

The last section in the report of EMF (2020) with the vision of a circular fashion is about the inputs. The importance of materials was also emphasized during the qualitative research. Azevedo et al. (2017) included the input of the production process as an indicator into his research. He divided this indicator into two focal points, namely virgin material and waste. The amount of virgin material is calculated based on the following formula:

$$V_{(x)} = M_{(x)}(1 - F_{R(x)} - F_{U(x)})$$

The formula exists of $M_{(x)}$, which is the mass of the finished product x, $F_{R(x)}$, the fraction of a product's feedstock x from recycled resources and $F_{U(x)}$, the fraction of a product's feedstock x from reused resources.

The amount of waste generated at the time of the collection of the product is calculated using the following formula (Azevedo et al., 2017)

$$W_{(x)} = M_{(x)}(1 - C_{R(x)} - C_{U(x)})$$

with $M_{(x)}$, being the mass of the product x, $C_{R(x)}$ being the fraction of mass of a product x being collected to go into a recycling process and $F_{U(x)}$ is the fraction of mass of a product x being collected to go into component reuse.

These two formulas are also applied by the EMF in their Material Circularity Indicator (MCI) (EMF, 2015). However, the EMF added some extra variables, such as the mass of the product comprising uncontaminated biological materials that are being composted (C_C) and the mass of the product comprising biological materials from Sustained Production being used for Energy Recovery (C_E), which are less relevant for the clothing industry and will thus be left out to avoid complexity. Since both formulas have a negative impact on the circularity, these formulas should be preceded by a minus sign when incorporating them into the overall indicator, the CFI.

IV. Transparency & Traceability

Transparency was a very important topic in the qualitative research. It was stated to be an important criterium when searching for a supplier. Moreover, it was mentioned by the fashion retailers as one of the reasons why there is a need for CE indicators. To find the necessary information to calculate the above indicators, there is a high need for transparency and traceability. This is also emphasized in the last section of the vision for circular fashion of the EMF (2020). *Achieving the vision will require transparency and traceability across the value chain, for example on product specifications, chemical inputs, materials used, and production practices. Such information will be crucial to inform after-use practices such as sorting, remaking, and recycling.*

Regarding transparency, Cayzer et al. (2017) stated in their research that products where a comprehensive Bill of Materials is available could be a good starting point.

5.2.3 Overview

In the figure below an overview is given of the different subparts that should be addressed when creating a circular economy indicator for the fashion industry.

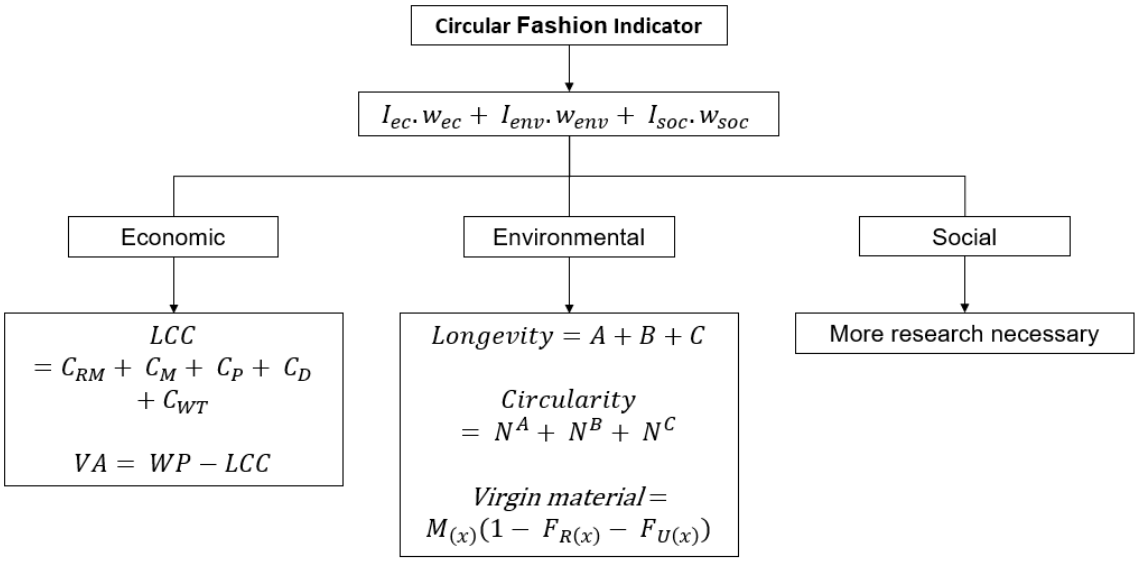

Figure 10: Overview of the subhierarchy of the Circular Fashion Industry

6 CONCLUSION AND DISCUSSION

This master dissertation contributes to the revelation of the role that indicators play in the move towards a circular economy on the micro level. The circular economy paradigm is a widely explored topic since it is seen as a necessary step to achieve sustainable development (Geissdoerfer et al., 2017). After many decennia, the current 'take-make-waste' model has been discredited for being an unsustainable path (EMF & Granta design, 2015).

In the literature review, an analysis was made of the need for circular economy indicators. Furthermore, research was performed on the advantages of such an indicator. In order to get a profound theoretical background, an overview of existing indicators was given. Academic literature revealed the advantages of an indicator in general. The most important advantages of indicators, in general, are tracking the progress, raising awareness of the opportunities and legislation.

A good CE indicator should include all the sustainability dimensions, namely economic, environmental and social, according to the academic literature. Moreover, academics state that we need a set of multi-dimensional indicators (Cayzer et al., 2017; Rossi et al., 2020). However, there is a clear trade-off on the micro level between the completeness of the indicator and the usability of the CE indicator in practice (Kristensen & Mosgaard, 2019). Elia et al. (2017) indicated that no single existing indicator encompasses all the requirements of the CE concept. In the last couple of years, a wide variety of circular economy indicators has been developed (Saidani et al., 2019). A review of the existing indicators was performed, which confirmed the above statements from the literature. The table exists out of 26 indicators, of which none fulfils all the requirements that are discussed in the literature review. The table shows very dispersed indicators with very diverse focus points. There is a clear lack of indicators that cover all three sustainability dimensions. The social dimension is undoubtedly underrepresented in the table, while most of the positive impacts of CE are presented in the social dimension (Korhonen et al., 2018). Another pitfall is the fact that not all of the existing CE indicators are already operationalised.

From the table of existing indicators, it can be concluded that the traditional and existing indicators cannot express CE in its totality. Most of them focus only on a few of the CE goals (Corona et al., 2019). The lack of indicators and methodologies for measuring the application level of CE strategies, in specific the lack of academic and scientific knowledge on CE indicators, is a barrier for further implementation. Based on the literature analysis and the table with existing indicators, the conclusion can be made that there is a clear need for circular economy indicators. The literature review also proves that indicators can facilitate the move towards a circular economy. However, we need to bear in mind, that certain challenges need to be tackled first. Those challenges often certify the lack of indicators at the moment. One of these challenges is the fact

that indicators may lack clarity on what they measure due to the magnitude of the CE paradigm and the various definitions of the CE.

In the qualitative research, the aim was to research the relevance of CE indicators in practice. A specific sector was chosen as the focal point for the qualitative research. The focal industry for the qualitative research of this master dissertation is the fashion industry. The fashion industry is worldwide an extremely wasteful and polluting industry (EMF, 2017). Moreover, there are many untapped opportunities due to the lack of scalable circular fashion research (Ki, Park & Ha-Brookshire, 2020).

To provide an insight into the relevance of CE indicators on the micro level in the fashion industry, the concept of a CE indicator has been reviewed in practice. The results of the case study demonstrate that there is a need for CE indicators in the fashion industry. Different reasons for the need for CE indicators and some limitations were mentioned by the retailers. In the interviews, I tried to assess how retailers perceive sustainability and circular economy. This resulted in interesting information since we need to know what we want to measure, to be able to create an indicator. The interviews confirmed that sustainability and circular economy are very comprehensive concepts, with many aspects, which are not always strictly defined. The magnitude of the CE paradigm and the various definitions of the CE was already indicated as one of the challenges in the literature review and is now endorsed by practice.

Furthermore, the retailers stated that sustainability covers multiple dimensions, and so should the indicator. Although the economic dimension only explicitly mentioned by the retailers who do not have a concept focused on sustainability, this is not a clear sign that it is not important for the other retailers as well. For the environmental dimension, different aspects were mentioned, such as materials, transport, waste and packaging. The main topics of the social dimension were safe working conditions and correct payment of the workers. Multiple cases confirmed, what has been indicated by the literature review, that the social dimension is very difficult to quantify, which might be the reason for the underrepresentation of the social dimension in the existing CE indicators. Another result from the case study is that all the 5 Rs (Reuse, Reduce, Repair, Refurbish & Recycle) are perceived to be important.

Although it is difficult to generalize the idea that most of the retailers utilize sustainability as one of the criteria when searching for a supplier, at the moment, five out of six cases indicated sustainability to be one of the criteria. The other criteria are design, transparency, quality, location and trust. One case mentioned that it was more an add on than a real criterium. Hence, it can be said that sustainability plays a significant role on the micro level.

The question of whether there already exists a CE indicator in the fashion industry was often doubtfully answered that they do not directly know such an indicator. Hence, based on these answers, it can be concluded that if there even would be an indicator, then it is definitely not a generally known indicator. A second reason to believe that there is a definite need for CE indicators are the many advantages that were

mentioned by the retailers. It was said that the indicator could be used as a guidance for retailers and that it would create more trust. The most mentioned advantages are that it would create more transparency and make more information available. This would then make the work of the retailers easier since they would have to do less research themselves. Another need that was mentioned was legislation, which was also introduced in the literature review as one of the main advantages of indicators. It is clear that there is a need for decision making, and an indicator would be a step in the right direction.

As with every new concept, there are some limitations. That sustainability is just very difficult to quantify and that it is not perceived in the same way by everybody are two limitations that were mentioned in the case study. Furthermore, the retailers with a sustainable concept store mentioned that they do their own research anyway so that it would not change their process much. Above all, some doubted whether there is enough academic research to create such an indicator since at this moment it is sometimes difficult to say what is better than something else.

As an answer to this clear need for a CE indicator in the fashion industry, a proof-of-concept of a CE indicator was proposed. For this proposal, a bridge between the table with existing CE indicators and the vision for a circular fashion was built. This resulted in a theoretical CE indicator for the fashion industry, namely the Circular Fashion Indicator. The theoretical base exists of three main components, namely the three sustainability dimensions. For the economic and environmental factor, some indicators are already proposed which form a base for further research. For the social dimension, no theoretical indicator is proposed due to a lack of academic research in this dimension. During the formation of the CFI, different limitations were brought to light. The concept of emotional durability is a hurdle to quantify since it is very subjective and thus difficult to grasp in an indicator. Furthermore, for many products, the longevity can be derived from warranty return rates and product testing. However, clothing has active and passive periods. Above all, the purchase of one piece does not necessarily replace one of the pieces that were already part of the wardrobe, but rather extends the wardrobe (Klepp et al., 2020). Buying and owning clothes is accompanied by a lot of subjective choices, which makes it very difficult to measure. Hence, this indicator is a theoretical concept which definitely needs to be extended with sector-specific research and which should be tested out in practice before being put to use.

The lack of research on the role of CE indicators but also the lack of CE indicators was stated multiple times during this research. This master dissertation is a step in the right direction to close this research gap. The need for all-encompassing indicators is demonstrated by literature, so is the need for CE indicators in the fashion industry based on statements from practice. There is still a long way to go and many challenges to tackle but the opportunities are undeniable.

7 LIMITATIONS AND FURTHER RESEARCH

In this master dissertation, a recommendation was done for a circular fashion indicator. This CE indicator was developed on the theoretical base I created by doing a literature review of the existing CE indicators. However, the number of existing indicators is very limited. Hence, the creation of this circular fashion indicator is also limited. The CFI is still in its infancy and should thus be extended with a more theoretical background. Furthermore, it should be tested in practice to make sure that it is proficient and realistic.

For the qualitative research of my dissertation, I opted for an explorative study. This led to a case study with a limited sample size. Since I only interviewed six retailers, it is difficult to generalize the results directly to the whole sector. Moreover, the selection of the cases is done via convenience sampling, which might have led to interviewing retailers who are already adopting sustainability in their shop. Extending the number of cases with shops that clearly indicate not to focus on sustainability, might thus give a more elaborate view on the current issue. However, since there is little research done about this subject, these results can provide a first insight into the need and challenges of CE indicators in the fashion industry.

Each of the retailers is situated in Belgium, which leaves little room for generalization to other regions, due to difference in regulations, culture and political system. As Jbc also indicated that in Germany there is more framework around circular economy in the fashion industry than there is in Belgium. I strictly limited the explorative study to the fashion industry on the micro level, which makes it difficult to generalize the results to other levels and sectors.

The interviews are done with interview guides and did thus not follow a strict questionnaire. Which sometimes leads to different questions. Hence, the fact that some retailers did not mention some principles is not a direct cause of not implementing them. Although, we can still make conclusions of the importance of the subjects, based on what they did mention during the interview.

The implications for business and policymakers are diverse. On the level of policymakers, it was stated that indicators could help assess whether we are moving in the right direction and whether sufficient actions have been taken. The implications for business, or thus the fashion industry in particular, are mainly focused on transparency. The indicators would create a more transparent framework in which more information is shared. When the CE indicators are proposed by an independent third party, this framework could lead to guidelines for the fashion retailers. Lastly, as the saying goes “what gets measured gets done”, CE indicators could accelerate the move towards a circular economy for both business and policymaking.

In this dissertation, I focused on the micro level. In order to get the full picture, it is necessary to also investigate the meso and macro level. It could be possible that making changes to the micro level does not impact the macro level. In the end, it is the customer who needs to buy sustainable clothes in order to move

towards a more circular economy in the fashion industry. Research is necessary to know whether the transparency on the micro level would also lead to more transparency on the macro level, and whether this influences the buying behaviour of the consumers in the long term.

The literature review proved that there is still a lot of research lacking in almost all the sectors. Hence, future research of the role of circular economy indicators in other sectors than the fashion industry might provide more insight into the value of indicators on the micro level in general.

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9 APPENDIX

Appendix 1: Interview guide

Introduction (warming-up)

a. Waarom bent u begonnen met een kledingwinkel die inzet op duurzaamheid? Wat waren de drijfveren?
b. Wat zijn voor u de belangrijkste aspecten als het over duurzaamheid gaat? (aanzet topic 1)

Topic 1: Economic, Environmental & Social

a. Wat zijn de hoofdcriteria wanneer je een leverancier zoekt?
b. Veel indicatoren kunnen opgesplitst worden in drie pilaren: sociaal, economisch en milieubewust. Welke vindt u belangrijk bij de aankoop van kleren?
    Probe questions:
        i. Welke eigenschappen van de kleding die u aankoopt linkt u aan deze dimensie die u zo belangrijk vindt?
        ii. Merkt u dat klanten dit ook het belangrijkste vinden?
        iii. Zou u zeggen dat één van de pilaren volledig onbelangrijk is?

c. Indien sociale aspect: Hoe zou u het sociale aspect meten?
    Probe question:
        i. Aan welke eigenschappen van kleding denkt u wanneer u spreekt over de sociale dimensie? (vb. fair wages)

Topic 2: the 5 Rs (Reuse, reduce, repair, refurbish, recycle)

a. Verkoopt u ook second-hand clothing?
b. Kunnen mensen kapotte kleding terugbengen voor reparatie?
c. Heeft u een inzamelpunt voor kapotte kleding?
d. Verkoopt u kledingstukken van gerecycleerd materiaal of materiaal dat bio-afbreekbaar is?
e. Timeless fashion, dus kleding die nooit uit de mode gaat, is dat iets waar u mee bezig bent? Iets dat terug te vinden is in uw kledinglijn?
f. In de circulaire economie wordt er vaak gesproken over de R's, namelijk reuse, reduce, repair, refurbish, recycle. Welk van die R's vindt u het meest belangrijke wanneer u denkt aan circulaire economie binnen de mode industrie?
    Probe question:
        i. Welke van deze R's is voor jullie het belangrijkste wanneer je kleren aankoopt?

j. Promoot u specifiek sommige van de R's naar uw klanten toe? En hoe dan?

g. Moet packaging ook in rekening gebracht worden?
    a. Probe questions:
        i. Wat is voor u de meest ideale packaging?
        ii. Aan welke R is deze packaging vooral gelinkt? Eerder hergebruik of recycled packaging bijvoorbeeld?

<u>Topic 3</u>: Existing labels

a. Worden er soms labels gebruikt bij de kleding die u koopt?
    a. Probe question
        i. Welke labels zijn dit dan zo? (Mogelijk voorbeeld: GOTS)
b. Hecht u veel belang aan labels?
    Probe question:
        i. Aan welke in het bijzonder?
        ii. Is er een label dat voor u de doorslag kan geven om het dan zeker wel te kopen?
        iii. Zijn er labels die voor u zo goed als betekenisloos zijn?

<u>Topic 4:</u> CE indicators in the fashion industry

a. Zijn er al indicatoren in verband met circular fashion die u kent?
    Probe question:
        i. Gebruikt u deze indicator soms?
b. Is er nood aan een CE indicator in de praktijk in de fashion industrie?
c. Hoe zou die indicator er volgens u moeten uitzien?
d. Zou u dan graag één indicator hebben? Of heeft u liever een opsplitsing in verschillende indicatoren, zoals een opsplitsing tussen economisch, milieubewust en sociaal?

Appendix 2: Sources of the company websites

Jbc: https://www.jbc.be/

A076: https://www.ao76.com/en

Supergoods: https://www.supergoods.be/

Just Hazel: https://justhazel.be/

Jukebox: https://jukeboxclothes.com/fr/service-location-vetements/

Twiggy: https://www.twiggy.be/

Appendix 3: Sources of secondary data

Jbc
https://blog.jbc.be/zo-jbc/duurzaamheid/fair-wear-foundation-wat-is-dat/
https://www.close-the-loop.be/en/ambassadors/ambassador/10/jbc
https://www.glo-be.be/en/articles/ann-claes-you-can-never-produce-ethically-if-you-calculate-everything-last-cent

A076
https://www.ao76.com/en/be-kind-act
https://www.facebook.com/AO76fashion

Supergoods
https://cosh.eco/nl/store/the-supergoods-gent
https://www.tdc-enabel.be/en/2021/03/24/supergoods-sustainable-clothes-for-trendy-shoppers/
https://www.facebook.com/Supergoodsstore

Just Hazel
https://cosh.eco/nl/store/just-hazel-1
https://justhazel.be/hazel-proof/

Jukebox
https://togethermag.eu/ethical-fashion-jukebox-is-a-new-way-to-consume-fashion/
https://jukeboxclothes.com/en/about/our-mission/
https://jukeboxclothes.com/en/about/our-ethical-chart/