Master Thesis

A Circular Economy Index for the consumer goods sector

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Master Thesis - 45 ECTS (GEO4-2606)
Faculty of Geosciences, Utrecht University
Master Sustainable Business and Innovation

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8st August 2016
Word count: 21.622

Universiteit Utrecht

accenture

The ultimate physical product of economic life is garbage.

Kenneth E. Boulding (1966)

Acknowledgement

A special thanks to my Accenture supervisor Sytze Dijkstra for the great cooperation and moments of enlightenment and to my mother for all support in times of nervous breakdown. And very special thanks to my supervisor Jesús Rosales Carreon for giving me the feeling the only reason he became a University professor was to help me graduate.

Abstract

The potential of the Circular Economy (CE) is widely recognized as a solution for todays' environmental and social problems associated with years of unsustainable economic growth. The circular economy is a new economic model that is restorative and regenerative by design and aim to keep products, components and materials at their highest utility and value at all time, distinguishing between technical an biological cycles. Specifically within the consumer goods sector, the CE is getting increasingly attention which is a crucial development considering the large uptake of agricultural output and enormous global waste levels. However, the CE is still an immature concept that needs to be further developed. There is a need for reliable CE indicators that measure actual CE performance of businesses, provide guidance on what to improve to become more circular and thereby accelerate the transition towards a circular economy, specifically within the consumer goods sector. A promising attempt is the Circular Economy Index (CEI) developed by Ruiter (2015) who identified Key Performance Indicators (KPIs) that can be used to assess and compare the level of circularity of companies and guide them in their transition. However, the CEI was not yet tested and did not enable a fair comparison of businesses because sector-specific differences in a circular economy transition were not incorporated into the CEI yet. Therefore, in this research the CEI is tested and improved in order to create an index which can be used to assess and stimulate the level of circularity of businesses within the consumer goods sector. This is done by testing the development of the CEI by Ruiter (2015), the performance of the individual KPIs and the usefulness of the KPIs for businesses in the consumer goods sector, with use of a CE indicator validation model and eight in-depth interviews. The main findings are that the usefulness and applicability of the CEI highly depend on two main business characteristics: 1) whether businesses sell *consumables* or *usables* and 2) whether businesses use *biological* or *technical* material for their products. Together with findings from the CE indicator validation model, a flow chart, KPIs, scoring card and circular economy performance ladder are developed that can be used to measure the CE performance of a business in five chronological steps and thereby improve and benchmark the level of circularity of businesses in the consumer goods sector.

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1. Introduction

1.1 Background

The linear 'take, make, waste' economic model, which relies on large quantities of cheap, easily accessible materials and energy, has been at the heart of economic development since the industrial revolution and has generated a tremendous level of growth (EMF, 2015; Joustra et al., 2013; WEF et al., 2014). However, international competitive pressure, scarcity and long-term rising prices of resources, energy and landfill space have alerted business leaders and policy makers to the necessity of rethinking the use of materials and energy (EMF, 2015; Fröhling et al., 2013; Vezzoli et al., 2015). This has only been strengthen by a growing consumption, increasing population and enormous costs in the public domain due to restoration of ecosystems (Joustra et al., 2013; Vezzoli et al., 2015). An answer to those problems would be to ultimately decouple global economic development from finite resource consumption, through a Circular Economy (CE) (Circle Economy, 2015; EMF, 2015; Sauvé et al., 2015; WEF et al., 2014).

The CE distinguishes itself from other eco-efficiency measures by promoting a new model of economic development, production, distribution and recovery of products that has the potential to understand and implement radically new patterns and help society reach increased Sustainable Development[1] and wellbeing at low or no material, energy and environmental costs (Ghisellini et al., 2014; Li, 2012; Sauvé et al., 2015). Where the CE concept was officially introduced by David Pearce in 1990, inspirer was Professor Kenneth E. Boulding, a pioneer environmental economist in 1960 who found that the earth can best be understood as a single spaceship with limited reservoir of anything either for extraction or pollution (Andersen, 2007; Boulding, 1966; George et al., 2015; Pearce & Turner, 1990).

1.2 Circular Economy

Circular Economy is a new economic concept with system thinking at its core based on three principles (EMF, 2015). First, natural capital has to be preserved and enhanced by controlling finite stocks and balancing renewable resource flows. Second, resource yields have to be optimised by circulating products, components and materials at their highest utility at all times, both in technical and biological cycles. Third, system effectiveness has to be promoted by identifying and designing out negative externalities (EMF, 2015). Increasingly companies recognize the useful value-added business opportunities of products, components and materials that were first considered as waste, as it will enable businesses to meet growing demands of reducing resource-intensity and risks of contemporary economic life (EMF, 2014; EMF and GRANTA, 2015; Lacy & Rutqvist, 2015; Wells & Seitz, 2005).

Several initiatives and organizations focus on promoting the CE of which the Ellen MacArthur foundation and the Dutch Circle Economy are the most well-known examples (Circle Economy, 2015; EMF, 2014). Also, more and more countries have taken measures to promote the circular economy, like The Netherlands, Japan, Austria and Germany (George et al., 2015; Ghisellini et al., 2014). Especially China is convinced, whose central government has accepted CE as a vital strategy for achieving sustainable development (George et al., 2015). Recently the European Commission has set ambitious goals for Europe in making the transition towards a Circular economy (Behrens et al., 2015; De Volkskrant, 2015), with specifically The Netherlands as Circular Hotspot of Europe (NLCH, 2016).

[1] Defined as *meeting the needs of the present without compromising the ability of future generations to meet their own needs* (World Commission on Environment and Development, 1987, p.16), completed by the three pillars of social, economic and environmental sustainability as highlighted by the UN in 1997 (Bond et al., 2001).

1.3 Consumer goods sector

In different market sectors[2] the opportunities of the circular economy have also been acknowledged (EMF, 2013; Lacy & Rutqvist, 2015). Especially within the Consumer Goods Sector (CGS), the largest sector worldwide in terms of market capture in USD, businesses are setting specific and measureable targets for energy and carbon emission driven by a desire to enhance brand reputation, concerns about managing risks associated with resource scarcity and interests in cost reduction (Farmer, 2013; FT, 2016; KPMG, 2011). The increase in attention for CE is a crucial development, as the CGS is an important actor in the transition towards a more sustainable development considering the CGS absorb more than 90% of our agricultural output (EMF, 2013), uses large amounts of packaging and is accountable for loss of value through enormous global food wastes (Farmer, 2013; Gavilan & Green, 2014; KPMG, 2011). The so-called fast-moving consumer goods[3] account for 35% of material inputs into the economy, a significant part of total consumer spending on tangible goods, and 75% of municipal waste (EMF, 2013). Therefore it is crucial to assess and improve the circular state of businesses within this sector. In fact, the Consumer Goods Forum has recognized that climate change will have an enormous impact on the CGS, its customers and employees (Gavilan & Green, 2014). This will be in the form of a decrease in available virgin resources with associated long-term rising prices and unstable supply chains (Fröhling et al., 2013; Vezzoli et al., 2015). Positively, economic opportunities lie ahead, since applying a circular model in the fast-moving CGS is estimated to yield a net material cost savings of 700 billion USD globally (EMF, 2014).

1.4 Problem description

Altogether, it shows the widely recognition of CE potential and the necessity of improving circularity within the consumer goods sector. However, researchers and practioners agree that the circular economy is still an immature concept that needs to be further developed (EMF, 2015; George et al., 2015; Xu et al., 2009). Although many different CE studies have been published worldwide (Ghisellini et al., 2014), there is still no recognised way of estimating how effective a business is in making the transition from a linear to a circular mode of operation, neither are there academically-sound CE indicators supporting such measurements (EMF and GRANTA, 2015). There is a need for reliable CE indicators that clarify the actual CE performance of businesses, sectors and/or countries in order identify opportunities to improve the level of circularity (Boulanger, 2008). Additionally, CE indicators could provide further proof of economy-wide and business specific benefits for policy makers and businesses and thereby accelerate the transition to a circular economy and contribute to the protection and improvement of the environment (Čuček et al., 2012; EMF and GRANTA, 2015; Sauvé et al., 2015).

A promising attempt is the Circular Economy Index (CEI) developed by Ruiter (2015) who identified Key Performance Indicators (KPIs) that can be used to assess the level of circularity of businesses. The CEI was officially named *Circular Economy Performance Index*, but in this research the *performance*-part is removed as it is found an already inherent part of the Index to measure performance. The CEI has three functions: 1) serve as a roadmap for businesses on what the CE entails and what to improve in order to become more circular, 2) to measure the performance of a business on the circular economy and 3) to benchmark the performance of the business against its competitors. As a result the CEI can stimulate and accelerate the transition towards a circular economy. The CEI is promising as the KPIs are based on the latest sustainability- and circular economy indexes, like the Dow Jones Sustainability

[2] Using the Financial Times classification of sectors (FT, 2016)

[3] Products that typically have a lower unit cost, are bought more often and have a much shorter service life than durable goods (EMF, 2013)

Index and Global Reporting Initiative, thereby providing an up-to-date and comprehensive Index. However, the CEI has not yet been tested and currently does not enable a fair comparison of businesses, because sector-specific differences in a circular economy transition are not incorporated in the CEI yet. This is of relevance since the activities of businesses in a circular economy may differ because of the sector in which they operate (Boulanger, 2008; Ruiter, 2015).

1.5 Aim and research questions

The aim of this research is to create a Circular Economy Index that can be used to assess the level of circularity of businesses within the consumer goods sector. This is done by performing a follow-up research on the Circular Economy Index developed by Ruiter (2015) in which the CEI is tested and improved for specifically the consumer goods sector. This leads to the following research question:

What would be a Circular Economy Index to assess the level of circularity of businesses in the consumer goods sector?

In order to answer the main research question, the following three sub questions are identified:

1) *What are the strengths and weaknesses of the development of the CEI?*

Since this research builds on previous research of Ruiter (2015), it is important to first analyze the strengths and weaknesses of the development of the CEI. After all, the quality of the outcome of this research rely partly on the quality of the original CEI. The goal of this sub question is two-fold: 1) acquire in-depth knowledge on the CEI and 2) determine what needs to be taken into account when improving the CEI.

2) *How do the KPIs perform in measuring the transition of a business towards a circular economy?*

After having obtained a first idea of the quality of the development of the CEI, the performance of the individual KPIs is tested. By doing so, focus points for improvement of the KPIs are identified which serve as input for improving the CEI.

3) *What is the opinion of businesses in the consumer goods sector on the usefulness of the KPIs for their business?*

In order create a CEI that can be used to assess the level of circularity of businesses within the consumer goods sector, the applicability of KPIs for this sector needs to be researched. This is done by asking the opinion of multiple businesses within the CGS on the usefulness of the KPIs.

1.6 Relevance

With this research a contribution is made to science as it: 1) meets the needs for academically-sound CE indicators that are currently lacking in academic literature and 2) can serve as a methodological example to other scholars who perform a similar research for another sector/area/country or CE Index. Especially considering this approach is relatively new in the academic world, since so-far no scholars are found to have included businesses and other stakeholders perspectives in the development of an index for the CE, with an exception for the Ellen MacArthur Foundation (EMF and GRANTA, 2015).

The research has societal relevance as the improved CEI by provide guidance for businesses on what to improve in order to become more circular in the largest economic sector accountable for enormous global food wastes and at the same time highly vulnerable to resource scarcity (EMF, 2013; Farmer, 2013; Gavilan & Green, 2014; KPMG, 2011). The research could also be used in policy decision making on how to stimulate businesses in their transition towards a CE (Čuček et al., 2012). By doing so, a

contribution is made to accelerate the transition of the consumer goods sector towards a circular economy which leads to a more balanced and harmonious economy, environment and society.

1.7 Scope

The scope of this research is to measure the CE performance of the largest Dutch companies within the consumer goods sector across the whole supply chain of consumer goods. Although the CEI from Ruiter (2015) was built to assess the 250 largest Dutch companies from the AEX & AMX, Water & Infra companies and others, this research does not limit to only the 250 largest companies. However, there is a fundamental difference in scope between this research and the research from Ruiter (2015). Ruiter (2015) frames CE as a concept that goes beyond sustainability, while in this research sustainability is framed as the end-goal of the process called sustainable development and CE is considered one of the most promising tools for this sustainable development (Diesendorf, 2000; Geng & Doberstein, 2008; Ghisellini et al., 2014; Sauvé et al., 2015). The most important reason for this is the absence of the social pillar in the CE concept while this is an inherent part of sustainable development, as will be explained in section 2.1.3 (Bond et al., 2001; Murray et al., 2015; Sauvé et al., 2015). This difference in scope is taken into account when improving the CEI.

1.8 Research guide

This report starts with a theoretical foundation in section 2 in which the concept of a circular economy is explained, its background, definition and critics, see section 2.1. In section 2.2 is explained how to measure circularity by providing a background in assessment, indexes and indicators, describing the Circular Economy Index developed by Ruiter (2015) and providing theory on how to validate indicators and indexes. In section 2.3 the consumer goods sector is defined together with its sub-segmentation and potential. In section 2.4 a conceptual model is presented. In section 3 the methods of this research are explained for all three sub questions through a visualisation of the research design. In section 4 the results of all three sub questions are described. In section 5 the results are discussed in order to find an answer to the main research question, together with the limitations and recommendations for Accenture and further research. Finally, the research is concluded in section 6 by providing an answer to the main research question.

2. Theoretical foundation

In this section the theoretical foundation is explained of the concepts used in this research. First, the concept of circular economy is put into perspective by explaining its background, definition and critics. Second, the measurement of CE is explained through the background of assessment, indexes and indicators and criteria for those measurements. Then the development of the Circular Economy Index is discussed and its strengths and weaknesses. Third, the consumer goods sector is defined, sub-segmented and the supply chain and potential for a CE transition are outlined. Finally, a conceptual model is presented that visualises the composition of the concepts.

2.1 Circular Economy

2.1.1 Background

The circular economy finds its origin in different schools of thought (Ghisellini et al., 2014). The environmental economists Pearce & Turner (1990) primarily introduced the concept of a CE by promoting the shift from the traditional open-ended economic system to a circular economic system, building on previous studies of ecological economist Boulding (1966) (George et al., 2015). According to these authors, the environment has three economic functions: life support system, provision of resources and sink for waste and emissions, and similar to other economic functions should have a price (Ghisellini et al., 2014). However, in reality there is neither a price nor a market for environmental goods, which is why promotors of a CE transition aim to fully internalize externalities into the prices of products and services (Ghisellini et al., 2014; Sauvé et al., 2015).

Roots of the CE concept can also be found in General Systems Theory who promotes holism, system thinking and complexity, and in Industrial Ecology (IE) who analyses the industrial system and its environment as a joint ecosystem characterized by flows of material, energy and information as well as by provision of resources and services from the biosphere (Ghisellini et al., 2014). Industrial Ecology already emphasised the benefits of minimising the use of resources and the environment as a sink through resource efficiency measures, the adoption of cleaner technologies and closed cycles of materials and energy (Andersen, 2007; Chiu & Yong, 2004; Li, 2012). Therefore IE can be used by companies to improve their performances and by policy makers for developing a roadmap to a more sustainable development (Chiu & Yong, 2004). The circular economy goes beyond IE by scaling up the analysis of industrial system operation optimization to an economy-wide system by establishing a new model of economic development, production, distribution and recovery of products (Ghisellini et al., 2014), while maintaining the analysis of benefits in terms of physical rather than economic flows (Andersen, 2007).

The circular economy can be used as a tool in reaching Sustainable Development (SD), a concept that has gained momentum since the summit of United Nations in Rio 1992 (Ghisellini et al., 2014; Hodge et al., 1999; Rennings & Wiggering, 1997). SD promotes a balanced and simultaneous consideration of the economic, environmental, technological and social aspects of an investigated economy, sector or individual industrial process as well as of the interaction among all these aspects within a set timeframe by considering the long-term effects of today's decision (EEA, 2016; Ghisellini et al., 2014; Lozano, 2008). CE contributes to reconcile those elements and promotes the justice in resource use within and among generations implicit in the definition of SD of the famous Bruntland Report *Our Common Future* (EMF, 2015; Ghisellini et al., 2014; World Commission on Environment and Development, 1987) and therefore leads to a more sustainable development and harmonious society (Geng & Doberstein, 2008; Ghisellini et al., 2014; Sauvé et al., 2015).

2.1.2 Definition

The circular economy concept is characterized, more than defined as:

An economy that is restorative and regenerative by design and aims to keep products, components and materials at their highest utility and value at all times, distinguishing between technical and biological cycles (EMF, 2015, p.5).

Within the technical cycle, the stocks of finite materials are managed by recovering and restoring technical materials. The biological cycle encompasses the flows of renewable materials by regenerating renewable nutrients from material that is not consumed (EMF, 2015). The essence of value creation for the biological cycle lies in the opportunity to extract additional value from products and materials by cascading them through other applications (EMF, 2015). As discussed in the introduction, the Ellen MacArthur Foundation (2015) has formulated a threesome principles that underlie the concept of a circular economy. Those principles relate to continuous positive development cycles who 1) preserve and enhance natural capital, 2) optimise resource yields and 3) minimise system risks by managing finite stocks and renewable flows (EMF, 2015). The CE works effectively at every level (micro, meso, macro) worldwide (EMF, 2015). A visualisation of the circular economy concept can be found in in figure 1.

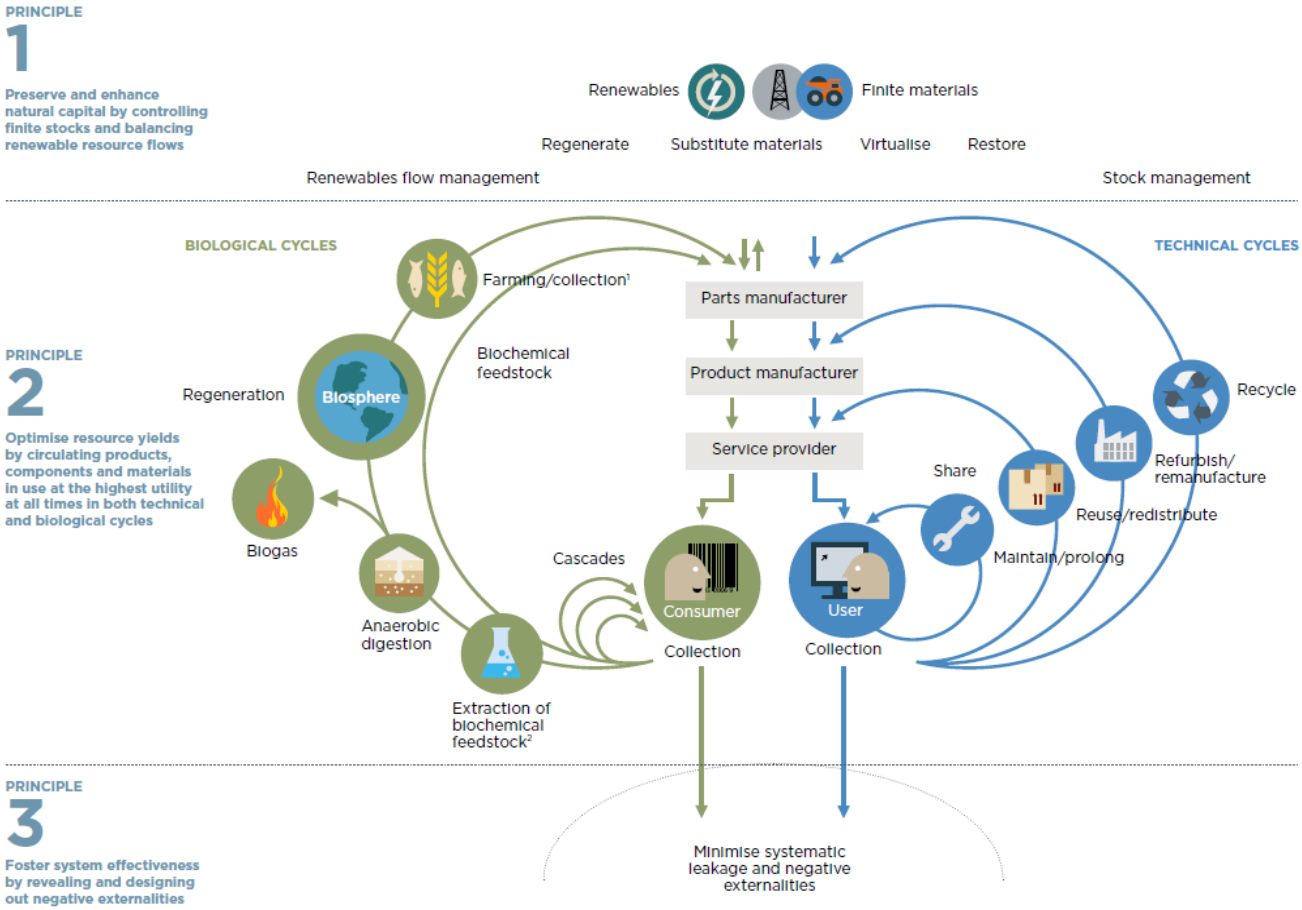

Figure 1 The circular economy (EMF, 2015)

2.1.3 Critics

Although overall scholars and practioners agree on the high potential of CE concept (EMF and GRANTA, 2015; Ghisellini et al., 2014; Lacy & Rutqvist, 2015), the concept also bears tensions and limitations.

First of all, a circular economy cannot promote recycling *in perpetuity* (Andersen, 2007). The question arises how far society should go in the recycling of materials? Although the benefits of the first and most straightforward recycling options provide evident benefits, at some point there will be a cut-off point where recycling will become too difficult and burdensome for net benefits (Andersen, 2007). Additionally, only a limited range of circular options will make sense from the perspective of company managers since prices of materials and natural resources will be too low as the cost mainly reflect mining and short-term values instead of the depletion or environmental costs (Andersen, 2007). Sceptics argue that if companies are rational and profit-seeking, the recycling and reuse options should already have been realised (Andersen, 2007).

Furthermore, critics arise regarding the scope of CE, since the concept remains narrower than sustainable development (Sauvé et al., 2015). Reason is that the CE puts the environmental sustainability forward, acknowledges the need for a favourable economic context, but does not specifically mention the social dimension that is inherent to SD (Murray et al., 2015; Sauvé et al., 2015). The social dimension entails equity, social mobility, social cohesion, participation, empowerment cultural identity and institutional development, and is equally important to the other pillars of SD (Meadows, 1998). This social dimension is only indirectly present through the importance of including all stakeholder groups and educating them in order to have a successful implementation, as mentioned earlier, but currently cannot be found in the definition of a circular economy (EEA, 2016; EMF, 2015).

2.2 Measuring the immeasurable

Since the circular economy can be placed under the umbrella of sustainable development (A+, 2014; Ghisellini et al., 2014; Sauvé et al., 2015), both concepts ask for a similar approach when measuring and assessing their transition. Therefore, when explaining the background of assessments, indexes and indicators required to understand and fulfill the purpose of this research, mainly theory on sustainable development is used.

2.2.1 Assessment, indexes and indicators

Sustainable development is a difficult concept to assess and measure, due to its holistic and multi-dimensional nature with associated uncertainties and risks (Caeiro et al., 2012). It is no coincidence scholars often refer to *measuring the immeasurable* (Bell & Morse, 2008; Böhringer & Jochem, 2007). SD Assessment, in which progress towards sustainable development is monitored, requires in the first place an identification of indicators that provide manageable units of information of economic, environmental and social conditions (Böhringer & Jochem, 2007). The central role of SD indicators has already been emphasized in the famous Agenda 21 by the United Nations Conference on Environment and Development, held in Rio de Janeiro in 1992, who called for the development and identification of SD indicators in order to improve the information basis for decision making at all levels (Boulanger, 2008; UNCED, 1992). An *indicator* summarizes, focuses and structures the enormous complexity of our dynamic environment, which is particularly relevant to a CE and SD, to a manageable amount of meaningful information (Singh et al., 2012) and can be both quantitative and qualitative (Meadows, 1998). Indicators are an important part of the stream of information we use to understand the world, make decisions and plan our actions (Meadows, 1998). An *index* is a comparison of a quantity to scientific or arbitrary standards and is often based on multiple indicators (Alberti & Parker, 1991; Boulanger, 2008). This reference point makes both indicators and indexes useful for benchmarking by making comparison possible (Waas et al., 2014).

Currently, multiple SD indicators and SD indexes have been developed, although the variety of SD indicators poses a huge problem for policy practice who demand an aggregate index that can be unambiguously interpreted and easily communicated to the general public (Böhringer & Jochem, 2007;

Hák et al., 2016). Examples of the currently most-well known SD indexes are the Dow Jones Sustainability Index (DJSI), Ecological Footprint (EF), Global Reporting Initiative (GRI) and Carbon Disclosure Project (CDP) (Böhringer & Jochem, 2007; Ruiter, 2015). SD Indicators are being used to collect, process, and use information with the following objectives: 1) to help decision-makers to make a better decision, 2) to guide smarter policy choices, 3) to measure progress and 4) to monitor feedback mechanisms (Caeiro et al., 2012). In practice, SD indicators are often of varied quality in terms of the fulfilment certain criteria (Hák et al., 2016). In fact, some indexes even fail to fulfil fundamental scientific requirements making them rather useless if not misleading with respect to policy advice (Böhringer & Jochem, 2007). Although SD indicators have a wide range of purposes, the selection and evaluation of SD indicators is hardly a fine art. One of the major critics is that they attempt to encapsulate complex and diverse processes in relatively few simple measures with the risk of oversimplification (Bell & Morse, 2008). Another critical note is the common perception that scientists, policy-makers and business are obsessed with quantification while this has its limitations, especially when measuring human experience (Bell & Morse, 2008). Therefore it is important to keep in mind the limitations of indicators/indexes in their attempt to represent reality and the boundaries of quantification when selecting and evaluating indicators.

The process of using indexes and indicators is often referred to as Sustainability Assessment, although often as synonym for SD Assessment (Bebbington et al., 2007; Böhringer & Jochem, 2007; Huang et al., 2012; Waas et al., 2014). In this thesis, the terms are used interchangeably, although kept in mind the difference as described by Diesendorf (2000) who considers *sustainability* the end goal of the process called *sustainable development*. In sustainable development, both Sustainability Assessment and Sustainability Indicators can be a decision-supporting tool (Waas et al., 2014). Also Sustainability indexes play a role, since they can provide a one-dimensional metric to evaluate e.g. country-specific information on the three dimensions of SD: economic, environmental and social conditions (Böhringer & Jochem, 2007).

Currently, many scholars already focus on creating indicators and indexes specifically for the circular economy, as the importance of those tools is increasingly being recognized (A+, 2014; Li, 2012). For example, indicators for resource efficiency, an important part of CE, forms a central pillar of Europe Union's 2020 growth strategy for the coming decade towards a *smart, sustainable and inclusive economy* (EC, 2013b). However, the discussion about which parameters should be measured and how is ongoing, since it is difficult to reflect the association of various sectors with production and consumption, resulting in a lack of evaluation of main features of material recycling between different businesses, and it is difficult to directly analyse the environmental and economic benefits because of the circular loops (A+, 2014). Many performance indicators for regions and industrial pars have been developed based on multiple well-known assessment methods: energy, CO2 emissions, (Geng et al., 2013), evaluation model of system dynamics (Li, 2012), material flow analysis (Huang et al., 2012), life-cycle assessment (A+, 2014), and resource-efficient indicators (Behrens et al., 2015). A related method that show how the parts of a system are affected by a change in one part of that system, is an input-output analysis, developed by the 20th century economist W.W. Leontief (Li, 2012). However, in spite of their usefulness, these indicators may not be optimal for CE assessments, because they were not originally designed for systemic, closed-loop, feedback features that characterize CE, the key issue that scholars still hope to resolve, and often do not consider the environmental problems caused by economic activities (Geng et al., 2013; Li, 2012).

2.2.2 The Circular Economy Index

As foregoing shows, scholars and practioners still have great difficulty finding suitable indicators that measure CE and, in particular, how far a business is in making the transition from a linear to a circular

mode of operation (Boulanger, 2008; EMF and GRANTA, 2015; Li, 2012; Su et al., 2013). However, Ruiter (2015) did a recent attempt to fill this gap by developing the Circular Economy Index. This index shows the current level of circularity of businesses and can be used for benchmarking, whereby businesses are compared on their performance 25 Circular Economy KPIs.

Ruiter (2015) developed the index in three methodological steps. First step was to gather information on CE using scientific research papers and reports, forums, cooperatives and events of businesses and research institutes like the Ellen MacArthur Foundation, Circle Economy, Accenture and TNO. In this step Ruiter (2015) created a circular value framework based on the sustainable value framework (Hart & Milstein, 2003) and green supply chain management (Zhu & Sarkis, 2004). The second step was to analyse multiple sustainability and CE indexes like the Dow Jones Sustainability Index, Carbon Disclosure Project, Global Reporting Initiative, Climate Counts and Morgan Stanley Capital Project. Those indexes were chosen because they give the broadest view on sustainability initiatives within businesses and therefore might already point out circularity measures useful to develop the Index. Ruiter (2015) obtained insights into the index landscape by reviewing those indexes together with all index questions and documentations of companies assessed by these indexes. Additionally, Ruiter (2015) consulted experts like the VBDO (Vereniging van Beleggers voor Duurzame Ontwikkeling) and circular economy on their vision on specifically Circularity Indexes. By doing so, she identified profound issues with the creation of indexes in order to avoid making similar mistakes. For example, Ruiter (2015) found that indexes often use “all or nothing” methodologies which may bias index scores. This refers to 1) indexes who lack a distinction between companies who are very sustainable and companies who are just below the preferred benchmark and 2) how indexes often request detailed information and score a company negatively when this detailed information is not available. In the third step Ruiter (2015) developed the CEI by combining all knowledge obtained in the previous steps with interviews she held with employees from multiple businesses during events and seminars. Those interviews concerned the businesses’ awareness on CE and the current status of CE within those businesses. By doing so, Ruiter (2015) obtained insights of the current data that is available for the index questionnaire, the level of knowledge about CE within the businesses, the most important aspects of CE from their perspective and how and why businesses would want to participate in the Index. Based on all this knowledge and the the circular value framework she developed the 25 KPIs which would provide the measurements to obtain an Circular Economy Index score. Ruiter (2015) made sure the index covered all activities and categories concerning circular business within three pillars: *circular strategy*, *circular servicing* and *circular enablement*, which she identified to be the major subjects that are used in other indexes to determine a company’s score.

The 25 KPIs touch upon the *circular strategy* of a business, whether they recognize the CE trend and know what the CE means for their business. Besides, it looks at the extent to which businesses see the circular economy as future business by focussing on actual measurable targets towards the future, like cooperation with partners and the creation of awareness among employees about the CE. The KPIs consider *circular servicing* of businesses by measuring the composition of products, the environmental impact during their lifecycle and whether products are taking back from the consumers. Finally, the *circular enablement* of businesses are measured by looking at circular supply chain management. This includes resource management by considering the amount of products that can be recycled and the use of renewable energy, combined with operations- and process management by measuring the modes of waste reduction and transportation. Besides insights on business level, the outcomes of Ruiter's (2015) study present the degree to which the circularity economy is already imbedded on sector and national level, even though the Index Ruiter (2015) developed does not specify yet on one specific sector.

The Index Ruiter (2015) has developed is purely based on circular economy activities regarding products, processes and future strategy and does not include activities linked to the social dimension of sustainability. The 25 KPIs can be found in Appendix A. Hereby, the shade of blue corresponds to the four performance categories going from 1) doing nothing or little on sustainability, 2) operating sustainable, 3) operating somewhat circular to 4) completely circular. Hereby *nothing* and *completely* are extreme terms, therefore many KPIs are distinguished by percentages, namely <25%, 25-50%, 50-75% and >75% circular (Ruiter, 2015). As Appendix A will show, the higher the percentage, the darker the shade of blue, the higher the level of circularity.

Ruiter (2015) divided the 25 KPIs into three importance categories, in order to have more accurate performance scores. The categories are based on importance of implementation, the impact a KPI has on the environment and on individual business performance. The three KPI categories are: High Impact (red), Medium Impact (orange) and Low Impact (green), who can be found in table 1. The High Impact relate to the KPIs that focus on basic components businesses have to implement in order to start working circular and whether there is a high value potential for both business and environment. The Medium Impact KPIs support execution of the High Importance KPIs or have a smaller impact on the environment. The Low Impact KPIs have minor impact on the actual circular performance of companies as they only form a small part of all operations or do not directly improve the environment within company reach (Ruiter, 2015).

Table 1 The 25 KPIs with corresponding importance categories

KPIs	Description
KPI 1	We are involved in the circular economy trend
KPI 2	We know what the Circular economy means for our company
KPI 3	The circular economy is part of our future targets
KPI 4	We measure the outcomes of our circular economy practices on a regular basis
KPI 5	Awareness on the circular economy is created among employees
KPI 6	We cooperate on the topic circular economy
KPI 7	Products contain recycled materials or recovered components
KPI 8	Products are designed to minimize waste over their lifetime
KPI 9	The amount of products that are recycled or upcycled
KPI 10	Products can be resold
KPI 11	Sharing of products by consumers is facilitated
KPI 12	Products can be leased by consumers
KPI 13	It is ensured that products are returned after their usage
KPI 14	Products are sold using circular packaging and documentation
KPI 15	The circular economy principle is applied to daily operations
KPI 16	There are selection criteria for suppliers & industrial buyers
KPI 17	The consumed electrical energy is renewable
KPI 18	The consumed electrical energy comes from reliable production sources
KPI 19	The extent to which technical input comes from pre-used materials
KPI 20	The biological material input stream is sustainable
KPI 21	The extent to which oil-based inputs are replaced by bio-based inputs
KPI 22	Involvement in ecosystem recovery
KPI 23	Waste is minimized or eliminated
KPI 24	Mode of waste reduction
KPI 25	Modes of transport are electric or on biofuels

Ruiter (2015) based the four importance categories on the sustainability value framework from Hart & Milstein (2003) and qualitative interviews with 10 companies. The main lesson learned from those

interviews, was that nine of ten interviewees would like standards on the circular economy for businesses, which was an important incentive for Ruiter (2015) to base the CEI on Key Performance Indicators that serve as a standard for circular development of businesses. Additionally, was found that businesses find innovating technical processes the most important aspect of the circular economy and secondly companies having a circular economy strategy, who Ruiter (2015) both included in the KPIs.

The 25 KPIs can be translated into an index score on which businesses can be benchmarked with use of the scoring overview in table 2.

Table 2 Scoring overview

Weight	# of KPIs	Score per category				Score incl. weighting				Scores per KPI category			
		1	2	3	4	Min			Max	Min			Max
3 (High)	10	-1	0	1	2	-3	0	3	6	-30	0	30	60
2 (Med)	12	-1	0	1	2	-2	0	2	4	-24	0	24	48
1 (Low)	3	-1	0	1	2	-1	0	1	2	-3	0	3	6
Totals										**-57**	**0**	**57**	**114**

The weighting of the KPIs is dependent on the importance of the KPIs. The KPIs with a High Impact KPIs have a weighting of 3, the Medium Impact have a weighting of 2 and the Low Impact have a weighting of 1. This is shown in the first column of table 2 together with the amount of KPIs with this importance in the second column. The four categories of the KPIs can be found in the third, fourth and fifth column of table 2 with corresponding weighting for all three importance categories. The fifth column shows the total scores that can be obtained, for all three KPI categories and combined. As table 2 shows, companies who are ranked in the Circular Economy Index have a range between -57 (not sustainable) and 114 (fully circular). To normalize the scores of the companies, the final score need to be divided by 1.14 in order to obtain the index score. By doing so, the company obtaining 114 credits will have a final index score of 100, which allows for an easier comparison with other businesses and a determinant of how circular a business is in percentages.

In order to rank companies within the Index on their circularity performance, Ruiter's (2015) created a Circular Performance Ladder based on the Sustainability Performance Ladder from Senge et al. (2008). Companies are positioned on this ladder based on their index score. The ladder serves as a tool to quickly observe to what extent the company has made the transition towards a circular economy. The Circular Performance Ladder has five steps and can be found in figure 2.

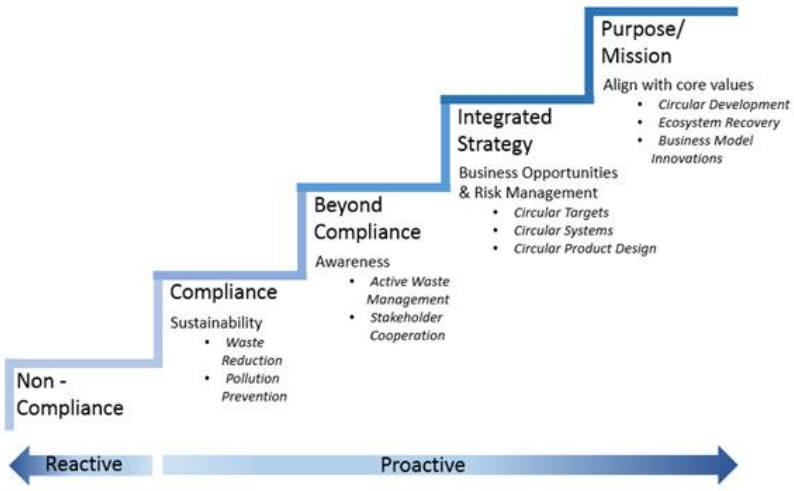

Figure 2 The Circular Performance Ladder (Ruiter, 2015)

The first step *non-compliance* concerns companies who do nothing on the field of sustainability and correspond to the negative companies scores. The second step *compliance* companies focus on sustainability but not on circularity. They have waste reduction and pollution prevention policies and a pro-active mind-set but do nothing on the circular economy. Third step *beyond compliance* are companies who are aware of the circular economy trend and act accordingly. They have active waste management systems, are looking at opportunities for reduction and extraction value from direct waste and waste further in the supply chain. Fourth, *integrated strategy* companies have a full overview of the opportunities the circular economy can bring and develop their business accordingly by setting circular targets and designing circular products. The fifth step are companies who have circularity as their *purpose* and *mission* also participate in activities outside of their usual business like ecosystem restoration programs or have innovated their traditional business models to a full extent. Table 3 shows the companies score related to the five steps on the ladder.

Table 3 Performance ladder steps and index scores

Step	Non-Compliance	Compliance	Beyond Compliance	Integrated Strategy	Purpose/Mission
Credits	-50 - 0	1-25	26-50	51-75	76-100

2.2.3 Validation of indicators and indexes

Since finding suitable indicators for CE measurement is a difficult process (Boulanger, 2008; EMF and GRANTA, 2015; Geng et al., 2013; Li, 2012; Su et al., 2013) and indicators and indexes for SD are often of a varied quality (Bell & Morse, 2008; Böhringer & Jochem, 2007; Hák et al., 2016), it is important to be critical towards proposed CE indicators and indexes. When verifying the suitability of the new developed indicators and indexes, the methodology of indicator validation by Cloquell-Ballester et al. (2006) can be of use.

This methodology is specifically designed for environmental and social impact assessment and validates new developed indicators and indexes in three complementary approaches: 1) self-validation, 2) scientific validation and 3) social validation (Cloquell-Ballester et al., 2006). The *self-validation* must be carried out by the research team itself, with the goal of a) avoiding conceptual inconsistencies as well as operational mistakes by favouring an internal reflection on the correct performance of new designed indicators and b) to assure a correct interpretation of the indicators by both the public and stakeholders through correct documentation of the developed indicators (Cloquell-Ballester et al., 2006). The *scientific validation* provides rigour and objectivity to the new designed indicators by integrating the judgements of independent scientific experts. The *social validation* can be used as a decisive tool to reach consensus in the environmental and social impact assessment processes and helps to maintain transparency levels as high as possible (Cloquell-Ballester et al., 2006).

In a validation process criteria for indicator selection are used to assess the correct performance of new developed indicators and indexes. According to Cloquell-Ballester et al. (2006) criteria have to be used from three fundamental perspectives: conceptual coherence, operational coherence and utility. *Conceptual coherence* determines the correct relation between the measuring instrument (indicator) and the measuring object (environmental/social quality). *Operational coherence* determines the correct definition of the internal operations of the measuring instrument (indicator). Last, *utility* determines the applicability of the indicators in environmental and social assessment studies (Cloquell-Ballester et al., 2006). For all three perspectives Cloquell-Ballester et al. (2006) proposed a list of criteria that can be used for the selection and validation of indicators and indexes.

However, since these criteria are not specifically designed for validating CE indicators and it seems there currently does not exist a list of such criteria academic literature, criteria are used for SD indicators. Because SD is the concept most in accordance with CE, and those criteria are in fact widely discussed in academic literature (Bell & Morse, 2008; Böhringer & Jochem, 2007; Dizdaroglu, 2015; EC, 2013b; Hák et al., 2016; Harger & Meyer, 1996; Waas et al., 2014). Criteria from Böhringer & Jochem (2007) are useful as their purpose is to evaluate sustainable development indexes, which links closely with the aim of this research, and because the authors propose a thorough list of key requirements including weighting of underlying variables. Harger & Meyer (1996) proposed a list of as they call it – *environmentally sound Sustainable Development Indicators* – which can be useful as their focus is on the environmental pillar of SD which is also the main focus of CE. The European Commission (2013b) focussed on indicators for resource efficiency in order to achieve a smart, sustainable and inclusive economy, which links to the second principle of the CE as explained in section 2.1.2 (Andersen, 2007; EMF, 2014; Tukker, 2015). A combination of these literature can be used to build a CE indicator validation model.

2.3 Consumer Goods Sector

As the CEI is modified for specifically the consumer goods sector, a thorough understanding of the CGS is required, its scope, definition, sub-segmentation and potential for CE implementation.

2.3.1 Holistic view

In general, a *sector* is an area of the economy in which businesses share the same or a related product or service (Investopedia, 2016b). Companies within the same sector tend to have relatively high correlations in their rate of revenue and earnings growth, stock price performance and earnings forecasts, especially over short- and medium term time periods (Investopedia, 2016a). Dividing an economy into different areas allows for more in-depth analysis of the economy as a whole. There are multiple sector designations possible dependent on the criteria used (Investopedia, 2016a; Reuters, 2016). The Financial Times identified the following sectors with according market share based on market capture in USD (figure 3) and the number of companies per sector (figure 4) (FT, 2016).

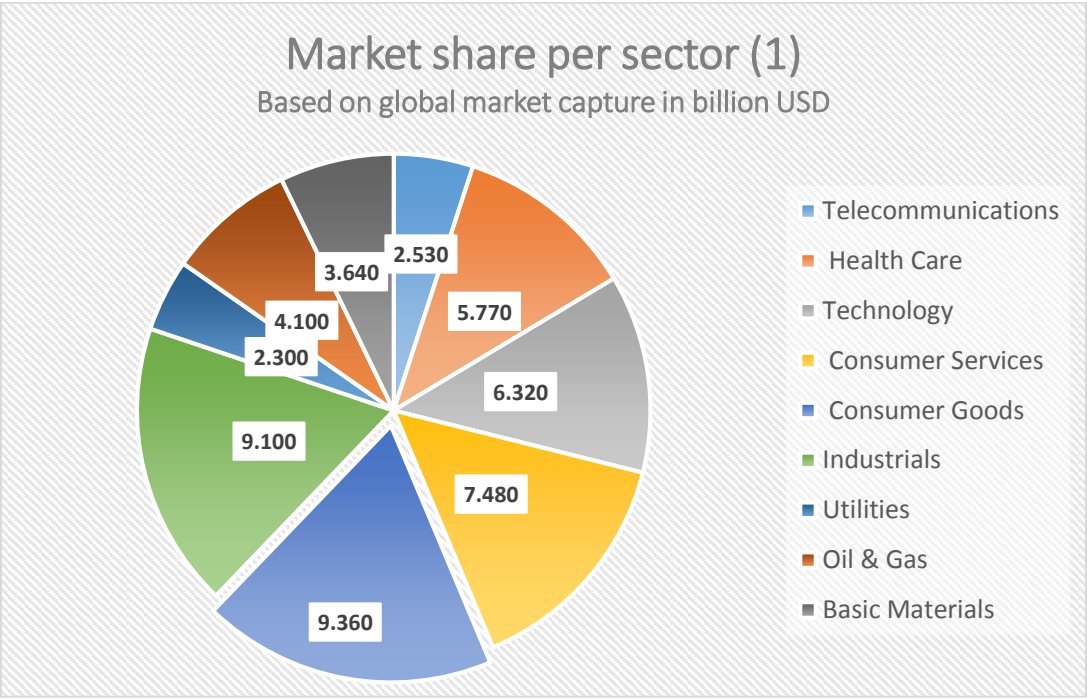

Figure 3 Market share per sector (1) derived from FT (2016)

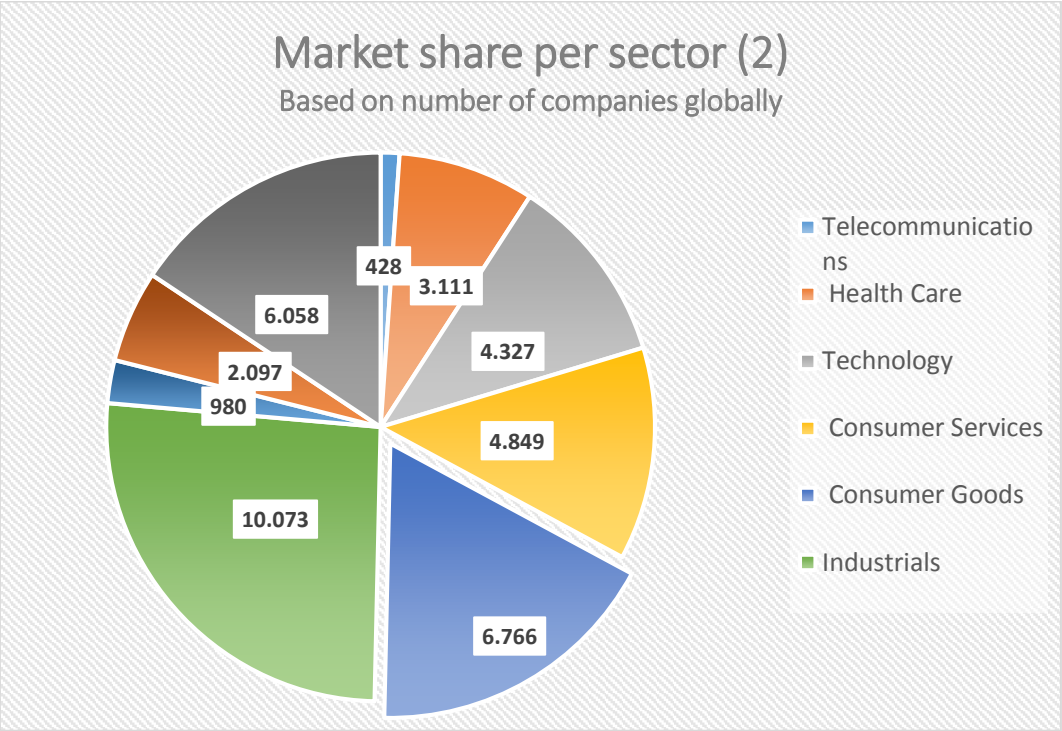

Figure 4 Market share per sector (2) derived from FT (2016)

As both figure 3 and 4 show, the consumer goods sector accounts for a relatively large share of the market (FT, 2016). Based on market capture in billion USD, Consumer Goods represents the largest sector (see figure 3) and the second largest, when using number of companies as basis (see figure 4). Currently, within all sectors companies are dealing with global issues like international competitive pressure, scarcity and long-term rising prices of resources, energy and landfill space, a growing consumption, increasing population and enormous costs in the public domain due to restoration of ecosystems (EMF, 2015; Fröhling et al., 2013; Joustra et al., 2013; Vezzoli et al., 2015). Although those problems are global, the relative large share of the consumer goods sector in the market highlights again its crucial position in finding a solution by transitioning towards a CE.

2.3.2 Sub-segmentation

The consumer goods sector can be further sub-segmented into different industries, see figure 5. The terms *sector* and *industry* are often used interchangeably, although they do have slightly different meaning regarding their scope. A *sector* refers to a large segment of the economy which describes a general economic activity, while the term *industry* describes a much more specific group of companies with similar business activities (Langager, 2016). In an attempt to specify the consumer goods sector, sources from both the world of academia and business show a large variety in possible definitions, explanations and sub-segmentations (Hausman, 2011; Shapito & Bonoma, 2016). However, recurring in all definitions is that items are purchased always by individuals rather than manufacturers or industries (EC, 2013a; Investopedia, 2016b; Ycharts, 2016). This research uses the sub-segmentation from the Financial Times, because the by then defined industries within the CGS almost perfectly match the definition from the European Commission (EC, 2013a). The different industries identified by the Financial Times (2016) can be found in figure 5, together their corresponding market share within the consumer goods sector. As the figure shows, from those 19 industries Food and Beverages represent the largest share (FT, 2016).

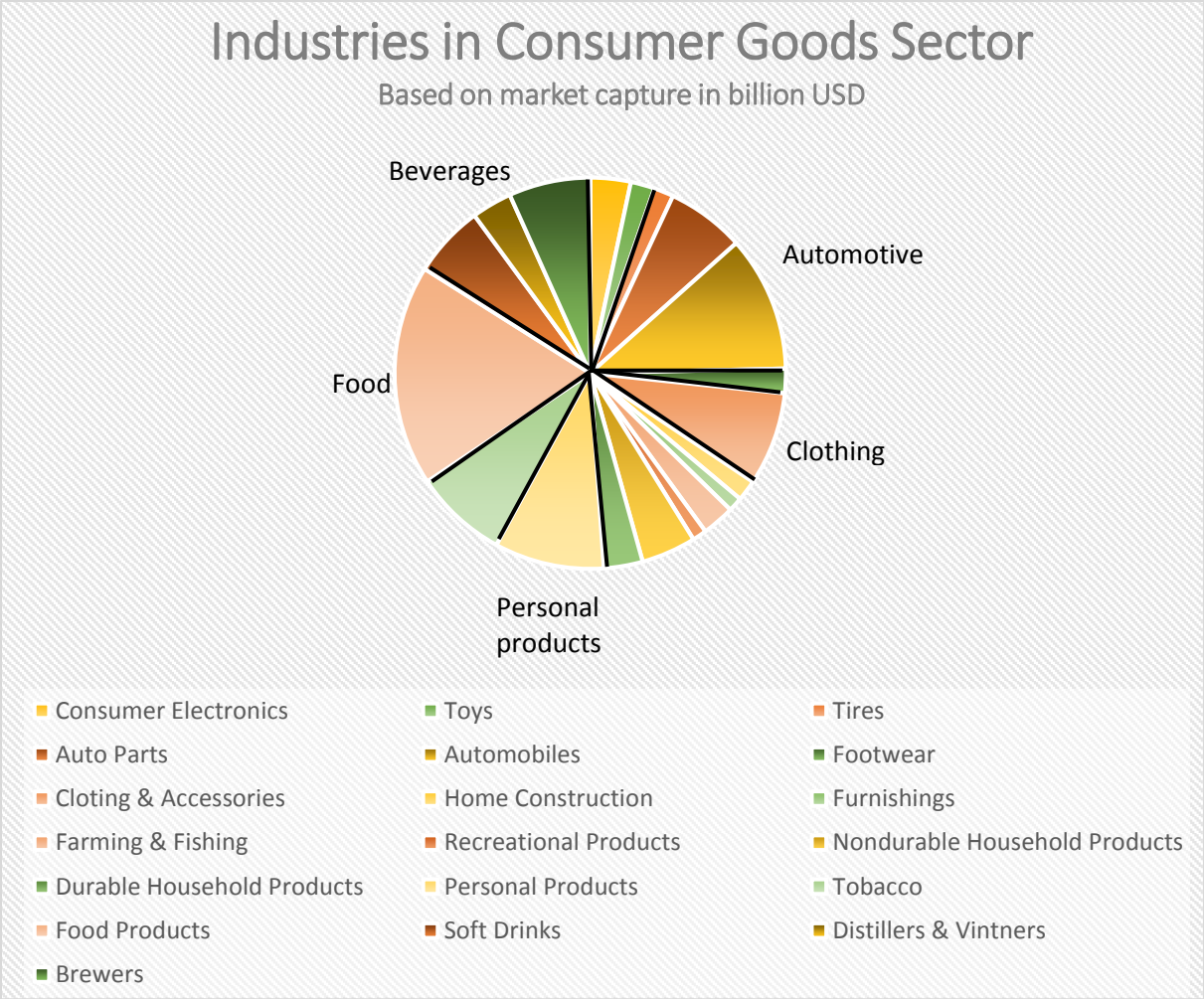

Figure 5 Industries within the Consumer Goods Sector - derived from FT (2016)

Beside this sub-segmentation, there are three often-used classifications which do not dependent on the industry a company operates in. Those are *durable* and *non-durable goods* (Investing Answers, 2016), *fast-moving consumer goods* (FMCG) *and slow-moving consumer goods* (SMCG) (Statista, 2016) and *consumables* and *usables*. Durable and non-durable goods differ in how long the product last, although the dividing line is not always rigid (Bogert et al., 2006). Durable goods are made to last at least three years, e.g. furnishing and automobiles, while non-durable goods shorter have useful lives of less than three years, e.g. food, beverages and clothing (Bogert et al., 2006). The definitions of FMCG and SMCG are based on how fast products are sold to the customer. The FMCG are bought relatively frequently, maximum once a year, with periotic expenditure while SMCG are bought less often (Statista, 2016). Although the latter implies those two types of classification are interchangeably, in practice it is possible to have fast-moving durable goods (Bogert et al., 2006). This is an interesting phenomena that can mostly be found in the world of electronic and fashion, where the use of the product is highly related to the availability of a newer product and fashion trends (Bogert et al., 2006). The definitions of *consumables* and *usables* is based on whether a business sells products which can be consumed (e.g. food, shampoo) or used (e.g. automobiles, clothing). Classification by the type of goods companies offer can be of help when defining company practice and comparing different companies.

2.3.3 Supply Chain

Within the consumer goods sector every good has a supply chain: from the extraction of raw materials to direct sales to the consumer through retail, see figure 6 for a linear example. Although currently many supply chains are still linear, circular and *closed-loop supply chains* in which growth is decoupled from the use of virgin resources, are getting more popular (Circle Economy, 2015; EMF, 2015; Sauvé et al., 2015; WEF et al., 2014), as explained in section 2.1. The management of *closed-loop supply chains* can be defined as *the design, control and operations of a system to maximize value creation over the entire life cycle of a product with dynamic recovery of value from different types and volumes of return over time* (Guide & Van Wassenhove, 2009, p. 10).

Figure 6 The linear supply chain

Companies can be operating in one or multiple parts of the supply chain. This means that although the end-user of the products is an individual, the direct customer could be another company. Nevertheless, the performance in the CGS depends heavily on consumer behaviour of the individual (Investopedia, 2016b).

2.3.4 Potential

The latter shows that the Consumer Goods Sector comprises many different industries, types of goods and represent a significant part of the global market throughout the whole supply chain. This size comes with certain responsibilities, especially when considering that the CGS absorbs more than 90% of our agricultural output – possibly our most embattled resource in the future- and is responsible for large waste streams through packaging and food losses (EMF, 2013; Farmer, 2013; Gavilan & Green, 2014; KPMG, 2011). Promising alternatives who tackle those problems are gaining ground in the form of modern circular and regenerative forms of consumption (EMF, 2013). Today powerful examples their economic viability can be found from anaerobic digestion of household waste to the recovery of clothing after usage (EMF, 2013). The Ellen MacArthur foundation (2013) estimated the full potential of the CE to be as much as 700 billion USD in global Consumer Goods material savings alone. Their product- and country-level analysis covered examples in product categories that represent 80% of the total consumer goods market by value, namely food, beverages, clothing and their packaging, a large share of the CGS as shown in figure 5 (EMF, 2013). Considering the current market capture of the CGS is 9.360 billion USD (see figure 3), the potential of material savings is at least 7,5% of the total value of the CGS in the global market. Over time the market is likely to systematically reward companies who are transforming through circular business practices and hence dramatically lower resource requirements by implementing new technologies (EMF, 2013).

However, while the benefits of reuse of durables have already been widely demonstrated, for non-durable consumer goods like food, beverages, clothing and their packaging the benefits of a circular economy are more complex in origin and harder to asses because those goods are often transformed during use (EMF, 2013). The challenge is to benefit market opportunities in the resell of waste as by-product, processing waste in a circular way through the generation of biogas and returning nutrients, re-use and recovery of end-of-life clothing, cascading materials in other industries, clothing lease business models, increase packaging circulation and use of biodegradable packaging (EMF, 2013).

2.4 Conceptual model

A composition of the main concepts used in this research can be found in the conceptual model in figure 7. As the figure shows, the Circular Economy Index was built in the research by Ruiter (2015) and uses 25 Key Performance Indicators to measure the performance of businesses on the circular economy. In this research focus is on the consumer goods sector who represent a large share of the global market and is currently in transition from a linear to a circular mode of operation. The 25 KPIs can be used to obtain an index score of multiple businesses within the CGS which can together form a Circular Economy Index for the CGS.

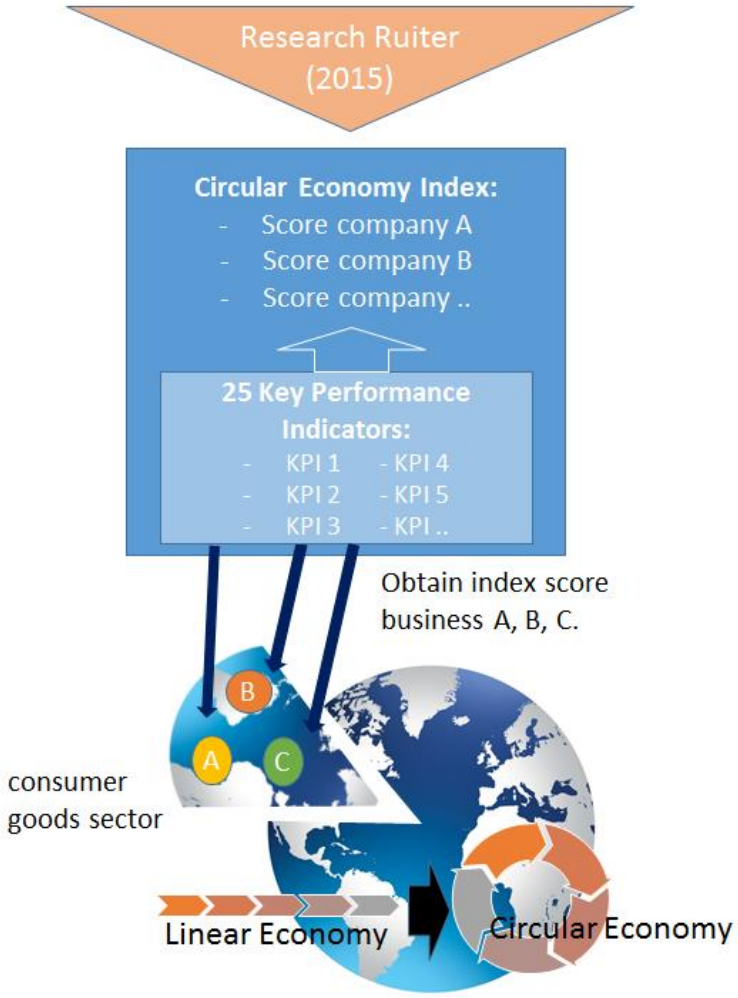

Figure 7 Conceptual model

3. Methods

In this section, the methods used to execute the research are explained, starting with an explanation of the different phases of the research.

3.1 Phases in research

The testing and improving the CEI is broken down into four research phases, see the research design in figure 8. In the first research phase a CE indicator validation model was built, see section 3.2. In the second phase the strengths and weaknesses of the development of the CEI were identified, see section 3.3. In the third phase, the performance of the KPIs was tested, see section 3.4. In the fourth phase the usefulness of the KPIs for the CGS was tested, see section 3.5. The second, third and fourth research phase were performed in parallel.

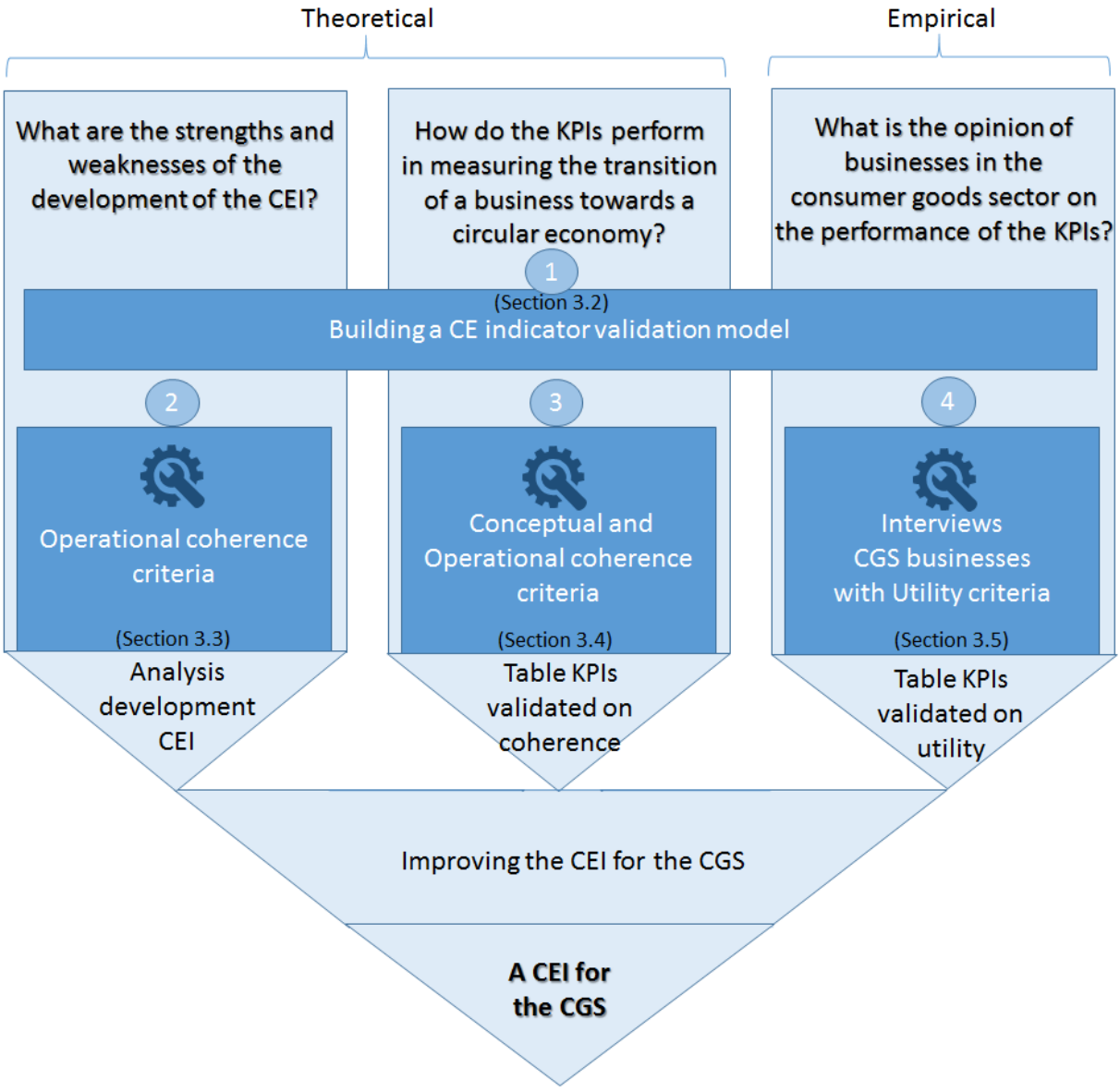

Figure 8 Research design

3.2 Phase 1: Building the CE indicator validation model

In the first research phase a CE indicator validation model was built in order to have a theoretically-founded tool to answer the three sub questions. This was done by using the theory from Cloquell-Ballester et al. (2006) as a foundation, because their three perspectives enable a categorization of criteria, and complementing this theory with criteria for SD indicator selection derived from Böhringer & Jochem (2007), Harger & Meyer (1996) and the European Commission (EC, 2013b), see section 2.2.3. The CE indicator validation model was built in three complementary steps. In the first step, one list was created from all criteria for SD indicator selection. In the second step, all criteria were categorized in a table according to the three perspectives from Cloquell-Ballester et al. (2006), see Appendix B. Third step was to translate the categorized criteria for SD indicator selection to criteria for CE indicator selection and built the CE indicator validation model accordingly. Result is the CE indicator validation model in Appendix C and the explanation of criteria for CE indicator selection in table 4. The different colours in table 4 represent the references of all four authors: Cloquell-Ballester et al. (2006) is blue, Böhringer & Jochem (2007) is green, Harger & Meyer (1996) is orange and the European Commission (EC, 2013b) is represented by yellow.

Table 4 Explanation CE indicator validation model

Conceptual coherence: relation indicator – circular economy		
Definition	The indicator connects to the definition of circular economy	
Relevance	The indicator covers all relevant categories and resources of the circular economy, but overlap amongst indicators is as small as possible.	
Interpretation	The interpretation and meaning of the indicator is suitable	
Operational coherence: correct definition of the internal operations of the indicator		
Formulation	The formulation of the indicator is as simple as possible	
Data	The data used to develop the indicator is suitable.	
Measuring method - Procedure	The proposed measurement procedures to obtain the indicator is suitable.	
- Transparency	The indicator should be sufficiently transparent in composition in order to be relevant for policy makers, allowing for its reproduction and comparison.	
Accuracy - Quantification	The indicator uses quantification where possible.	
- Sensitivity & timeline	The indicator is sensitive for later changes in implementation of the CE by including a timeline for production of the data and calculation of the indicator.	
- Comparability	The indicator enables a fair comparison through normalization or/and weighting.	

Utility: applicability of the indicators

Reliability	
- Indicator	The reliability of the indicator is suitable.
- Sources	The reliability of the data to determine the indicator score is suitable.
Data Availability	The data required to determine the indicator score is available.
Indicator Applicability	The indicator is applicable at the addressed level of economic activity (EU, countries, sectors, firms, products).
Information	
- Security	The information provided by the indicators is reliable
- Costs	The costs of the information offered by the indicators can be considered acceptable.

The CE indicator validation model (Appendix C) and explanation of criteria (table 4) can be used to validate and improve CE indicators and indexes. The three perspectives (conceptual coherence, operational coherence and utility) guide the researcher in their choice for the right criteria at the required level. In this research, for every sub question multiple criteria are used from the CE indicator validation model. Figure 9 shows which criteria are used for which sub question by linking the CE indicator validation model to the conceptual model from figure 7. As shown, criteria from the operational coherence perspective are used to research the development of the CEI in sub question 1. Criteria from both the conceptual coherence and operational coherence perspective are used to test the performance of the KPIs in sub question 2. In sub question 3 the usefulness of the KPIs for the CGS is researched with use of criteria from the utility perspective.

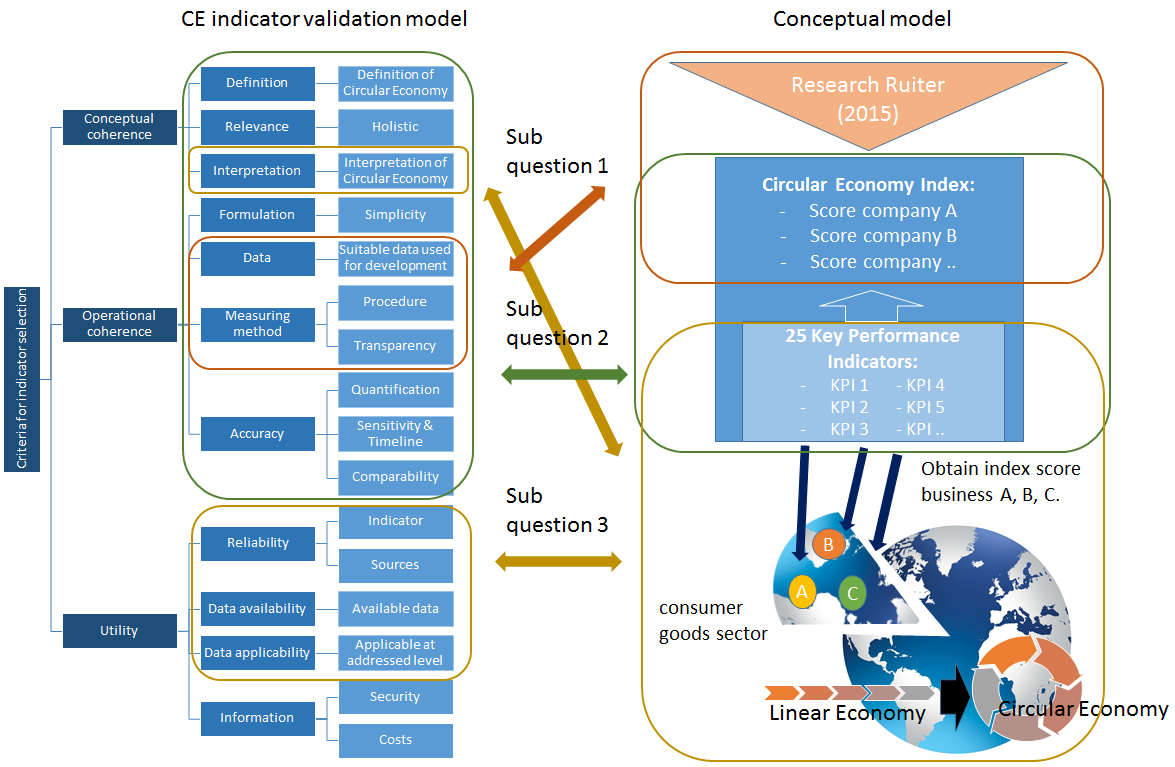

Figure 9 Link CE indicator validation model to conceptual model

For every indicator can be determined whether the indicator meets the criteria and can therefore be considered *valid* or that the indicator does not meet the criteria and can therefore be considered *not valid.* Note that the *information* criteria will not be used for the CEI, reason for that is that the CEI will be a free Index applied by a company who is used to deal with confidential information.

3.3 Phase 2: Development CEI

The second phase in the research is a desktop research in which the strengths and weaknesses of the development of the CEI are identified with use of the *data, procedure* and *transparency* criteria from the CE indicator validation model. This is a scientific validation approach as described by Cloquell-Ballester et al. (2006) in section 2.2.3. Result of this research phase is a table with the strengths and weaknesses of the development of the CEI for all three criteria.

3.4 Phase 3: Performance of KPIs

In the third research phase, the performance of the KPIs in measuring the transition of a business towards a circular economy was tested. This was done using the conceptual and operational coherence perspective of the CE indicator validation model. The criteria used on conceptual coherence are *definition* and *relevance* and on operational coherence are *formulation, quantification, sensitivity & timeline* and *comparability.* The criteria *definition, relevance, formulation* and *quantification* were used to validate every KPI separately. The criteria *sensitivity & timeline* and *comparability* were used to validate the CEI as a whole. For example, whether a KPI connects to the definition of CE needs to be determined for every KPI while whether the *comparability* is suitable need to be determined for the CEI as a whole. For the validation of all KPIs separately, the result is a table with the 25 KPIs validated on the 4 criteria.

3.5 Phase 4: Opinion of businesses

In the fourth phase, the usefulness of the KPIs empirically is researched by asking the opinion of businesses in the consumer goods sector, following the social-validation approach as described by Cloquell-Ballester et al. (2006), see section 2.2.3.

3.5.1 Case selection

From the CGS, seven businesses were selected for the sake of generalisability and in order to have enough comparative data to draw conclusions on the performance of the KPIs (Yin, 2004). The seven businesses were selected based on the following criteria:

1) All businesses are part of the consumer goods sector
2) All businesses are based in the Netherlands
3) All businesses have more than 500 employees
4) All businesses are to some extent active on the CE and/or sustainability
5) From the seven businesses some have to sell *consumables* and some *usables*,
6) The businesses have to diverse in position in supply chain
7) The businesses have to cover the largest industries of the CGS[4], see section 2.3.2
8) Multiple businesses have to be part of the Food & Beverages industry as this represents the largest share in the CGS (FT, 2016).

The seven businesses are named in an anonymous way (case A, B, C, D, E, F, G) for confidentiality reasons and will be analysed and grouped with use of their characteristics. The interviewed businesses with corresponding characteristics can be found in figure 10. The position of businesses on the supply

[4] It is assumed that the Dutch CGS market sub-segmentation is similar to the global

chain is visualised by their position and length on the x-axis and the businesses are divided in businesses selling products which can be consumed (*consumables)* and used (*usables)* on the y-axis. The colours in figure 10 correspond to the industries in which the businesses are operating and can be found in the legend. For example, figure 10 shows that case A is part of the Food & Beverages industry of the CGS, sells *consumables* and covers wholesale and retail in the supply chain.

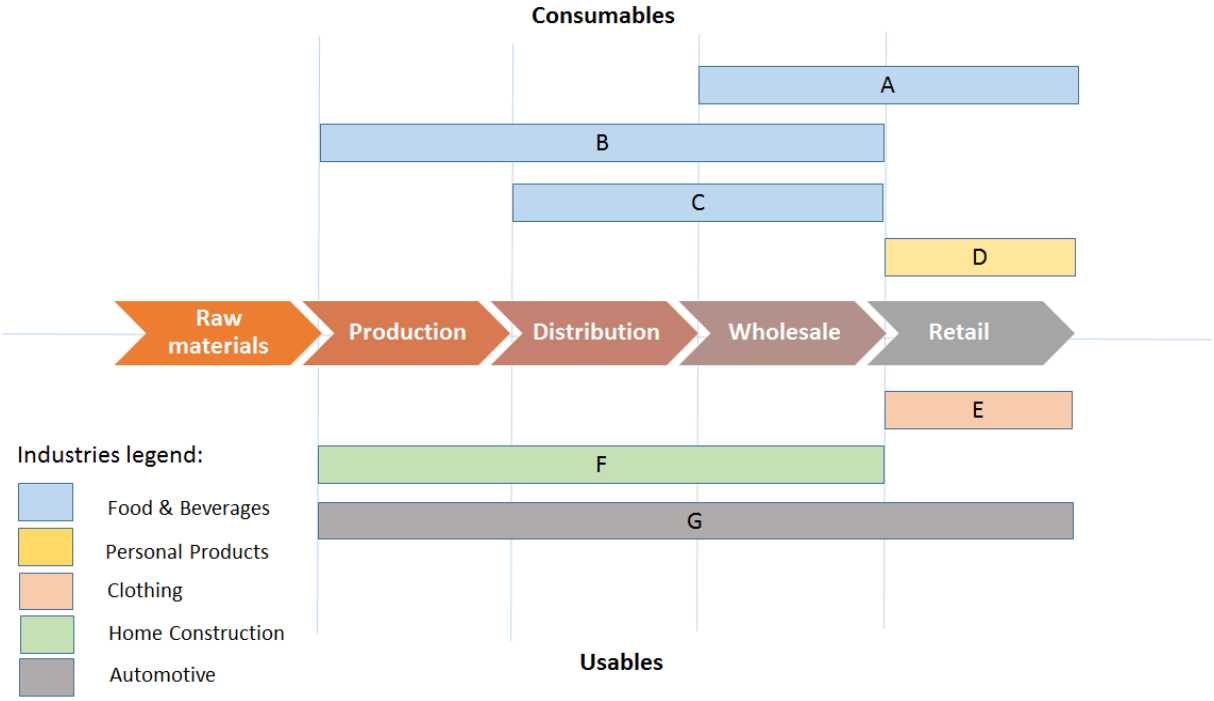

Figure 10 Selected cases

As figure 10 shows, all interviewees fit the given criteria. However, one exception is being made: case G is not based in the Netherlands, but in the UK, although there are dealers situated in the Netherlands. This is done in order to cover the automotive industry, which is the second largest sector of the CGS (section 2.3.2), while the number of Dutch automotive manufacturers is limited (FIER, 2016).

Additionally to the interviewed businesses, an expert in the field of the CGS was interviewed. This to obtain insights on performance of the KPIs on the overall CGS.

3.5.2 Data collection

From the selected seven cases, data was collected through in-depth interviews. There was chosen for semi-structured interview questions because there was expected that the interviewee's viewpoints were more likely to be expressed in an openly designed interview situation than an standardized interview or questionnaire (Flick, 2006). The interviewees were people managing the circular economy policy of the company, with focus on sustainability, waste management, energy reductions, etc.

Those interviewees were asked to give their opinion on each of the 25 KPIs on three utility criteria: *reliability, applicability* and *data availability* and one conceptual coherence criteria: *interpretation*. Those criteria were translated to semi-structured interview question. The interview questions and design of the interview can be found in Appendix D. Prior to the interviews a pilot test was performed with multiple experts in the field of circular economy in which the research design and interview questions were tested to ensure the data collected will enable the investigated questions to be answered and thereby increases the question's validity (Saunders et al., 2009).

3.5.3 Data analysis

The interview data was processed in two steps. First, the recordings were transcribed as literal as possible and send to the interviewees for evaluation purposes. Second, relevant sentences from the transcript were copied to an excel file. Third, the sentences were coded using an iterative open-coding approach. Sentences were considered relevant when the content connected to one of the four criteria or when extra information was provided on how to improve the CEI. The used coding scheme with both label and description is shown in table 5. Every sentence got a code consisting of four parts: C*ase*, *Topic*, *Criteria*, *Pos./Neg.* (Positive/ Negative). The coding was iterative, meaning that extra labels were created when a sentence was relevant but did not yet match to an existing code. An example of this excel file can be found in figure 11.

Table 5 Coding scheme

Case		Topic		Criteria		Pos/Neg.	
Label	**Description**	**Label**	**Description**	**Label**	**Description**	**Label**	**Description**
A	Case A	**1**	KPI 1	**R**	Reliability	**P**	KPI does not need changes
B	Case B	**2**	KPI 2	**App**	Applicability		
C	Case C	**3**	Etc.	**Av**	Availability		
D	Case D	**SS**	Sub-segment	**I**	Interpretation	**N**	KPI does need changes
E	Case E	**D**	Definition CE				
F	Case F	**SC**	Supply Chain				
G	Case G	**E**	Extra KPI suggestion				
		I	Importance categorisation				
		G	In General about CEI				

Case	Topic	Criteria	Pos/neg	Text
A	1	Av	P	Wij zijn daar inderdaad mee bezig dus een vraag als deze zouden wij dan inderdaad kunnen beantwoorden
A	1	Av	N	Het probleem met deze vraag is dat wij daar wel informatie over hebben maar dat wij heel veel kleine projec
A	1	Av	N	Wij werken onder het dak van opdrachtgevers. We zijn bezig geweest bij een project met het ophalen van pa
A	1	App	P	**En is deze wel toepasbaar op de consumer goods sector? Dus in general?** Als jij op één locatie zit en je bent b
A	2	Av	N	Nee. We hebben op onze website <..> de GRI en transparantie. <..> En ook daar zie je dat de meetbaarheid hee
A	4	Av	N	Ja, dat zouden ze niet mee moeten nemen want de data is daar niet beschikbaar voor.
A	7	App	N	Disposables is een kriem want ze zijn niet circulaire te krijgen
A	SS	App	N	Die CE is voor ons een enorme worsteling. Eten en drinken is onze business en dienstverlening onder mensen

Figure 11 Example Excel file with coded interviews

From the 7 interviews, 5 interviews were conducted in Dutch and 2 in English. Therefore the quotes in figure 11 are in Dutch. When the interviewees were quoted in this research, the quotes were translated to English. The result is an analysis of the opinion of the interviewees on the utility of the KPIs, presented in both a table and explanation.

4. Results

4.1 Strengths and weaknesses development CEI

In this section, the strengths and weaknesses of the development of the CEI by Ruiter (2015) are analyzed on three criteria: *data, procedure* and *transparency* from the CE indicator validation model, see section 3.3. An overview of the strengths and weaknesses can be found in table 6.

4.1.1 Data

There are three strengths and no remarkable weaknesses regarding the *data* used for the development of the CEI. First strength is use of the multiple scientific and empirical sources by Ruiter (2015). The main scientific sources that form the basis of the CEI are the sustainable value framework by Hart & Milstein (2003) and green supply chain management (GSCM) by Zhu & Sarkis (2004). The sustainability value framework proposes multiple drivers for companies to become sustainable and the activities required to achieve this, distinguishing between both internal and external practices and current (today) and new business opportunities (tomorrow) (Hart & Milstein, 2003). This scientific source of the development of the CEI is found to be suitable and can be considered the second strength as 1) both Hart & Milstein (2003) and Ruiter (2015) attempt to do the same: simulating and accelerating a transition by identifying activities that can serve as a guideline for businesses, 2) sustainability is the concept most in line with CE, as already identified in section 2.1.1, 3) the inclusion of external stakeholder groups in those activities is also an important part of the CE (EEA, 2016) and 4) the inclusion of a timeframe by distinguishing between urgent and less urgent actions (Lozano, 2008).

Additionally, Ruiter (2015) incorporated the four dimensions of GSCM from Zhu & Sarkis (2004) into the sustainable value framework because she found that the actual management of implementing these practices was not covered yet by the framework of Hart & Milstein (2003), while this is important to identify a company's performance and develop the necessary KPIs. The four dimensions of the GSCM are a suitable addition as they include practices also important within the CE, being the presence of a CE strategy (internal practices) which is also emphasized by Tukker (2015) including suppliers and stakeholders (external practices) (EEA, 2016), the extraction of value from items (investment recovery) and developing products or services with the intention of reducing its energy and material consumption (design for environment) which both correspond with the second principle of the EMF regarding optimizing resource yields (EMF, 2014). The third strength regarding the data used, is the suitability of the empirical data. Ruiter (2015) used Sustainability and Circularity Indexes, consults with experts like the VBDO and Circle Economy on their vision on specifically Circularity Indexes and interviews with multiple companies as an empirical basis for the development of the CEI. These indexes can be considered a suitable source because 1) Ruiter (2015) used multiple indexes both focusing on sustainability and already on circularity, 2) the Dow Jones Sustainability Index, Carbon Disclose Project and Global Reporting Initiative are the largest and most-used indexes that measure the practices of companies and 3) lessons learned from similar indexes could increase the quality of the CEI. The VBDO and Circle Economy can also be considered suitable sources as 1) both companies have developed their own Circularity Indicator System and Circularity Assessment, in line with the CEI and 2) their objectivity as both companies are non-profit which emphasizes their objective view. The interviews with 10 multiple companies are a valuable addition for confirming the importance on creating standards for the CE and providing some insights on which KPIs should have the most impact on the index scoring.

4.1.2 Procedure

A strength is the suitable measurement *procedure* of Ruiter (2015) for developing the CEI, as Ruiter (2015) 1) built a thorough theoretical foundation as a base for the CEI in the form of a circular value framework, 2) complemented the theoretical part with empirical input to secure the practical value of

the developed CEI and 3) made sure the developed KPIs cover all activities identified in the circular value framework.

There are three weaknesses related to the *procedure* used by Ruiter (2015). The first weakness is the scope used by Ruiter (2015), which fundamentally differences from the scope in this research, as described in section 1.7. Ruiter (2015) frames the CE as a concept that goes beyond sustainability and therefore defines her four performance categories going from 1) doing nothing or little on sustainability, 2) operating sustainable, 3) operating somewhat circular to 4) completely circular. Those performance categories are also part of the circular performance ladder which is used to position and compare the companies on their circular performance. This is a weakness because Ruiter (2015) uses this scope while lacking to incorporates the social pillar which is an inherent part of sustainability. Because in this research sustainability is framed as the end-goal of the process called sustainable development and CE is a tool for sustainable development, in this research the social pillar does not to have to be included. After all, the social pillar is also not included into the definition of CE. All in all, the KPIs and four performance categories need to be adapted according to the new scope. The second weakness also relates to the measurement procedure and is the absence of any testing procedure of the developed KPIs. Ruiter (2015) did not use any criteria for indicator selection in her research, which could have verified her steps. The third weakness is the lack of specific criteria set (size, age, position in supply chain, comparable etc.) for the selection of 10 companies for interviews. Those weaknesses imply a rather subjective measurement procedure and outcome.

4.1.3 Transparency

A strength related to the *transparency* of the development of the CEI and the possibilities of deriving political objectives through a reliable and transparent measurement procedure, is that Ruiter's (2015) thoroughly explained her methodological steps with the use of aforementioned data. Whether the CEI is useful in reaching political objectives, depends on what those objectives exactly are. When those objectives would be a comparison of businesses on their level of circularity and guiding businesses in their transition towards a CE, the CEI can be of help. The CEI does not include yet a benchmark itself, but it provides guidelines to develop CE standards, which can be of use for policy makers that aim to stimulate a transition towards a CE and like to know the present state of circularity within a specific country, region or sector.

However, a weakness is that although Ruiter (2015) did include lessons learned and discussions with VBDO, Duurzaambedrijfsleven, Accenture and MVO NL into the development of the CEI, she did not add any documentation nor references that verify her statements. By doing so, Ruiter (2015) makes it unable to reproduce this part of the research. An overview of the strengths and weaknesses of the development of the CEI can be found in table 6.

Table 6 Strengths and weaknesses of the development of the CEI

Criteria:	Strengths	Weaknesses
Data	- Use of multiple sources of both scientific and empirical data - Suitable quality of scientific sources - Suitable quality of empirical sources	
Procedure	- Suitable measurement procedure	- Scope of relation sustainability - CE

		- CEI not tested nor criteria for indicator selection included into the research - No specific criteria set for the selection of 10 companies for interviews
Transparency	- Suitable transparency allowing for reproduction, comparison and reaching political objectives.	- No documentation of lessons learned from collaboration with VBDO Duurzaambedrijfsleven, Accenture and MVO NL

As the latter shows, overall the CEI is of a high quality with many strengths when validating the development of the CEI according to the three criteria. However, some weaknesses have been identified as well. The weaknesses regarding the *procedure* of the CEI can be taken into account in this research. This is done by: 1 adapting the KPIs and four performance categories according to the new scope as will be described in section 5.2.1, 2) testing the CEI with use of criteria for indicator selection, in the form of the CE indicator validation model from section 3.2 and 3) setting specific criteria for the selection of businesses within the scope of this research, see section 3.5.1.

4.2 Performance KPIs

In this section, the performance of all 25 Key Performance Indicators is tested with the use of criteria from the CE indicator validation model from two perspectives: conceptual coherence and operational coherence, see section 3.3. From the conceptual coherences perspective, the individual KPIs are validated with two criteria *definition* and *relevance,* and can be found in table 7. The operational coherence perspective includes the criteria *formulation* and *quantification* which are used to validate the individual 25 KPIs, see table 8, and the criteria *sensitivity & timeline and comparability* which are used to validate the CEI in total. In table 7 and 8, a green box means the KPI meets the criteria and is therefore considered valid. A red box means the KPI does not meet the criteria and is therefore considered not valid.

4.2.1 Definition

As shown in table 7, all KPIs can be considered valid with regard to their connection to the *definition* of the CE. This means all KPIs measure one or more of the three principles of the circular economy as defined by the EMF (2015). The only exceptions are KPI 1-4 who focus on the strategy and targets, KPI 5-6 who focus on creating awareness and cooperation and KPI 15-16 who focus on supplier engagement. Although those KPIs measure parts of the CE that are not included into the exact definition of the CE used in this research, they can also be considered valid for the following three reasons. First, as described by Waas et al. (2014) having a decision-making strategy is crucial in actually realizing sustainable development, because at the heart of every action lies a decision. Given the similarities between CE and SD, this also applies to the CE, making KPI 1-4 valid. Second, the European Environment Agency (EEA, 2016) stated that a successful transition requires a cooperation of all stakeholder groups and the acquisition of new skills and knowledge through education, thereby highlighting these KPIs as fundamental part of the transition towards a CE. Third, supplier engagement is also an important part of the CE as EMF describe that waste must be removed throughout both the production and supply chain (EMF, 2015).

4.2.2 Relevance

The *relevance* criteria measures whether all relevant categories and resources of the CE are covered by the indicator(s). The 25 KPIs are valid on this criteria as the three principles of the CE are all present

in the KPIs. The first principle of the CE *preserve and enhance natural capital* (EMF, 2015, p.7) is present in KPI 17, 18, 21 and 25. The second principle of the CE *optimise resource yields by circulating products, components and materials at the highest utility at all times in both technical and biological cycles* (EMF, 2015, p.7) is measured by KPI 7 to 14, 19 and 20. The third principle of the CE *foster system effectiveness by revealing and designing out negative externalities* (EMF, 2015, p.7) is present in KPI 22 to 24. However, the distribution of the KPIs in the second principle between the biological and technical cycle shows that they mainly address the technical cycle (KPI 7 to 14 and 19) as only KPI 20 mentions the biological cycle. As these cycles address products you *consume* (biological cycle) or *use* (technical cycle), this is a large gap in the current CEI that needs to be improved.

Additionally, some of the KPIs overlap and can therefore not be considered valid, since part of the *relevance* criteria is that overlap amongst indicators have to be as small as possible. KPI 7 and 19 overlap as they both address the amount of recycled material as input in the production process. KPI 15 and 16 focus both on supplier engagement. KPIs 17 and 18 overlap as they both address the use of renewable energy and have a similar first category.

Also, the CEI currently does not measure whether businesses also offer a service to extend the life time of their products, which correspond to the maintain/prolong cycle in figure 1 as described by EMF (2015). This could be a valuable addition to the KPIs from Ruiter (2015).

Table 7 Validation of the KPIs – conceptual coherence

KPIs	Description	Conceptual coherence criteria: definition	Conceptual coherence criteria: Relevance
KPI 1	We are involved in the circular economy trend		
KPI 2	We know what the circular economy means for our company		
KPI 3	The circular economy is part of our future targets		
KPI 4	We measure the outcomes of our circular economy practices on a regular basis		
KPI 5	Awareness on the circular economy is created among employees		
KPI 6	We cooperate on the topic circular economy		
KPI 7	Products contain recycled materials or recovered components		
KPI 8	Products are designed to minimize waste over their lifetime		
KPI 9	The amount of products that are recycled or upcycled		
KPI 10	Products can be resold		
KPI 11	Sharing of products by consumers is facilitated		
KPI 12	Products can be leased by consumers		
KPI 13	It is ensured that products are returned after their usage		
KPI 14	Products are sold using circular packaging and documentation		
KPI 15	The circular economy principle is applied to daily operations		
KPI 16	There are selection criteria for suppliers & industrial buyers		
KPI 17	The consumed electrical energy is renewable		
KPI 18	The consumed electrical energy comes from reliable production sources		
KPI 19	The extent to which technical input comes from pre-used materials		
KPI 20	The biological material input stream is sustainable		
KPI 21	The extent to which oil-based inputs are replaced by bio-based inputs		
KPI 22	Involvement in ecosystem recovery		
KPI 23	Waste is minimized or eliminated		
KPI 24	Mode of waste reduction		
KPI 25	Modes of transport are electric or on biofuels		

4.2.3 Formulation

Most KPIs are formulated as simple as possible and can therefore be considered valid on the *formulation* criteria. However, the following KPIs are not valid: KPI 4 as the first category does not correspond to what the KPI measures. KPI 9 for it addresses *upcycling* without including this into the four categories. KPI 10 for it implies a link to the reuse-loop of the CE but does not formulate this accordingly. KPI 14 for lacking an explanation what is meant by *circular packaging and documentation*. KPI 15 as it measures the application of *circular economy principles* without explaining what it entails and also do not link with its four categories who measure supplier engagement. KPI 16 as the categorization who mention *service providers* does not match the KPI who mentions *suppliers and industrial buyers.* KPI 18 as it mentions *reliable production sources* which is not the same as *renewable* which is measured in the categorization of KPI 18. KPI 20 as the categorization also does not match what the KPI indicates and for mentioning *sustainable material input* instead of *circular material input.* KPI 23 for the KPI refers to minimization of waste, while the categorization only measures whether there is reported on waste or a policy/targets are in place. Finally, KPI 25 for it implies that all electric energy is a renewable which is not true as electrical energy can also be generated from fossil fuels.

4.2.4 Quantification

Almost all KPIs are *quantified* when possible. The CEI uses percentages for quantification, which is suitable for the comparison of business performance on CE implementation. After all, only a comparison in relative terms would be useful when measuring a CE transition, e.g. to compare a reduction in energy usage between companies presented in percentages instead of the energy usage of every company in absolute terms. The only KPIs not valid are: KPI 13 as the amount of products returned after their usage could be measured in percentages, KPI 17 as the use of renewable energy could be measured in percentages, KPI 20 as the biological input stream could be measured in percentages just as KPI 19 who focusses on the technical input.

Table 8 Validation of the KPIs – operational coherence

KPIs	Description	Operational coherence criteria: Formulation	Operational coherence criteria: Quantification
KPI 1	We are involved in the circular economy trend		
KPI 2	We know what the circular economy means for our company		
KPI 3	The circular economy is part of our future targets		
KPI 4	We measure the outcomes of our circular economy practices on a regular basis		
KPI 5	Awareness on the circular economy is created among employees		
KPI 6	We cooperate on the topic circular economy		
KPI 7	Products contain recycled materials or recovered components		
KPI 8	Products are designed to minimize waste over their lifetime		
KPI 9	The amount of products that are recycled or upcycled		
KPI 10	Products can be resold		
KPI 11	Sharing of products by consumers is facilitated		
KPI 12	Products can be leased by consumers		
KPI 13	It is ensured that products are returned after their usage		
KPI 14	Products are sold using circular packaging and documentation		
KPI 15	The circular economy principle is applied to daily operations		
KPI 16	There are selection criteria for suppliers & industrial buyers		
KPI 17	The consumed electrical energy is renewable		
KPI 18	The consumed electrical energy comes from reliable production sources		
KPI 19	The extent to which technical input comes from pre-used materials		

KPI 20	The biological material input stream is sustainable		
KPI 21	The extent to which oil-based inputs are replaced by bio-based inputs		
KPI 22	Involvement in ecosystem recovery		
KPI 23	Waste is minimized or eliminated		
KPI 24	Mode of waste reduction		
KPI 25	Modes of transport are electric or on biofuels		

4.2.5 Sensitivity& Timeline

This criteria is used to validate the CEI in total. The CEI is found to be not valid regarding its *sensitivity* for later changes in implementation of the CE. Reason for this is that although the CEI measures a transition, the *timeline* for calculation of a company's score is currently suggested at a single moment and not more frequently. This means that if a company further implements CE measures, the index score is not accurate anymore and needs to be calculated again. One could argue that, as the overall goal of the CEI is to stimulate a transition towards a CE, calculating a company's score more frequently could increase this stimulation. After all, the company would be rewarded for its effort through a higher score and therefore better benchmark position against its competitors. Additionally, the index would be more up-to-date and therefore more representative of the actual performance of companies in the implementation of the CE.

4.2.6 Comparability

The *comparability* of the CEI can be determined on two levels: 1) whether the KPIs are mutually comparable and 2) whether the companies who are scored with the CEI are comparable within one index. Ruiter (2015) aimed for mutually comparable KPIs by dividing the KPIs into three ranges of importance and weighting them accordingly (section 2.2.2). Whether this weighting mechanism is indeed valid, is tested empirically in the third sub question of this research. The comparability of the scored companies is not valid as the CEI from Ruiter (2015) is designed for companies sector-wide which are not comparable due to the large differences in the activities of companies in a circular economy within different sectors. However, this problem is tackled in this research as the CEI is modified for one specific sector, the consumer goods sector, in order to enable a benchmark which is comparable.

As the latter shows, the performance of the KPIs regarding the conceptual coherence and operational coherence are mostly valid although some KPIs need to be improved. This serves as input for improving the CEI in the discussion section 5 of this research.

4.3 Opinion of CGS businesses

In this section, the results of the interviews with multiple businesses from the CGS are presented. Their opinion was asked on the usefulness of the KPIs on four criteria: *reliability, indicator applicability, data availability* and *interpretation,* see section 3.2. An overview of the validated KPIs can be found in table 9 on *reliability* and *indicator applicability* and in table 10 on *data availability* and *interpretation.* Hereby green indicates that all interviewees found the KPI to match the criteria, red means all interviewees found the KPI to not match the criteria and orange indicates there were mixed opinions. There is referred to specific interviewees by using e.g. (A) who refers to Interviewee A.

4.3.1 Reliability

Interviewees A, C, D, E, F were all positive about the reliability of all KPIs. This means they all found the KPIs to be measuring circularity. However, some had doubts about KPI 1, 2, 4 and 22. Regarding KPI 1, 2 and 4, interviewee B stated:

"*irrelevant as they do not actually measure something, they are more a prerequisite for participating in the CEI then an actual KPI itself" (B).*

Although KPI 22 is framed in the research by Ruiter (2015) as an activity only frontrunners on the CE do, interviewees A and F clearly showed their disapproval of this way of "doing good". Interviewee A stated:

"this is an easy way to avoid taking responsibility and major interventions in the current business model" (A).

In other words, not something to be proud of. However, other interviewees B, C, E and G were in favour of KPI 22 when used as an addition to a business' internal practices. As interviewee G stated:

"*it is good to do extra, go beyond your internal practices and have a valuable extra impact, e.g. socially".* (G)

Additionally, the interviewees were asked if there were KPIs missing. Most interviewees found that the current list of KPIs was complete and would cover all their CE activities (C, D, E, G). Some interviewees found that the scope of the index should more include sustainability measurements instead of only focussing on the CE (A, B, F). However, after explaining the scope of the CE in this research: CE as the environmental and economic pillar of sustainability without including the social pillar, all interviewees agreed. Nevertheless, interviewees A, B and G still found that it has little use to measure all those concepts separately because you do not want to:

"*measure concepts just for measuring, you want to use them as tools to improve your business"* (A) and "*sustainability is a concept people are already familiar with"* (B).

Additionally, interviewee F stated that safety of materials should be incorporated into the CEI, as he stated "*it is also possible to recycle toxic materials"* (F). He also encouraged to add a KPI that asks whether a company offers a service to increase the lifetime of the product:

"Some of our products need a lot of maintenance as they are used for 20 to 30 years. A lack of this maintenance would create a lot of hassle. [..] So even if a product is designed to minimize waste, it will not mean anything if this service is not offered" (F).

4.3.2 Indicator Applicability

From the interviews three main business characteristics were found that determine how much influence a business has on the implementation of the CE and therefore whether the KPIs are applicable to them:

1) Whether businesses sells *consumables*, so products which can be consumed (A, B, C, D) or *usables*, so products which are used (E, F, G)
2) Whether businesses use material which has a *technical* (D) or *biological* nature (A, B, C) or both (E, F, G)
3) Whether businesses have *direct* or *indirect* influence on the implementation of CE measurements due to their position on the supply chain.

Consumables vs usables

The first determinant can be found in figure 12 who zooms in on the orange box of KPI 7 in table 7 (see circle). Figure 12 shows businesses who find this KPI applicable (green box) and not applicable (red box). The corresponding legend can be found in figure 13, which is derived from figure 7.

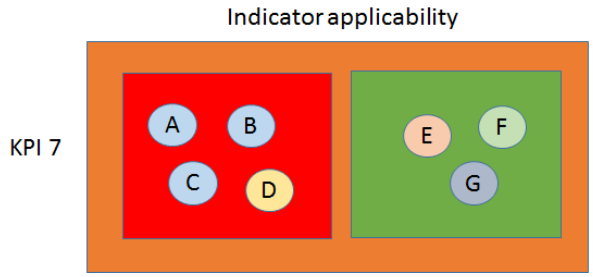

Figure 12 Zoom-in KPI 7 from table 9

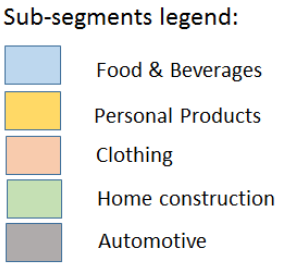

Figure 13 Legend

As figure 12 and 13 show, KPI 7 was found not applicable by all businesses selling *consumables* (Food&Bev. and Personal Products) but applicable by all businesses selling *usables* (Clothing, Home Construction, Automotive). KPI 7 to 14 address the circularity of the product portfolio which is the second principle of the CE, see section 2.1.2. From those KPIs also KPIs 8, 9, 12 and 13 were found applicable to *usables* but not to *consumables.* However, interviewees A, B, C and D stated that reversed logistics (KPI 13) would be applicable for them when relating to the packaging of their *consumable.* Additionally, interviewee G stated that legislation forces you to facilitate KPI 13 and pointed out that in this respect legislation of Europe was similar to the UK. Thereby he confirmed the selection of a UK-based company to represent the automotive industry in the Netherlands, see section 3.5.1. However, while packaging covers quit a large share of used materials for interviewee A, B, C, D, E and F, for interviewee G packaging was not important at all because *"it does not have a significant volume*" (G) compared to the product itself.

KPI 10 and 14 were found applicable by all interviewees. For KPI 10 some mentioned examples were: reselling cloths to other businesses (E), donation of company clothes to charity (A), using leftovers food and beverages internally in the canteen (C), reselling refurbished materials to road construction industry (F), donation of food to the Voedselbank and furnishing to schools and second hand shops (C). However, all interviewees from Food&Bev. industry stated that it is difficult to reuse or resell food because of its short-term expiration date (A, B, C) and strict legislation from the Food and Drug Administration (A, B). KPI 11 was found not applicable by all interviewees nor within their scope of influence. Only interviewee G highlighted that for the automotive industry car sharing is applicable, although other companies would facilitate this.

Technical vs biological material

KPI 19 and 20 were found applicable dependent on the either *biological* (A, B, C) or *technical* (D) or both (E, F, G) material used by businesses. However, interviewee F stated that:

> *"the use of a combination of biological yarn and synthetic yarn should not be stimulated as it is not reusable and therefore not according to the CE principles, although you would expect otherwise"* (F).

Indirect vs direct influence

From the interviews was also found that the applicability of the KPIs in the CGS depend on the position of the business in the supply chain. This is illustrated in figure 14 which shows for every KPI which part of the supply chain it addresses and therefore whether a business has *direct* or *indirect* influence on taking the action the KPI measures. In case of *direct* influence, the business can change their own

internal operations while for in*direct* influence the business is dependent on their suppliers (upstream) and industrial buyers (downstream). In figure 14, the blue KPIs can be *direct* influenced regardless of the business' position in the supply chain while the red KPIs only address part of the supply chain. KPI 22 is green as it measures an activity outside of the company's internal operations and is not linked to the supply chain.

Figure 14 Direct or indirect influence of the KPIs per part of the supply chain

When comparing figure 14 to the characteristics of the interviewed businesses in figure 10, section 3.5.1, the remarks of interviewees on their *direct* or *indirect* influence on the KPIs can be explained. For example, interviewee A, who's business covers in the supply chain wholesale and retail (see figure 10), states that KPI 13 and 14 were only *indirect* applicable for her business. When looking at figure 14, these KPIs are found to address the production and distribution of products, which is indeed not part of the supply chain covered by the business of interviewee A. However, in both cases of *direct* and *indirect* influence, the KPIs are applicable as the business still has influence on it. Additionally, was found that direct or indirect contact with the consumer does not influence whether businesses are more motivated to increase their CE or not. The interviewees stated that the consumer does not really care about the circularity of the products they buy (E, F) or otherwise that they are not willing to pay more for a circular product (E).

Overall applicable

All interviewees found KPIs 1 to 6, 10, 14, 15 to 18 and 21 to 25 applicable to their business, as these address topics businesses can always influence, no matter the business characteristics. However, regarding KPI 5 multiple interviewees pointed out that CE is a difficult concept to explain to their employees since most of them are low educated (interviewee A, B, G). Nevertheless, most interviewees highlighted that it is very important to create awareness on the CE amongst employees (interviewee B, C, E, F, G). KPI 21 is not applicable for *consumables* like food, since the used oil will

always be bio-based, but is applicable for the packaging around the *consumables* and therefore applicable for all businesses.

Table 9 Validated KPIs by interviewees (1)

KPIs	Description	Criteria: Reliability	Criteria: Indicator applicabilit
KPI 1	We are involved in the circular economy trend		
KPI 2	We know what the circular economy means for our company		
KPI 3	The circular economy is part of our future targets		
KPI 4	We measure the outcomes of our circular economy practices on a regular basis		
KPI 5	Awareness on the circular economy is created among employees		
KPI 6	We cooperate on the topic circular economy		
KPI 7	Products contain recycled materials or recovered components		
KPI 8	Products are designed to minimize waste over their lifetime		
KPI 9	The amount of products that are recycled or upcycled		
KPI 10	Products can be resold		
KPI 11	Sharing of products by consumers is facilitated		
KPI 12	Products can be leased by consumers		
KPI 13	It is ensured that products are returned after their usage		
KPI 14	Products are sold using circular packaging and documentation		
KPI 15	The circular economy principle is applied to daily operations		
KPI 16	There are selection criteria for suppliers & industrial buyers		
KPI 17	The consumed electrical energy is renewable		
KPI 18	The consumed electrical energy comes from reliable production sources		
KPI 19	The extent to which technical input comes from pre-used materials		
KPI 20	The biological material input stream is sustainable		
KPI 21	The extent to which oil-based inputs are replaced by bio-based inputs		
KPI 22	Involvement in ecosystem recovery		
KPI 23	Waste is minimized or eliminated		
KPI 24	Mode of waste reduction		
KPI 25	Modes of transport are electric or on biofuels		

4.3.3 Data availability

The data availability of interviewees on the KPIs was highly diverse and was found to be dependent on the applicability of the KPI, see table 10. Overall interviewees were in favour of asking as much quantitative data in absolute terms or percentages as it would increase the validity and comparability of the data (C, D, E, F). However, remarkably, it was found that especially quantitative data was often not available by all interviewees, see KPIs with "%" in table 10. The data for KPI 1 to 6, 15, 16, 17, 23, and 24 was found available by all interviewees. Only KPI 5 was found hard to measure in terms of how high the level of knowledge is (B, C), but measurable in the way it is currently proposed in the categorization by Ruiter (2015).

For the other KPIs the level of data availability was divers. KPIs 7 to 12 were often found measurable by the businesses to who it was applicable for and otherwise for packaging. However, KPIs 11 which include consumer behavior were found hard to measure by interviewee D, E, F because:

"the business often does not know what happens to the products after they are sold" (E) and "*it's a part you do not control anymore"* (F).

Although asking for quantitative data was recommended by many interviewees, KPI 13 who measures reversed logistics was not found measurable at all by all interviewees, especially not in quantitative terms (C, E, F, G) because:

"they also take products back from other brands, measuring only their own product would be hard" (E), "*you can only measure what is included in the deal and not what actually is returned as it takes a long time before that happens"* (F) and "*cars go all over the world so it would be impossible to measure it and data is often withhold by companies who are dealing with end of life*" (G).

KPI 14 was also found difficult to measure by most interviewees (A, B, C, D, E) because:

"you do *not always know which packaging is fixed to which product"* (C) and "*the absence of packaging is not taken into account"* (E).

But it would be measurable by interviewee F and G, although "*packaging is often complex"* (F). The data for KPI 17 was found available by all interviewees, although they all suggested to use percentages of energy use which is renewable. Absolute terms were found to be irrelevant by interviewee C, D and B since:

"*the improvements in reducing the use and percentages of renewables count, not how much you use"* (D) and "*there is a point where you cannot reduce anymore"* (B).

A workable suggestion was to ask whether the company has policy on this (D, F) and whether somebody is responsible (F). Regarding KPI 18, the interviewees had mixed opinions. Some interviewees found the energy market very transparent (C) with clear energy sources (B), while for others this was unknown and irrelevant (A) and hard to measure because of mixed energy sources (G). On the other hand, all interviewees found that it would be possible to measure how much energy is generated by the business itself. Also on KPI 19 and 20, the data availability differ per company, even when the KPI was found applicable. For interviewee C and F both KPIs were found measurable in a quantitative way (F) and qualitative way (C). However, interviewee A, E and G indicated that they barely know the origin is of their product because of "*highly complex supply chains"* (A, E, G). Data for KPI 21 would be available according to interviewee C, D, E and F but not according to A, B and G. In fact, interviewee B stated:

"this is a weird question for a food and beverages company since agriculture should be use to feed people instead of used for e.g. biodiesel" (B).

KPI 22 all interviewees found very hard to determine and measure. Last, for KPI 25 most interviewees found the data available (A, B, C, D, E, F). Only interviewee G found KPI 25 hard to measure because:

"the available sources of generated energy highly depend on the country you are in. An electric car charged from a coal plant in China would not be renewable, but the same car charged from a renewable power plant in France would be renewable" (G).

4.3.4 Interpretation

The interviews showed that the formulation of KPIs needs a lot of improvement, as the KPIs were often multi-interpret or not understood at all, see table 10. The interviewees frequently asked for an explanation or definition of the KPIs. This was mainly because the KPIs were unclear on what part and process of the business was referred to (upstream, downstream, internal operations etc.). Overall the interviewees indicated that the KPIs should ask for more examples and other form of proof that verify the statements made (C, D, E, F, G), to reduce the risk of "*greenwashing"* (F), and needs to be formulated "*much more concrete"* (D, F). The descriptions of KPIs 15, 16, 20, 23, 25 were found not to

match the four categories, which needs to be improved. Because a lot of KPIs were not found applicable to the businesses, adding a category "not applicable" was overall recommended (D).

KPI 1 to 4 were found to be overlapping and very extensive for KPIs that are so general and measure intention (C, F). A suggestion for improvement was provided by the CGS expert who stated that:

"in fact, those KPIs are already four categorizations by measuring overall how far you are on the CE, going from 1) do you have a strategy on the CE?, 2) do you also know what this implies for your business?, 3) do you have set clear targets that needs to be reached? and 4) do you measure what you do?" (CGS expert).

Some interviewees asked to define *circular economy trend* in KPI 1 (D, E), delete *future* since *"it not clearly defined nor relevant with regard to targets"* (B) in KPI 3 and define *outcomes* in KPI 4 (D). Additionally, interviewee G found that for KPI 1 to 4 a focus on sustainability would be enough, instead of only on the CE. According some interviewees KPI 5 and 6 need some improvements in formulation, as currently they are found to be "*suggestive"* (C), "*vague"* (D), "*lacking a report on the progress"* (F) and "*cooperation not clearly defined"* (B, C). Suggestions for improvement was to "*ask for proof of the activities"* (C) and more "*examples"* (C, F).

On KPI 7 to 14 the overall comment was that the definition needs to be improved and a better explanation is needed on to what specific product or packaging is referred to in which part of the supply chain. Specifically, *recovered components* (KPI 7), *lifetime* (KPI 8), *upcycled* (KPI 9), *circular packaging and documentation* (KPI 14) were asked to be defined (C, D). Most interviewees liked *documentation* to be removed from KPI 14 (A,B,C,D,E,F) although for interviewee G the difference between packaging and documentation was very clear and relevant in relation to cars. Some suggestions for improvements made was to include a clear *pre-consumer* and *post-consumer* terminology into the KPIs (D, E, G). Specifically for KPI 8, interviewee F suggested to change the formulation to "*design to disassemble*". Also *resold* (KPI 10) was multi-interpreted by the interviewees as some understood this as reselling of unused materials or products by the *company* (applicable to FMCG) while others interpret it as the possibility of the *consumer* reselling products through second-hand shops (not applicable to FMCG) (C, D, E, G).

To none of the interviewees the difference between KPI 15 and 16 was clear. Interviewees also asked which suppliers were meant as they regularly have multiple suppliers, doing business with some directly and some indirectly (D, E, G). Additionally, the terms *circular economy principle* in KPI 15 was not clear (D, F) nor *industrial buyer* in KPI 16 (B, E), "*one question on suppliers was found to be enough"* (C) and *"suppliers of high value materials should be prioritized"* (G). KPI 17 was clear to all interviewees, although they all stated that *electrical energy* need to be changed to *renewable energy*. Additionally, interviewees D and F suggested that this KPI should measure the "*maturity of energy policy of the business"* (F). KPI 18 was found to cause a lot of confusion, especially the term *reliable* (B, D, E), e.g. interviewee B asked:

"*what if I consume nuclear energy from a local reliable source?"* (B).

All interviewees found that the question should focus more on whether a business (or their suppliers (E)) generates their own renewable energy, and quantify this data. All interviewees found KPI 19 not clear at all, especially not whether it implies technical input from the business itself or from suppliers. From KPI 20 the term *sustainable* frequently asked for clarification (B, C, D) and whether the KPI is supposed to cover all food when applied to Food&Bev. (B). KPI 21 was multi-interpret. Some interviewees thought of *biodiesel* (B, C) while others interpreted it as *plastic bags* (D) or the oil- or bio-based of their products (E, F, G). As interviewee C explained, KPI 21 could be:

"*applied to multiple parts of the process: daily operations (logistics, wholesale) or input of products who are bought and sold"* (C).

KPI 22 was multi-interpret by all interviewees. The KPI needs to be defined and asked for examples, e.g. interviewee B asked whether was meant "*the provision of money or that you organize it yourself*?". Also, the difference between KPI 23 and KPI 24 was frequently found confusing (D, G). Nevertheless, KPI 23 was found understandable by all interviewee, although it was suggested to split KPI 23 into two KPIs: 1) *do you monitor your waste* and 2) *do you have targets on waste management to improve it and are you currently doing it* (B). This was supported by interviewee D and G, who pointed out the importance of monitoring, targets and a roadmap on waste management. In fact, interviewee D pointed out that with the current categorization he:

"*could easily report on his waste reduction but not actually do it".* (D).

KPI 24 was not found clearly formulated by interviewee D: define *mode, one waste stream* and *internal processes* and by interviewee G who suggested to delete *mode of.* It was suggested to quantify KPI 24 (D, F) and to specifically ask whether waste is separated or not (F). Regarding KPI 25 all interviewees pointed out that *electric and biofuels* is not the same as *non-polluting* and that the overall term *renewable energy* would be a better alternative: *"Non-polluting does not exist"* (G). Additionally, both interviewee B and E highlighted that it needs to be defined whether KPI 25 refers to *people* or *goods*.

Table 10 Validated KPIs by interviewees (2)

KPIs	Description	Criteria: Data availability	Criteria: Interpretation
KPI 1	We are involved in the circular economy trend		
KPI 2	We know what the circular economy means for our company		
KPI 3	The circular economy is part of our future targets		
KPI 4	We measure the outcomes of our circular economy practices on a regular basis		
KPI 5	Awareness on the circular economy is created among employees		
KPI 6	We cooperate on the topic circular economy		
KPI 7	Products contain recycled materials or recovered components	%	
KPI 8	Products are designed to minimize waste over their lifetime	%	
KPI 9	The amount of products that are recycled or upcycled	%	
KPI 10	Products can be resold	%	
KPI 11	Sharing of products by consumers is facilitated	%	
KPI 12	Products can be leased by consumers	%	
KPI 13	It is ensured that products are returned after their usage		
KPI 14	Products are sold using circular packaging and documentation	%	
KPI 15	The circular economy principle is applied to daily operations		
KPI 16	There are selection criteria for suppliers & industrial buyers		
KPI 17	The consumed electrical energy is renewable		
KPI 18	The consumed electrical energy comes from reliable production sources		
KPI 19	The extent to which technical input comes from pre-used materials	%	
KPI 20	The biological material input stream is sustainable		
KPI 21	The extent to which oil-based inputs are replaced by bio-based inputs	%	
KPI 22	Involvement in ecosystem recovery		
KPI 23	Waste is minimized or eliminated		
KPI 24	Mode of waste reduction		
KPI 25	Modes of transport are electric or on biofuels	%	

4.3.5 KPI importance

In order to test the importance categorization of Ruiter (2015), all interviewees were asked what they found the most important KPIs, see Appendix D. Also in this part businesses producing *usables* and *consumables* found different KPIs important and some KPIs were found important for all businesses.

The KPIs found important by all businesses was KPI 1 and 3 addressing the CE strategy and targets of a business (C, E). As interviewee C mentioned:

"KPI 1 and 3 measure whether the CE is an actual part of your business policy. Whether you have actual goals on it. That is very important. You need that in order to get anywhere in a structured way" (C).

Also KPI 6 measuring cooperation and 17 measuring the use of renewable energy were found important by interviewees regardless of their type of products (A, B, E, F), just as the quality of the used materials in KPI 19 and 20, as interviewee F stated:

"*the most important is that you start in the right way through the right materials. That you know what materials you have and what you need to improve*" (F).

Overall was found that there should be focus on measurable KPIs and the KPIs that measure the actual implementation of the CE principles instead of the intention of doing so. Specifically quantitative KPIs were emphasized (D, E), as was stated:

"focus on measurable KPIs. The ones where you have measurable results, because that directly links to your effort" (E).

However, the difference became clear in e.g. the design of the product which is important for *usables* (E, F, G) but not for *consumables* (A, B, C, D). For example, for the Food&Bev. industry, which makes *consumables,* both interviewee B and C pointed out that it is important to focus on the reduction of waste (KPI 23 and 24) and recycling of packaging (KPI 14), as this is the field where the Food&Bev. industry can actually make a change with regard to the CE.

Additionally, interviewee G highlighted that one should look at the difference between supply chain, own operation and the use-phase and determine when the largest impact is being made and weight accordingly. He stated that in his case the biggest impact is during the use of the product, therefore:

"*design is the most important part to assure optimization of the efficiency. Minimize the materials used, make sure you know where the products are coming from and influence this"* (G).

The differences in opinion between both types of business and overall remarks regarding the importance of the KPIs needs to be taken into account when creating a CEI for the CGS.

5. Discussion

In this discussion section, first the results of the three sub questions are discussed. Second, the Circular Economy Index is improved for the consumer goods sector with use of the three sub questions. Third, the limitations of the research are discussed. Finally, recommendations are provided for Accenture and further research.

5.1 Three sub questions

The three sub questions show that the CEI has potential but also needs improvements, in particular to be useful for the consumer goods sector. From the first sub question was found that overall the CEI is well developed and in that respect of a good quality. However, the second sub question showed that

according to the CE indicator validation model all KPIs need to be improved to some extent in order to be useful to measure the transition of a business towards a CE. Main outcome of the third sub question was that the KPIs are often multi-interpretable, data is not always available and that it is highly complex to assess CGS businesses because the usefulness and applicability of KPIs differs between businesses with different business characteristics. Two main business characteristics are:

1) Whether businesses sells *usables* (e.g. cloths, cars) or *consumables* (e.g. food, personal products).
2) Whether businesses use material which has a *technical* (e.g. metal, synthetic fiber) or *biological* nature (e.g. nutrients, natural fiber).

However, another factor was found to influence the applicability of the KPIs. This was whether businesses have *direct* or *indirect* influence on the implementation of CE measurements due to their position in the supply chain. Nevertheless, this business characteristic is not taken into account when improving the CEI. Reason for this is twofold: 1) although *indirect* or *direct,* business will still have influence on the supply chain, therefore all KPIs are still applicable and 2) at this level of detail the businesses are not comparable anymore, which is a prerequisite for an Index. Linked to the supply chain was the remarkable finding that the role of the consumer was not that important for the interviewed businesses, although this was expected otherwise (see section 2.3.2). Therefore, whether a business has direct or indirect consumer-interaction is not taken into account in improving the CEI.

Altogether, the CEI is improved with use of the two main business characteristics and other findings in the three sub questions. Table 11 shows an overview of the validated KPIs on criteria from the CE indicator validation model.

Table 11 Overview validated KPIs

KPIs	Description	Criteria: definition	Relevance	Formulation	Quantification	Reliability	Indicator applicability	Data availability	Interpretation
KPI 1	We are involved in the circular economy trend								
KPI 2	We know what the circular economy means for our company								
KPI 3	The circular economy is part of our future targets								
KPI 4	We measure the outcomes of our circular economy practices on a regular basis								
KPI 5	Awareness on the circular economy is created among employees								
KPI 6	We cooperate on the topic circular economy								
KPI 7	Products contain recycled materials or recovered components							%	
KPI 8	Products are designed to minimize waste over their lifetime							%	
KPI 9	The amount of products that are recycled or upcycled							%	
KPI 10	Products can be resold							%	
KPI 11	Sharing of products by consumers is facilitated							%	
KPI 12	Products can be leased by consumers							%	
KPI 13	It is ensured that products are returned after their usage								
KPI 14	Products are sold using circular packaging and documentation							%	

KPI 15	The circular economy principle is applied to daily operations								
KPI 16	There are selection criteria for suppliers & industrial buyers								
KPI 17	The consumed electrical energy is renewable								
KPI 18	The consumed electrical energy comes from reliable production sources								
KPI 19	The extent to which technical input comes from pre-used materials							%	
KPI 20	The biological material input stream is sustainable								
KPI 21	The extent to which oil-based inputs are replaced by bio-based inputs							%	
KPI 22	Involvement in ecosystem recovery								
KPI 23	Waste is minimized or eliminated								
KPI 24	Mode of waste reduction								
KPI 25	Modes of transport are electric or on biofuels							%	

5.2 Improving the CEI for the CGS

In this section, the Circular Economy Index as developed by Ruiter (2015) is improved for the consumer goods sector. First the improved KPIs are discussed. Second, a flow chart is represented that guides the business to the applicable KPIs. Third, the KPI importance is discussed and a scoring card is presented which can be used to obtain a company's score in the CEI. Fourth, it is explained how to perform the assessment and an example is provided on how to obtain a company's score.

5.2.1 KPIs for the CGS

Strategy and targets - KPI 1 to 4

KPI 1 to 4 are improved on *formulation, relevance* and *interpretation.* Therefore, KPI 1 to 4 are merged into two KPIs: 1) measuring the presence of a strategy on the circular economy and whether the business actually knows what it implies (merge KPI 1 and 2) and 2) measuring the presence of targets and whether the business actually measures their progress (merge KPI 3 and 4). Hereby the suggestion of the CGS expert is taken into account to consider KPI 1 to 4 already as a scale and modify this accordingly, see section 4.3.4. As the scope of this research regarding the relation of the CE and sustainability concept differs from Ruiter (2015), as discussed in section 4.1.2, the CE is now formulated as part of the sustainability strategy. This leads to the following KPIs:

KPI 1 We have a strategy on the circular economy and know what it implies for our business

We do not have a strategy on the circular economy	We have a strategy on the circular economy and are currently analyzing the implications of the CE for our business	We have a strategy on the circular economy and have analyzed the implications of the circular economy for our business at strategic level	The circular economy is an important part of our business strategy and we have analyzed the implications of the circular economy for all aspects of our business (e.g. finance, safety, competitiveness, supply chain, etc.)

KPI 3 The Circular economy is part of our targets and we measure our progress towards these targets

We do not have targets on the circular economy	We have targets on the circular economy but do not measure our progress towards these targets	We have targets on the circular economy and measure our progress towards these targets on a yearly basis	We have targets on circular economy, they are SMART and we measure our progress towards these targets on

			a half-year or quarterly basis

Awareness and cooperation – KPI 5 and 6

Both KPI 5 and 6 are improved on *interpretation*. KPI 5 is made more concrete by not asking for awareness on the CE in general, but specifically awareness on the Circular Economy strategy of the business. As some interviewees pointed out that the CE is a difficult topic to explain to most employees, see section 4.3.2, measuring awareness on the CE strategy of the business makes the communication and training more focussed on what the CE means for the employees. As some interviewees stated that a focus on sustainability could be enough instead of only on the circular economy, see section 4.3.1, *sustainability* is kept part of the second categorization. KPI 6 is improved by now measuring concrete cooperation with NGO's that promote the CE (e.g. Ellen Mac Arthur foundation, Circle Economy), suppliers and/or other companies that could improve the CE performance of the business. This leads to the following KPIs:

KPI 5 We create awareness on the circular economy strategy of the business among employees

We do not create awareness on our circular economy strategy among employees	We create awareness on sustainability in general, but not specifically on our strategy of the circular economy	We create awareness on our circular economy strategy through communication	We actively train our employees on the implications of the circular economy for their job and stimulate initiatives from employees that could improve the circular economy performance of our business

KPI 6 We cooperate on the topic Circular economy

We currently do not cooperate on the topic circular economy	We are looking at opportunities to cooperate on the topic circular economy	We are a member of one or more NGO's that promote the circular economy and/or cooperate with suppliers to increase our circular economy performance	We actively cooperate with suppliers, NGO's that promote the circular economy and/or other companies to increase our circular economy performance.

Circulation of product portfolio– KPI 7 to 14

In the interviews, the influence of whether businesses make *usables* or *consumables* was found to influence the applicability of KPIs addressing the circulation of product portfolio (KPI 7 to 14). When linking this to the outline of the circular economy in figure 1, it shows that *usables* have a *technical* cycle and *consumables* have a *biological* cycle. This explains the applicability of the KPI as *usables* can later on be e.g. *reused, redistributed, refurbished* etc., while a *consumable* does not have this possibility as the product either disappears or is metabolised by the economy in which resource value can only be regenerated through a *biological* cycle (EMF, 2015). It was already found in the second sub question that the KPIs from Ruiter (2015) underexpose the biological cycle, see section 4.2.2. The interviews confirmed this, as businesses selling *consumables* (A,B,C,D) found current KPIs 7 to 14 barely applicable to their business, while the interviewees selling *usables* (E, F, G) found the KPIs applicable. The classification of *usables* and *consumables* relate to the FMCG and SMCG businesses sub-segmentation as mentioned in section 2.3.2. Hereby *consumables* are always FMCG (e.g. Food, Beverages, Personal Products), while *usables* can be both FMCG (e.g. Consumer Electronics, packaging) and SMCG (e.g. Automotive, Clothing).

In order to make sure only the applicable KPIs are used to assess a business, three separate lists are created:

1) For c*onsumables*: KPIs addressing the biological cycle of the CE
2) For *usables*: KPIs addressing the technical cycle of the CE
3) For both: all KPIs which are applicable for both types of business

Based on the KPIs develop by Ruiter (2015), the only KPI for the *consumables* that can be made applicable is the presence of a system for reversed logistic of packaging (KPI 13A), although this by-far does not cover all CE activities related to the biological cycle, see figure 1. As KPI 13A is also applicable to *usable*s, this KPI is added to the list of applicable KPIs for both types of products. This leaves the list of KPIs for *consumables* currently empty, which shows the limited usefulness of the CEI for businesses selling *consumables.*

Additionally, KPI 7 to 14 are improved on *indicator applicability, data availability* and *interpretation.* Also some KPIs are improved on *relevance, formulation* and *quantification.* The most important improvements are the following: in KPI 7 *recycled material* is removed to make sure there is no overlap anymore with KPI 19. KPI 11 who measures sharing is removed from the CEI as none of the interviewees found this KPI within their scope of influence. It is an important part of the CE but as a business model not applicable to the consumer goods sector, only e.g. to the consumer services sector through sharing platforms. It would be applicable through a product-as-a-service business-model (Lacy & Rutqvist, 2015), but this is already included in KPI 12 which covers leasing. However, from the interviews (section 4.3.1) and second sub question (section 4.2.2) was found that currently a KPI is missing: whether businesses offer service to extend the lifetime of the product. As this KPI also addresses the circulation of product portfolio on *usables*, this KPI now replaces KPI 11 on sharing and is placed in the list of KPIs for *usables.* Additionally, KPI 13 is split into two KPIs: 13A: reversed logistics of packaging and 13B: reversed logistics of the product itself. KPI 13 is not quantified although this is not in accordance with the *quantification* criteria, see section 4.2.4. The reason for this is that all interviewees pointed out that quantified data would not be available, see section 4.3.3.

Taken all improvements into account this leads to the following KPIs. Note that the order of KPIs is changed, but the numbering from Ruiter (2015) is maintained in order keep track of the changes.

For businesses of consumables:

<no specific KPIs>

For businesses of *usables:*

KPI 7 Products contain recovered components

<25% of our products are made from recovered components	25%-50% of our products are made from recovered components	50%-75% of our products are made from recovered components	>75% of our products are made from recovered components

KPI 8 Products are designed to disassemble, remanufacture and/or repair

<25% of our products are designed to disassemble, remanufacture and/or repair	25-50% of our products are designed to disassemble, remanufacture and/or repair	50-75% of our products are designed to disassemble, remanufacture and/or repair	>75% of our products are designed to disassemble, remanufacture and/or repair

KPI 9 The amount of products that are recycled or upcycled post-consumer

<25% of our products are being recycled or upcycled	25-50% of our products are being recycled or upcycled	50-75% or our products are being recycled or upcycled	>75% of products are being recycled or upcycled

KPI 11 We offer a service to extend the life time of our products

We do not offer a service to extend the life time of our products	We work together with third parties who offer a service to extend the life time of our products	We offer a service ourselves to extend the life time of our products	We offer a service to extend the life time of our products and we actively stimulate our customers to extend the life time of our products instead of buying new products

KPI 12 Products can be leased by consumers

Our products cannot be leased	We are looking for ways to facilitate leasing or sharing	We offer a leasing system for <50% of our products	We offer a leasing system for >50% of our products

KPI 13A We offer reversed logistics of packaging and/or cooperate with third parties in a deposit system

We do not offer reversed logistics of packaging and/or cooperate with third parties in a deposit system	We are developing reversed logistics of packaging and/or are looking for possibilities to cooperate with third parties in a deposit system	We offer reversed logistics of packaging and/or cooperate with third parties in a deposit system	We actively recover our products from consumers at the end of the lifetime by stimulating the use of our reversed logistics and/or larger deposit system

KPI 13B We offer reversed logistics to return products after their usage

We do not offer reversed logistics to return products after their usage	We are developing reversed logistics to return products after their usage	We have a system to ensure that our products are returned after their usage by consumers	We actively recover our products from consumers at the end of the lifetime

For both businesses of *consumed* products and *used* products:

KPI 10 Unsold products are resold/reused/redistributed to third parties who maintain the highest value possible

<25% of our unsold products are resold/ reused/redistributed by other parties	25-50% of our unsold products are resold/ reused/redistributed by other parties	50-75% of our unsold products are resold/ reused/redistributed by other parties	>75% of our unsold products are resold/ reused/redistributed by other parties

KPI 13A We offer reversed logistics of packaging and/or cooperate with third parties in a deposit system

We do not offer reversed logistics of packaging and/or cooperate with third parties in a deposit system	We are developing reversed logistics of packaging and/or are looking for possibilities to cooperate with third parties in a deposit system	We offer reversed logistics of packaging and/or cooperate with third parties in a deposit system	We actively recover our products from consumers at the end of the lifetime by stimulating the use of our reversed logistics and/or larger deposit system

KPI 14 Products are sold using recycled packaging

We use recycled materials for <25% of our product's packaging	We use recycled materials for 25-50% of our product's packaging a	We use recycled materials for 50-75% of our product's packaging	We use recycled materials for >75% of our product's packaging

Supply chain engagement – KPI 15 and 16

KPI 15 and 16 are improved on *relevance, formulation* and *interpretation* by making KPI 15 to measure the engagement of suppliers and service providers upstream in the supply chain and KPI 16 to measure the engagement of industrial buyers downstream in the supply chain.

KPI 15 There are selection criteria for suppliers and/or service providers based on the circular economy (upstream)

There are no selection criteria for suppliers and/or service providers	We prefer suppliers and/or service providers that have a good circular	There are selection criteria for the most important suppliers	There are selection criteria for all suppliers and/or service providers

based on circular economy	economy performance, but do not have selection criteria	and/or service providers based on circular economy	based on circular economy and we engage them to increase their circular economy performance

KPI 16 There are selection criteria for industrial buyers based on the circular economy (downstream)

There are no selection criteria for industrial buyers based on circular economy	We prefer industrial buyers that have a good circular economy performance, but do not have selection criteria	There are selection criteria for the most important industrial buyers based on circular economy	There are selection criteria for all industrial buyers based on circular economy and we engage them to increase their circular economy performance

Use of natural capital – KPI 17 to 21

Both KPI 17 and 18 are improved on *relevance, data availability* and *interpretation,* KPI 17 on *quantification* and KPI 18 on *formulation.* As found in the interviews, KPI 18 now measures the generation of renewable energy by the company itself instead of addressing a reliable production source, because this does per se address the use of renewable energy.

KPI 17 The consumed energy is renewable

None of our energy input comes from renewable sources	< 50% of our energy input comes from renewable sources	50-75% of our energy input comes from renewable sources	>75% of our energy input comes from renewable sources

KPI 18 We generate our own renewable energy

We do not generate our own renewable energy	We generate less than 25% of our own renewable energy	We generate 25-75% of our own renewable energy	We generate >75% our own renewable energy

Both KPIs 19 and 20 are improved on *relevance, indicator applicability, data availability* and *interpretation,* and KPI 20 on *formulation* and *quantification.* As found in the interviews, the *applicability* of KPI 19 and 20 dependent on the business characteristic: whether businesses use material which has a *technical* or *biological* nature. Hereby *technical* material follows the technical cycle of the CE and *biological* material follows the biological cycle, see section 2.1.2. So the difference between following the *technical* and *biological* cycle of the CE depend on whether businesses produce *usables* vs *consumables* (product-level) or use *technical* or *biological* material (material-level). This is not the same, as material can have a *biological* nature (e.g. cotton) but processed to *usables* (e.g. clothing). In order to clarify the distinction, the terms *technical* and *biological* are only used in KPI 19 and 20. Note that businesses can use both *technical* and *biological* material for their products (e.g. food in packaging). In that case both KPI 19 and 20 are applicable to the business.

In order to make sure only the applicable KPIs are used to assess a business, three separate lists are created:

1) For *technical* material: KPI addressing the technical input
2) For *biological* material: KPI addressing the biological input
3) For both: KPIs addressing technical and biological input

An additional KPI was suggested by an interviewee (F) concerning whether non-toxic materials are used, see section 4.3.1. This is not added as an additional KPI as only one interviewee made this remark, however it is a valuable addition to the KPI measuring biological material input, see KPI 20.

For products of *technical* material:

KPI 19 The extent to which technical input stream comes from pre-used materials

<25% of our technical input materials are pre-used	20-50% of our technical input materials are pre-used	50-75% of our technical input materials are pre-used	>75% of our technical input materials are pre-used

For products of *biological* material:

KPI 20 The biological material input stream is bio-degradable, non-toxic and/or sustainable (fiber, food, etc.)

<25% of our biological material input stream is bio-degradable, non-toxic and/or sustainable	25-50% of our biological material input stream is bio-degradable, non-toxic and/or sustainable	50-75% of our biological material input stream is bio-degradable, non-toxic and/or sustainable	>75% of our biological material input stream is bio-degradable, non-toxic and/or sustainable

For both:

KPI 19 The extent to which technical input stream comes from pre-used materials

<25% of our technical input materials are pre-used	20-50% of our technical input materials are pre-used	50-75% of our technical input materials are pre-used	>75% of our technical input materials are pre-used

KPI 20 The biological material input stream is bio-degradable, non-toxic and/or sustainable (fiber, food, etc.)

<25% of our biological material input stream is bio-degradable, non-toxic and/or sustainable	25-50% of our biological material input stream is bio-degradable, non-toxic and/or sustainable	50-75% of our biological material input stream is bio-degradable, non-toxic and/or sustainable	>75% of our biological material input stream is bio-degradable, non-toxic and/or sustainable

KPI 21 is improved on *indicator applicability, data availability* and *interpretation.* The KPI is made applicable to all types of businesses for it addresses all oil-based inputs. Examples are added to explain what the KPI measures and to make clear this question does not address the use of bio-diesel, which is measured in KPI 25 and was an often misinterpretation in the interviews.

KPI 21 The extent to which oil-based inputs for our products are replaced by bio-based inputs (e.g. packaging, fiber, plastic bags)

<25% of our traditional oil-based inputs are replaced by bio-based inputs	20-50% of our traditional oil-based inputs are replaced by bio-based inputs	50-75% of our traditional oil-based inputs are replaced by bio-based inputs	>75% of our traditional oil-based inputs are replaced by bio-based inputs

Managing externalities – KPI 22 to 24

KPI 22 is improved on *indicator applicability, data availability* and *interpretation.* Examples are added from EMF (2015) and it is emphasized that the KPI is an addition to internal CE activities, not as an indulgence. Additionally, as interviewees highlighted that it would be almost impossible to measure the ratio between the recovery and extraction of the ecosystem, the KPI now focusses first on whether the business is involved in ecosystem and second whether the business knows their extraction-recovery ratio.

KPI 22 We are involved in ecosystem recovery as addition to our internal CE activities (e.g. reducing damage to systems and areas such as food, mobility, shelter, education, health and entertainment)

We are not involved in ecosystem recovery and do not know if our extraction exceeds natural restoration	We are involved in ecosystem recovery, but do not measure what this implies for our business	We are involved in ecosystem recovery and know that our investment in restoring ecosystems is less than our extraction	We are involved in ecosystem recovery and know that our investment in restoring ecosystems is equal to or higher than our extraction.

KPI 23 and 24 are both improved on *interpretation,* KPI 23 on *formulation* and KPI 24 on *quantification.* The *interpretation* is improved by clarifying the difference between both KPIs: one measuring targets and other the actual reduction of waste. Although some interviewees suggested to *quantify* KPI 24 and the overall aim is to use as much quantification as possible, KPI 24 is left qualitative. The reason for this is that it would be difficult to compare waste reductions in terms of reduced waste in percentages. It has to be avoided that a company who reduces a lot of waste will get a better score than a company who has already done the maximum on waste reduction. Changing this to relative terms is also not possible because the *maximum on waste reduction* is different per company and will depend highly on the interpretation of the company.

KPI 23 We monitor and have targets to minimize our waste

We do not know how much waste we produce nor have targets to minimize our waste	We monitor our waste but do not have targets to minimize our waste	We monitor our waste stream and have targets to minimize our waste	We monitor our waste, have a clear policy, targets and implementation plan for waste minimization

KPI 24 We reduce our waste stream

We currently do not reduce our waste stream	We reduce waste through internal process optimization on one waste stream	We reduce waste through internal process optimizations on multiple waste streams	We reduce waste through internal process optimizations on multiple waste streams and create closed loop systems, where our waste is reused by ourselves or another company

Transport – KPI 25

KPI 25 is improved on *formulation, data availability* and *interpretation.* There are examples added and non-polluting is replaced by electric and biofuels.

KPI 25 Modes of transport are electric or on biofuels (employees, distribution)

<25% of our transport is electric or on biofuels	25-50% of our transport is electric or on biofuels	50-75% of transport is electric or on biofuels	>75% of our transport is electric or on biofuels

Performance categories

When improving the KPIs for the CGS, also the four categories of the KPIs which correspond to the shade of blue in the KPIs need to be adapted accordingly. The performance categories from Ruiter (2015) were going from 1) doing nothing or little on sustainability, 2) operating sustainable, 3) operating somewhat circular to 4) completely circular. However, as the scope of this research is to frame CE as part of sustainability, see section 4.1.2, the performance categories used in the improved KPIs for the CGS are going from: 1) doing nothing on circularity, 2) operating somewhat circular, 3) operating circular and 4) completely circular. Hereby *nothing* and *completely* are extreme terms, therefore many KPIs are distinguished by percentages, namely <25%, 25-50%, 50-75% and >75% circular.

5.2.2 Flow chart of the KPIs

In order to guide a business to the KPIs which are applicable for them, the flow chart in figure 15 can be used. The influence of the two business characteristics can be found through the splits at the pink bars. The comment tree on the right side of the flow chart summarizes the main improvements made to the KPIs. The numbering of the KPIs correspond to the numbering used in section 5.2.1. The final CEI for the CGS is presented in Appendix E with corresponding flow chart. Here the KPIs have got a new subsequent numbering, so does the flow chart.

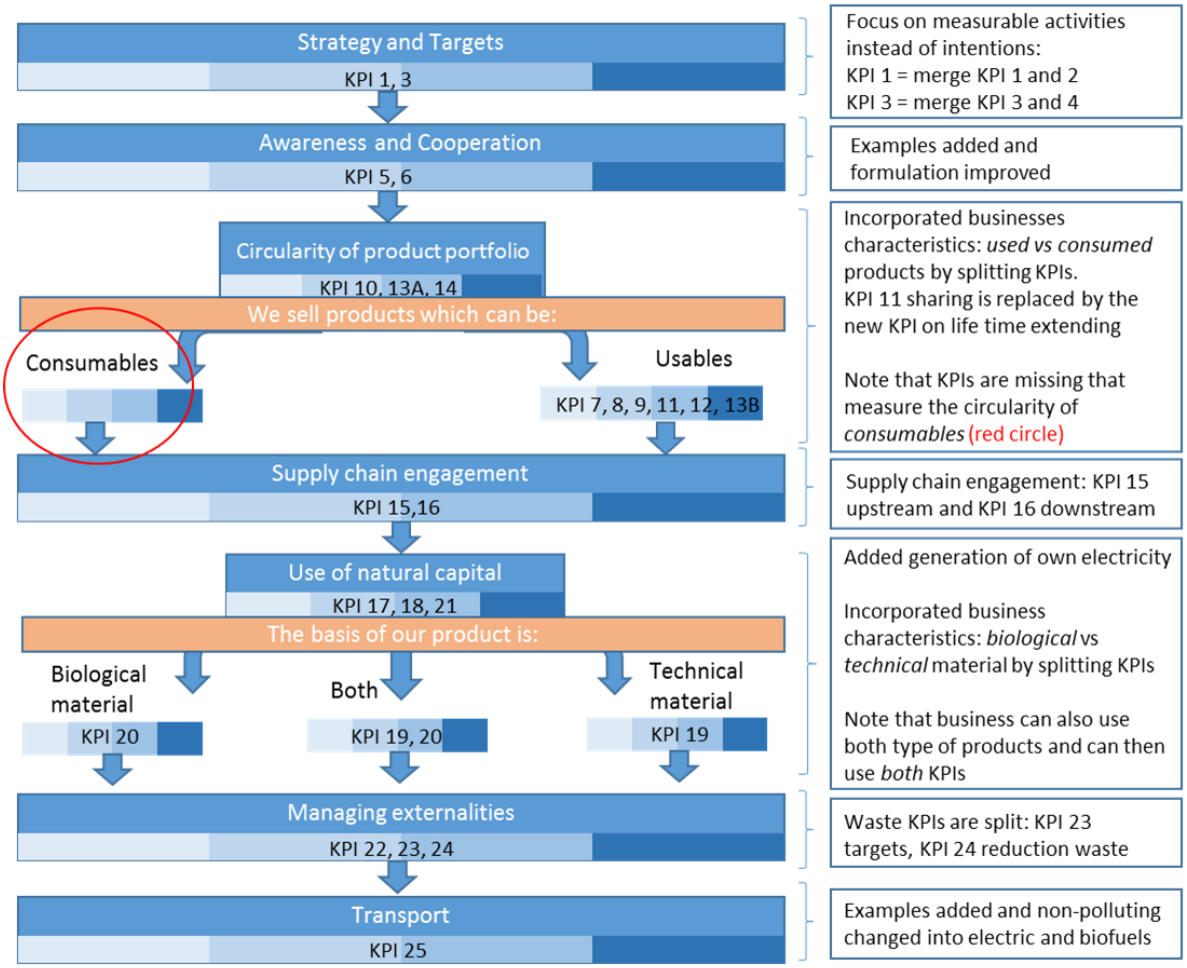

Figure 15 Flow chart CEI for the CGS and comment tree

5.2.3 From KPIs to index score

To get from the KPIs to the index score, first the KPI importance is improved according to the findings in the interviews and second the KPIs are weighted accordingly. Third, a scoring card is presented to calculate the index score. Fourth, the circular economy performance ladder is improved to and can be used to position a business, based on the company score.

KPI importance

When comparing the findings from the interviews (section 4.3.5) to the KPI importance of Ruiter (2015) (section 2.2.2), it turned out that most KPIs which are found to be important are already weighted high (KPI 8, 17, 19, 20). Therefore, only the importance of a few KPIs needs to be modified. KPI 1 and 6 are changed from medium to high importance. KPI 24 is increased while KPI 23 is decreased in importance. By doing so, focus is on the actual implementation of waste reduction (KPI 24) instead of only the

intention of doing so (KPI 23). KPI 22 was found by interviewees to be not important at all compared to implementing the CE internally within your business and is therefore decreased in importance.

The interviews showed that the importance of some KPIs differed between business selling *usables* and *consumables.* This is taken into account by creating two separate lists of KPI importance, see table 12. For the *consumables* KPIs 13A and 14 is made more important, while these are less important for *usables.* The KPIs addressing the either *technical* or *biological* nature of the material have a similar importance, just as applicable KPIs for both *usables* and *consumables.* This leads to the following KPI importance:

Table 12 KPI importance in CEI for CGS

KPIs *Consumables*	KPIs *Usables*	Description
KPI 1	KPI 1	We have a strategy on the circular economy and know what it implies for our business
KPI 3	KPI 3	The circular economy is part of our targets and we measure our progress towards these targets
KPI 5	KPI 5	We create awareness on the circular economy strategy of the business among employees
KPI 6	KPI 6	We cooperate on the topic circular economy
N.A	KPI 7	Products contain recovered components
N.A	KPI 8	Products are designed to disassemble, remanufacture and/or repair
N.A	KPI 9	The amount of products that are recycled or upcycled post-consumer
KPI 10	KPI 10	Unsold products are resold/reused/redistributed to third parties who maintain the highest value possible
N.A	KPI 11	We offer a service to extend the life time of our products
N.A	KPI 12	Products can be leased by consumers
KPI 13A	KPI 13A	We offer reversed logistics of packaging and/or cooperate with third parties in a deposit system
N.A	KPI 13B	We offer reversed logistics to return products after their usage
KPI 14	KPI 14	Products are sold using recycled packaging
KPI 15	KPI 15	There are selection criteria for suppliers and/or service providers based on the circular economy (upstream)
KPI 16	KPI 16	There are selection criteria for industrial buyers based on the circular economy (downstream)
KPI 17	KPI 17	The consumed energy is renewable
KPI 18	KPI 18	We generate our own electricity
KPI 19	KPI 19	The extent to which technical input stream comes from pre-used materials
KPI 20	KPI 20	The biological material input stream is bio-degradable, non-toxic and/or sustainable (fiber, food, etc.)
KPI 21	KPI 21	The extent to which oil-based inputs for our products are replaced by bio-based inputs (e.g. packaging, fiber, plastic bags)
KPI 22	KPI 22	We are involved in ecosystem recovery as addition to our internal CE activities (e.g. planting trees, social programs, charity)
KPI 23	KPI 23	We monitor and have targets to minimize our waste
KPI 24	KPI 24	We reduce our waste stream
KPI 25	KPI 25	Modes of transport are electric or on biofuels (employees, distribution)

Weighting of KPIs

A single and comparable score for businesses on the CEI can be calculated based on the KPI importance categorization and weighting. As businesses of *consumables* have a different KPI importance then businesses of *usables,* there are two separate scoring overviews created, see table 13 and 14. The

colors represent the four categories of the KPIs, with corresponding score and weighting. Both tables are modified from table 2 scoring overview from Ruiter (2015) in section 2.2.2.

Table 13 Scoring overview for *consumables*

Weight	# KPIs	Score per category				Score incl. weighting				Scores per KPI category			
		1	2	3	4	Min			Max	Min			Max
3 (High)	10	-1	0	1	2	-3	0	3	6	-30	0	30	60
2 (Med)	6	-1	0	1	2	-2	0	2	4	-12	0	12	24
1 (Low)	2	-1	0	1	2	-1	0	1	2	-2	0	2	4
Totals										**-44**	**0**	**44**	**88**

In table 13 the upper row shows the following: the KPIs with a high importance (red) have a weighing of 3 (first column). As shown in table 13 there are 10 KPIs with a high importance (second column). The four categories of the KPIs have a different score ranking from -1 to +2 which is similar for all KPI importance categorizations (third column). However, since the weighting for high important KPIs is 3 this leads to a score between -3 and +6 (fourth column). This makes up a minimum score of 11*-3= -33 and maximum score of 11*6=66 (fifth column) for high importance KPIs. As table 13 shows, businesses of *consumables* who are ranked in the Circular Economy Index have a range between -44 (not circular) and 88 (fully circular). To normalize the scores of the companies, the score need to be divided by 0.88 in order to obtain the final index score. By doing so, the company obtaining a score of 88 will have a final index score of 100, which allows for an easier comparison with other businesses and a determinant of how circular a business is in percentages.

Table 14 Scoring overview for *usables*

Weight	# KPIs	Score per category				Score incl. weighting				Scores per KPI category			
		1	2	3	4	Min			Max	Min			Max
3 (High)	11	-1	0	1	2	-3	0	3	6	-33	0	33	66
2 (Med)	8	-1	0	1	2	-2	0	2	4	-16	0	16	32
1 (Low)	5	-1	0	1	2	-1	0	1	2	-5	0	5	10
Totals										**-44**	**0**	**44**	**88**

As table 14 shows, businesses of *usables* who are ranked in the Circular Economy Index have a range between -54 (not circular) and 108 (fully circular). To normalize the scores of the companies, the final score need to be divided by 1.08 in order to obtain the index score. By doing so, the company obtaining 88 credits will have a final index score of 100. Through the normalizations of both *consumables* and *usables* businesses in percentages, both types of businesses can be compared in the CEI.

Scoring card

In order to calculate the index score of a business, the score card as presented in table 15 can be used. This scoring card is created for both businesses of *consumables* (left column) and *usables* (right column).

Table 15 Scoring card for both *usables* and *consumables*

KPIs ***Consumables***	KPIs categories				Weighting per category				Score	KPIs ***Usables***	KPIs categories				Weighting per category				Score
KPI 1	1	2	3	4	-3	0	3	6		**KPI 1**	1	2	3	4	-3	0	3	6	
KPI 3	1	2	3	4	-3	0	3	6		**KPI 3**	1	2	3	4	-3	0	3	6	
KPI 5	1	2	3	4	-2	0	2	4		**KPI 5**	1	2	3	4	-2	0	2	4	
KPI 6	1	2	3	4	-3	0	3	6		**KPI 6**	1	2	3	4	-3	0	3	6	
N.A										**KPI 7**	1	2	3	4	-3	0	3	6	

N.A										**KPI 8**	1	2	3	4	-3	0	3	6	
N.A										**KPI 9**	1	2	3	4	-3	0	3	6	
KPI 10	1	2	3	4	-2	0	2	4		**KPI 10**	1	2	3	4	-2	0	2	4	
N.A										**KPI 11**	1	2	3	4	-2	0	2	4	
N.A										**KPI 12**	1	2	3	4	-2	0	2	4	
KPI 13A	1	2	3	4	-3	0	3	6		**KPI 13A**	1	2	3	4	-1	0	1	2	
N.A										**KPI 13B**	1	2	3	4	-1	0	1	2	
KPI 14	1	2	3	4	-3	0	3	6		**KPI 14**	1	2	3	4	-1	0	1	2	
KPI 15	1	2	3	4	-2	0	2	4		**KPI 15**	1	2	3	4	-2	0	2	4	
KPI 16	1	2	3	4	-2	0	2	4		**KPI 16**	1	2	3	4	-2	0	2	4	
KPI 17	1	2	3	4	-3	0	3	6		**KPI 17**	1	2	3	4	-3	0	3	6	
KPI 18	1	2	3	4	-1	0	1	2		**KPI 18**	1	2	3	4	-1	0	1	2	
KPI 19	1	2	3	4	-3	0	3	6		**KPI 19**	1	2	3	4	-3	0	3	6	
KPI 20	1	2	3	4	-3	0	3	6		**KPI 20**	1	2	3	4	-3	0	3	6	
KPI 21	1	2	3	4	-3	0	3	6		**KPI 21**	1	2	3	4	-3	0	3	6	
KPI 22	1	2	3	4	-1	0	1	2		**KPI 22**	1	2	3	4	-1	0	1	2	
KPI 23	1	2	3	4	-2	0	2	4		**KPI 23**	1	2	3	4	-2	0	2	4	
KPI 24	1	2	3	4	-3	0	3	6		**KPI 24**	1	2	3	4	-3	0	3	6	
KPI 25	1	2	3	4	-2	0	2	4		**KPI 25**	1	2	3	4	-2	0	2	4	
							Total score:										**Total score:**		
							Divide by:		**0.88**								**Divide by:**		**1.08**
							Company score in CEI:										**Company score in CEI:**		

Circular Economy Performance Ladder

In order to rank and compare companies within the Index on their circularity performance, a Circular Performance Ladder can be used. The ladder makes it possible to quickly determine to what extent a business has made the transition towards a circular economy by using five steps. In order to make this ladder useful for the CGS, the ladder is improved by 1) adapting it to the scope of this research in which CE is framed as part of sustainability and 2) including the new KPI importance from table 12 in the definition of the five steps of the ladder. This leads to the following ladder, see figure 16. The red terms are the improved parts.

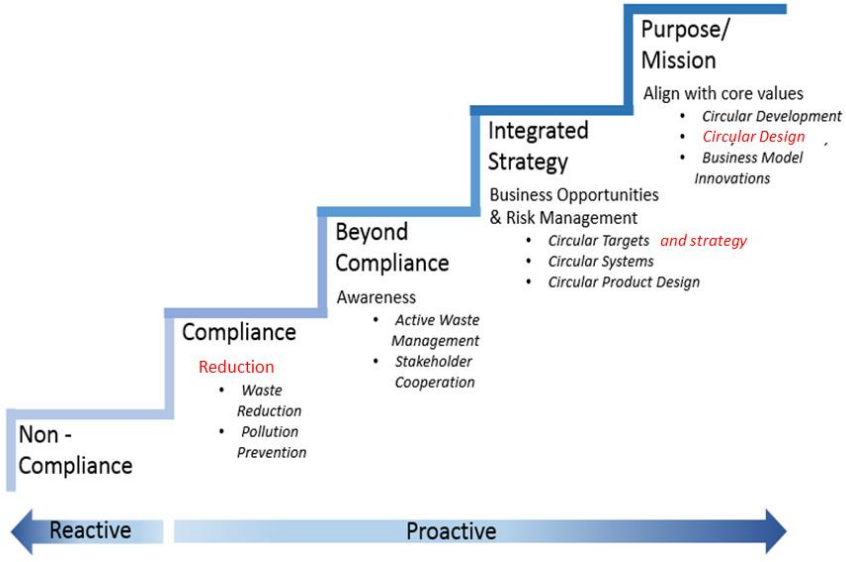

Figure 16 The Circular Performance Ladder for the CGS

The first step *non-compliance* concerns companies who do nothing in the field of circular economy and correspond to the negative companies scores. The second step *compliance* have waste reduction and pollution prevention policies and a pro-active mind-set but do not implement any other aspect of the circular economy. Third step *beyond compliance* are companies who are aware of the circular economy trend and act accordingly. They have active waste management systems, are looking at opportunities for reduction and extraction value from direct waste and waste further in the supply chain. Fourth, *integrated strategy* companies have a full overview of the opportunities the circular economy can bring and develop their business accordingly by setting circular targets and designing circular products. The fifth step are companies who have circularity as their *purpose* and *mission* and have innovated their traditional business models to a full extent. Table 16 shows the companies score related to the five steps on the ladder.

Table 16 Performance ladder steps and index scores

Step	Non-Compliance	Compliance	Beyond Compliance	Integrated Strategy	Purpose/Mission
Score	-50 - 0	1-25	26-50	51-75	76-100

5.2.4 Assessment

Businesses in the consumer goods sector can be assessed and scored for the Circular Economy Index by means of the flow chart, KPIs, scoring card and performance ladder presented in Appendix E. Note that in Appendix E the numbering and order of the KPIs has changed in order to present subsequent numbering in the flow chart. To perform the assessment and obtain the company score, the following steps have to be followed:

1) Determine characteristics of the business:
    a. Does the business sell *consumables* or *usables?*
    b. Does the business use *technical* or *biological* material?
2) Follow the flow chart according to the business characteristics (Appendix E1) and determine the categories 1) doing nothing on circularity, 2) operating somewhat circular, 3) operating circular and 4) completely circular, fitted to the business on all applicable KPIs (Appendix E2)
3) Fill in the scores of the business on the scoring card (Appendix E3)
4) Calculate the score per KPI, total score and company score in CEI
5) Determine position on Circular Performance Ladder (Appendix E4) with use of table performance ladder steps and company score (Appendix E5)

To provide an example on how to obtain an Index score, the right side of table 17 is filled in for an imaginary company Z (red) which produces *usables* and uses only *technical* material, after following the 5 steps. Table 17 is the final scoring card presented in Appendix E3.

Table 17 Scoring card for both *usables* and *consumables* – Company Z

KPIs *Consumables*	**KPIs categories**				**Weighting per category**				**Score**	**KPIs *Usables***	**KPIs categories**				**Weighting per category**				**Score**
KPI 1					-3	0	3	6		**KPI 1**		x			-3	0	3	6	**0**
KPI 2					-3	0	3	6		**KPI 2**			x		-3	0	3	6	**3**
KPI 3					-2	0	2	4		**KPI 3**			x		-2	0	2	4	**2**
KPI 4					-3	0	3	6		**KPI 4**			x		-3	0	3	6	**3**
KPI 5					-2	0	2	4		**KPI 5**		x			-2	0	2	4	**0**
KPI 6					-3	0	3	6		**KPI 6**		x			-1	0	1	2	**0**

KPI 7					-3	0	3	6		**KPI 7**				x	-1	0	1	2	**1**
N.A										**KPI 8**				x	-3	0	3	6	**3**
N.A										**KPI 9**				x	-3	0	3	6	**3**
N.A										**KPI 10**				x	-3	0	3	6	**3**
N.A										**KPI 11**			x		-2	0	2	4	**2**
N.A										**KPI 12**			x		-2	0	2	4	**2**
N.A										**KPI 13**			x		-1	0	1	2	**1**
KPI 14					-2	0	2	4		**KPI 14**	x				-2	0	2	4	**-2**
KPI 15					-2	0	2	4		**KPI 15**	x				-2	0	2	4	**-2**
KPI 16					-3	0	3	6		**KPI 16**		x			-3	0	3	6	**0**
KPI 17					-1	0	1	2		**KPI 17**		x			-1	0	1	2	**0**
KPI 18					-3	0	3	6		**KPI 18**		x			-3	0	3	6	**0**
KPI 19					-3	0	3	6		**KPI 19**			x		-3	0	3	6	**3**
KPI 20					-3	0	3	6		**KPI 20**			x		-3	0	3	6	**3**
KPI 21					-1	0	1	2		**KPI 21**				x	-1	0	1	2	**1**
KPI 22					-2	0	2	4		**KPI 22**				x	-2	0	2	4	**2**
KPI 23					-3	0	3	6		**KPI 23**				x	-3	0	3	6	**3**
KPI 24					-2	0	2	4		**KPI 24**				x	-2	0	2	4	**2**
								Total score:										**Total score:**	**33**
								Divide by:	**0.88**									**Divide by:**	**1.08**
								Company score in CEI:	**…%**									**Company score in CEI:**	**31%**

After followed step 1 to 4, it is found that company Z obtained a score of 31% on the CEI, see table 17. When following step 5, in Appendix E4 and E5 is found that 31% correspond to the third step on the Circular Performance Ladder: *beyond compliance*.

5.3 Limitations

This research shows the complexity of measuring and comparing the performance of businesses on such a comprehensive topic as the circular economy, even within one specific sector. When reflecting on the research, some limitations can be identified for the CEI for the CGS and for the method used in this research.

There are two limitation of the CEI for the CGS. First, the biological cycle of the circular economy is currently under addressed by the CEI for the CGS. This means the CEI is currently less useful to measure the circular performance of businesses who sell *consumables.* This needs to be taken into account when using the Circular Economy Index to compare businesses, especially when the CE performance of businesses selling *consumables* is compared to businesses selling *usables.* The second limitation is that in this research the level of detail of the KPIs is increased but the KPIs are still quit general to enable a benchmark which was one of the functions of the CEI. However, through the interviews was found that general KPIs are often multi-interpret and are not very useful to guide businesses in improving their level of circularity. Additionally, benchmarking increases the risk for greenwashing and trade-offs as businesses will focus more on *seeming* more circular instead of *becoming* more circular. Which unfortunately is not the same, especially not for a difficult concept as the circular economy, for it entails radical changes in business operations which often leads to resistance to change (Lozano, 2013). Since the overall goal of the CEI is not to benchmark businesses, but to accelerate their transition towards a circular economy, the question rises whether the CEI should include a benchmark at all. However, even at a detailed level, the KPIs attempt to measure and compare highly complex and diverse processes in relatively simple measures with the risk of oversimplification (Bell & Morse, 2008). It should be kept in mind when using the CEI that the method to assess the businesses also measures

what is measurable and thereby represent a simplification of reality instead of an unquestionable truth.

Additionally, five scientific limitations can be identified. First is the use of empirical data from only seven businesses which limits the generalisability of the results and decreases the external validity of the research (Saunders et al., 2009). Although in the case selection process the sub segmentation of the CGS is taken into account, the selected cases cannot claim to be representative for the whole CGS. However, as the largest Dutch businesses are selected, a relatively large share of the CGS market is covered which increases the generalisability. Second, the case selection is based on the sub segmentation of the global CGS, while the scope of this research is to focus on the Dutch CGS. The assumption that both levels are similar caused a possible bias in the research. Third, some of the interviews were conducted in Dutch and later translated into English when used as quotes. This may have resulted in interpretational errors of translated quotes, although the possible error reduced by translating as literal as possible. Fourth, semi-structured interview questions where used in this research as it was found that interviewee's viewpoints were more likely to be expressed in an openly designed interview situation than an standardized interview or questionnaire (Flick, 2006). However, this could be subject to a participant bias as the semi-structured interview questions gives more room for open interpretation and the possibility that interviewees have been saying what their bosses wanted them to say, which is a risk to the internal validity of the findings (Saunders et al., 2009). However, this bias is decreased with multiple pilot tests performed prior to the research, ensuring the anonymity of the interviewees and by having an additional interview with a CGS expert who did not represented a specific business which increased his objectivity (Saunders et al., 2009). Fifth, a limitation of the CE indicator validation model used in this research is that the criteria use to some extent subjective terms like *suitable* and *acceptable* which can be a threat to the reliability of the results, as this has the risk of being interpreted differently by other researchers (Saunders et al., 2009). However, this observer bias has been reduced by thoroughly explaining why a KPI was found to be valid or not valid on a given criteria and with use of additional academic literature.

5.4 Recommendations

5.4.1 Advice to business

The methods to obtain the Circular Economy Index presented in appendix E can be used by Accenture to assess the circularity performance of the Dutch businesses within the consumer goods sector. To assess businesses in a structured and comparable way, it is advised to follow the five steps when assessing the business as described in section 5.2.4 and use the flow chart, KPIs, scoring card and circular economy performance ladder in Appendix E.

Given the risks associated with benchmarking with other businesses, it is advised to use the CEI mainly for its two other functions: 1) as a roadmap for businesses on what the CE entails and what to improve in order to become more circular, 2) to measure the performance of a business on the circular economy. It is advised to benchmark businesses only internally on their performance within a set timeframe, for example once a year. Additionally, when assessing the business, Accenture is advised to not use a self-survey/questionnaire as recommended by Ruiter (2015), but to perform the assessment together with the business. By doing so, ambiguities can be clarified, businesses are helped to translate the general KPIs to their specific and often highly complex situation and it is possible to control the conditions in which the assessment is performed. This will increases the internal validity, comparability (both internal and external) and reliability of the findings and thereby the quality of the Circular Economy Index for both Accenture and assessed businesses (Bryman, 2008; Saunders et al., 2009). Finally, it is advised to consider the presented Circular Economy Index for the consumer goods

sector a useful method to assess and guide businesses in their transition but not as an unquestionable truth given the complexity of assessing the businesses and simplification associated with the CEI.

5.4.2 Further research

A suggestion for further research is to develop KPIs specifically on the biological cycle of the circular economy and incorporate those in the presented Circular Economy Index in this research in order to increase the usefulness of the CEI for businesses of *consumables* in the consumer goods sector. It is recommended to develop KPIs that measure the regeneration of new resource value of products and materials that are not consumed through the decomposition of biological nutrients (EMF, 2015). A suggestion for this research is to use the book *Permaculture, a Designers' Manual* from the Austrian ecologists Bill Mollison (1975) as a basis for the KPIs as it promotes *conscious design and maintenance of agriculturally productive ecosystems which have the diversity, stability and resilience of natural ecosystems* (p.1) and forms amongst others the foundation of the biological cycle designed by EMF (2013). Additionally, further research is suggested on the effect of benchmarking for the transition of businesses in the circular economy to provide an answer to whether the CEI should include a benchmark or not. Last, further research could be of help to address the question whether the social pillar should be incorporated into the circular economy or not. As the overall goal of the circular economy is sustainable development, including the social pillar could be of help. However, this would imply changes for the Circular Economy Index which needs to be further researched.

6 Conclusion

A worldwide transition towards the circular economy is needed to restore the balance and harmony between economy, environment and society. To guide this transition indicators can be of help that measure the CE performance of businesses and identify opportunities to improve their level of circularity. Although many CE studies have been published worldwide, there is a lack of academically-sound CE indicators. A promising attempt is the Circular Economy Index developed by Ruiter (2015) who uses Key Performance Indicators to measure and guide the transition of businesses towards a circular economy, although the CEI was not yet tested nor enabled a fair comparison of businesses because sector-specific differences were not incorporated into the CEI yet. This research attempts to fill this gap by testing and improving the CEI for the largest sector worldwide: the consumer goods sector. Reason for this is the crucial role of the CGS in accelerating the transition towards a circular economy within the CGS for it is accountable for enormous global food wastes and at the same time highly vulnerable to resource scarcity. Therefore this research aims to answer the main research question:

What would be a Circular Economy Index to assess the level of circularity of businesses in the consumer goods sector?

It is found that measuring and comparing businesses within the consumer goods sector is highly complex, primarily due to differences in two main business characteristics: 1) whether businesses sell *usables* or *consumables* and 2) whether businesses use *technical* or *biological* material. Together with additional findings on the development of the CEI, the performance of the individual KPIs and the opinion of businesses on the usefulness of the CEI, the CEI is improved to be applicable for the CGS. This resulted in a Circular Economy Index that can be used to assess, guide and compare businesses within the consumer goods sector by measuring a company score through five chronological steps: 1) determine characteristics of the business (*usables* or *consumables* and *technical* or *biological* material used) 2) use the flow chart according to the business characteristics and determine the score of the business in the four categories: 1) doing nothing on circularity, 2) operating somewhat circular, 3) operating circular and 4) completely circular, on all applicable KPIs, 3) fill in the scores of the business on the scoring card, 4) calculate the score per KPI, total score and company score in CEI on the scoring card and 5) determine the position of the business on the Circular Performance Ladder to quickly determine to what extent a business has made the transition towards a circular economy within the consumer goods sector.

Although it is found that measuring and specifically comparing businesses in the consumer goods sector on their CE performance is complex, the developed Circular Economy Index can serve as a roadmap for businesses on what the CE entails and what needs to be improved in order to become more circular. With especially internal benchmarking, the progress of the business can be measured and compared throughout a set time frame. By doing so, the CEI can stimulate businesses to shift from an unsustainable linear to a fully circular business model and thereby accelerate the transition towards a circular economy within the consumer goods sector.

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Appendix A – KPIs from Ruiter (2015)

KPI 1 We are involved in the circular economy trend

We do not have a sustainability strategy	We have a sustainability strategy, but circularity is not mentioned in it	We have a sustainability strategy that includes circular economy	We have a sustainability strategy in which circular economy is a priority

KPI 2 We know what the circular economy means for our company

We have not analyzed the implications of the circular economy for our business	We have anecdotal evidence of the implications of the circular economy for our business	We have analyzed the implications of the circular economy for our business at strategic level	We have analyzed the implications of the circular economy for all aspects of our business (e.g. finance, safety, competitiveness, supply chain, etc.)

KPI 3 The circular economy is part of our future targets

We do not have targets on this topic	We have targets for sustainability, but these do not include circularity	We have targets on circular economy	We have targets on circular economy and they are SMART

KPI 4 We measure the outcomes of our circular economy practices on a regular basis

We do not have circular economy targets	We measure the outcomes of our circular economy initiatives and progress towards targets on an ad hoc basis	We measure the outcomes of our circular economy initiatives and the progress towards targets on a yearly basis	We measure the outcomes of our circular economy initiatives and the progress towards targets on a quarterly basis

KPI 5 Awareness on the circular economy is created among employees

We do not create awareness among employees	We create awareness on sustainability in general, without covering circular economy	We create awareness on the circular economy through communication	We actively train our employees on the implications of the circular economy for their job

KPI 6 We cooperate on the topic circular economy

We currently do not work with partners on the topic circular economy	We are looking at opportunities to cooperate on the topic circular economy	We are a member of organization(s) that focus on the circular economy or have partnerships of our own	We are a member of organization(s) that focus on the circular economy and have partnerships of our own

KPI 7 Products contain recycled materials or recovered components

<25% of our products are made from recycled materials or recovered components	25%-50% of our products are made from recycled materials or recovered components	50%-75% of our products are made from recycled materials or recovered components	>75% of our products are made from recycled materials or recovered components

KPI 8 Products are designed to minimize waste over their lifetime

<25% of our products are designed to minimize waste over the lifetime	25-50% of our products are designed to minimize waste over the lifetime	50-75% or our products are designed to minimize waste over the lifetime	>75% of products are designed to minimize waste over the lifetime

KPI 9 The amount of products that are recycled or upcycled

<25% of our products are being recycled	25-50% of our products are being recycled	50-75% or our products are being recycled	>75% of products are being recycled

KPI 10 Products can be resold

<25% of our products can be resold	25-50% of our products can be resold	50-75% of our products can be resold	>75% of our products can be resold

KPI 11 Sharing of products by consumers is facilitated

We do not facilitate sharing of our products by consumers	We are looking for ways to facilitate sharing of our products by consumers	We facilitate sharing of <50% of our products by consumers	We facilitate sharing of >50% of our products by consumers

KPI 12 Products can be leased by consumers

Our products cannot be leased	We are looking for ways to facilitate leasing or sharing	We offer a leasing system for <50% of our products	We offer a leasing system for >50%of our products

KPI 13 It is ensured that products are returned after their usage

We do not have end-of-life customer interactions	We are developing customer interaction for recovering products	We have a system to ensure that our products are returned after their usage by consumers	We actively recover our products from consumers at the end of the lifetime

KPI 14 Products are sold using circular packaging and documentation

We use circular materials for <25% of our product's packaging and documentation	We use circular materials for 25-50% of our product's packaging and documentation	We use circular materials for 50-75% of our product's packaging and documentation	We use circular materials for >75% of our product's packaging and documentation

KPI 15 The Circular economy principle is applied to daily operations

There are no requirements for suppliers based on Circular economy	We engage with our suppliers on the topic Circular economy	We prefer suppliers that have a good Circular economy performance	We select our suppliers based on their Circular economy performance

KPI 16 There are selection criteria for suppliers & industrial buyers

There are no requirements for service providers based on circular economy	We engage with our service providers on the topic circular economy	We prefer service providers that have a good circular economy performance	We select our service providers based on their circular economy performance

KPI 17 The consumed electrical energy is renewable

None of our energy input comes from renewable sources	The minority of our energy input comes from renewable sources	The majority of our energy input comes from renewable sources	All of our energy input comes from renewable sources

KPI 18 The consumed electrical energy comes from reliable production sources

We do not consume renewable energy or our renewable energy has a foreign certificate	Our renewable energy has a domestic (Dutch) certificate	Our renewable energy has a domestic (Dutch) Certificate and we invest in the generation of additional renewable energy	We generate our own renewable energy

KPI 19 The extent to which technical input comes from pre-used materials

<25% of our technical input materials are pre-used	25-50% of our technical input materials are pre-used	50-75% of our technical input materials are pre-used	>75% of our technical input materials are pre-used

KPI 20 The biological material input stream is sustainable

We do not know if we extract too much and imbalance natural restoration	Our extraction is equal to or less then natural restoration	Our investment in restoring the environment is equal to our extraction	We invest more in restoring the environment then we extract from it

KPI 21 The extent to which oil-based inputs are replaced by bio-based inputs

<25% of our traditional oil-based inputs are replaced by bio-based inputs	25-50% of our traditional oil-based inputs are replaced by bio-based inputs	50-75% of our traditional oil-based inputs are replaced by bio-based inputs	>75% of our traditional oil-based inputs are replaced by bio-based inputs

KPI 22 Involvement in ecosystem recovery

We do not actively recover ecosystems and do not know if our extraction exceeds natural restoration	Our extraction is equal to or less then natural restoration	Our investment in restoring ecosystems is equal to our extraction	We invest more in restoring the environment then we extract from it

KPI 23 Waste is minimized or eliminated

We do not know how much waste we produce	We report on our waste, but do not focus on minimization	We want to reduce our current waste generation, but do not have clear targets	We have a clear policy, target and implementation plan for waste minimization

KPI 24 Mode of waste reduction

We currently do not reduce our waste	We reduce waste through internal process optimization on one waste stream	We reduce waste through internal process optimizations on multiple waste streams	We reduce waste through internal process optimizations on multiple waste streams and create closed loop systems, where our waste is reused by ourselves or another company

KPI 25 Modes of transport are electric or on biofuels

<25% of our transport is non-polluting	25-50% of our transport is non-polluting	50-75% of transport is non-polluting	>75% of our transport is non-polluting

Appendix B – Criteria for SD indicator selection

Conceptual coherence: relation indicator – measuring object	
Definition	The definition of the indicator and the concepts that comprise it up is suitable. There is a rigorous connection to the definition of sustainability.
Relevance	There is a bi-univocal correspondence between the indicator and the factor to be quantified. Coverage of all relevant categories and resources. The indicators covers the whole spectrum of human activities related to economy and environment but overlap amongst particular indicators should be as small as possible. Coherence and completeness. The selection of meaningful indicators represent holistic fields.
Interpretation/ meaning	The interpretation and meaning of the indicator are suitable
Operational coherence: correct definition of the internal operations of the indicator	
Formulation	The mathematical formulation of the indicator is suitable with regard to the concept which is to be quantified. The indicators are as simple as possible.
Data and units	The data used to establish the indicator and its units are suitable.
Measuring method - Reproduction	The proposed measurement procedures to obtain the indicators is suitable, allowing for its reproduction and comparison.
- Transparency	The index should be sufficiently transparent in composition, allowing for the possibility to derive political objectives. Policy relevance.
Accuracy - Quantification	The accuracy is suitable to quantify the factor. The elements are readily measurable.
- Sensitivity & Timeline	The indicator is sensitive for changes in the latter. The chosen indicators are sensitive enough to reflect important changes in environmental characteristics. Frequency and coverage of the elements should be sufficient to enable timely identification of the performance trends. Link to a timeline for production of the data and calculation of the indicator. The indicator is process orientated.
- Comparability	The indicators enable a fair comparison through normalization or/and weighting.

Utility: applicability of the indicators

Reliability - Indicator	The indicators' reliability is suitable.
- Sources	The reliability of the sources of data which the indicator is made up of is suitable.
Data Availability	The accessibility of the data is suitable. The data is available for quantification over longer time horizons. The elements are capable of being monitored to establish performance trends.
Indicator Applicability	The applicability of the indicator is suitable. Applicability to different levels of economic activities (EU, countries, sectors, firms, products).
Information - Security - Costs	The information provided by the indicators is reliable. The costs of the information offered by the indicators can be considered acceptable.

Legend for table Appendix B:

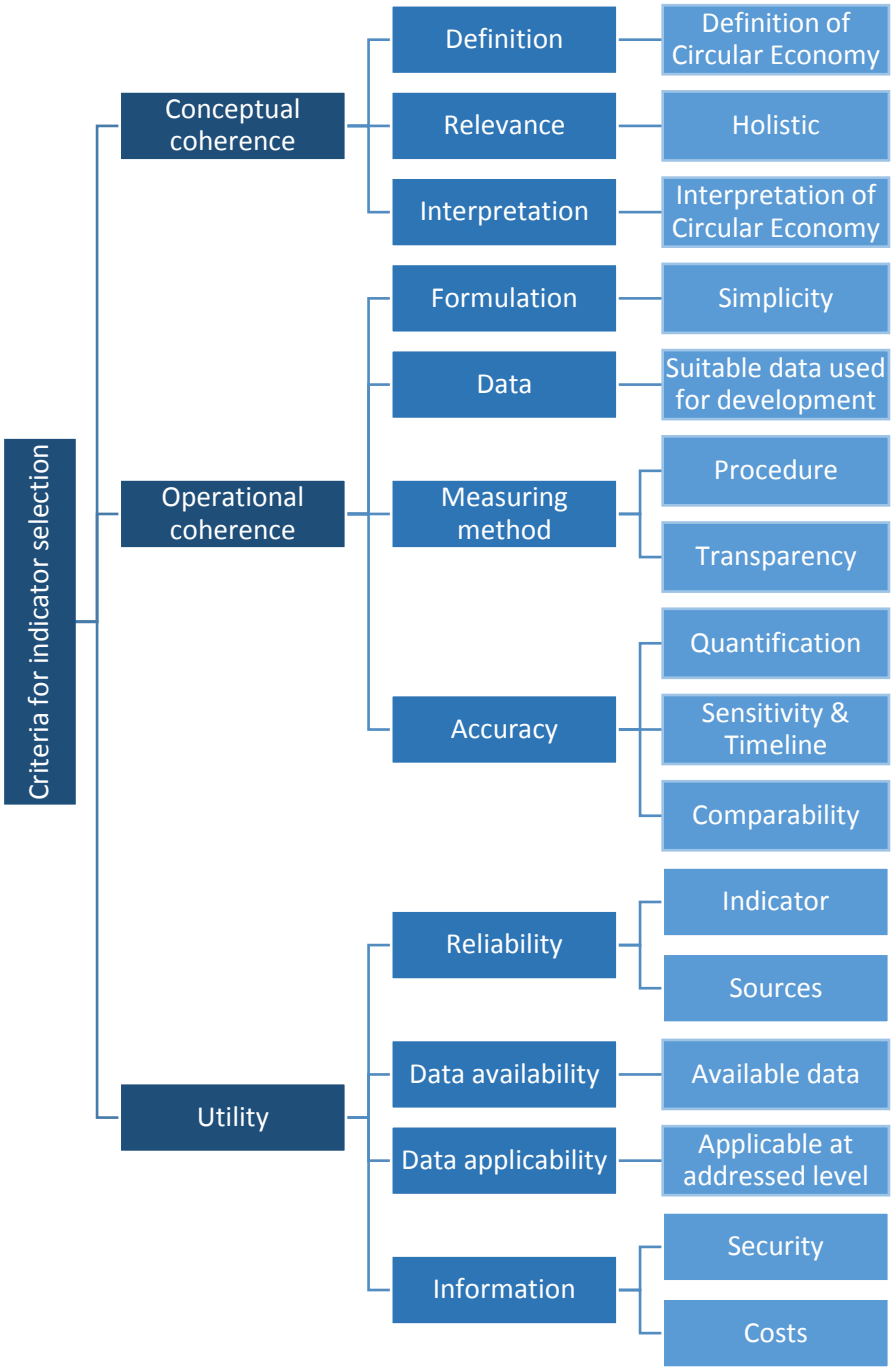
Cloquell-Ballester et al. (2006)

Böhringer & Jochem (2007)

Harger & Meyer (1996)

European Commission (2013b)

Appendix C – CE indicator validation model



Appendix D – Interview design

Aim of this research is to test and improve the Circular Economy Index (CEI) as developed by Ruiter (2016) and modify this index for the consumer goods sector. The CEI measures the transition of a business towards a circular economy through 25 Key Performance Indicators (KPIs). By doing so, the current state of businesses in this transition is identified and compared to other companies. The CEI can also be used as a guideline for businesses and as a result stimulate and accelerate the transition towards a circular economy. Part of the research is a series of semi-structured interviews to determine the opinion of companies in the consumer goods sector on the performance of the KPIs. The outcome of the interviews will be used to improve and modify the CEI.

Thank you very much for your participation in this research. I would like to ask you to validate the 25 KPIs with an either + or – on 4 criteria and ask for your opinion more thoroughly on the KPIs that need to be changed/excluded/added according to you.

Date:

Name:

Position:

Name company:

Disclaimer:
The content of this interview is confidential and will be used anonymously. Should you have any questions/concerns prior to, during, or after the interview, please feel free to voice your apprehensions. If requested you may receive a copy of the interview prior to analysis for evaluation purposes after the interview.

Criteria for KPI validation:

- **Reliability**
  Do you believe this KPI should be used to measure circularity? / Does this KPI measure circularity?
- **Indicator applicability**
  Is the KPI applicable to the your business and the consumer goods sector?
- **Data availability**
  Would you have the data available to determine this score? Is this KPI in your eyes quantifiable (=questions with %)?
- **Interpretation**
  How would you interpret this KPI? Is it formulated in an understandable way?

KPIs	Description	Criteria: Reliability	Indicator applicability	Data availability	Interpretation
KPI 1	We are involved in the circular economy trend				
KPI 2	We know what the circular economy means for our company				
KPI 3	The circular economy is part of our future targets				
KPI 4	We measure the outcomes of our circular economy practices on a regular basis				
KPI 5	Awareness on the circular economy is created among employees				
KPI 6	We cooperate on the topic circular economy				
KPI 7	Products contain recycled materials or recovered components			%	
KPI 8	Products are designed to minimize waste over their lifetime			%	
KPI 9	The amount of products that are recycled or upcycled			%	
KPI 10	Products can be resold			%	
KPI 11	Sharing of products by consumers is facilitated			%	
KPI 12	Products can be leased by consumers			%	
KPI 13	It is ensured that products are returned after their usage				
KPI 14	Products are sold using circular packaging and documentation			%	
KPI 15	The circular economy principle is applied to daily operations				
KPI 16	There are selection criteria for suppliers & industrial buyers				
KPI 17	The consumed electrical energy is renewable				
KPI 18	The consumed electrical energy comes from reliable production sources				
KPI 19	The extent to which technical input comes from pre-used materials			%	
KPI 20	The biological material input stream is sustainable				
KPI 21	The extent to which oil-based inputs are replaced by bio-based inputs			%	
KPI 22	Involvement in ecosystem recovery				
KPI 23	Waste is minimized or eliminated				
KPI 24	Mode of waste reduction				
KPI 25	Modes of transport are electric or on biofuels			%	

Additional questions:

- What do you find the most important KPIs?
  The current categorization is based on importance of implementation, the impact a KPI has on the environment and on individual business performance.

  KPI categorization legend:

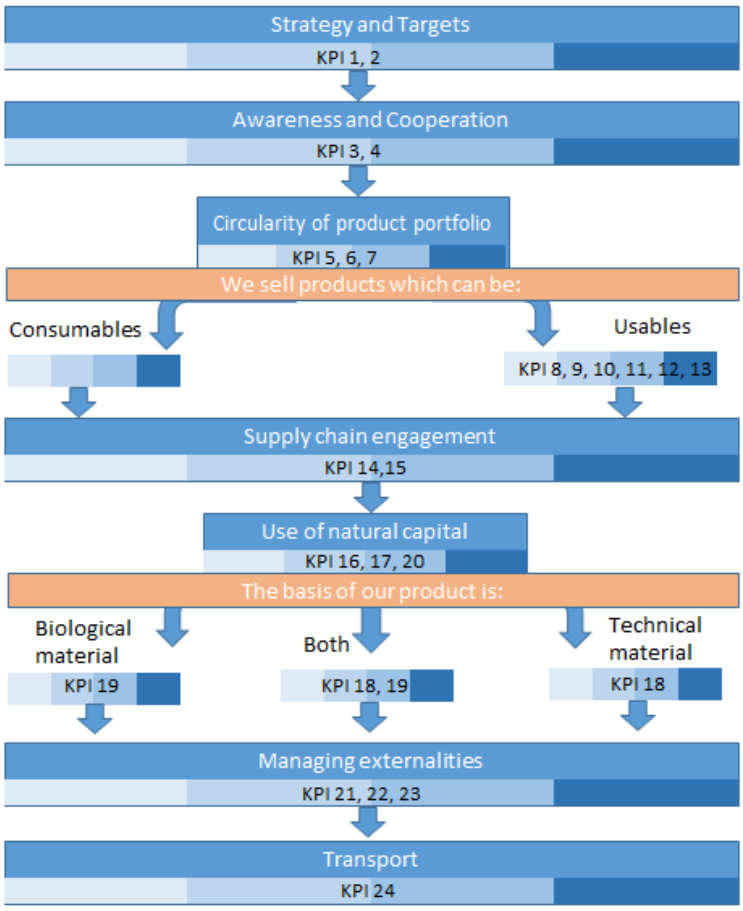
	High impact
	Medium impact
	Low impact

- Are there KPIs you would add to this CEI? / Are there KPIs missing?

Thank you very much for your time and input!

Appendix E – CEI for the CGS

E1 Flow chart



E2 Key Performance Indicators for the consumer goods sector

KPI 1 We have a strategy on the circular economy and know what it implies for our business

We do not have a strategy on the circular economy	We have a strategy on the circular economy and are currently analysing the implications of the circular economy for our business	We have a strategy on the circular economy and have analysed the implications of the circular economy for our business at strategic level	The circular economy is an important part of our business strategy and we have analysed the implications of the circular economy for all aspects of our business (e.g. finance, safety, competitiveness, supply chain, etc.)

KPI 2 The circular economy is part of our targets and we measure our progress towards these targets

We do not have targets on the circular economy	We have targets on the circular economy but do not measure our progress towards these targets	We have targets on the circular economy and measure our progress towards these targets on a yearly basis	We have targets on circular economy, they are SMART and we measure our progress towards these targets on a half-year or quarterly basis

KPI 3 We create awareness on the circular economy strategy of the business among employees

We do not create awareness on our circular	We create awareness on sustainability in general, but not specifically on our	We create awareness on our circular economy	We actively train our employees on the implications of the

economy strategy among employees	strategy of the circular economy	strategy through communication	circular economy for their job and stimulate initiatives from employees that could improve the circular economy performance of our business

KPI 4 We cooperate on the topic circular economy

We currently do not cooperate on the topic circular economy	We are looking at opportunities to cooperate on the topic circular economy	We are a member of one or more NGO's that promote the circular economy and/or cooperate with suppliers to increase our circular economy performance	We actively cooperate with suppliers, NGO's that promote the Circular economy and/or other companies to increase our circular economy performance.

KPI 5 Unsold products are resold/reused/redistributed to third parties who maintain the highest value possible

<25% of our unsold products are resold/ reused/redistributed by other parties	25-50% of our unsold products are resold/ reused/redistributed by other parties	50-75% of our unsold products are resold/ reused/redistributed by other parties	>75% of our unsold products are resold/ reused/redistributed by other parties

KPI 6 We offer reversed logistics of packaging and/or cooperate with third parties in a deposit system

We do not offer reversed logistics of packaging and/or cooperate with third parties in a deposit system	We are developing reversed logistics of packaging and/or are looking for possibilities to cooperate with third parties in a deposit system	We offer reversed logistics of packaging and/or cooperate with third parties in a deposit system	We actively recover our products from consumers at the end of the lifetime by stimulating the use of our reversed logistics and/or larger deposit system

KPI 7 Products are sold using recycled packaging

We use recycled materials for <25% of our product's packaging	We use recycled materials for 25-50% of our product's packaging a	We use recycled materials for 50-75% of our product's packaging	We use recycled materials for >75% of our product's packaging

KPI 8 Products contain recovered components

<25% of our products are made from recovered components	25%-50% of our products are made from recovered components	50%-75% of our products are made from recovered components	>75% of our products are made from recovered components

KPI 9 Products are designed to disassemble, remanufacture and/or repair

<25% of our products are designed to disassemble, remanufacture and/or repair	25-50% of our products are designed to disassemble, remanufacture and/or repair	50-75% of our products are designed to disassemble, remanufacture and/or repair	>75% of our products are designed to disassemble, remanufacture and/or repair

KPI 10 The amount of products that are recycled or upcycled post-consumer

<25% of our products are being recycled or upcycled	25-50% of our products are being recycled or upcycled	50-75% or our products are being recycled or upcycled	>75% of products are being recycled or upcycled

KPI 11 We offer a service to extend the life time of our products

We do not offer a service to extend the life time of our products	We work together with third parties who offer a service to extend the life time of our products	We offer a service ourselves to extend the life time of our products	We offer a service to extend the life time of our products and we actively stimulate our customers to extend the life time of our products instead of buying new products

KPI 12 Products can be leased by consumers

Our products cannot be leased	We are looking for ways to facilitate leasing or sharing	We offer a leasing system for <50% of our products	We offer a leasing system for >50% of our products

KPI 13 We offer reversed logistics to return products after their usage

We do not offer reversed logistics to return products after their usage	We are developing reversed logistics to return products after their usage	We have a system to ensure that our products are returned after their usage by consumers	We actively recover our products from consumers at the end of the lifetime

KPI 14 There are selection criteria for suppliers and/or service providers based on the circular economy (upstream)

There are no selection criteria for suppliers and/or service providers based on circular economy	We prefer suppliers and/or service providers that have a good circular economy performance, but do not have selection criteria	There are selection criteria for the most important suppliers and/or service providers based on circular economy	There are selection criteria for all suppliers and/or service providers based on circular economy and we engage them to increase their circular economy performance

KPI 15 There are selection criteria for industrial buyers based on the circular economy (downstream)

There are no selection criteria for industrial buyers based on circular economy	We prefer industrial buyers that have a good circular economy performance, but do not have selection criteria	There are selection criteria for the most important industrial buyers based on circular economy	There are selection criteria for all industrial buyers based on circular economy and we engage them to increase their circular economy performance

KPI 16 The consumed energy is renewable

None of our energy input comes from renewable sources	< 50% of our energy input comes from renewable sources	50-75% of our energy input comes from renewable sources	>75% of our energy input comes from renewable sources

KPI 17 We generate our own renewable energy

We do not generate our own renewable energy	We generate less than 25% of our own renewable energy	We generate 25-75% of our own renewable energy	We generate >75% our own renewable energy

KPI 18 The extent to which technical input stream comes from pre-used materials

<25% of our technical input materials are pre-used	20-50% of our technical input materials are pre-used	50-75% of our technical input materials are pre-used	>75% of our technical input materials are pre-used

KPI 19 The biological material input stream is bio-degradable, non-toxic and/or sustainable (fiber, food, etc.)

<25% of our biological material input stream is bio-degradable, non-toxic and/or sustainable	25-50% of our biological material input stream is bio-degradable, non-toxic and/or sustainable	50-75% of our biological material input stream is bio-degradable, non-toxic and/or sustainable	>75% of our biological material input stream is bio-degradable, non-toxic and/or sustainable

KPI 20 The extent to which oil-based inputs for our products are replaced by bio-based inputs (e.g. packaging, fiber, plastic bags)

<25% of our traditional oil-based inputs are replaced by bio-based inputs	20-50% of our traditional oil-based inputs are replaced by bio-based inputs	50-75% of our traditional oil-based inputs are replaced by bio-based inputs	>75% of our traditional oil-based inputs are replaced by bio-based inputs

KPI 21 We are involved in ecosystem recovery as addition to our internal CE activities (e.g. reducing damage to systems and areas such as food, mobility, shelter, education, health and entertainment)

We are not involved in ecosystem recovery and do not know if our extraction exceeds natural restoration	We are involved in ecosystem recovery, but do not measure what this implies for our business	We are involved in ecosystem recovery and know that our investment in restoring ecosystems is less than our extraction	We are involved in ecosystem recovery and know that our investment in restoring ecosystems is equal to or higher than our extraction.

KPI 22 We monitor and have targets to minimize our waste

We do not know how much waste we produce nor have targets to minimize our waste	We monitor our waste but do not have targets to minimize our waste	We monitor our waste stream and have targets to minimize our waste	We monitor our waste, have a clear policy, targets and implementation plan for waste minimization

KPI 23 We reduce our waste stream

We currently do not reduce our waste stream	We reduce waste through internal process optimization on one waste stream	We reduce waste through internal process optimizations on multiple waste streams	We reduce waste through internal process optimizations on multiple waste streams and create closed loop systems, where our waste is reused by ourselves or another company

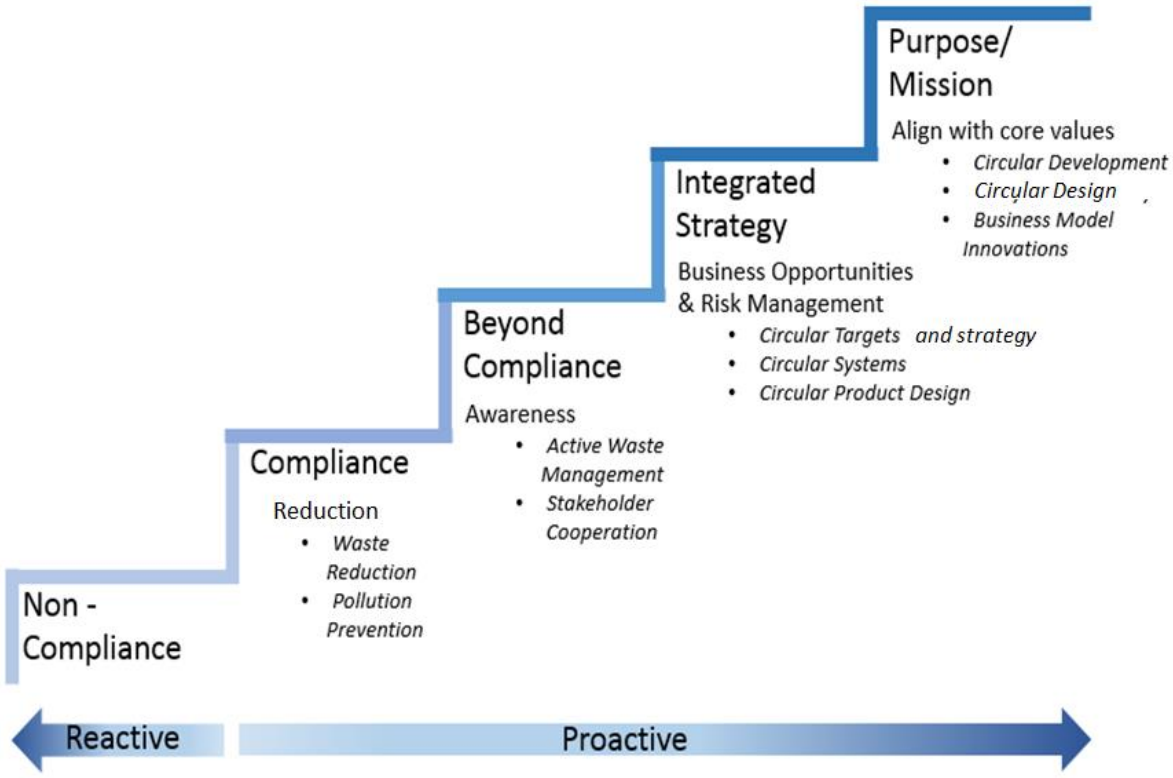
KPI 24 Modes of transport are electric or on biofuels (employees, distribution)

<25% of our transport is electric or on biofuels	25-50% of our transport is electric or on biofuels	50-75% of transport is electric or on biofuels	>75% of our transport is electric or on biofuels

E3 Scoring card

KPIs *Consumables*	KPIs categories	Weighting per category				Score	KPIs *Usables*	KPIs categories	Weighting per category				Score
KPI 1		-3	0	3	6		KPI 1		-3	0	3	6	
KPI 2		-3	0	3	6		KPI 2		-3	0	3	6	
KPI 3		-2	0	2	4		KPI 3		-2	0	2	4	
KPI 4		-3	0	3	6		KPI 4		-3	0	3	6	
KPI 5		-2	0	2	4		KPI 5		-2	0	2	4	
KPI 6		-3	0	3	6		KPI 6		-1	0	1	2	
KPI 7		-3	0	3	6		KPI 7		-1	0	1	2	
N.A							KPI 8		-3	0	3	6	
N.A							KPI 9		-3	0	3	6	
N.A							KPI 10		-3	0	3	6	
N.A							KPI 11		-2	0	2	4	
N.A							KPI 12		-2	0	2	4	
N.A							KPI 13		-1	0	1	2	
KPI 14		-2	0	2	4		KPI 14		-2	0	2	4	
KPI 15		-2	0	2	4		KPI 15		-2	0	2	4	
KPI 16		-3	0	3	6		KPI 16		-3	0	3	6	
KPI 17		-1	0	1	2		KPI 17		-1	0	1	2	
KPI 18		-3	0	3	6		KPI 18		-3	0	3	6	
KPI 19		-3	0	3	6		KPI 19		-3	0	3	6	
KPI 20		-3	0	3	6		KPI 20		-3	0	3	6	
KPI 21		-1	0	1	2		KPI 21		-1	0	1	2	
KPI 22		-2	0	2	4		KPI 22		-2	0	2	4	
KPI 23		-3	0	3	6		KPI 23		-3	0	3	6	
KPI 24		-2	0	2	4		KPI 24		-2	0	2	4	
					Total score:							Total score:	
					Divide by:	0.88						Divide by:	1.08
					Company score in CEI:							Company score in CEI:	

E4 Circular Performance Ladder



E5 Performance ladder steps and index scores

Step	Non-Compliance	Compliance	Beyond Compliance	Integrated Strategy	Purpose/Mission
Score	-50 - 0	1-25	26-50	51-75	76-100