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Exploring assessment practices of companies actively engaged with circular economy

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Abstract

An emerging research area is dedicated to developing approaches for assessing the 'circularity' of companies and their products, within the context of sustainability goals. However, empirical evidence on the uptake of these assessment approaches remains scarce. Using a purposive sampling, we conducted a survey receiving 155 responses and held 43 semi-structured interviews with Dutch and Italian companies active in circular economy (CE), pursuing three research aims: to explore the use of CE and sustainability assessment approaches; to study the process of developing assessment approaches; and to uncover benefits of—and barriers to—CE assessment. While we find high variability of assessment approaches, most often, companies develop tailor-made sustainability indicators and apply life cycle assessments to CE strategies. Importantly, assessment development for CE practices requires and facilitates collaboration with external stakeholders. Finally, we reflect on the paradox of standardisation versus tailoring of assessment approaches within the CE reality and recommend establishing company needs and capabilities before designing assessment approaches.

KEYWORDS

circularity indicators, corporate sustainability, material flow analysis, mixed methods, stakeholder engagement, sustainability assessment

1 | INTRODUCTION

The circular economy (CE) is proposed as a potential solution to the imbalance of the current linear economic system between limited resource supply and increasing demand for goods (Marino & Pariso, 2020). It has been described as an umbrella concept, building on fields in sustainability science, such as industrial ecology (IE) and eco-efficiency, and aims at retaining value embedded in materials through a series of systemic feedback loops between different life cycle stages (Hobson & Lynch, 2016). Within EU-level policies on sustainable growth, the Circular Economy Action plan plays a key role in the European Green Deal (European Commission [EC], 2019). Simultaneously, CE is growing as a business paradigm (Murray et al., 2017). Indeed, private sector initiatives are an important driver of the CE transition in many countries, and the diversity of CE business models is increasing (EC, 2020; Henry et al., 2020; Santa-Maria et al., 2021). In literature, CE is dominated by a corporate and technocentric perspective, aligning CE with current business paradigms, such as innovation and green growth (Calisto Friant et al., 2020; Schoeggl et al., 2020). Perceived benefits for companies implementing CE are related to lowering environmental impacts, realising social improvements and economic benefits, such as cost savings and developments of new markets—or growing existing ones (Laubscher & Marinelli, 2014). Therefore, the putative promise of CE practices lies in reducing negative sustainability impacts without jeopardising growth and prosperity (Ferasso et al., 2020).

While companies are becoming increasingly aware of the potential benefits associated with improving their resource efficiency, the uptake of CE practices is still lacking (Hartley et al., 2020). Translating the concept of CE into corporate strategies is obstructed by various technical and non-technical barriers, ranging from high start-up costs to the complexity of current supply chains (Jaeger & Upadhyay, 2020). Companies need to develop and apply dynamic capabilities to overcome such barriers and enable the implementation of CE practices (Khan et al., 2020). One of such capabilities, which has not yet received considerable attention in academic literature and is the focus of this article, is that of assessing CE practices and their sustainability impacts (Roos Lindgreen et al., 2020).

This assessment is essential because for many CE solutions and business models available to companies, it is unclear whether—or to what extent—they actually lead to more sustainable outcomes (Blum et al., 2020; Harris et al., 2021). Therefore, in order to contribute towards reaching the United Nations (UN) Sustainable Development Goals (SDGs) (UN, 2017), assessing the sustainability impact of CE practices before implementing them is key. Otherwise, well-intended CE strategies might actually lead to unintended sustainability impacts and burden shifting (Blum et al., 2020; Corona et al., 2019). Indeed, Roos Lindgreen et al. (2021) have found that applying resource-focused CE metrics in isolation can lead to contradicting results when compared to impacts calculated through life cycle assessments (LCAs). Different terms for managing units of information are used in academic literature on sustainability or CE assessment, such as metric, variable, indicator, methodology or index (Saidani et al., 2019; Sala et al., 2013; Veleva & Ellenbecker, 2001). Since we aim to capture a wide range of applied approaches from practice, we use the term 'assessment approaches' here. For a company, such an assessment approach includes obtaining data on the sustainability performance of any system (product or company level), allowing for its effective management (Beloff et al., 2004). The obtained information can be used for internal purposes, such as monitoring and evaluating company performance towards the SDGs, but also for external purposes, for example, communication to guarantee compliance with legislation or benchmarking between companies (Bae & Smardon, 2011). While discussing the value of both sustainability and circularity assessment,[1] it is important to remember that for most companies, especially small and medium enterprises (SMEs) which are not required to produce a mandatory sustainability report, these assessments are voluntary activities (EC, 2014). Thus, with limited incentives promoting the assessment of circularity or clarity regarding its integration with sustainability assessment, the motivations of companies to conduct additional assessments remain unknown.

While private sector engagement with CE and assessment approaches for CE from academic literature have been investigated (Kristensen & Mosgaard, 2020; Santa-Maria et al., 2021), empirical evidence on the assessment approaches applied by companies that actively participate in the CE transition is scarce (Hartley et al., 2020). Furthermore, research gaps exist with respect to the joint application of CE and sustainability assessment approaches, as well as the process of developing them, given the collaborative nature of most CE practices (Brown et al., 2019; Niero & Kalbar, 2019). Finally, the perceived benefits of—and barriers to—CE assessment have also yet to be studied (de Pascale et al., 2020; Rossi et al., 2020).

Therefore, we study CE and sustainability assessment practices of frontrunner companies already engaged with CE, which thus are inclined to assess their CE practices. Firstly, we study the practical application of CE and sustainability assessment approaches at company level. Secondly, the process of developing tailor-made CE assessment approaches and the involvement of stakeholders in this process are investigated. Our third aim is to reveal the benefits and barriers of implementing CE assessment. We use an explorative mixed-methods approach consisting of a semi-quantitative survey and semi-structured interviews with companies which are members of national or international CE networks and operating in Italy or the Netherlands. In both European countries, such networks play an active role in sharing knowledge, practices and connecting stakeholders, resulting in a thriving ecosystem of companies engaged with CE (Institut National de l'Économie Circulaire & Orée, 2020). Such networks were thus used within this study to identify a diverse range of companies engaged with CE, both in terms of sector and size.

In the remainder of this article, we present the theoretical background to the study, underlining the addressed research gaps and resulting research questions (Section 2), as well as the mixed-methods approach employed (Section 3), and the results of the survey and interview approach (Section 4). Then, the discussion section amalgamates these results in the context of existing—and future—research directions (Section 5), while the last section offers concluding remarks (Section 6).

2 | THEORETICAL BACKGROUND

This section highlights the research gaps identified in the three CE assessment-related areas investigated in this article: (i) practical application of CE and sustainability assessment approaches at company level; (ii) use of tailor-made CE assessment approaches; and (iii) benefits and barriers of implementing CE assessment. From the identified research gaps, three main research questions are formulated to guide the study.

2.1 | CE and sustainability assessment approaches for companies

A considerable number of review articles on CE assessment approaches for companies have been published in the past 3 years (e.g. Corona et al., 2019; de Oliveira et al., 2021; de Pascale et al., 2020; Kristensen & Mosgaard, 2020; Moraga et al., 2019; Roos

Lindgreen et al., 2020; Saidani et al., 2019; Sassanelli et al., 2019). These articles describe various assessment approaches and their characteristics, such as their connection to different sustainability dimensions and specific CE strategies. Generally, they focus on the environmental and economic domains, with social elements rarely being considered (de Oliveira et al., 2021). Indicators with an economic focus might be more attractive to business but carry the risk of detaching CE from environmental and social sustainability (Kristensen & Mosgaard, 2020). Furthermore, many indicators are centred around resource use or specific strategies from the 'R-hierarchy' (Potting et al., 2017), a framework commonly associated with CE by companies (Walker, Opferkuch, et al., 2021), making them unsuitable to assess the three-dimensional sustainability performance of circular systems (Corona et al., 2019).

From the wide range of available assessment approaches, we recognise four general categories relevant to companies. First, life cycle-based methods enable the quantification of impacts across all phases of a product's or system's life cycle, from the extraction of raw materials to its disposal (Finkbeiner et al., 2010). A precursor to such life cycle-based methods are material flow analysis (MFA)-based methods, which establish an overview of resource and energy flows across the life cycle of a system (Brunner & Rechberger, 2016). These MFA-based methods have provided the blueprint for more recent industry-developed CE metrics such as the Circular Transition Indicators (CTI) (WBCSD, 2020). Footprint tools, such as the carbon footprint approach, take on a similar approach and are therefore included in this category (WBCSD & WRI, 2004). Second, also relevant are the several available sustainability reporting frameworks, such as Global Reporting Initiative (GRI) Standards, which have the goal to create a common language and format for organisations to report on their sustainability impacts (Global Reporting Initiative, 2018). Next, various authors point out the presence of single indicators: quantitative indicators presenting circularity as a single number, which are mainly oriented around metrics such as recycling rate or resource use (Kristensen & Mosgaard, 2020). Lastly, and as discussed in the next section, the category of tailor-made indicators, which could be based on a life cycle approach or direct impact, allow for tailoring the CE or sustainability assessment more closely to a company's specific context (Kravchenko et al., 2020). As opposed to life cycle tailor-made approaches, direct impact here refers to 'Scope 1' impacts occurring from sources that are controlled or owned by an organisation (WBCSD & WRI, 2004).

Some authors (e.g. Geissdoerfer et al., 2017; Schroeder et al., 2018) have already stressed that the complex nature of the relation between CE and sustainability affects its assessment. However, a lack of consensus persists on the issue whether CE and sustainability assessment are different or the same and whether one forms part of the other (Vinante et al., 2020; Walzberg et al., 2021). Indeed, some authors consider it essential to complement resource-focused CE assessment with the assessment of the respective sustainability impacts, given that applying resource-focused assessment approaches only could lead to a risk of pursuing 'CE for the sake of CE' (Harris et al., 2021; Kristensen & Mosgaard, 2020). Furthermore, CE assessment approaches may potentially distract the decision-making process or even provide a vehicle for greenwashing when the results do not point towards sustainability, allowing companies to pick CE indicators which suit their corporate narrative (Pauliuk, 2018). Various other scholars nevertheless regard resource-focused CE metrics as valuable for decision-making and product comparisons (Parchomenko et al., 2019; Sassanelli et al., 2019). It has further been established that, to ensure the quantification of CE solutions' sustainability impacts, existing sustainability assessment methods could be used (Roos Lindgreen et al., 2020; Walzberg et al., 2021).

While available CE assessment approaches for companies are well documented, information on their practical application is scarce (Kristensen & Remmen, 2019; Stewart & Niero, 2018). One of these few practical studies showed that about three-quarters of the 39 involved companies applied a self-made CE assessment framework, instead of using existing frameworks developed by consultancy companies or academia (WBCSD, 2018). Similarly, Stumpf et al. (2019), analysing 131 case studies from the Circular Economy Industry Platform, found CE indicators from literature to play a negligible role in mainstream industrial assessment practices. Regarding sustainability assessment approaches, the capability of companies to carry out this assessment has been emphasised as a prerequisite for corporate sustainability (CS) (Maas et al., 2016). For SMEs, this capability increases when a company develops more sustainable (and holistic) business practices (Witjes et al., 2017). Since sustainability assessment is a field with a longer history, more information on its degree of implementation by companies is available. In fact, sustainability tools, initiatives and approaches, such as corporate social responsibility (CSR) and the GRI, are well known among companies (Lozano, 2020); however, their uptake of CE issues is lacking and less concrete (Opferkuch et al., 2021).

From the above, we highlight a lack of empirical evidence on the implementation of CE and related sustainability assessment approaches by companies, leading to the following research questions:

RQ1: How do frontrunner companies assess CE and sustainability?
RQ1A: Which assessment approaches are applied?
RQ1B: What are the differences between CE and sustainability assessment?

2.2 | Development process of tailor-made CE and sustainability assessment approaches

It is in the nature of CE practices to go beyond company boundaries and ideally encompass the whole life cycle of a product, thus requiring increased collaboration (Brown et al., 2019). Within the scope of this collaboration, companies are starting to assess the impacts of these CE practices. The development and implementation of tailor-made CE assessment frameworks indicates that companies are utilising the CE concept based on how it is most material to their core business (WBCSD, 2018). In literature, the selection of specific CE KPIs suitable to a company's CE strategy is recommended (Kravchenko et al., 2019). This would also be in line with the long-standing finding in the field of sustainability assessment that indicators should reflect the business realities of a particular organisation; as such, they should not be limited to general methodologies or standards (Keeble et al., 2003). However, there are certain points of reference that could be considered universally applicable, such as the planetary boundaries (Rockström et al., 2009) or the Paris Agreement (UN, 2015). Furthermore, Niemeijer and de Groot (2008) have developed a framework for indicator selection based on causal networks which has found widespread uptake from scholars for discussion with the environmental domain. They point out the importance of looking at the integration of the indicator set rather than focusing on single indicators. Similarly, Addison et al. (2020) propose the creation of an assessment framework for evaluating the biodiversity impact of business practices, and mention the central role of involving stakeholders in the assessment, if the assessment scope goes beyond company boundaries. This is particularly relevant for CE practices, given that they mostly require collaboration of companies within their supply chain network (Brown et al., 2019). Moreover, the involvement of stakeholders in general is described as a methodological necessity for sound sustainability assessment by several scholars (Sala et al., 2013; Troullaki et al., 2021). It is by way of this transdisciplinary involvement that the assessment approaches can be adapted to contextual specificities of the sustainability impacts to be assessed, while also including some standardised indicators based on international consensus (Kühnen & Hahn, 2018).

However, evidence on *how* companies develop such context-specific CE assessment approaches is limited in literature (WBCSD, 2018). As in sustainability assessment, one key element in this process is the involvement of stakeholders, especially in connection to the flourishing field of CE consultancies and research agencies that offer CE assessment services (Pereira & Vence, 2021). For example, for public sector organisations, a co-developed CE assessment framework with the active involvement of internal stakeholders has been proposed; it emphasises including sector specifics in CE assessments of organisations (Droege et al., 2021a). With respect to the involvement of stakeholders, for micro-level CE assessment approaches from academic literature, only a low number have been designed in a participatory manner (Roos Lindgreen et al., 2020). Yet, to our knowledge, no research exists on how companies engaged with CE practices develop assessment practices either internally or with external consultation and how, if at all, the process differs from the development of sustainability assessments.

Following this, we address this lack of empirical data on the development of CE assessment approaches by companies and their stakeholders through inquiring specifically about their development process. To improve the development of future CE assessment approaches, company needs with respect to external expertise throughout the assessment process are extracted, revealing at what scale assessment tools are needed.

RQ2: What is the process of developing tailor-made CE and sustainability assessment approaches?

RQ2A: How are stakeholders involved in the creation of assessment approaches for CE practices?

RQ2B: What are the assessment needs and preferences of companies engaged with CE?

2.3 | Benefits of—and barriers to—CE assessment

Considerable research exists regarding the identification of drivers and barriers for embedding CS assessment processes within organisations (Lozano, 2020; Triste et al., 2014). The assessment process is a critical element of strategic management, facilitating and driving change towards CS within a company (Doppelt, 2003; Lozano et al., 2016). Bae and Smardon (2011) determined that the measurement and disclosure of sustainable business indicators allowed companies in manufacturing industries to integrate sustainable business practices into decision-making processes. This integration enabled companies to transform their practices from only environmental management towards broader sustainable business strategies (Bae & Smardon, 2011). Other, more general, benefits of assessing sustainable business practices are related to stakeholder communication, benchmarking between companies (Zimek & Baumgartner, 2019) and organisational learning (Sala et al., 2015). To complement this, several studies have identified barriers which can be both internal to the company (e.g. lack of awareness on sustainability issues, an absence of perceived benefits, lack of resources), as well as external (e.g. insufficient drivers, complexity of available tools) (Johnson & Schaltegger, 2016; Lozano, 2007). The identification of barriers enables the development of corresponding capabilities, allowing companies to not only overcome these barriers, but to go further than only compliance (Hart, 1995; Khan et al., 2020). In addition, the identification of barriers supports the revision of assessment approaches themselves to improve their applicability and relevance to companies. For instance, evidence points towards SMEs experiencing more significant barriers to sustainability assessment (Jaramillo et al., 2019; Johnson & Schaltegger, 2016), which has led to the development of new or modified assessment approaches for smaller companies (Garza-Reyes et al., 2018; Global Reporting Initiative, 2018). These advancements are essential as SMEs represent more than 99% of all companies in the EU (Eurostat, 2018). Companies implementing CE strategies are faced with critical challenges in terms of stakeholder management, financial and regulatory aspects, resource management and consumer acceptance (Ritzén & Sandström, 2017; Stewart & Niero, 2018). Several studies have focussed on such barriers to the implementation of CE business models and strategies (de Jesus & Mendonça, 2018; Mont et al., 2017; Ranta et al., 2018). However, the exploration of barriers exclusively for the assessment of CE practices has only been addressed by Droege et al. (2021b), focusing on Portuguese public sector organisations. To date, no study has identified the barriers related explicitly to the assessment of CE practices from private sector companies. Furthermore, no study has addressed the motivation and benefits of companies which voluntarily conduct a CE assessment.

From the above, the following research question emerges:

RQ3: Why do (or don't) companies conduct CE assessment?

3 | METHODS

Figure 1 illustrates the mixed methods approach (Creswell & Plano Clark, 2018) consisting of two complementary research methods to obtain insights from frontrunner companies engaged with CE: a semi-quantitative survey and semi-structured interviews (Adams, 2015). We chose the combination of these two methods to identify the approaches that were applied (through the survey), and how and why companies applied these approaches (through interviews). It should be highlighted that the survey and the interviews contained additional questions analysed in the context of a separate study (Walker, Opferkuch, et al., 2021).

3.1 | Sampling procedure

To identify companies actively engaged with CE practices in Italy and the Netherlands, we applied a purposive sampling method (Hibberts et al., 2012). Namely, we only included companies which are members of existing national and international CE networks since we assume they are frontrunners in CE and its assessment. A list of the included CE networks can be found in Appendix A. In order to be included in the survey, besides being part of a CE network, respondents needed to satisfy two other criteria: being a private sector organisation, according to national law; and having an official website. The survey was delivered through the online survey tool SurveyMonkey (2021), with personalised email invitations and was open from July until the end of September 2019. At the end of the survey, respondents had the option to opt in for successive interviews; thus, the interview sample consists of a subset of the survey respondents. These interviews were conducted between May and June 2020 through video

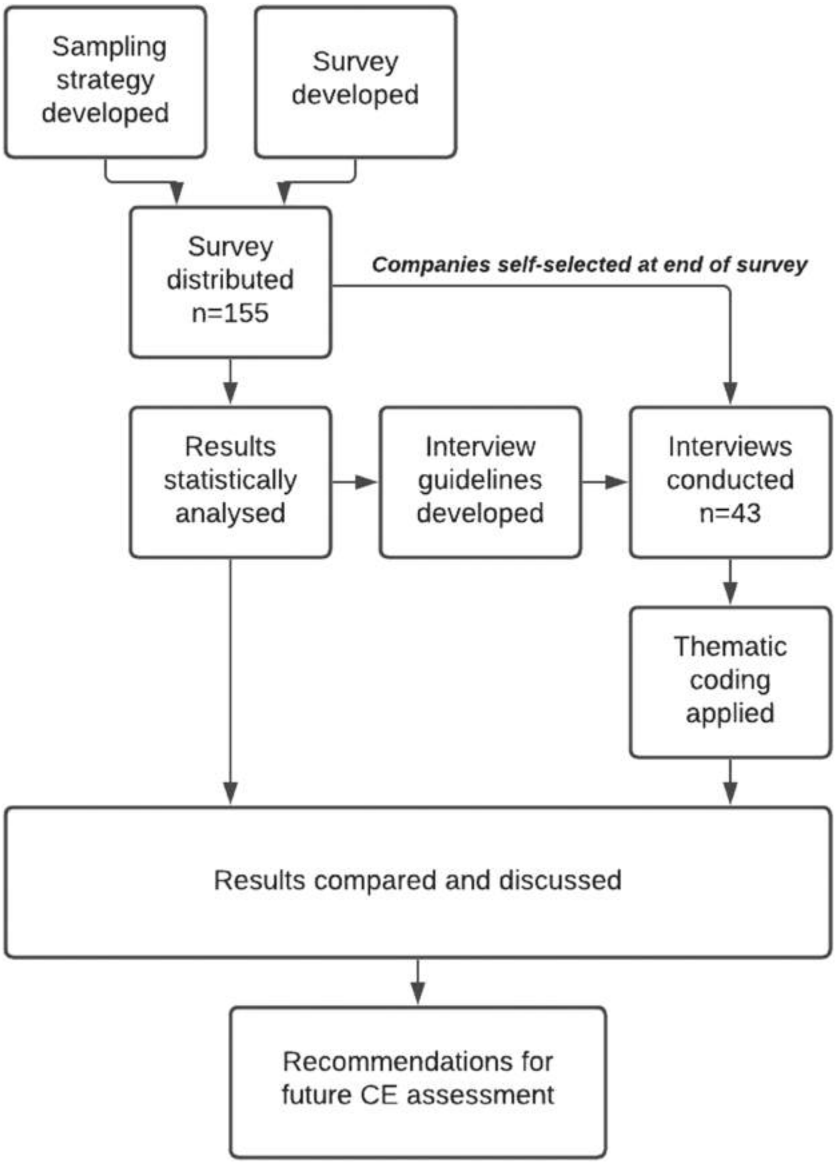

FIGURE 1 Illustration of overall research steps employed in this study

calls. Both the survey and interview participants were aware that the results of the study would be anonymised.

3.2 | Sample description

The survey was sent out online to a total of 809 companies and was fully completed by 155 (survey response rate: 19%). Of the responding companies, 46% were based in Italy and 52% in the Netherlands. Two respondents were part of Italian or Dutch CE networks while being based outside of these countries: one from Luxemburg and one from Austria. In the interviews, the distribution of companies ($n = 43$) was nearly the same, with 20 companies based in Italy and 23 in the Netherlands.

The companies were subdivided into the Eurostat classification scheme for SMEs. For the 155 survey companies, 45% consisted of micro companies (1–9 employees), 33% of SMEs (10–249 employees) and 22% of large companies (250+ employees). For the 43 interviewed companies, this was almost the same, with 49% micro companies, 26% SMEs and 25% large companies.

The respondents categorised their company sectors themselves according to the statistical classification of economic activities in the European Community (NACE) (Eurostat, 2008). Though both samples were diverse, Figures 2 and 3 show that the most frequently named sector in both cases was 'Manufacturing', followed by 'Other service activities' and 'Professional, scientific and technical activities', both of which represented consultancy companies. Whereas the former category would actually be assigned to repair services, the analysis of individual survey answers revealed that several companies in this category were in fact consultancy companies. As to be expected, 'Waste & water management' companies were also present in the sample, given the inherent circular qualities of their business models.

Finally, Figures 4 and 5 prove that the survey and the interviews collected information from decision-makers with generally high authority and knowledge on the topic of sustainability and CSR. Interestingly, in the interviews, the share of respondents from the 'General management' and 'Sustainability & CSR' was notably larger than in the survey, representing a higher willingness of these respondents to discuss sustainability and CE-related matters.

3.3 | Survey development

For a detailed description of the creation of the overall survey and its distribution to 809 companies, readers should refer to Walker, Opferkuch, et al. (2021). Regarding the survey questions addressed in this paper, we first asked companies whether they regarded a list of assessment approaches as either CE or sustainability assessment and whether they applied them on a company or product level. The identification of CE and sustainability assessment approaches was based on literature (Corona et al., 2019; Ness et al., 2007; Sala et al., 2013; Vinante et al., 2020), as well as input from a sustainability consultancy specialised in life cycle-based assessments. As identified in Section 2, the assessment approaches were categorised into life cycle-based/footprint, reporting frameworks, tailor-made indicators and single indicators, depicted in Table 1.

We also asked what system boundaries companies considered when doing assessments and whether they had developed their own assessment systems besides those postulated by the authors. In case companies had developed their own assessment frameworks, we further inquired whether this had happened in collaboration with external stakeholders or not, in order to get a better understanding of the development process of such assessment approaches. Finally, we posed the question in what assessment phase, of either sustainability or circularity assessment, companies would benefit most from external expertise. These assessment phases were composed of the steps of the LCA, the identification of suitable indicators (Kravchenko et al., 2020), the communication of the results to internal and external audiences and their inclusion into corporate decision-making (Bae & Smardon, 2011). This would help identify if company needs were different regarding CE or sustainability assessment and whether there were specific phases of assessment where support would be particularly useful. In all questions, it was possible to provide additional comments in open text fields.

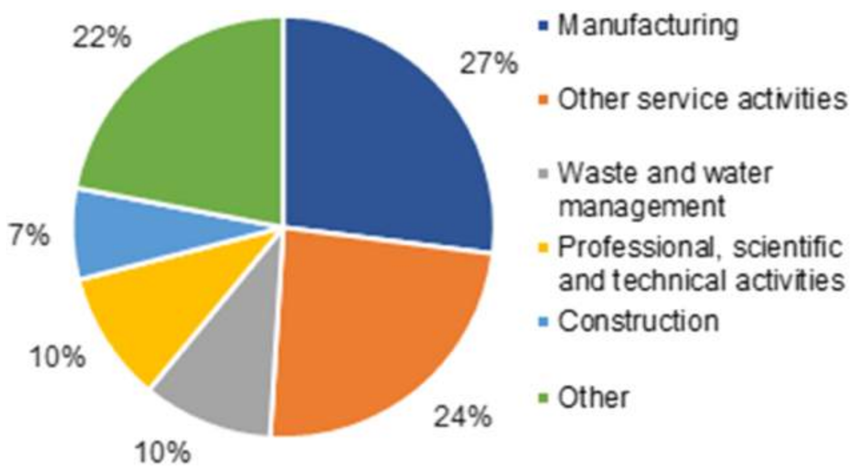

FIGURE 2 Industry sector of survey respondents ($n = 155$)

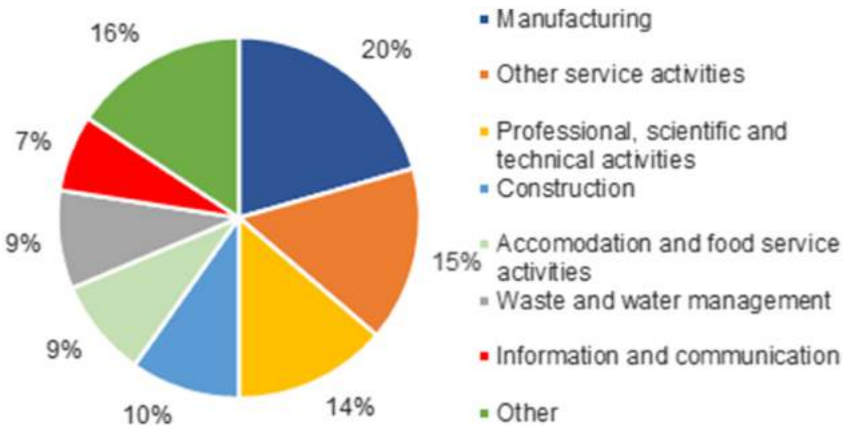

FIGURE 3 Industry sector of interview respondents ($n = 43$)

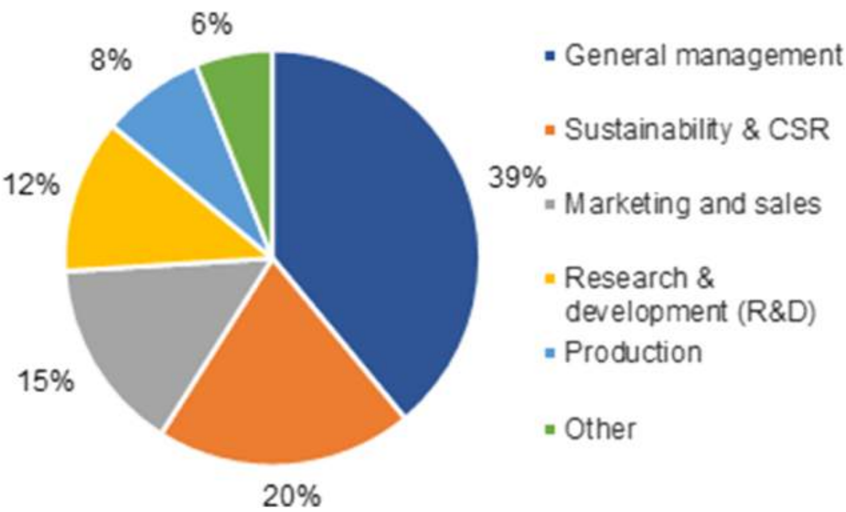

FIGURE 4 Department of survey respondents ($n = 155$)

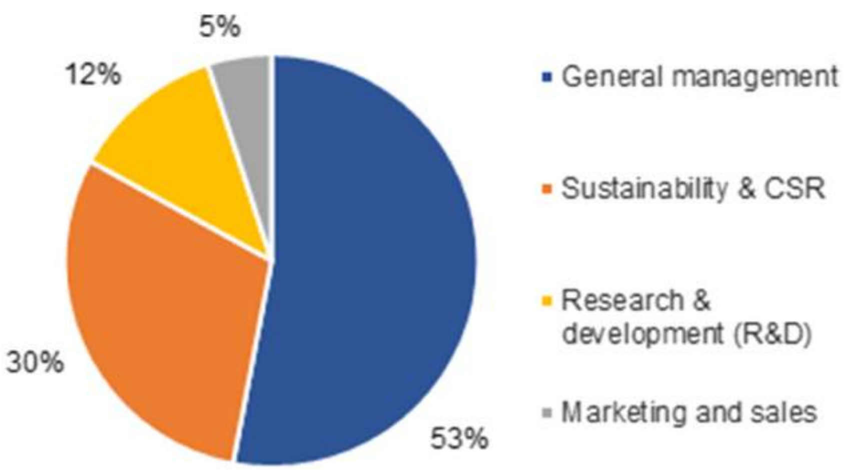

FIGURE 5 Department of interview respondents ($n = 43$)

3.4 | Interview guideline development and process

To get a better picture of how frontrunner companies engaged with CE practices develop assessment approaches and why they do (or why they do not) implement these, we conducted interviews with 43 respondents which ranged between 45 and 90 mins. The interview questions focus on companies' understanding of CE and sustainability assessment, the assessment creation and application, and barriers and benefits of assessing CE (available in Appendix B). These questions emerged from the survey results and, in particular, from the open answer fields. Since the interviews were held in English, Dutch and Italian, we applied the Loubere's (2017) Systematic and Reflexive Interviewing and Reporting (SRIR) method. This method requires scholars to hold frequent meetings to discuss the findings and impressions of the individual interviews, instead of writing and analysing full transcripts.

TABLE 1 Assessment approaches and their abbreviations

Category	Assessment approach	Abbreviation	References
Life cycle based/footprint	Carbon footprint	CF	WBCSD & WRI, 2004
	Ecological footprint	EF	Wackernagel & Beyers, 2019
	Product environmental footprint	PEF	European Commission, 2013
	Environmental life cycle assessment	E-LCA	ISO, 2006a, 2006b
	Life cycle costing	LCC	Hunkeler et al., 2008
	Material flow analysis	MFA	Brunner & Rechberger, 2016
	Social life cycle assessment	S-LCA	UNEP, 2020
	Water footprint	WF	Hoekstra et al., 2011
Reporting framework	Environmental accounting	EA	Bebbington et al., 2021
	GRI standards	GRI	GRI, 2016
Tailor-made indicators	Tailor-made circularity indicators based on a life cycle approach	TCEI (life cycle)	N/A
	Tailor-made circularity indicators based on direct impact	TCEI (direct)	N/A
	Tailor-made sustainability indicators based on direct impact	TSI (direct)	N/A
	Tailor-made sustainability indicators based on a life cycle approach	TSI (life cycle)	N/A
Single indicators	Material Circularity Indicator (by Ellen MacArthur Foundation)	MCI	EMF and Grata, 2015
	Material durability	MD	Figge et al., 2018
	Recycled content	RC	Kristensen & Mosgaard, 2020
	Recycling rate	RR	Kristensen & Mosgaard, 2020
	Time for disassembly	TfD	Vanegas et al., 2018
	Volume of non-renewable resources not extracted	VNRRne	Kristensen & Mosgaard, 2020
	Volume of virgin material production prevented	VVMp	Kristensen & Mosgaard, 2020
	Volume of waste diverted from landfill	VWdL	Kristensen & Mosgaard, 2020

3.5 | Data analysis and integration

After the survey was closed, we exported the answers from SurveyMonkey into the statistical analysis software IBM SPSS Statistics 26 (IBM, 2020). Then, we took a univariate analysis approach and analysed the descriptive statistics. To identify whether variations in the answers correlated with the size (micro, small to medium and large) as well as the sectors (divided into production and service sector) of the respective companies, we employed cross-tabulations (Bartiaux et al., 2018) and conducted a contingency coefficient test to determine the significance of the correlations.

Regarding the interviews, we jointly analysed the interview notes in the qualitative data analysis software NVivo R1 (QSR International, 2020) with an inductive coding approach based on thematic analysis (Braun & Clarke, 2006). After assigning codes to the responses for each sub-question, we compiled them into major themes, as presented and discussed in the following sections. This inductive approach was chosen following the (1) novel nature of the research topic, and the inherent conceptual ambiguities between sustainability and CE, as described in chapter 2, and (2) the scarcity of empirical evidence on company engagement with CE assessment. Lastly, for a comprehensive analysis, the findings from the survey answers were confronted and complemented with the findings from the interview responses in an iterative manner.

4 | RESULTS

This section presents the results according to the three main research questions formulated in Section 2.

4.1 | Assessment of CE and sustainability by companies

4.1.1 | Application of assessment approaches

As seen in Figure 6, the application rate of the 22 approaches, previously introduced in Table 1, shows large variability, both overall and within each of the categories. Generally, 36% of companies have not applied any of the approaches on either a product or company level. On the product level, 53% of respondents do not apply any

FIGURE 6 Application of CE- and sustainability assessment approaches ($n = 98$). CF, carbon footprint; EA, environmental accounting; EF, ecological footprint; E-LCA, environmental life cycle assessment; GRI, GRI standards; LCC, life cycle costing; MCI, Material Circularity Indicator (by Ellen MacArthur Foundation); MD, material durability; MFA, material flow analysis; PEF, product environmental footprint; RC, recycled content; RR, recycling rate; S-LCA, social life cycle assessment; TCEI (direct), tailor-made circularity indicators based on direct impact; TCEI (life cycle), tailor-made circularity indicators based on a life cycle approach; TfD, time for disassembly; TSI (direct), tailor-made sustainability indicators based on direct impact; TSI (life cycle), tailor-made sustainability indicators based on a life cycle approach; VNRRne, volume of non-renewable resources not extracted; VVMp, volume of virgin material production prevented; VWdL, volume of waste diverted from landfill; WF, water footprint

approaches, 7% of respondents apply one approach, and the remaining 40% applied two or more approaches. Looking at the frequency of approaches applied at company level, 46% of respondents do not apply any approaches on a company level, 10% apply only one approach, and the remaining 44% apply two or more approaches.

Figure 6 shows that popular assessment approaches are tailor-made sustainability indicators (both with a life cycle and a direct impact approach), single indicators (for example, the volume of waste diverted from landfill), and E-LCA, especially on the product level. In the group of life cycle-based methods, MFA, PEF, LCC and S-LCA in particular are less frequently applied, the latter having the lowest application count. In contrast, CF is applied by more than half of the companies.

While the application of assessment approaches is in most cases not entirely attributable to either company or product level, there are some cases where differences were observed which may relate to the intended goal of these assessment approaches. The GRI standards, designed to help companies assess and report their impacts, are applied by >80% on company level. The same holds for EA (75%) and for tailor-made sustainability indicators with direct impact (75%). E-LCA is, on the other hand, applied by around 70% of companies at the product level, signalling a high application rate within the sample. Appendix C (Table C1) provides more insights on the level on which the other approaches are applied.

The companies were also able to leave comments with respect to their assessment of sustainability and CE. Several pointed out that company size and sector were important determinants when applying a certain approach or not. Therefore, the relation of both company size (micro, SME, large) and sector (production or service) with assessment application has been analysed. The complete results of this analysis are presented in Appendix C (Table C2). After performing Pearson chi-square tests, the correlation results between company size and CF, LCA and GRI showed statistical significance (Table 2): Large companies are more likely to implement these three approaches than SMEs or micro companies. For the remaining 19 assessment approaches, no statistically significant results were obtained that suggest company size influences the use of each of the assessment approaches. In the same vein (Table 3), production companies were

TABLE 2 Applied assessment approaches differing by company size ($n = 98$)

Assessment approach applied	Company size			Statistical significance	
	Micro	SME	Large	*p*-value	Contingency coefficient
CF	36%	60%	83%	0.001*	0.360
E-LCA	46%	56%	87%	0.004*	0.320
GRI	20%	17%	70%	0.000*	0.435

**Statistically significant at 99th confidence interval.

TABLE 3 Applied assessment approaches differing by company sector (n = 98)

Assessment approach applied	Sector		Statistical significance	
	Production	Service	*p*-value	Contingency coefficient
LCA	69.2%	48.8%	0.043*	0.203
Recycling rate	66.7%	46.5%	0.046*	0.199
Recycled content	67.3%	40.5%	0.009**	0.259
Volume of waste diverted from landfill	68.6%	45%	0.023*	0.231

*Statistically significant at 95th confidence interval.
**Statistically significant at 99th confidence interval.

more likely than service companies to apply LCA, and the single indicators RR, RC and VWdL, whereas for the other assessment approaches, the sector did not influence their application in a statistically significant manner (refer to Table C3 in Appendix C for complete results).

Almost two-thirds of the surveyed companies indicated that they take a product life cycle approach. Concerning the remaining third, 14% of the total assessed the company only from gate to gate, while the rest also included the most important up- and downstream supply chain partners.

Taking a look at the interview results, around three-quarters (30) of the respondents stated that their company conducts some form of circularity assessment. These respondents provided examples of various indicators, metrics, tools and strategies which they utilised for circularity assessment (Table 4). This list highlights the diverse range of assessment approaches used and how companies are applying and integrating existing assessment approaches within their circularity assessment. Particularly, various assessment approaches designed for broader sustainability assessment are applied to assess CE practices. Many companies have stressed that they would like to become more active in assessing CE in particular. Besides CE assessment approaches, companies also provided further insights into tailor-made indicators and assessment methods in the survey, which were not always clearly attributed to either CE or sustainability assessment. Yet, it emerged that CE indicators were mostly related to either waste (e.g. kg of food saved from waste or waste reduction), material use (e.g. trees saved by use of alternative material or material inputs and outputs) and the R-hierarchy (e.g. design for recycling, reassembly and reuse), while those considered sustainability indicators more often concerned energy-use (e.g. energy saved), CO_2 emissions (e.g. CO_2 emissions reduced) and social aspects (e.g. number of people benefitting from a product/service).

TABLE 4 Approaches applied to assess CE practices by interviewees ($n = 30$)

Assessment approach	Times mentioned
Material inventory and mass balance	7
External approach developed by consultancy	6
LCA	4
Waste production and/or waste prevention	4
EMF Circulytics tool	2
General business performance- increased business means increased circularity	2
Linking CO_2 impacts of circular economy strategies	2
World Business Council for Sustainable Development (WBCSD) Circular Transition Indicators (CTI)	2
Ladder Van Lansink ranking of materials	1
Volume of products developed with CE strategies sold	1

4.1.2 | Distinguishing between CE and sustainability assessment

Survey results (Appendix D) showed that most approaches were considered useful to both assess CE and sustainability. This general finding was most prominent for the single indicators included in the list, while life cycle-based/footprint approaches and reporting frameworks had a higher association with sustainability only. In particular, CE was highlighted as the approach associated most often with sustainability assessment. Indicators designed to strictly measure CE (SD CEI direct, SD CEI indirect, MCI) were naturally more frequently linked to CE assessment. Meanwhile, MFA, GRI, S-LCA and MCI were the approaches that the respondents were least familiar with.

The survey results and explicit comments by survey respondents on the need for a clarification between CE and sustainability assessment motivated analysing the difference further within the interviews. Through inductive coding, we identified two groups of respondents: the first group (two-thirds of the respondents) considered CE and sustainability assessment to be different. Within this group, the most important differentiation was that the scope of sustainability assessment was characterised as wider, including more elements that would be listed under the social dimension of sustainability. In the same group, interviewees indicated that CE assessment would therefore form part of sustainability assessment. Furthermore, CE assessment was considered to be more straightforward, since it is more directly linked to material use, which is relatively simple to monitor. Moreover, it takes place in the context of industrial processes, which are generally more measurable. Other differences were that CE assessment is mainly linked to resource management, that it is less verifiable because of its novelty, and that it is focused on high-value reuse of resources.

The second group, composed of approximately one-third of the interviewees, highlighted that CE and sustainability assessment are the same. They, for example, considered CE to be a new version of sustainability, with the existing sustainability assessment tools applicable to CE as well. Social aspects were also considered a central part of CE by a few interviewees, while others mentioned that, to them, 'something cannot be circular if it is not sustainable. So in the measurement, there is no difference' (micro company, accommodation and food service activities sector). Finally, some respondents considered CE and sustainability to be integrated so densely that any differentiation in terms of assessment was not necessary.

4.2 | Development of CE and sustainability assessment approaches

4.2.1 | Stakeholder involvement

The companies answering the survey indicated that 39% of them did not create their own assessment framework, 24% have developed their framework internally, and 27% worked with external partners (Figure 7). Slightly less than half of those external stakeholders were consultancies (16), followed by universities (12) and other partners (11); also, several survey respondents involved more than one of these stakeholder groups. We further addressed the assessment development process and the inclusion of stakeholders in the interviews.

In a first step, interviewed companies mostly consulted internally with their employees. Frequently, they created cross-departmental focus groups to develop a sustainability or circularity assessment in line with their own corporate strategy pillars. This assessment was often based on existing industry standards, such as those from the GRI, as well as the sustainability reports of other companies. Several respondents mentioned that they did not develop specific tools for CE assessment but instead relabelled some of their existing environmental sustainability indicators as CE indicators. Upper management engagement was crucial to starting the assessment development process. However, in order to become more circular or sustainable, assessment development should be diffused through the whole company to create a better understanding of sustainability and CE amongst employees. After internal consultation, three-quarters of all interviewees also involved external stakeholders; those who did not involve external stakeholders refrained from doing so mostly in relation with the CE assessment, which was considered technical, and they perceived little benefit of stakeholder feedback. A few micro

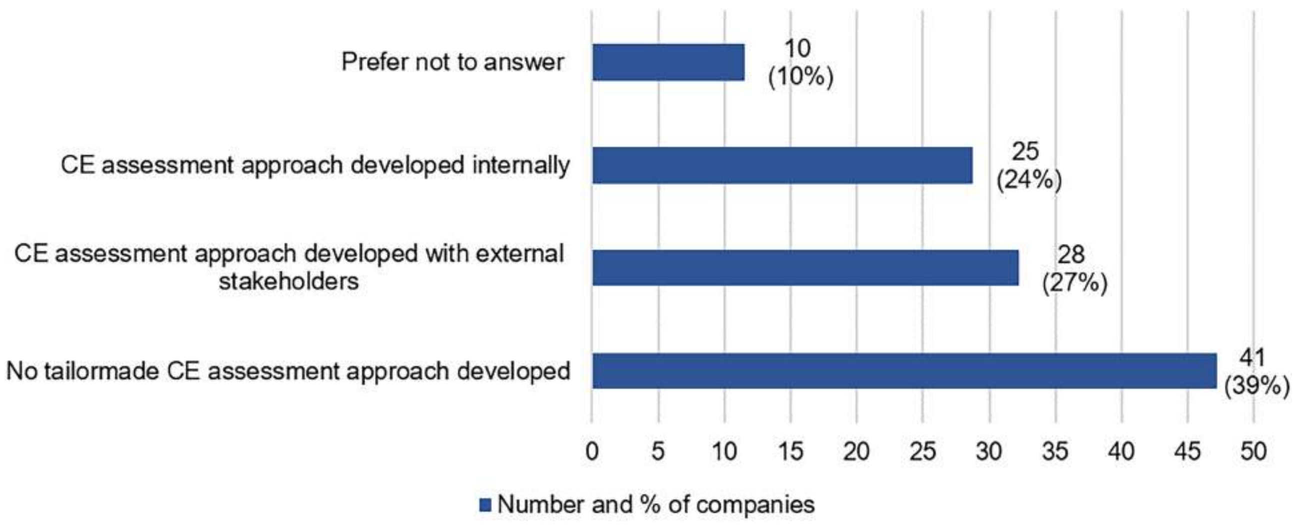

FIGURE 7 Involvement of external partners in development of tailor-made CE and sustainability assessment framework ($n = 104$)

companies also simply did not have the resources to involve external partners.

Overall, external stakeholder engagement was seen as essential by a large majority of the interviewees. Non-technical stakeholders played a central role in determining companies' strategic sustainability priorities, supporting and approving corporate activities in their respective communities. The assessment was then adapted to these strategic goals through, for example, stakeholder workshops or a materiality assessment by means of a stakeholder survey. Such surveys were a frequently used tool, mostly by large companies, to collect feedback, with practitioners highlighting the need for common understanding of the issues at hand in order to correctly allocate priorities. Our findings demonstrate that for companies engaged with CE, these stakeholder surveys are being utilised within the context of CE assessment. For example, for large companies, shareholders and investors are putting CE on the strategic agenda, driving the inclusion of CE in the assessment process.

Frequently included stakeholder groups were suppliers with which companies had close relationships, clients and universities. Companies had different forms of collaboration with these groups. The initiative to create assessments usually came from larger companies in the supply chain. Their collaboration with the 'preferred suppliers' was sometimes based on joint method development, but more often on delivering data regarding the sustainability impacts of upstream production steps. Companies' clients were the second largest group that influenced corporate assessment practices by, for example, stipulating certain certifications or indicators to be reported in the tenders the respondents were bidding for, such as Environmental Product Declaration, SA8000 or ISO 14001. Companies also considered the clients' needs and knowledge of software tools when opting for a certain assessment procedure. Following this, for companies with a larger product portfolio, assessment was described as more complex. Conducting client workshops was a frequent approach to identify their needs with regard to the companies' impact assessment. Finally, universities were often involved to either jointly develop an assessment methodology or to verify the scientific rigour of the assessment process.

Consultants were at times hired to support the assessment process, both through tool development and assistance with its implementation. This collaboration allowed the consultants to continuously adapt and improve their assessment methods. Furthermore, consultants also provided expert knowledge regarding life cycle inventory data of secondary materials used as production inputs.

Finally, larger companies in particular were working on standardising assessment approaches within industry groups such as Factor10 of the WBCSD or the CE100 by the EMF. While they themselves did not develop the tools, they conducted pilots and provided feedback to the working groups. In contrast, smaller companies often did not assess their activities in a quantitative manner but had an open ear for feedback from their clients and employees, as to align their activities with their often-idealistic corporate values.

4.2.2 | Assessment needs and preferences

Overall, respondents indicated that expert input would be moderately beneficial throughout the assessment phases listed, except for 'Internal communication of results'. Even though the need for expertise was similar in both sustainability and circularity phases, Figure 8 shows it was considered slightly more beneficial for the

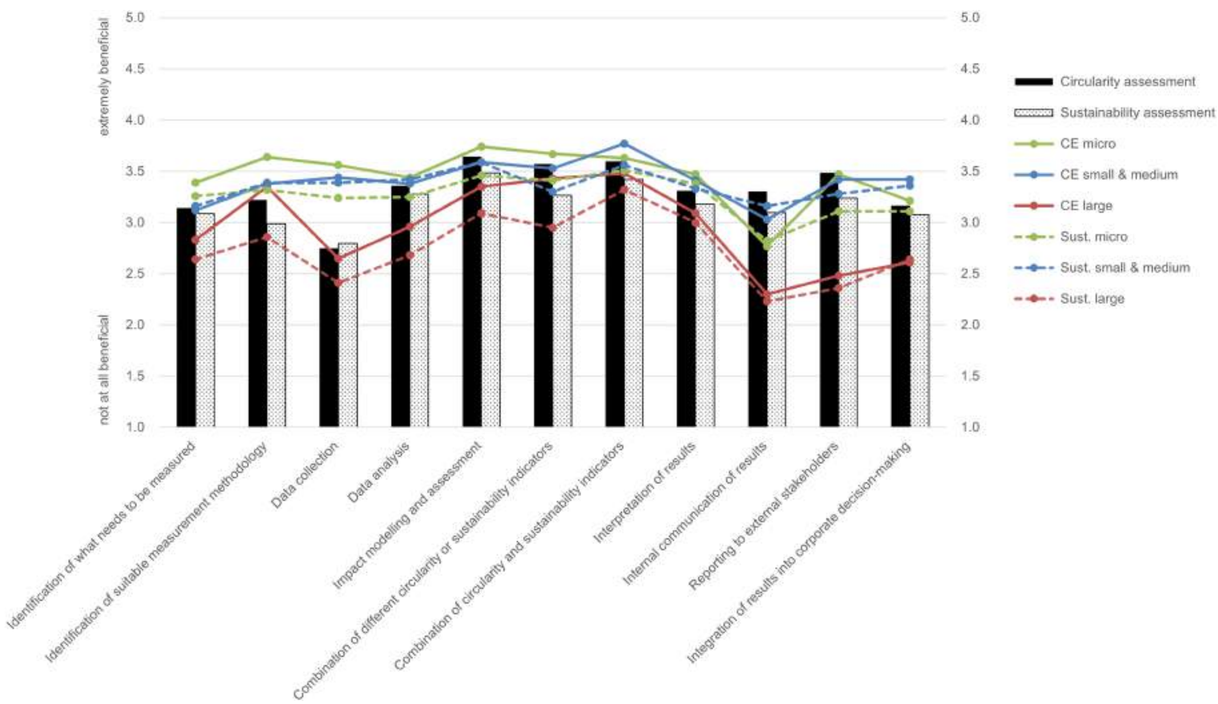

FIGURE 8 Benefit of expert support for sustainability and circularity assessment, by company size ($n = 101$)

implementation of circularity assessment approaches than for sustainability assessment approaches.

We also found that large companies had a considerably lower need for expert involvement than SMEs and micro companies. It was further observable that the spread between benefitting from help between circularity (higher) and sustainability (lower) assessment was the highest within large companies, while SMEs and smaller companies seemed to potentially benefit more evenly from both circularity and sustainability assessment support.

When contrasted with the interview findings, it is interesting to observe that micro companies simultaneously form part of the group of companies which seem to potentially benefit the most from external assessment, while also considering assessment in general as superfluous.

With regard to the development of future CE assessment approaches, almost half of the respondents designated the supply chain to be the most suitable level for assessment, given the collaborative nature of CE practices. However, it was also acknowledged that this might be too complex, especially for large companies with an extensive portfolio of products and their respective supply chains. About a third of interviewees proposed that the level of assessment should be adapted to the context. A similar number of respondents advocated for employing an assessment on organisational level, especially if a company provided services or included internal supply chains. Yet, again, it was argued that companies were already using several assessment tools on an organisational level, so adding more might not always be favourable nor feasible, especially in the case of a diverging product range. The product level was suggested by about a quarter of companies, with the proposition that metrics should be clearly measurable and not subjective. According to them, it was easier to establish a product's rather than a company's degree of ‘circularity’, given there was no clear benchmark against which to compare company circularity. Other levels proposed included project level, mainly raised by construction companies, the regional, business group or portfolio level.

TABLE 5 External and internal benefits of CE assessment ranked by number of times mentioned by interviewees ($n = 30$)

#	External communication and collaboration	Number of interviewees who mentioned the benefit
1	Marketing and improving reputation of company	6
2	Communicating and reporting to stakeholders	6
3	Communicating to clients	5
4	Providing evidence of activities to increase transparency	5
5	Identifying opportunities and evaluating collaboration	3
#	**Internal improvements and insights**	**Number of interviewees who mentioned the benefit**
1	Improving and internal optimising of CE strategies	7
2	Providing insights into broader sustainability performance	5
3	Enabling a learning process and cultural change (employees)	5
4	Developing company strategy and vision (future planning)	4
5	Allowing for comparability and identifying market opportunities	2

4.3 | Benefits of—and barriers to—circularity assessment

The 30 interviewed companies which stated that they implemented some form of CE assessment discussed the perceived benefits they obtain from this assessment. Respondents could mention more than one benefit, and through the inductive coding process, each benefit was grouped into one of two domains: (1) external communication and collaboration or (2) internal improvements and insights. The most frequently mentioned benefits are presented in Table 5.

Generally, the interview participants discussed how conducting some form of CE assessment has benefitted their marketing and external communication processes with stakeholders and clients in particular, as the results demonstrate the value of adopting CE strategies. Internally, responses highlight that for the companies, the entire CE assessment development process resulted in a positive learning experience, rather than from only receiving the final assessment result. Interestingly, investors were only mentioned once with relation to the benefits of CE assessment, suggesting that in its current form, CE assessment approaches are not necessarily integrated within management-level decision-making. In addition, several participants indicated that although through CE assessment they have been able to improve collaborations, the assessment process always needs an initial goal: ‘Are we measuring CE to involve different members of the chain or are we measuring for the sake of measuring?’ (micro company, other services sector).

The 13 companies which stated that they did not conduct any type of CE assessment then elaborated on the 15 main barriers encountered when considering implementing a CE assessment approach, presented in Figure 9. Through the inductive coding approach, two key categories of barriers became apparent within the interviews: (1) internal and (2) external. Within this second category, codes were grouped to form a subcategory of methodological barriers. Generally, the nine external barriers relate to the fact that circularity assessment was perceived as too complex. Furthermore, several external barriers are influenced by the current absence of a benchmark or standard for CE assessment, causing difficulty for companies to contextualise their CE assessment results and integrate them within their broader sustainability and/or communication strategies. For the seven internal barriers to CE assessment identified,

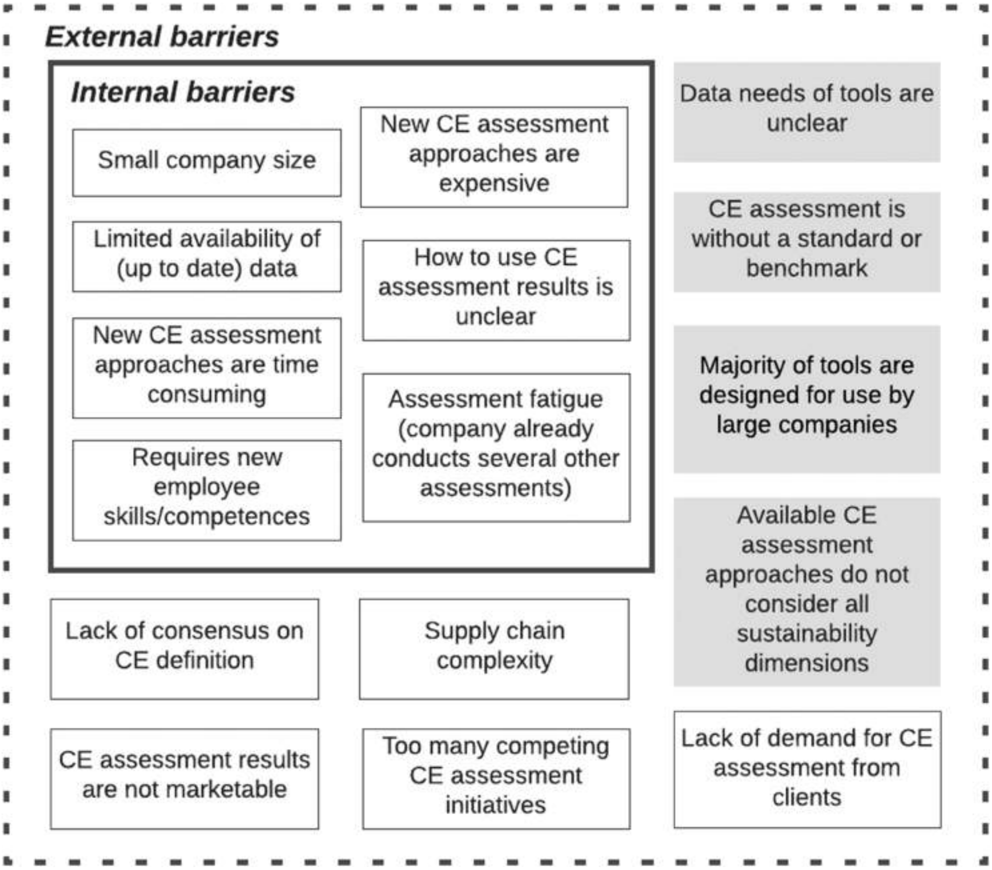

FIGURE 9 The seven internal and nine external barriers to CE assessment identified by companies not conducting any form of CE assessment. The four external barriers shaded in grey form the subcategory of methodological barriers ($n = 13$)

interviewees commented that the internal capacity of their companies to conduct yet another kind of assessment was limited. This was emphasised by the fact that it was unclear how the assessment results would be used, making it more difficult to justify allocating resources. Within these responses, no correlations were observed between company size, sector or country and their respected barriers and/or benefits.

5 | DISCUSSION

Overall, around a third of the companies in the survey sample do not conduct any CE or sustainability assessment. Also, as previously identified in literature, a low uptake of the CE assessment approaches proposed in academic literature (Stumpf et al., 2019; WBCSD, 2018) was found. Within this study, this is likely influenced by the composition of the sample, consisting mainly of micro companies (45%) and SMEs (33%). The survey results further show that a slight majority of companies engaged with CE assess their practices on a company, rather than a product level. When inquiring about their preferred level of assessment, the supply chain and organisational level are, despite their complexity, indicated as most valuable. Previous inventories of CE assessment approaches find product-level assessment approaches to be most commonly proposed (de Oliveira et al., 2021; Roos Lindgreen et al., 2020) and signal the need for methodological development of supply chain and organisational approaches (Harris et al., 2021; Walker, Vermeulen, et al., 2021). For company level assessment, respondents mainly rely on tailor-made indicators. On a product level, however, the most frequently used tool is LCA, a standardised methodology. This finding is in line with research and industry efforts to align LCA and CE assessment (Ávila-Gutiérrez et al., 2019; Niero et al., 2021). Recently, MFA has been promoted as an apt approach for circularity assessments (Kalmykova et al., 2018); however, within our sample, there was both a low application of and familiarity with MFAs from companies, irrespective of their size or sector. However, a significant correlation was observed between company size and the application of three out of 22 assessment approaches: GRI indicators, CF and LCA. This might point to both institutional conditions (e.g. the increasingly obligatory nature of sustainability reporting and rise in industry reporting initiatives) and resource availability as drivers for the uptake of assessment approaches by large companies (Di Maio & Rem, 2015). We also found that companies in the production sector were significantly more likely to implement LCA and three single indicators related to resource flows (RR, RC and VWdL) which could be explained by the higher importance of such flows in companies which are transforming materials into products. In contrast, companies in the service sector, which are more often working with intangible products, might apply different CE strategies, subsequently resulting in different impact assessment needs (Blomsma et al., 2019).

With respect to CE and sustainability assessment, findings here show that for companies, the distinction between the two is not clearly defined. This is in line with the persisting blurred perspectives of the two paradigms from both companies and academic literature (Schoeggl et al., 2020; Walker, Opferkuch, et al., 2021). Most assessment approaches were considered by survey participants to be useful to assess CE as well as sustainability. Yet, from the interviews, two-thirds of respondents perceived CE assessment as a part of a wider sustainability assessment, where the latter encompasses the social dimension as well as certain environmental aspects which interviewees considered being not directly related to resource use (e.g. CO_2 emissions and energy use). Some companies with CE 'in their DNA' equated their general performance assessment with CE performance. However, as various authors have indicated, CE practices do not always lead to improved sustainability impacts (Blum et al., 2020; Corona et al., 2019). While our research demonstrates the confusion companies have regarding the differences and similarities between CE and sustainability assessment approaches, the majority of interviewees agreed that sustainability takes precedence over CE, as is promoted in other studies (Kristensen & Mosgaard, 2020). Regarding tailor-made approaches, a small majority of companies in our sample that developed assessment approaches have collaborated with external parties, primarily consultancies, but also universities or supply chain partners. In such collaborations, consultancies and universities often provide knowledge, in line with Pereira and Vence (2021). Consultancies often help companies to adapt existing assessment approaches to corporate realities and to generate information for decision-makers. Furthermore, the consultancies also use their assignments to improve their tailor-made methodologies. Meanwhile, supply chain partners are mainly involved for data collection. This draws attention to the ability of CE strategies to increase collaborations along the supply chain (Brown et al., 2019). At the same time, closer collaboration is needed to address the existing disconnect between research and practice with respect to assessing (the sustainability of) CE practices (Harris et al., 2021).

In the development process, larger companies often make use of available frameworks which support mandatory reporting, such as the GRI as well as tendering requirements made by their governments or clients. While using existing frameworks can be considered a top-down approach to developing assessment approaches, the involvement of stakeholders enables a bottom-up co-creation of assessment approaches, potentially resulting in enhanced assessment capabilities. This reflects two established findings from sustainability assessment literature: (1) Tailor-made assessment approaches better reflect companies' business realities, and (2) the involvement and participation of stakeholders is crucial for the development and application of assessment methodologies (Maas et al., 2016; Sala et al., 2013). Regarding the requirements for external assistance when developing CE and sustainability assessment approaches, we find that the company's expectations are similar for both CE and sustainability assessment. This indicates there is a similar level of understanding of the two concepts, although some tendencies stood out. Primarily, companies indicated they need the most external support when deciding how to combine circularity and sustainability indicators as well as to model the impacts of their CE practices. The latter is also one of the most challenging phases documented in literature, especially for SMEs not experienced with impact assessment methods of life cycle-based/footprint-based assessment approaches (Chevalier et al., 2011). Interestingly, external expertise was considered least beneficial for internal communication within the survey, whereas internal improvements and insights were established as major benefits of CE assessment in the interviews.

This study, to our knowledge, is the first to identify the benefits of and barriers to CE assessment within the private sector. Within the interview sample, three-quarters of companies declared that they conducted some form of CE assessment, while the remaining one-quarter did not. The latter group pointed to seven internal and nine external barriers to CE assessment, a categorisation of barriers that has previously been found in literature on sustainability assessment. Some of those barriers were categorised as methodological issues, related to the current absence of any standard or benchmark for CE assessment. Companies explained that this has resulted in a lack of demand or general awareness for CE assessment from clients, as similarly found by Droege et al. (2021b). Interestingly, for the companies that had implemented some form of CE assessment, the primary benefits concern the internal optimisation of CE strategies and the use of CE assessment results within marketing and external communication. This result highlights the value companies obtain from the overall learning process associated with developing and implementing CE assessment, as companies were able to further integrate CE within their CS and strategic management processes, as is expected by Skærbæk and Tryggestad (2010) and Lozano (2015). Additional benefits of CE assessment, such as increasing transparency and identifying opportunities for collaboration, were in line with the general benefits of sustainability assessment a company will experience, as described in Bae and Smardon (2011).

With respect to most of the internal barriers to CE assessment we identified (e.g. small company size), our findings suggest that they are consistent with general barriers to sustainability assessment approaches, as seen in Johnson and Schaltegger (2016) and Jaramillo et al. (2019). This suggests that ongoing efforts to develop a single standard for CE assessment, e.g. by the ISO/TC 323 (ISO, n.d.), will not remove all barriers to CE assessment. This highlights the continued importance of acknowledging existing barriers to assessment within sustainability research; future CE assessment approaches must consider them in order to increase the accessibility of sustainability assessment in general, as opposed to amplifying assessment fatigue (Khalid et al., 2020). Our study also reveals the limited assessment capacities of SMEs, as already established in previous studies (Johnson & Schaltegger, 2016), and stresses the benefits of CE assessment with the hopes that SMEs and micro companies can be informed and supported to allocate resources for this endeavour.

Finally, the results of this study call for a reflection on a long-discussed paradox associated with assessment: standardisation versus tailoring of assessment approaches. First, as already mentioned, our results showed a key barrier for companies to conduct CE assessments was a lack of relevant benchmarks or standards, prompting a call for some form of standardisation of CE assessment and reporting. However, we have found that companies obtained numerous benefits through the process of developing tailor-made CE assessment approaches, benefits which would be potentially reduced, if standardisation was to occur in an overly prescriptive way. At the same time, it is important to acknowledge that companies selecting their own CE indicators opens the doors for incidences of greenwashing, as observed in recent studies on CE assessment and reporting guidelines (Opferkuch et al., 2021; Pauliuk, 2018). These studies indicated that companies are able to cherry-pick CE indicators, reporting more on aims and intentions, rather than actual performance. In response to this, we refer to the suggestions of previous studies including Kühnen and Hahn (2018), who discussed this paradox within the context of social sustainability assessment. The authors suggest that while a normative consensus is emerging on what kind of indicators are to be included, decision-makers have to accept that at least part of the assessment results will remain incomparable, but are adapted to the respective context (Kühnen & Hahn, 2018). Similarly, Veleva et al. (2001) noted that lists of environmental performance indicators provided by global sustainability frameworks (e.g. GRI) offer very little insights into how a company may annually select, revise and reselect indicators they deem to more accurately measure sustainability. To potentially overcome the standardisation vs. tailoring paradox, Veleva and Ellenbecker (2001) suggest the use of core and supplemental indicators, facilitating both comparability of performance and flexibility for context-specific aspects, a suggestion which could be utilised within the context of assessing CE practices.

5.1 | Recommendations for academia

While academia was swift to propose a ubiquity of assessment approaches designed to assess circularity, sometimes explicitly identifying their relation to sustainability, less robust knowledge has been developed on the topic of assessment benefits. How the assessment process and results are used for strategic decision-making should be further investigated to direct the development of assessment practices. Moreover, such assessments often require expert knowledge and data that might not be readily available in the private sector. Therefore, we recommend that scholars should attempt to create CE assessment approaches with benefits that are validated by their end users (companies), as to facilitate their uptake. For this, a clearer picture of company needs and capabilities is required to design assessment approaches that match business realities, as has been the case for sustainability assessment. For example, companies expressed they would appreciate, if CE assessment were to include the whole life cycle or product supply chain, which implies the involvement of a wider set of stakeholders. When designing CE assessment approaches, it is thus essential to include not only the immediate stakeholders of companies, but to ideally involve the actors involved throughout the entire life cycle of the companies' products. While this has also been advocated for in sustainability assessment (Sala et al., 2013), the life cycle perspective inherent in CE provides a comprehensible and accepted rationale for the co-creation of CE assessment approaches. It could be the role of scholars to facilitate the joint development of assessment approaches that help to identify and involve such stakeholders, promoting the integration of participatory processes, while ensuring that interests beyond the businesses' stakes are covered (Keeble et al., 2003). Future studies could also integrate such participatory processes for assessment development in fields not directly related to CE, such as innovation and strategic management studies.

Finally, we recommend that academia should be clear in disseminating the message that CE is best used as a means to achieve sustainability and that assessing circularity in itself would not serve this purpose. While circularity and sustainability indicators tend to overlap in some instances, assessment should be able to reveal whether a CE practice will make a company and its partners more sustainable or not. Nevertheless, we argue that CE assessment can still provide companies with insights valuable to managing their resources; it could be seen as a precursor of and not a substitute for sustainability assessment. After all, to assess the impact of resource flows on sustainability, these flows first need to be identified and quantified. For this, we recommend incorporating the use of existing assessment approaches such as MFA-based methodologies, instead of promoting the development of new assessment approaches from scratch (Birat, 2015; Kalmykova et al., 2018). Instead, more academic attention could be paid to understanding assessment capacities of companies and aligning their needs with the existing methods, thus reducing assessment fatigue. This should be done considering the requirements and developments of international environmental standards, tools and labels such as the proposed Corporate Sustainability Reporting Guidelines (EC, 2021).

5.2 | Recommendations for practitioners

Corporate ambitions that go beyond profit maximisation are commendable; however, assessment is needed to ensure whether these ambitions can also be transformed into practices that result in the desired impacts, preferably prior to implementing such practices. For impact assessment, stakeholder involvement is recommended for setting priorities, given the strong context dependency of the impacts which CE practices can have on CS. Whereas external experts can help during this process, corporate learning associated with the process of assessment will facilitate cultural change. This requires cross-sectional involvement of employees as well as close collaboration with suppliers and clients. The scope of the assessment should be determined by the life cycle of a product or a cumulation of different products, where in a first step, the resource flows are to be mapped—for example, through the application of MFA-based approaches. Then, in line with recent research, only in a second step the related impacts in the three sustainability dimensions can be established through application of life cycle impact assessment methods (see Kalmykova et al., 2018; Rufí-Salís et al., 2021; Schulte et al., 2021). It should be noted that traditional MFA-based methods do not, in contrast to tools such as the CTI, provide insights into the different recovery options inherent in material or product flows (WBCSD, 2020). Transparency on the recovery options of resource flows can offer information on suitable CE strategies to take. It needs to be underlined that existing data on resource flows can be used for both assessment steps, thus streamlining the data collection efforts. Further guidance on design strategies, setting up assessment processes for manufacturing companies and balancing the trade-offs when making decisions based on assessment results are covered by Diaz et al. (2021) and Kravchenko et al. (2020).

6 | CONCLUSION

In this article, we collected empirical evidence on the development and application of assessment approaches by European frontrunner companies engaged with CE practices. The results show that despite ample assessment propositions from the academic realm, only few are implemented by companies. Instead, companies most often develop their own tailor-made assessment approaches to assess sustainability and CE, frequently in collaboration with consultancies and universities. The applied assessment approaches are either based on direct impact or life cycle-based methods, such as LCA. In addition, our results suggest that the majority of companies engaged with CE are aware of the importance of assessment and are applying assessment approaches that are life cycle based.

The distinction between sustainability and CE assessment is seldom explicit, but the results show that companies perceive sustainability assessment to have a wider scope, notably also including the social dimension. While CE assessment is often understood to fall under the environmental dimension and mainly concerns material use, it provides pertinent information on resource flows, the impacts of which can then be assessed from a sustainability perspective. The companies that conduct such a CE assessment use the results to support external communication and provide strategic insights into resource use. Yet, several of the interviewed companies have abstained from conducting a CE assessment, because of a lack of an assessment standard, limited client demand and having only moderate assessment capabilities and capacities.

We are aware that the results of this article are subject to some limitations: the majority of both the survey and interview respondents are micro companies, asking for the results to be generalised with caution. However, given that the majority of companies in the EU are either micro companies or SMEs, the population to which the findings are relevant could be considerable nevertheless. Furthermore, we received several comments in the survey that pointed out that the questionnaire seemed to be designed for large companies, with questions covering a rather extensive list of topics. Therefore, we paid special attention to inclusively addressing, for example, the distinction between CE and sustainability assessment and the benefits and barriers to CE assessment in the interviews. Additionally, we acknowledge the overlapping nature of various assessment approaches described within this study (e.g. MCI, MFA and single indicators) which may have distorted some of the results, potentially further complicated by companies' lack of familiarity with assessment approaches.

The empirical insights into the assessment practices of frontrunner companies engaged with CE, as identified in this article, can support the design of assessment approaches that are (1) adjusted to company needs, increasing their applicability, and (2) able to accurately assess sustainability impacts of CE practices. This sustainability assessment could in part be informed by the quantification of resource flows, making circularity assessment a precursor and not a substitute for assessing sustainability. Furthermore, future research could build on the presented findings by analysing the general usefulness and suitability of assessment processes and results in facilitating transformative sustainable change. As mentioned, we recommend both academia and practitioners to drive the involvement of various stakeholders to co-create assessment approaches, which, by improving company capabilities, may have the potential to accelerate private sector initiatives towards SD. Ultimately in the future, clients and other stakeholders will probably more frequently request companies to communicate the contribution of their CE practices to the SDGs in a transparent and systematic manner, for which assessment approaches are essential.

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ENDNOTE

[1] Within this article, *circularity assessment* and *CE assessment* are used interchangeably.

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APPENDIX A

LIST OF INCLUDED CE NETWORKS

TABLE A1 CE networks by country

Italy	Netherlands	International[a]
• Atlante Italiano dell'Economia Circolare • Italian Circular Economy Stakeholder Platform (ICESP) • Circular Economy Network • Mercato Circolare	• Circulair ondernemen • Ontertekenaars van Grondstoffakkoord • Circle Economy • Holland Circulair Hotspot • Circulaire Coalitie	• Ellen MacArthur Foundation CE 100 • Circular Economy Club

[a]Included companies needed to have primary business operations in Italy or the Netherlands.

APPENDIX B

INTERVIEW GUIDELINES

1. Why does your company assess circularity? If not applicable, why not?
    1. If does assess CE: What benefits does your company get from assessing circularity?
    2. If does not assess CE: Is the reason for this linked to the characteristics of assessment methodologies available for circular economy or linked with internal capacity (barriers)?
    3. If does OR does not assess CE: There are various CE assessment approaches available on various scales (i.e. material, product, organisational and supply chain). In your opinion, if we were to develop an assessment approach for circularity, what scale/level(s) should be the focus, and why?
2. How does your company approach sustainability assessment and circularity measurement?
    1. If company does assess: In your opinion, what is the difference between the two?

2. If your company does not do circularity assessment: Do you think there is a difference between sustainability assessment and circularity measurement?
3. If company does assess CE: Within your company, what was the process for creating the assessment approach for circularity?
4. If company does assess either: How have you included stakeholders in creating a circularity or sustainability assessment process? Does this internal process differ for circular economy and sustainability assessment?

APPENDIX C

APPLICATION OF ASSESSMENT APPROACHES

TABLE C1 Complete results of application of approaches on product and company level ($n = 98$)

Category	Abbreviation	Yes, on company level	Yes, on product level	Not yet, but planned	No
Life cycle based/footprint	CF	39%	17%	16%	28%
	E-LCA	18%	42%	13%	27%
	EF	16%	16%	15%	54%
	WF	14%	10%	11%	65%
	MFA	13%	11%	4%	72%
	PEF	11%	16%	15%	58%
	LCC	7%	17%	10%	66%
	S-LCA	5%	1%	16%	78%
Reporting framework	EA	32%	10%	13%	45%
	GRI	27%	5%	9%	59%
Single indicators	VWdL	38%	20%	8%	34%
	RR	36%	22%	5%	37%
	VVMp	29%	22%	12%	38%
	RC	23%	32%	4%	40%
	VNRRne	20%	14%	11%	54%
	MD	16%	30%	1%	53%
	TfD	9%	13%	5%	73%
	MCI	7%	6%	12%	76%
Tailor-made indicators	TSI (direct)	46%	14%	12%	27%
	TSI (life cycle)	27%	26%	10%	37%
	TCEI (life cycle)	24%	19%	8%	49%
	TCEI (direct)	21%	24%	7%	48%

Abbreviations: CF, carbon footprint; EA, environmental accounting; EF, ecological footprint; E-LCA, environmental life cycle assessment; GRI, GRI standards; LCC, life cycle costing; MCI, Material Circularity Indicator (by Ellen MacArthur Foundation); MD:, material durability; MFA, material flow analysis; PEF, product environmental footprint; RC, recycled content; RR, recycling rate; S-LCA, social life cycle assessment; TCEI (direct), tailor-made circularity indicators based on direct impact; TCEI (life cycle), tailor-made circularity indicators based on a life cycle approach; TfD, time for disassembly; TSI (direct), tailor-made sustainability indicators based on direct impact; TSI (life cycle), tailor-made sustainability indicators based on a life cycle approach; VNRRne, volume of non-renewable resources not extracted; VVMp, volume of virgin material production prevented; VWdL, volume of waste diverted from landfill; WF, water footprint.

TABLE C2 Complete results of application of approaches by company size ($n = 98$)

Category	Abbreviation	Yes (micro)	No (micro)	Yes (SME)	No (SME)	Yes (large)	No (large)	Stat. significance
Life cycle based/footprint	E-LCA	46%	54%	56%	44%	87%	13%	0.004*
	CF	36%	64%	60%	40%	83%	17%	0.001*
	EF	32%	68%	70%	30%	33%	67%	0.986
	PEF	26%	74%	21%	79%	35%	65%	0.561
	MFA	26%	74%	23%	77%	14%	76%	0.97
	LCC	23%	77%	19%	81%	33%	67%	0.499
	WF	21%	79%	27%	73%	26%	74%	0.806
	S-LCA	3%	97%	7%	93%	10%	90%	0.586
Reporting framework	EA	33%	67%	50%	50%	45%	55%	0.35
	GRI	20%	80%	17%	83%	70%	30%	0.000*
Single indicators	MD	50%	50%	43%	57%	41%	59%	0.758
	RC	49%	51%	61%	39%	68%	42%	0.543
	VWdL	49%	51%	61%	39%	70%	30%	0.255
	RR	49%	51%	62%	38%	67%	33%	0.315
	VVMp	45%	55%	56%	44%	52%	48%	0.621
	VNRRne	35%	65%	37%	63%	30%	70%	0.888
	TfD	21%	79%	34%	66%	9%	91%	0.093
	MCI	11%	89%	21%	79%	5%	95%	0.221
Tailor-made indicators	TSI (direct)	61%	39%	48%	52%	77%	23%	0.100
	TSI (life cycle)	52%	48%	52%	48%	54%	46%	0.982
	TCEI (life cycle)	44%	56%	45%	55%	46%	54%	0.994
	TCEI (direct)	37%	63%	43%	57%	52%	48%	0.502

Abbreviations: CF, carbon footprint; EA, environmental accounting; EF, ecological footprint; E-LCA, environmental life cycle assessment; GRI, GRI standards; LCC, life cycle costing; MCI, Material Circularity Indicator (by Ellen MacArthur Foundation); MD:, material durability; MFA, material flow analysis; PEF, product environmental footprint; RC, recycled content; RR, recycling rate; S-LCA, social life cycle assessment; TCEI (direct), tailor-made circularity indicators based on direct impact; TCEI (life cycle), tailor-made circularity indicators based on a life cycle approach; TfD, time for disassembly; TSI (direct), tailor-made sustainability indicators based on direct impact; TSI (life cycle), tailor-made sustainability indicators based on a life cycle approach; VNRRne, volume of non-renewable resources not extracted; VVMp, volume of virgin material production prevented; VWdL, volume of waste diverted from landfill; WF, water footprint.

*Statistically significant at 99th confidence interval.

TABLE C3 Complete results of application of approaches by company sector ($n = 98$)

Category	Abbreviation	Yes (production)	No (production)	Yes (service)	No (service)	Stat. significance
Life cycle based/footprint	E-LCA	69%	31%	49%	51%	0.043*
	CF	63%	37%	46%	54%	0.099
	EF	35%	65%	28%	72%	0.467
	PEF	24%	76%	30%	70%	0.560
	MFA	21%	79%	28%	72%	0.444
	LCC	23%	77%	26%	74%	0.768
	WF	24%	76%	24%	76%	0.923
	S-LCA	4%	96%	8%	92%	0.444
Reporting framework	EA	48%	52%	34%	66%	0.182
	GRI	35%	65%	27%	73%	0.427
Single indicators	MD	43%	57%	49%	51%	0.574
	RC	67%	33%	40%	60%	0.009**
	VWdL	69%	31%	45%	55%	0.023*
	RR	67%	33%	47%	53%	0.046*
	VVMp	58%	42%	40%	60%	0.077
	VNRRne	41%	59%	27%	73%	0.164
	TfD	28%	72%	16%	84%	0.192
	MCI	11%	89%	15%	85%	0.512
Tailor-made indicators	TSI (direct)	62%	38%	59%	41%	0.717
	TSI (life cycle)	57%	43%	48%	52%	0.383
	TCEI (life cycle)	47%	53%	43%	57%	0.675
	TCEI (direct)	44%	56%	41%	59%	0.828

*Statistically significant at 95th confidence interval.
**Statistically significant at 99th confidence interval.

APPENDIX D

ATTRIBUTION OF APPROACHES TO SUSTAINABILITY OR CE

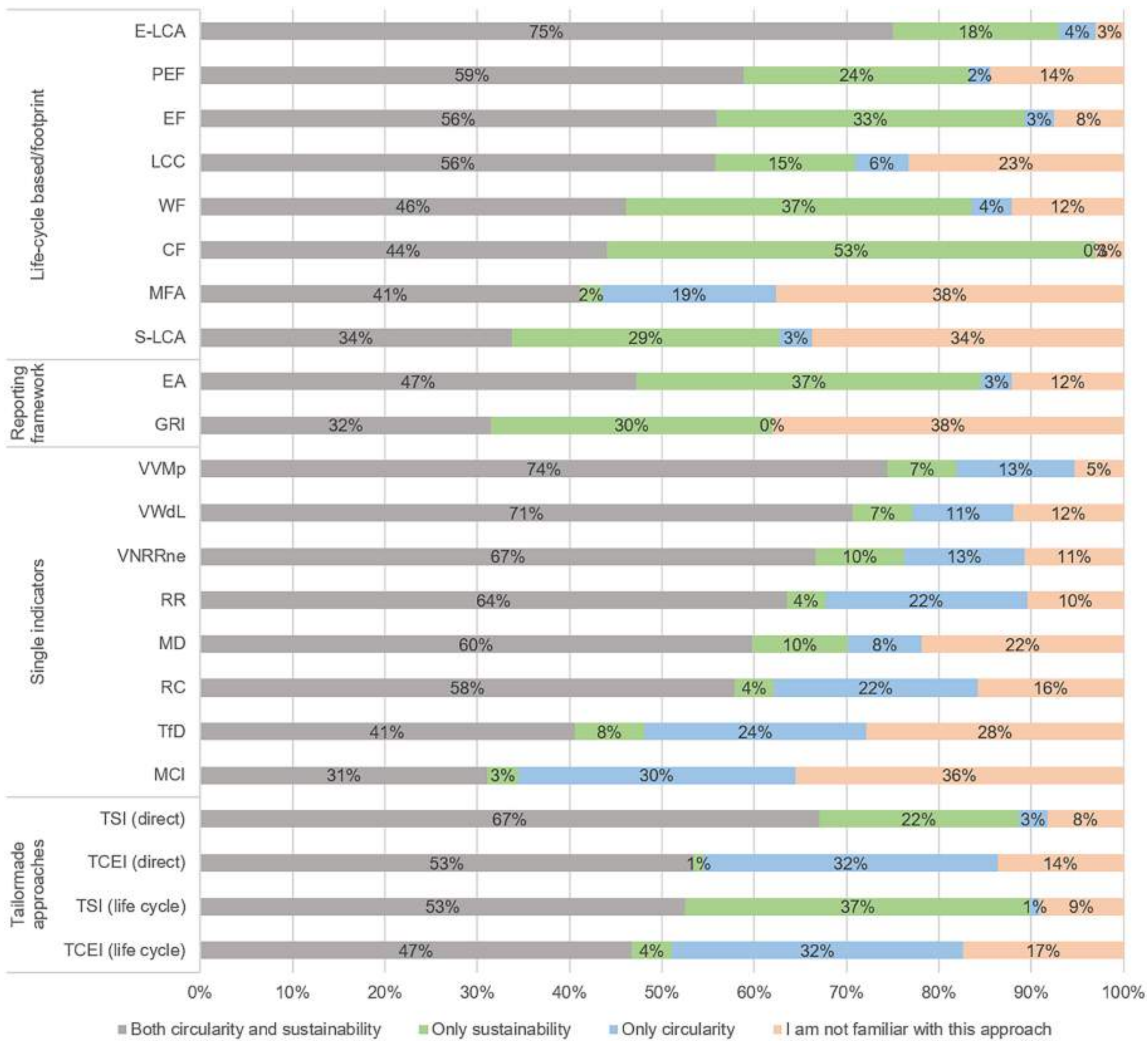

FIGURE D1 Attribution of approaches to CE- and/or sustainability assessment (n = 97). CF, carbon footprint; EA, environmental accounting; EF, ecological footprint; E-LCA, environmental life cycle assessment; GRI, GRI standards; LCC, life cycle costing; MCI, Material Circularity Indicator (by Ellen MacArthur Foundation); MD, material durability; MFA, material flow analysis; PEF, product environmental footprint; RC, recycled content; RR, recycling rate; S-LCA, social life cycle assessment; TCEI (direct), tailor-made circularity indicators based on direct impact; TCEI (life cycle), tailor-made circularity indicators based on a life-cycle approach; TfD, time for disassembly; TSI (direct), tailor-made sustainability indicators based on direct impact; TSI (life cycle), tailor-made sustainability indicators based on a life cycle approach; VNRRne, volume of non-renewable resources not extracted; VVMp, volume of virgin material production prevented; VWdL, volume of waste diverted from landfill; WF, water footprint