Received: 2 May 2022 | Revised: 3 March 2023 | Accepted: 12 March 2023

DOI: 10.1002/csr.2487

Corporate Social Responsibility and Environmental Management

WILEY

CASE STUDY

A dynamic capabilities perspective on implementing the Circular Transition Indicators: A case study of a multi-national packaging company

Anna M. Walker[1,2] | Alberto Simboli[1] | Walter J. V. Vermeulen[2] | Andrea Raggi[1]

[1]Department of Economic Studies, University "G. d'Annunzio" of Chieti-Pescara, Viale Pindaro 42, Pescara 65127, Italy

[2]Copernicus Institute of Sustainable Development, Utrecht University, Princetonlaan 8a, Utrecht 3584 CB, the Netherlands

Correspondence
Anna M. Walker, Department of Economic Studies, University "G. d'Annunzio" of Chieti-Pescara, Viale Pindaro 42, Pescara 65127, Italy.
Email: anna.walker@unich.it

Funding information
European Union's Horizon 2020 Research and Innovation Programme, Grant/Award Number: 765198

Abstract

The use of life cycle-based assessment has been defined a crucial microfoundation to implement circular business models from a dynamic capabilities perspective. Through a case study of a multi-national packaging corporation in the plastics sector, the application of an industry-developed circularity assessment, the Circular Transition Indicators (CTI), is analysed in two manufacturing locations (Italy and China). The aim is to identify how this life cycle-based assessment can amplify the company's capability to sense, seize and reconfigure its resources. Data were collected from a company placement, interviews, and sustainability reports. The CTI mainly contributed to the sensing microfoundations concerning the company's life cycle-based perspective and the use of environmental management tools. It also proved to complement existing life cycle-based approaches because it does not identify sustainability impacts, but only captures material flows. Furthermore, the results showed how the CTI implementation benefitted from existing microfoundations, such as the strategic collaboration with knowledge partners and previously collected sustainability and process efficiency data. Finally, it was also discussed for which microfoundations the CTI results could be most useful: to improve internal resource management processes and to support external circularity pledges. This paper contributes an empirical example to connect dynamic capabilities with life cycle management literature in a circular economy context.

KEYWORDS
circular economy, circularity metrics, dynamic capability, life cycle assessment, life cycle management, sustainability assessment

1 | INTRODUCTION

As more companies consider the circular economy (CE) to be a promising business paradigm to advance sustainability (Cecchin et al., 2021; Walker, Opferkuch, Roos Lindgreen, Raggi, et al., 2022) the question of how to assess this advancement remains contested (Walzberg et al., 2021). International standards on measuring CE are currently being developed by ISO (2020), but to date the applied approaches are mainly created by the industry (WBCSD, 2018). One of the most prominent assessment frameworks was developed under

the guidance of the World Business Council for Sustainable Development (WBCSD) within its Factor 10 working group: the Circular Transition Indicators (CTI) (WBCSD, 2020). Alongside the Circulytics, a survey-based circularity assessment by the Ellen MacArthur Foundation (2019), the CTI framework is one of the first assessment approaches dedicated to assessing circularity at company level. In contrast, previous initiatives were focused on the circularity of products, such as the Material Circularity Indicator (Ellen MacArthur Foundation & Grata, 2015). The CTI framework provides a customisable internal assessment of the circularity of company processes with the goal of providing an overview of material and energy flows. Its implementation, thus, depends on the actual areas of improvement a company's CE strategy foresees (WBCSD, 2020). However, the integration of the CTI with sustainability assessment approaches has yet to be documented, given that circularity should not be aspired for the sake of being circular (Walker, Opferkuch, Roos Lindgreen, Raggi, et al., 2022). After all, circular solutions might not always have superior sustainability performance, which should ideally be analysed through ex-ante assessment (Roos Lindgreen et al., 2022).

In management literature, the dynamic capability perspective argues that especially in the context of CE and supply chain management, taking a life cycle perspective and assessing sustainability impacts are crucial for a sustained competitive advantage (Khan et al., 2020a, 2020b, 2021; Santa-Maria et al., 2022). According to recent literature on dynamic capabilities, the latter are defined as "the firm's potential to systematically solve problems, formed by its propensity to sense opportunities and threats, to make timely and market-oriented decisions, and to change its resource base" (Barreto, 2010, p. 271). It is thus essential to understand how companies are using these circularity assessment approaches in combination with sustainability assessment approaches and other sustainability management tools within decision-making processes (Das et al., 2022; Lozano, 2020). Ideally, such an integrated assessment could ameliorate transparency on material and energy flows going in and out of the company, whilst at the same time increasing collaboration with suppliers and clients along the life cycle of a product (Brown et al., 2019, 2021; Walker, Opferkuch, Roos Lindgreen, Simboli, et al., 2022). The process of adapting the CTI to a large company and implementing it necessitates the relevant technical know-how, data provision and potential involvement of cross-sectoral departments and suppliers (Roos Lindgreen et al., 2022). All of these requirements are additional so-called microfoundations of dynamic capabilities, lined out by Santa-Maria et al. (2022) as essential for circular business model innovation.

To date, the actual implementation and integration of the CTI framework into corporate strategy and its roll-out through large companies have not yet been documented in academic literature. Therefore, this article uses the Teece's (2007) concept of dynamic capabilities, subdivided into sensing, seizing and reconfiguring capabilities, to analyse a case study of a multi-national packaging corporation in the plastics sector. This company integrated CE as one of its main sustainability strategy pillars and has tested the CTI framework as member of the Factor10 working group. Given the heightened scrutiny the plastics, and in particular the packaging sector is exposed to (Bishop et al., 2020; Hahladakis et al., 2020), the corporation has also joined several industry initiatives such as the New Plastics Economy Global Commitment (Ellen MacArthur Foundation & UNEP, 2018). As part of reputation management, these types of initiatives, setting targets for recycling and the use of recycled plastic, have been shown to positively affect financial performance (Mazzucchelli et al., 2022). The corporation appointed its Italian sites with a strong track-record of piloting sustainability assessments, in close collaboration with a university in the sites' proximity, to test the CTI. Thereafter, that pilot was repeated in China, to identify the suitability of the methodology to be rolled out throughout the whole company. Whilst the exact calculations of the CTI framework cannot be shared due to data confidentiality, this paper aims to shed light on how the CTI, as part of the life cycle-based assessments, a) constituted, b) affected and c) was affected by the company's dynamic capabilities. Particular attention will be attributed to the assessment process itself in different geographical contexts, as well as the integration with the sustainability strategy. In the following Section 2, a brief literature review on dynamic capabilities in CE, life cycle-based assessments in a global context and the application of the CTI framework will be provided. Thereafter, the case study method is described in Section 3, followed by the results (Section 4). Section 5 contextualises the findings and proposes future research avenues.

2 | THEORETICAL BACKGROUND

In the following section, the dynamic capabilities concept and its applicability to the CE context is lined out. Thereafter, the particularity of assessing CE practices within supply chains is presented and finally the CTI framework is described in more detail.

2.1 | Dynamic capabilities in a CE context

The concept of dynamic capabilities can be considered a comparatively young field in strategic management (Barreto, 2010) and aims to explain, why and how companies can sustain a comparative advantage within a fast-moving environment (Eisenhardt & Martin, 2000). It originates from the resource-based view, which implies that companies have comparative advantage through the resources they possess. Yet, the dynamic capabilities view goes a step further and puts the attention on how these resources are obtained, managed and used (Helfat & Peteraf, 2003; Teece, 2007). Whilst the focus has traditionally been on large international companies, given these are most exposed to supranational, dynamic environments (Barreto, 2010), recent literature has also started to integrate the idea of dynamic capabilities for company performance that goes beyond the economic sustainability dimension (Amui et al., 2017). Besides its relation to corporate social responsibility (CSR), the dynamic capabilities perspective in sustainable supply chains has also been discussed by Beske (2012) in a theoretical framework. It maps out five central dynamic capabilities for supply chains: supply chain reconceptualization, partner development along the supply chain, co-evolving of capabilities with

partners, knowledge accessing through partners, and reflexive supply chain controls, meaning information management which is constantly adapted to the supply chain's needs. These were later analysed empirically in the food (Beske et al., 2014) and automotive sector (Siems et al., 2021), where it was observed that the integration of stakeholders and joint development and knowledge management increased in importance. Similarly, Kırcı and Seifert (2015) found that to improve the environmental performance of an international supply chain, capabilities related to information transparency and integration with partners' communication and reporting were essential. As some of the first scholars to adapt the dynamic capabilities view to CE, Scarpellini et al. (2020) documented that there was a positive relationship between the implementation of environmental management systems (EMS), environmental accounting, specialised human resources, CSR, as well as accountability towards stakeholders and the successful implementation of CE practices. Similarly, Khan et al. (2020b) quantitatively showed how dynamic capabilities positively affect corporate performance through CE implementation. Both Khan et al. (2020a, 2021) and Santa-Maria et al. (2022) then used the conceptualisation by Teece (2007) to determine the microfoundations of dynamic capabilities necessary for successful CE implementation. In particular, "(i) adopting a life cycle perspective, (ii) implementing environmental management tools (e.g., life cycle analysis), (iii) ideating and developing value propositions with environmental and/or social impact, (iv) developing a sustainability strategy and culture, (v) engaging strategic partners in collaboration and cocreation, and (vi) integrating stakeholders and coordinating partners in the business ecosystem" are seen as best practices (Santa-Maria et al., 2022, p. 18). Whereas particularly (i) and (ii) relate to corporate assessment practices, they are both directly and indirectly connected to the remaining ones. It needs to be underlined that these best practices are fairly similar to those previously proposed for life cycle management (LCM) (Nilsson-Lindén et al., 2019; Sonnemann et al., 2015). However, due to their different origins—dynamic capabilities stemming from management literature, whilst LCM is coming from natural sciences—these strands of literature have only recently crossed (Bianchi et al., 2022). In a study on the connection of LCM and dynamic capabilities, Bianchi et al. (2022) described how LCM could be embedded in Italian manufacturing companies primarily through sensing and seizing capabilities. They also underlined the importance of LCM for companies wanting to implement CE practices.

2.2 | Assessing circularity and sustainability in inter-firm networks

Whilst literature proposes several assessment approaches (Corona et al., 2019; Kravchenko et al., 2019; Roos Lindgreen et al., 2020; Walker, Vermeulen, Simboli, & Raggi, 2021) for companies with global supply chains, life cycle-based approaches seem to be most prevalent for evaluating the environmental impacts of CE practices on a product (Das et al., 2022; Khan et al., 2021; Roos Lindgreen et al., 2022; Santa-Maria et al., 2022; Schöggl et al., 2020). The assessment approaches must be in line with the overall sustainability goals of a company, which can be deduced from the corporate sustainability reports (Stewart & Niero, 2018). To date, these reports tend to mention CE practices of large corporates, but do not yet systematically include CE in the sustainability strategy, or leave the connection implicit (Calzolari et al., 2021; Opferkuch et al., 2021). Another critical aspect when assessing CE practices is the related interconnectedness of the supply chains, since CE practices such as reverse logistics or industrial symbiosis require a (cross-sectoral) network of companies (Bressanelli et al., 2021; Vegter et al., 2020; Walker, Vermeulen, Simboli, & Raggi, 2021). These network actors collectively need to be involved into the assessment, be it to help coordinate an overarching assessment of a product or to simply provide data on the products supplied (Walker, Opferkuch, Roos Lindgreen, Simboli, et al., 2022). There is frequently a so-called "ecosystem orchestrator" (Parida et al., 2019) that assumes the role of coordinating local supply chains. It monitors business activities for potential product improvement, whilst screening the macro-context, including, for example, relevant governmental policies for both threats and opportunities. Additionally, the composition of company networks and particularly the dynamics within them is mostly context specific; for this reason the collaboration and assessment of CE practices in Europe might provide different insights to different actors compared to, for example, in China or India (Deutz et al., 2015; Kırcı & Seifert, 2015). Whereas the methodology of assessment can be similar across companies, sectors and geographical areas, the adaptation to local conditions can increase or shift the relevance of the results within the respective contexts (Roos Lindgreen et al., 2022).

2.3 | CTI framework

The documentation on the CTI framework clearly states that it does not replace a traditional sustainability assessment (WBCSD, 2020), but provides an internal point of reference for companies that aim to become more circular. Since its launching in January 2020, there have been two revisions of the methodology (called CTI V3.0); after the introduction of Water Circularity, indicators related to revenue flows and further guidance on how to apply the framework to products and processes concerned with the bioeconomy in the first revision (WBCSD, 2021), it now also includes the impact of recycling on greenhouse gas emission reductions and indicators on lifecycle extension (WBCSD, 2022). The CTI indicator framework applied in this pilot (V1.0) is presented in Figure 1.

The assessment does not necessarily involve the whole supply chain of a product, but requires companies to be aware of the composition of materials they are sourcing and the products they are selling. In particular, transparency is requested on the recovery type, namely reuse, repair, refurbish, remanufacture, recycle, which could be considered as a reduced number of the R-value retention options (R-VROs) coined by Reike et al. (2018). The information required implies communication with both the upstream and downstream supply chain, though mostly related to the direct supply chain partners. Through this need for assessment, collaboration between the companies along a product life cycle can potentially be increased (Walker, Opferkuch, Roos Lindgreen, Simboli, et al., 2022). Whilst the results of the CTI are not designed to be used for benchmarking against other corporations or external communication, they provide insight on production processes and the volumes of material and energy flows.

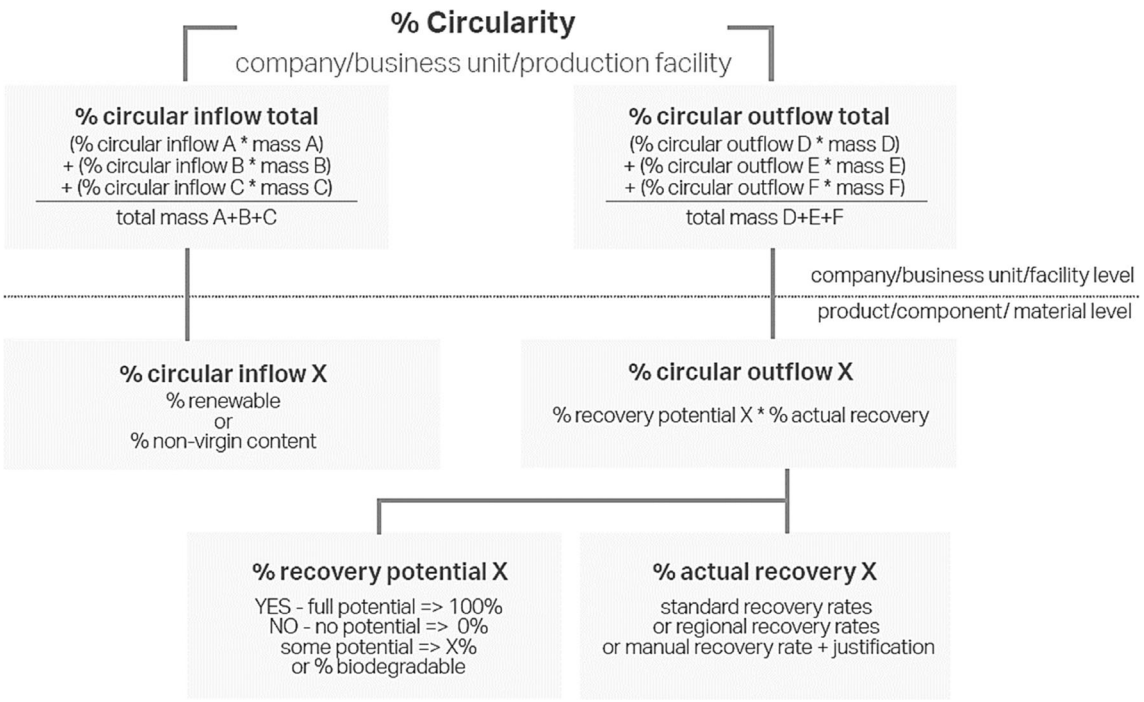

FIGURE 1 Closing the loop indicators as defined by WBCSD (2020) p. 17.

Moreover, they also capture the respective R-VROs inherent in the product or material. Mapping out the resource use offers information on where companies could manage their inputs in a more circular way, meaning to either ensure the reintroduction of the material into the loop or narrowing of the loop (Bocken et al., 2016). Furthermore, the data collected to create this overview of flows can then be used to assess their environmental and social impacts through, for example, a life cycle assessment (LCA) (Roos Lindgreen et al., 2022) and a Social LCA (S-LCA) (D'Eusanio et al., 2019).

3 | METHODS

The method chosen for this paper is an explorative case study (Yin, 2018), given the novelty of both the applied assessment itself and the integration of an industry-developed circularity assessment approach into the sustainability strategy. The dynamic capabilities of sensing, seizing and reconfiguring will be used as macro-categories, into which the activities of the company related to the implementation of the CTI framework will be integrated. In the following subsection, the case study is described in more detail, and thereafter the data collection and analysis are presented.

3.1 | Case study description

The case study company was primarily selected due to its long-standing strategic partnership with the university where three of the authors are based. Furthermore, within the international industry group Factor10, the company has been one of the first to both test and implement the CTI framework and use the related online CTI-tool (WBCSD & Circular IQ, 2020). Due to the trust established between the management and the university, as well as the company's pioneering position regarding the CTI framework, its purposive choice is deemed justified. It is a Fortune 1000 corporation active in the field of dispensing solutions, with an annual revenue of 2.9 billion USD and 13,000 employees. The sites in Italy, located in the provinces of Pescara and Chieti, are of the primary experimenting spaces for sustainability initiatives by the company. A number of assessment methods and standards were originally introduced in this location and later rolled out throughout the corporation globally; these include LCA (Guinée, 2002), organisational LCA (OLCA) (UNEP, 2015), social OLCA (SOLCA) (D'Eusanio et al., 2022; Martínez-Blanco et al., 2015), carbon footprint (WBCSD & WRI, 2004), Environmental Product Declaration (Del Borghi, 2013) as well as a Landfill-free certification (ZWIA, 2021). The other site analysed, situated in the Suzhou Industrial Park, is the corporation's largest production site in China. The company's location is unique, given that this eco-industrial park (EIP), established in 1994, requires its tenants to demonstrate higher environmental performance than the Chinese average and incentivises circular resource use (Yu et al., 2015). This is also one of the reasons why the Suzhou-based company has been chosen as a second pilot case, partially representative for sites in emerging economies. Whilst the Italian sites produce only dispensing pumps for the beauty and home (B&H) sector, the Chinese site in Suzhou also manufactures taps and dispensing solutions for the food and beverage (F&B) sector, as well as for the pharmaceutical sector.

TABLE 1 Data sources for case study.

Data source	Function	Primary or secondary
CTI framework document (WBCSD, 2020, 2021)	Description of CTI methodology	Secondary
Customised CTI excel sheet	CTI analysis for company with adapted formulae	Primary
Project report on CTI	Description of CTI implementation pilot with customised CTI formulae and selection of materials and products to be analysed	Primary
Powerpoint presentation for management	Description of CTI methodology and pilot results for corporate management and Suzhou plant	Primary
Automatic report from CTI online tool	Description of CTI results with propositions for additional value recovery	Primary
Semi-structured interviews (transcribed ad-verbatim)	Follow-up of implementation of CTI in Suzhou, further insights into how the CTI is integrated with other environmental and social assessment methods, establishing of benefits for corporation from assessment, prospective on roll-out through whole corporation	Primary
Sustainability reports	Understanding of CE integration into corporate sustainability strategy	Secondary
Meeting notes	Notes and memos from meetings with WBCSD workgroup leaders, CTI programmes, sustainability department and other departments	Primary

3.2 | Data collection

This subsection describes the data collected for analysing the role of life cycle-based assessment as microfoundation of dynamic capabilities. It should not be confused with the data collection for the CTI assessment itself, though there are some overlaps of the collection processes. Data were collected during a three-month placement at the Italian company, where the first author conducted the CTI assessment. During this time, the author participated in meetings with the global sustainability department of the corporation, with the WBCSD Factor10 working group leader, the programmer of the online CTI tool and with managers from other company departments involved in the CTI data collection. She adapted the generic formulas of the CTI V1.0 (WBCSD, 2020), depicted in Figure 1, to the operations of the corporation and collected the data for the CTI. Thereafter, under the supervision of a sustainability manager located in Italy and in constant coordination with a sustainability manager located in China, she created an excel file of the assessment and inserted it into the online CTI tool, from where they obtained an automated report. The pilot in Italy was conducted in 2019, with company and site level data from the reference year 2018.

After finalising the pilot in Italy and having it audited by a third-party company appointed by the WBCSD, the implementation was initiated for the corporation's site in Suzhou. However, for the sake of facilitating the data collection, only the F&B sector was analysed in China and not the B&H sector, as in Italy. Since the authors of this study were not directly involved in the second pilot, two semi-structured interviews (Adams, 2015) of 1h each were held in summer 2021 with sustainability managers in Italy and China, overseeing the CTI assessment process. These interviews also informed the integration of the CE assessment results into the general sustainability strategy. Furthermore, the sustainability reports of the company published since 2013 were screened for "circularity" and "circular economy" as well as the R-VROs, to complement the findings of the interviews. To increase the internal validity of the case study the different pieces of information (see Table 1) were triangulated. Moreover, the main contact person of the company reviewed a draft document of this article to verify the analysis and its interpretation.

3.3 | Data analysis

The information in Table 1 was analysed through Teece's (2007) categorisation of dynamic capabilities into sensing, seizing and reconfiguring. Sensing refers to scanning, filtering, learning and analysing of threats and opportunities, whilst seizing these opportunities involves the creation of new products, processes or services. Finally, reconfiguring or transforming capabilities do recombine and integrate assets and organisational structures, but also facilitate knowledge sharing and dissemination throughout the corporation (Teece, 2007). Specific attention was attributed to whether and how the CTI assessment integrates with microfoundations, that is, "distinct skills, processes, procedures, organisational structures, decision rules, and disciplines" (Teece, 2007, p. 1319). The microfoundations and their underpinning practices were presented in the framework for circular business model innovation established by Santa-Maria et al. (2022), further developing a previous framework by Khan et al. (2020b). In particular, the six microfoundations pointed out in Section 2.1, considered prevalent, relevant and specific to the CE and sustainability (Santa-Maria et al., 2022) were focused on.

4 | RESULTS

This section is subdivided into a descriptive account of the sensing, seizing and reconfiguring capabilities. An overview of the microfoundations built and affected when implementing the CTI in the two company sites is presented in Table 2. Throughout the following paragraphs, the present microfoundations are emphasised by italic script.

TABLE 2 Microfoundations found in case study, based on framework of Santa-Maria et al. (2022).

Dynamic capability	Microfoundations	Skills, processes, procedures, and activities	Case study
Sensing and shaping opportunities	External sensitivity	Understanding the needs of customers and key stakeholders	CE is a global trend, so company management is alert to developments in this field
		Anticipating and responding to changes in regulation	Chinese environmental regulation on recycling is becoming more stringent
	Adopting holistic perspectives	***Adopting a life cycle perspective***	To conduct the CTI assessment, the whole life cycle of products needs to be included
	Knowledge creation	Undertaking R&D activities	CTI results can be beneficial for engineers designing products and machinery for plastic moulding
		Employing accumulated experience, know-how and intellectual property	Know-how on life cycle-based assessment is available and data have already been collected for previous assessments
	Use of sustainability oriented instruments	***Implementing environmental management tools (e.g., LCA, ISO14001, & Sustainability reporting)***	Company has employed numerous life cycle-based assessments, publishes yearly sustainability reports and has most of its plants ISO14001 certified
Seizing opportunities	Delineating sustainable solutions and business models	***Ideating and developing value propositions with environmental and/or social impact***	CTI results can help to inspire changes in product material—for example, favouring mono-material or from fossil-based to renewable and/or post-consumer resin (PCR)
	Stakeholder engagement & collaboration	***Engaging strategic partners in collaboration and co-creation***	Long-standing collaboration with university, active participation in industry groups such as Factor10 and joint LCAs with clients
	Supporting a sustainability & innovation culture	***Developing a sustainability strategy and culture***	CE is a pillar of company's sustainability strategy and the CTI results can give a systematic overview of the company's current CE performance
Reconfiguring resources and structures	Organisational flexibility	Implementing experiments/pilots to validate, learn, and adapt quickly	CTI was piloted in Italy (where e.g., LCA, OLCA and SOLCA had been first introduced) and then copied in China, before being rolled out through the corporation
		Build decentralised (sustainability-oriented) innovation teams and allow flexible organisational structures	Italian sustainability team has become a space of innovation in terms of life cycle-based assessments due to their expertise
	Trust-building communication	Having a fact-based consistent and transparent external communication	CTI results can support claims on the percentage of recycled materials in connection to the New Plastics Economy
	Ecosystem orchestration	***Skills to integrate stakeholders and coordinate partners in the business ecosystem***	Strong collaboration with suppliers, but to increase data quality and communication with clients on CE, further integration of stakeholders is necessary
	Leadership & change management	Commitment and support from top management	Top management involvement is necessary to substantiate the strategic importance of the CTI to the Suzhou plant
		Implementing specific sustainable and circular KPIs	CTI results are set to become official KPIs of the company
	Knowledge management	Organisational learning, knowledge transfer, know-how integration and intellectual property management	Data collection through the CTI tool is set to be automated and rolled out through the company, whilst local managers get training on its use

Note: Skills, processes, procedures, and activities in italic bold are best practices for circular business innovation.

4.1 | CTI and sensing capability

Given that CE is currently a global megatrend the company was frequently confronted with in their meetings with customers, *upper management was closely following the most recent developments* regarding the creation of circularity assessment tools. In the involvement with both CE100 by the EMF and Factor10 by the WBCSD, a *life cycle perspective on the company's products* was always paramount, though

TABLE 3 Data sources for CTI assessment.

	Data type	Related sustainability initiative	Department involved
Inflow	Production inputs	Design for sustainability	Purchasing + Production
	Packaging materials	Sustainable sourcing	Purchasing + Logistics
	Maintenance	OLCA	Purchasing + Maintenance
Outflow	Shipped finished product	New plastics economy	Supply Chain + Logistics
	Shipped interim product	New plastics economy	Supply Chain + Logistics
	Production waste	Landfill free certification	Environmental health & safety (EHS)
	Packaging waste	Landfill free certification	EHS
	Maintenance waste	Landfill free certification	EHS + Maintenance

limited to championing the use of post-consumer resin (PCR) and recycling. In the Italian context, the waste management was already well regulated and additional information on the company's waste management practices were not required. Meanwhile, the Chinese policy context with recent developments on recycling and environmental sustainability provided a persuasive narrative for the usefulness and timeliness of the assessment in *anticipation of changes in regulation*. This was underlined with the company's strategic positioning in the Suzhou Industrial Park, with one of the highest environmental standards in China. Given the government's and the EIP's focus on recycling, PCR use, and CE, the CTI framework provides the opportunity for the company to identify corrective action initiatives that can improve the environmental features of the product portfolio in China.

4.1.1 | Consolidating accumulated experience for CTI implementation

The *accumulated experience in life cycle-based sustainability assessment and the existing data monitoring infrastructure* facilitated in particular the data collection for the CTI assessment. Whilst the data collection is usually seen as one of the most time-intensive and challenging stages of an assessment, a combination of pre-existing datasets presented in Table 3 accelerated this step considerably.

The material flows the company focused on were the raw materials, namely plastics and metals, and packaging such as cardboard boxes, plastic bags, and pallets. The inflow data were obtained from the purchasing department, with transparency on the amount of recycled content, for example, in cardboard boxes. Regarding the outflow, the data supporting the previously obtained landfill-free certification provided most of the information needed regarding the reuse of cardboard boxes and recycling of site level waste. All discarded materials had been labelled by their European Waste Catalogue code. Additionally, local recyclers had been contacted to estimate both the potential and actual recyclability of the production waste. Furthermore, the commitment to the New Plastics Economy by the EMF had previously required the company to acquire data from external laboratories on the potential product recyclability, which is also suitable for the CTI framework. In China, information on material recyclability was also available in the so-called "business certificates" which each of the recyclers needs to have to operate in the EIP. Though the recyclers had previously not necessarily been chosen based on their recycling rate, the company was able to access this information retrospectively. The data collection on outflows of sold products is described in Section 4.3.1, as it involves the integration of external stakeholders. Overall, the company had a higher data transparency on the material inflows and the direct waste outflows than on the outflows related to finished products.

4.1.2 | CTI as an environmental management tool

As anticipated, the Italian sites had pioneered several *sustainability assessment approaches as part of their environmental management tools*, whilst the Chinese site is yet to conduct an OLCA or SOLCA. When analysing the similarities between the OLCA, LCA and CTI, the company employees observed that the methods are relying on information from the bill of materials. However, the data were used for different purposes. For the CTI, they supported the mapping of input and output flows with their recovery potential. Meanwhile, for the OLCA and LCA, they helped identifying the environmental hotspots of the organisation or a product's life cycle, and the most affected impact categories such as global warming and water consumption. Furthermore, the interviewees described that the data collection for LCA methods is more extensive than for the CTI and can be used for different environmental tools (including e.g., the landfill free certification). Another difference between the LCA methods and the CTI was that LCA results are more insightful for the product level strategy (to increase e.g., the recyclability of a product), whilst the CTI enables a high level view on process efficiency with regard to raw material, energy and waste management within their operations. As one interviewee explained: "With LCA we have a very nice zoom on the product, whilst the CTI method can help us to get a high-level helicopter view of what is happening in the operations." Though the interviewees did not specifically compare the CTI and the OLCA, it was observed from their internal analysis that the OLCA determines the environmental impacts of a single plant, whereas the CTI merely maps out the material and energy flows.

4.2 | CTI and seizing capability

Circular economy is an official pillar of the company's sustainability strategy, and the findings of the CTI were beneficial to analyse what percentage of the products manufactured are made (in part) from recycled or renewable materials, or are recyclable after use. So, whilst the company was already applying several R-strategies such as reduce, reuse, recycle and recover, the CTI framework helped to capture these efforts in a systematic manner. This allowed the company to obtain better visibility of how the materials go through the manufacturing process and leave the company. One of the main benefits that these CTI results can create is *ideating and developing value propositions* with environmental impact. A concrete improvement proposed for the F&B sector was that in a product consisting of several materials which are not all recyclable (e.g., silicon), the non-recyclable material could be replaced with the same material as the rest of the closure. This would eliminate the need to separate the individual product components at its end of life. Furthermore, they obtained data on the energy efficiency and material efficiency of their production processes, including the production of scrap and waste. This information is especially useful for the production managers and engineers to *improve the design of the injection moulds for the products within Research and Development (R&D) processes*.

With regard to *strategic engagement of partners in collaboration and co-creation*, which is also a pillar of the company's sustainability strategy, membership in industry groups helped them to get access to the CTI and test the CTI online tool. Furthermore, the corporation made use of the long-standing collaboration with the university and hosted a researcher with expertise in CE assessment to conduct the pilot. The collaboration with the university goes back more than 12 years and has been a source of continuous knowledge flows from academia to practice. It was underlined in the interviews that the implementation approach for life cycle-based assessments has been bottom up. This means that the assessments were first piloted in Italy by university student interns, and then scaled throughout the whole corporation or strategically selected sites in other countries. Besides these collaborations, it is relevant to mention that for some of the life cycle-based assessments, the company had cooperated across the supply chain (cradle-to-end-of-life). In these cases, it established the environmental impact of some of the final products, to which the firm contributes components, jointly with its clients. Therefore, a similar collaboration might also be feasible for the CTI data collection to improve the data quality, which is in several cases based on estimates.

4.3 | CTI and reconfiguring capability

Besides supporting internal process optimisation, the CTI results were especially relevant in the light of the public pledges in initiatives such as the New Plastics Economy, of which the company is a signatory. The company committed itself to making its products 100% recyclable by 2025 and include at least 10% of recycled plastics into its products. With the results of the CTI framework, these kinds of *public claims can be more transparently substantiated*. The CTI was described as a tool to provide the board level with actual numbers on the company's achievement of the set sustainability goals, given that CE is an official sustainability strategy pillar since 2018. In comparison to other circularity assessments which were described as more qualitative, the CTI provides a simple and transparent formula with results that can be externally communicated. It could even be used for comparing circularity performance across companies, if within the same sector. Given that the CTI has not yet been rolled out throughout the corporation, its results were not yet included in external communication. However, the WBCSD has already used the company as a case study applying the CTI. With regard to other life cycle-based assessments, the company reports its environmental performance in the format of a carbon footprint, as well as water footprint and cumulative energy demand in their sustainability report. However, if strategic customers have more detailed requirements with, for example, a wider set of impact categories, the disclosure of the data can also be wider.

4.3.1 | Collecting CTI data through ecosystem orchestration

Whilst data from previous assessments on material inflows and waste outflows was readily available, downstream data of sold products was more difficult to obtain. Given the company provides packaging components and is a B2B company, it does not have direct consumer contact. Therefore, the actual recovery rate of the packaging in which the component is shipped depends on the buyer (another company), whereas the actual recovery rate of the final product packaging itself depends on the municipal waste management system where the consumer disposes the product. As mentioned previously, the packaging of the product makes up a considerable amount of the overall product outflow in terms of mass. Therefore, it was proposed to ask buyer companies whether they recycle the packaging (i.e., the cardboard boxes and plastic bags) of the products they purchase. However, for the purposes of this study, the company did not inquire about buyers' recycling practices, as this might be considered as "invasive" and would require extra resources. Hence, both for the finished products and their packaging, the national recycling rates of the respective destination countries were used, assuming that the products would also be consumed and discarded there. In both pilot cases, it was found that *increased integration and coordination of partners on the topic of CE*, not merely for the environmental assessment, as described in Section 4.2, would improve the data quality for the CTI.

4.3.2 | Organisational flexibility enabling two CTI pilots

The fact that the sustainability department in the Italian company of the multinational corporation was able to pilot the CTI framework, as it had experimented with several other life cycle-based assessments before, *is a sign of organisational flexibility*. Through the

aforementioned collaboration with the university, it has built a *decentralised sustainability-oriented innovation team which is allowed to operate in an entrepreneurial manner* and with limited hierarchies. Besides the CTI framework, the company also recently conducted a SOLCA of the Italian plant, which is, due to its methodology, similar to the OLCA in terms of goal and scope, inventory and interpretation of the data. The SOLCA is meant to increase the transparency regarding social aspects within individual plants. However, there seemed to be no apparent connection between the results of the SOLCA and the CTI itself, given that for the company, the social and circularity aspects are not directly related. Another pilot the company launched was a real time carbon footprint calculation for product solutions, given that, according to the interviewee, about 80% of product impacts are generated by the raw materials. As one of the first companies in its sector, it automatised data collection for the carbon footprint through the bill of materials. The very same bill of materials could also be used for a more streamlined data-collection for the CTI.

The data collection process in China was of similar efficiency as in Italy, given the previous involvement of a Suzhou-based sustainability manager in the conceptualisation of the assessment. However, it took additional time and proof of concept of the CTI assessment to ensure the pilot would also be implemented in the Suzhou plant. *Top level-management involvement* was needed from the corporation's headquarters in the United States as well as the global sustainability team to explain to the local management why such an assessment could be beneficial for the company. Besides the benefits that the CTI results could provide in the light of changing environmental regulation in China, the fact that the plants in Italy had already conducted the assessment created peer pressure to follow suit. Moreover, as the company was planning to achieve the landfill free certification soon, the CTI assessment was communicated as a suitable tool to start with the data collection. Whilst for the high-level management it was essential to understand these benefits of the assessment, mid-level managers such as warehouse managers, production managers, and EHS managers, were mainly interested in the amount of time and resources necessary for conducting the assessment. This is why the global sustainability department, together with the plant, decided not to analyse the B&H segment, as in Italy, but to assess the F&B segment. The latter encompasses simpler product solutions from a material composition perspective. Furthermore, simplified data templates and frequent meetings with the middle-level management enabled a fast and qualitatively satisfactory data collection. However, it was observed that there is still room for improvement in the data collection process to increase reliability of the information. Due to the layout of the plant combining B&H and F&B in the same production unit, the data had been collected for both segments simultaneously. This meant that raw material, energy and waste flows were then allocated through sales numbers to the F&B segment and not directly measured, as in the case of the Italian plants. Other than that, the assessment process of the two pilots was almost identical. After the assessment was inserted into the CTI online tool, the automatically generated report from this tool was shared with all involved managers to explain the insights from the study.

4.3.3 | Integrating the CTI into knowledge management

After conducting the pilot in Italy and China, the CTI results were perceived as useful information to support continuous improvement of the products and production process efficiency. The CTI should be conducted in regular intervals, though the duration of these was not yet specified. Therefore, the company started working on *facilitating the integration of the assessment in their database structure*, given that most data-points were already being collected for other performance and monitoring-related purposes. This streamlining of data collection and *integration of the CTI results as a KPI* should further facilitate the roll-out of this methodology throughout the company. However, it was stated to be essential that the *local team takes ownership of the assessment process*, and is transferred the knowledge to shape it in a way that the information can be beneficial for them. One of the issues in this respect was that the CTI online tool was not available in the local language, which prevented the local managers from being able to insert the data. This task was then executed by the corporate level sustainability team. Whilst the CTI and environmental impact assessments have proved to be of high strategic importance for the company, the social strategy and related KPIs are still under development and are being adapted to the environmental strategy.

5 | DISCUSSION

The case study has shown that the implementation of the CTI was connected to 16 practices constituting the microfoundations of the sensing, seizing and reconfiguring capabilities, including the six best practices for circular business model innovation by Santa-Maria et al. (2022). It emerged that the CTI either *contributed directly* to certain microfoundations, whilst it *benefitted from* the existence of others or *created benefits for* them.

The CTI has contributed mainly to the microfoundation related to the implementation of environmental management tools and adoption of a life-cycle perspective. It can be understood as yet another life cycle-based assessment tool that supports the sensing capability of the corporation, as part of the company's LCM processes (Sonnemann et al., 2015). An interesting connection was observed between the LCA, hailed by many as one of the most frequently used methods to assess circular practices (Roos Lindgreen et al., 2022; Stumpf et al., 2021), and the CTI. Whilst the LCA provides a full-fledged overview of product-related material and energy flows and their potential environmental impacts, the CTI is less detailed and thus faster implemented. Furthermore, it provides an overview of all inputs and outputs (and their recovery options) of a single site or business unit, which is why in this regard it can be more directly compared to the OLCA. However, the interpretation of the CTI's results is facilitated with a simple visual representation and, more importantly, it attributes the different R-strategies to the material and product flows. Especially the latter aspect allows for companies to get a wider understanding of CE practices they apply within their company for the most relevant

materials and products. This also provides an informational basis for redirecting material flows to higher R-strategies. Yet, given the missing information on the environmental (and social) impacts of the material flows, it is crucial to understand the potential effects of the simplification of the CTI versus the LCA. A high performance in the CTI, meaning a high percentage of circular input and output, is mainly based on material mass and the R-strategies implemented. So, whilst a company might have a favourable CTI score overall, the environmental impact of it could still be less promising, depending on how and what kinds of materials are being circulated. Roos Lindgreen et al. (2021) have shown in their paper, that the results of LCAs and circularity indicators (amongst others the CTI), do not necessarily point into the same directions. Hence, whilst the mass of the materials and products as well as the R-strategies are relevant for conducting LCAs and applying the CTI, the additional step of evaluating the potential sustainability impacts of the new strategy should be an integral part of the assessment process (Das et al., 2022; Roos Lindgreen et al., 2022). Importantly, this should also include the social sustainability dimension, which was not considered as directly connected to CE by the company. This is in line with the findings of Walker, Opferkuch, Roos Lindgreen, Simboli, et al. (2021), who have shown that companies do not necessarily relate CE aspects with social aspects, and instead tend to consider them as part of CSR. However, naturally, CE practices also have social implications, and these must be identified to avoid burden-shifting between sustainability dimensions (Walker, Opferkuch, Roos Lindgreen, Simboli, et al., 2021). Interestingly, the CTI results seem to have a higher strategic value, with a prospect of getting established as KPIs, a microfoundation contributing to reconfiguring, than the results of the SOLCA carried out by the company. Previous literature on LCM in supply chains found that the existence of a business case was a prime predictor of collaborative assessments (Nilsson-Lindén et al., 2019). This indicates a more favourable business case for doing CE than social assessments.

Besides these direct contributions of the CTI, the implementation of the CTI pilots benefitted from several existing microfoundations. The implementation benefitted from understanding the needs of customers and key stakeholders, employing accumulated experience and know-how (sensing), engaging strategic partners in collaboration and co-creation (seizing), implementing experiments/pilots to validate, learn, and adapt quickly, building decentralised (sustainability-oriented) innovation teams, commitment and support from top management, organisational learning, knowledge transfer and integration (reconfiguring). Due to the preceding sustainability assessments conducted by the packaging company, it was not necessary to collect a significant amount of data from scratch. Moreover, it was observed that company waste data and information on actual recovery potential was more readily available than information on waste management of the clients. Both Italy and the Suzhou Industrial Park, have strongly regulated waste management, and in the case of China, only companies that fulfil certain environmental criteria are licenced to operate in the EIP (Xie & Lu, 2022).

The diffusion of the assessment through a global organisation also provides interesting insights in terms of the strategic involvement of external parties, considered a highly strategic microfoundation of the seizing capability (Beske et al., 2014; Siems et al., 2021). In their research, Roos Lindgreen et al. (2022) found that most companies employing some kind of CE assessment engage with external stakeholders, such as consultancies or universities, to favour knowledge exchange and increase organisational learning (Teece, 2007). In this case, the company had a long-standing collaboration with a university on product innovation and the implementation of sustainability assessment tools, with a high level of trust, which is a microfoundation that is not easily copied by competitors due to its idiosyncratic pathway (Barreto, 2010). This also meant that in the Italian plant, there was no additional lobbying necessary with the plant managers to launch the pilot, given the entrepreneurial function of the sustainability team (Scarpellini et al., 2020; Teece, 2007). In contrast, it was essential to get the high-level management in China on board, before starting with the assessment. Similarly, Kırcı and Seifert (2015) found in their case study that in countries with a more hierarchical management structure and high importance attributed to seniority, top-down directions were more effective. This confirms findings by other scholars underlining the importance of top management support for implementing CE practices (Khan et al., 2020b) as well as LCM (Nilsson-Lindén et al., 2018; Nilsson-Lindén et al., 2019). It also needs to be acknowledged that for Italy, one of the authors conceptualised and conducted the assessment, whereas the Chinese team carried out the assessment themselves, under the supervision of the global sustainability department. Therefore, more resources were required for the data collection in the Chinese plant. In the future, it is expected that the data collection for the CTI online tool can be automated and integrated with the automated data collection for the LCA, thus bundling and reducing the resources needed for this step. This type of technological upgrade and streamlining is also underlined as an essential reconfiguring microfoundation by Khan et al. (2020a) and has previously been described by Baitz (2015) in the context of LCM.

Finally, the CTI results created benefits for the microfoundations related to anticipating and responding to changes in regulation, undertaking R&D activities (sensing), ideating and developing value propositions with environmental and/or social impact, developing a sustainability strategy and culture (seizing), having a fact-based consistent and transparent external communication, integrating stakeholders, and coordinating partners in the business ecosystem (reconfiguring). Whilst the R-VRO strategies related to the CE practices have already been part of the company's strategy previous to making CE an official pillar in 2018, the CTI results offer a more unified picture of where the specific sites currently stand with regard to CE. The results were perceived useful both for internal process optimisation and product innovation, as well as for providing data for external communication. These were also the two overarching types of benefits found by Roos Lindgreen et al. (2022). However, for the assessment to be useful in its respective context, the rational of why such an assessment should be implemented needed to be adapted to the local environment. So, whilst the company in China had to report to the global level of the corporation, it is also subject, as part of the Suzhou Industrial Park, to for example, energy audits, and encouraged

to increase CE practices such as recycling and reuse (Yu et al., 2015). This provided the management team with additional reasons to conduct the CTI assessment, because it could externally communicate its involvement with CE activities to the local authorities. It is thus central to understand that whilst the core of the methodology stayed the same across the two pilots, the benefits and beneficiaries differed across geographical locations. The local benefit is also crucial to create a sense of local ownership of the assessment, which enables its integration into ongoing monitoring of corporate processes, as a microfoundation contributing to the reconfiguring capability.

However, the company was still hesitant to ask downstream clients how they manage their packaging waste, also mentioning a lack of leverage to ask for this type of information. This was related to the limited communication channels established for this kind of data exchange; this type of integration of the stakeholders into the business ecosystem is also considered a microfoundation which would need to be developed further. Whilst Roos Lindgreen et al. (2022) acknowledge this barrier to CE assessment as well, such communication issues could be overcome through collaboration with key supply chain actors to enable innovation (Brown et al., 2019; Walker, Opferkuch, Roos Lindgreen, Simboli, et al., 2022). Both the Italian and the Chinese plants have done pilots with their large international clients on conducting full product LCAs and creating a reverse logistics solution for secondary packaging from PCR. If the importance of the CTI results in terms of the company's sustainability vision for CE can be clearly communicated to the corporation's clients, it should provide an incentive for their data provision (Santa-Maria et al., 2022).

5.1 | Theoretical implications

The findings of this paper show that the company was able to leverage its pre-existing knowledge in implementing life cycle-based sustainability assessment in order to more readily implement a new assessment method, namely the CTI. Through applying a dynamic capabilities perspective on this implementation process, it became possible to distil where the CTI contributes directly to microfoundations, what existing microfoundations it benefits from and which microfoundations it creates benefits for. This contextualised understanding is essential to find the optimal combination of sustainability and circularity assessment, and CSR management instruments (Lozano, 2020). At the same time, this lens also allowed the authors to capture the development of this microfoundation through its distinct stages of maturity, up to the point of replication in another country (Helfat & Peteraf, 2003). The case study further contributes to literature by providing empirical evidence of how and why life cycle-based assessments can play a strategic role in companies aiming to make their operations and products more circular, which has previously been described in less detail by other scholars (Khan et al., 2020a, 2020b, 2021; Santa-Maria et al., 2022). Moreover, the authors make a first attempt at connecting CE assessment with LCM literature as called for by Zinck et al. (2018). This is justified by the CTI's focus on the life cycle perspective and inclusion into the set of sustainability assessments (Bianchi et al., 2022; Sonnemann et al., 2015). The results of these assessments can be seen as decision-supporting tools, providing a science-based rational for opting for one strategy over the other (Pryshlakivsky & Searcy, 2021). However, with regard to the CTI, its limitations as mass-balance assessment approach need to be clearly communicated and understood by the companies implementing it. Otherwise, a company could run the risk of trading a higher circularity score for adverse sustainability impacts (Roos Lindgreen et al., 2022).

5.2 | Managerial implications

For practitioners, the findings have yet again underlined the importance of strategic cooperation with knowledge-creating entities, which in this case were a university and an industry working group. Whilst it is possible to have the needed knowledge in-house (Scarpellini et al., 2020), collaboration with external experts is also a viable option. Including a diverse set of actors can ensure a systemic and life cycle-based perspective on new potential CE practices to be implemented (Brown et al., 2019), averting the risk of burden-shifting. Moreover, the CTI provides managers with an instrument to showcase their efforts towards circularity in the context of managing their brand reputation, which has shown to have positive financial implications for firms (Mazzucchelli et al., 2022). Concerning the implementation of the CTI, it should always be complemented, as in the current case study, with some kind of life cycle-based sustainability assessment. Just using the "rule of thumb" (Das et al., 2022) that the higher the R-strategy, the more favourable the sustainability performance, is not recommended as a baseline for decision-making for substantial process or material composition changes. It is however understandable that smaller companies do not necessarily have the resources to conduct an LCA on a regular basis or automatise the LCA as in this case study. Therefore, an option could be to use the LCA as an ex-ante decision-making tool for designing a product or process (Diaz et al., 2021), to identify the most favourable configuration. Thereafter, the CTI could be used as a yearly monitoring tool, given its lower complexity.

6 | CONCLUSIONS

The role of life cycle-based assessment approaches has become evermore important in the context of guiding companies and their interfirm networks towards CE practices. They can help understand how, in a sector that is mainly relying on finite, fossil-based resources, products can become more circular and sustainable through, for example, using renewable materials and PCR, or through implementing reuse systems. The implementation of the CTI framework, piloted in a multinational corporation, in two different countries and industrial contexts, provided empirical evidence on how such an assessment can be seen as a microfoundation of a dynamic capability. This case study has further showed that CE assessment is often closely related to

environmental sustainability assessment and particularly LCAs. Given the CTI did not cover environmental impacts and its results are lower in complexity, it can be considered a LCM method that is easier to apply and to internally communicate than an LCA. It was also found that data availability on the material input and company waste output side was sufficient due to the company's experience in conducting life cycle-based assessments, in collaboration with strategic knowledge partners. However, data quality could still be improved with regard to down-stream supply chain partners on how they handle packaging waste, requiring additional efforts in eco-system orchestration.

The findings of the case study also showed that the benefits of the assessment were related both internally, to process optimisation and externally, to communication of the results to stakeholders. However, the nature of these benefits and the stakeholders involved differed slightly, depending on the location. For instance, in the Chinese case, the results were useful to demonstrate the favourable material management to the EIP's authorities the company is located in. In contrast, the Italian plants had to adhere to EU and national regulation only. On a group level, the assessment provided the company with data demonstrating its adherence to CE commitments, and thus had considerable strategic value. In the light of a corporation-wide rollout, automation of the assessment through the integration of data collection of the LCA and the CTI could decrease the resources needed. This reconfiguring microfoundation would further increase the availability of information, supporting decision-making at different levels. In order to reap the benefits of the assessment, it was considered essential that the parties conducting it were well instructed and aware of its ultimate purpose and usefulness, underlining the importance of organisational learning.

Due to the methodological setting as a single case study, the article's results can only be generalised to a limited degree. It could also be argued that the packaging sector does not constitute a fast-moving environment to which the dynamic capability perspective is preferably applied, compared to, for example, the electronics sector. However, given the perspective's application to the food and automotive sector (Siems et al., 2021), the theoretical lens seems justified. It also needs to be acknowledged that the authors of the article are not impartial towards the company, due to the long-standing research cooperation. However, the latter also enabled the development of trust and therefore granted deep insights into the company's strategy, which benefitted the quality of the information analysed. Future research could focus on how the implementation of the CTI framework might have taken place without a company's preceding experience in life cycle-based (or any) assessment methods and a trusted knowledge partner. It is also essential to collect more empirical evidence on how CE strategies and CE assessment connect to assessing sustainability, and in particular, social aspects. Only in this way can companies identify whether their business activities are in line with their sustainability ambitions.

ACKNOWLEDGMENTS

This research is part of the CRESTING project, which has received funding from the European Union's Horizon 2020 Research and Innovation Programme under the Marie Skłodowska-Curie grant agreement No 765198. The authors would like to thank Michele Del Grosso, Wen Zhang and Michela Rimano for their continuous support in the pilots and Tomás Santa-Maria for his insights on the dynamic capability perspective.

ORCID

Anna M. Walker https://orcid.org/0000-0001-7420-4864
Alberto Simboli https://orcid.org/0000-0001-8753-3974
Walter J. V. Vermeulen https://orcid.org/0000-0002-5947-8688
Andrea Raggi https://orcid.org/0000-0001-9748-3077

REFERENCES

Adams, W. C. (2015). Conducting semi-structured interviews. In K. E. Newcomer, H. P. Hatry, & J. S. Wholey (Eds.), *Handbook of practical program evaluation* (pp. 492–505). John Wiley & Sons, Ltd.. https://doi.org/10.1002/9781119171386.ch19

Amui, L. B. L., Jabbour, C. J. C., de Sousa Jabbour, A. B. L., & Kannan, D. (2017). Sustainability as a dynamic organizational capability: A systematic review and a future agenda toward a sustainable transition. *Journal of Cleaner Production*, *142*, 308–322. https://doi.org/10.1016/j.jclepro.2016.07.103

Baitz, M. (2015). From projects to processes to implement life cycle Management in Business. In G. Sonnemann & M. Margni (Eds.), *Life cycle management, LCA compendium – The complete world of life cycle assessment* (pp. 93–104). Springer Netherlands. https://doi.org/10.1007/978-94-017-7221-1_8

Barreto, I. (2010). Dynamic capabilities: A review of past research and an agenda for the future. *Journal of Management*, *36*(1), 256–280. https://doi.org/10.1177/0149206309350776

Beske, P. (2012). Dynamic capabilities and sustainable supply chain management. *International Journal of Physical Distribution & Logistics Management*, *42*(4), 372–387. https://doi.org/10.1108/09600031211231344

Beske, P., Land, A., & Seuring, S. (2014). Sustainable supply chain management practices and dynamic capabilities in the food industry: A critical analysis of the literature. *International Journal of Production Economics*, *152*, 131–143. https://doi.org/10.1016/j.ijpe.2013.12.026

Bianchi, G., Testa, F., Tessitore, S., & Iraldo, F. (2022). How to embed environmental sustainability: The role of dynamic capabilities and managerial approaches in a life cycle management perspective. *Business Strategy and the Environment*, *31*, 312–325. https://doi.org/10.1002/bse.2889

Bishop, G., Styles, D., & Lens, P. N. L. (2020). Recycling of European plastic is a pathway for plastic debris in the ocean. *Environment International*, *142*, 105893. https://doi.org/10.1016/j.envint.2020.105893

Bocken, N. M. P., de Pauw, I., Bakker, C., & van der Grinten, B. (2016). Product design and business model strategies for a circular economy. *Journal of Industrial and Production Engineering*, *33*(5), 308–320. https://doi.org/10.1080/21681015.2016.1172124

Bressanelli, G., Visintin, F., & Saccani, N. (2021). Circular Economy and the evolution of industrial districts: A supply chain perspective. *International Journal of Production Economics*, *243*, 108348. https://doi.org/10.1016/j.ijpe.2021.108348

Brown, P., Bocken, N., & Balkenende, R. (2019). Why do companies pursue collaborative circular oriented innovation? *Sustainability*, *11*(3), 635. https://doi.org/10.3390/su11030635

Brown, P., Von Daniels, C., Bocken, N. M. P., & Balkenende, A. R. (2021). A process model for collaboration in circular oriented innovation. *Journal of Cleaner Production*, *286*, 125499. https://doi.org/10.1016/j.jclepro.2020.125499

Calzolari, T., Genovese, A., & Brint, A. (2021). The adoption of circular economy practices in supply chains – An assessment of European Multi-National Enterprises. *Journal of Cleaner Production*, *312*, 127616. https://doi.org/10.1016/j.jclepro.2021.127616

Cecchin, A., Salomone, R., Deutz, P., Raggi, A., & Cutaia, L. (2021). What is in a name? The rising star of the circular economy as a resource-related concept for sustainable development. *Circular Economy and Sustainability.*, *1*, 83–97. https://doi.org/10.1007/s43615-021-00021-4

Corona, B., Shen, L., Reike, D., Rosales Carreón, J., & Worrell, E. (2019). Towards sustainable development through the circular economy—A review and critical assessment on current circularity metrics. *Resources, Conservation and Recycling*, *151*, 104498. https://doi.org/10.1016/j.resconrec.2019.104498

Das, A., Konietzko, J., & Bocken, N. (2022). How do companies measure and forecast environmental impacts when experimenting with circular business models? *Sustainable Production and Consumption*, *29*, 273–285. https://doi.org/10.1016/j.spc.2021.10.009

Del Borghi, A. (2013). LCA and communication: Environmental product declaration. *The International Journal of Life Cycle Assessment*, *18*(2), 293–295. https://doi.org/10.1007/s11367-012-0513-9

D'Eusanio, M., Tragnone, B. M., & Petti, L. (2022). Social organisational life cycle assessment and social life cycle assessment: Different twins? Correlations from a case study. *The International Journal of Life Cycle Assessment*, *27*(1), 173–187. https://doi.org/10.1007/s11367-021-01996-w

D'Eusanio, M., Zamagni, A., & Petti, L. (2019). Social sustainability and supply chain management: Methods and tools. *Journal of Cleaner Production*, *235*, 178–189. https://doi.org/10.1016/j.jclepro.2019.06.323

Deutz, P., Lyons, D., & Bi, J. (2015). *International perspectives on industrial ecology*. Edward Elgar Publishing. https://doi.org/10.4337/9781781003572

Diaz, A., Schöggl, J.-P., Reyes, T., & Baumgartner, R. J. (2021). Sustainable product development in a circular economy: Implications for products, actors, decision-making support and lifecycle information management. *Sustainable Production and Consumption*, *26*, 1031–1045. https://doi.org/10.1016/j.spc.2020.12.044

Eisenhardt, K. M., & Martin, J. A. (2000). Dynamic capabilities: What are they? *Strategic Management Journal*, *21*, 1105–1121.

Ellen MacArthur Foundation. (2019). Circulytics—Measuring circularity. https://www.ellenmacarthurfoundation.org/resources/apply/circulytics-measuring-circularity

Ellen MacArthur Foundation, & Grata. (2015). Circularity-indicators—Project overview. Ellen MacArthur Foundation. https://www.ellenmacarthurfoundation.org/assets/downloads/insight/Circularity-Indicators_Project-Overview_May2015.pdf

Ellen MacArthur Foundation, & UNEP. (2018). Global commitment. New plastics economy. https://www.newplasticseconomy.org/projects/global-commitment

Guinée, J. B. (2002). Handbook on life cycle assessment operational guide to the ISO standards. *The International Journal of Life Cycle Assessment*, *7*(5), 311. https://doi.org/10.1007/BF02978897

Hahladakis, J. N., Iacovidou, E., & Gerassimidou, S. (2020). Chapter 19—Plastic waste in a circular economy. In T. M. Letcher (Ed.), *Plastic waste and recycling* (pp. 481–512). Academic Press. https://doi.org/10.1016/B978-0-12-817880-5.00019-0

Helfat, C. E., & Peteraf, M. A. (2003). The dynamic resource-based view: Capability lifecycles. *Strategic Management Journal*, *24*(10), 997–1010. https://doi.org/10.1002/smj.332

ISO. (2020). ISO/TC 323—Circular economy. ISO. https://www.iso.org/cms/render/live/en/sites/isoorg/contents/data/committee/72/03/7203984.html

Khan, O., Daddi, T., & Iraldo, F. (2020a). Microfoundations of dynamic capabilities: Insights from circular economy business cases. *Business Strategy and the Environment*, *29*(3), 1479–1493. https://doi.org/10.1002/bse.2447

Khan, O., Daddi, T., & Iraldo, F. (2020b). The role of dynamic capabilities in circular economy implementation and performance of companies. *Corporate Social Responsibility and Environmental Management*, *27*(6), 3018–3033.

Khan, O., Daddi, T., & Iraldo, F. (2021). Sensing, seizing, and reconfiguring: Key capabilities and organizational routines for circular economy implementation. *Journal of Cleaner Production*, *287*, 125565. https://doi.org/10.1016/j.jclepro.2020.125565

Kravchenko, M., Pigosso, D. C. A., & McAloone, T. C. (2019). Towards the ex-ante sustainability screening of circular economy initiatives in manufacturing companies: Consolidation of leading sustainability-related performance indicators. *Journal of Cleaner Production*, *241*, 118318. https://doi.org/10.1016/j.jclepro.2019.118318

Kırcı, M., & Seifert, R. (2015). Dynamic capabilities in sustainable supply chain management: A theoretical framework. *Supply Chain Forum: An International Journal*, *16*(4), 2–15. https://doi.org/10.1080/16258312.2015.11728690

Lozano, R. (2020). Analysing the use of tools, initiatives, and approaches to promote sustainability in corporations. *Corporate Social Responsibility and Environmental Management*, *27*(2), 982–998. https://doi.org/10.1002/csr.1860

Martínez-Blanco, J., Lehmann, A., Chang, Y.-J., & Finkbeiner, M. (2015). Social organizational LCA (SOLCA)—A new approach for implementing social LCA. *The International Journal of Life Cycle Assessment*, *20*(11), 1586–1599. https://doi.org/10.1007/s11367-015-0960-1

Mazzucchelli, A., Chierici, R., Del Giudice, M., & Bua, I. (2022). Do circular economy practices affect corporate performance? Evidence from Italian large-sized manufacturing firms. *Corporate Social Responsibility and Environmental Management*, *29*(6), 2016–2029. https://doi.org/10.1002/csr.2298

Nilsson-Lindén, H., Baumann, H., Rosén, M., & Diedrich, A. (2018). Organizing life cycle management in practice: Challenges of a multinational manufacturing corporation. *The International Journal of Life Cycle Assessment*, *23*, 1368–1382. https://doi.org/10.1007/s11367-014-0818-y

Nilsson-Lindén, H., Rosén, M., & Baumann, H. (2019). Product chain collaboration for sustainability: A business case for life cycle management. *Business Strategy and the Environment*, *28*, 1619–1631. https://doi.org/10.1002/bse.2388

Opferkuch, K., Caeiro, S., Salomone, R., & Ramos, T. B. (2021). Circular economy in corporate sustainability reporting: A review of organisational approaches. *Business Strategy and the Environment*, *30*(8), 4015–4036. https://doi.org/10.1002/bse.2854

Parida, V., Burström, T., Visnjic, I., & Wincent, J. (2019). Orchestrating industrial ecosystem in circular economy: A two-stage transformation model for large manufacturing companies. *Journal of Business Research*, *101*, 715–725. https://doi.org/10.1016/j.jbusres.2019.01.006

Pryshlakivsky, J., & Searcy, C. (2021). Life cycle assessment as a decision-making tool: Practitioner and managerial considerations. *Journal of Cleaner Production*, *309*, 127344. https://doi.org/10.1016/j.jclepro.2021.127344

Reike, D., Vermeulen, W. J. V., & Witjes, S. (2018). The circular economy: New or refurbished as CE 3.0? — Exploring controversies in the conceptualization of the circular economy through a focus on history and resource value retention options. *Resources, Conservation and Recycling*, *135*, 246–264. https://doi.org/10.1016/j.resconrec.2017.08.027

Roos Lindgreen, E., Mondello, G., Salomone, R., Lanuzza, F., & Saija, G. (2021). Exploring the effectiveness of grey literature indicators and life cycle assessment in assessing circular economy at the micro level: A comparative analysis. *The International Journal of Life Cycle Assessment*, *26*, 2171–2191. https://doi.org/10.1007/s11367-021-01972-4

Roos Lindgreen, E., Opferkuch, K., Walker, A. M., Salomone, R., Reyes, T., Raggi, A., Simboli, A., Vermeulen, W. J. V., & Caeiro, S. (2022). Exploring assessment practices of companies actively engaged with circular economy. *Business Strategy and the Environment*, *31*(4), 1414–1438. https://doi.org/10.1002/bse.2962

Roos Lindgreen, E., Salomone, R., & Reyes, T. (2020). A critical review of academic approaches, methods and tools to assess circular economy at the micro level. *Sustainability*, *12*(12), 4973. https://doi.org/10.3390/su12124973

Santa-Maria, T., Vermeulen, W. J. V., & Baumgartner, R. J. (2022). How do incumbent firms innovate their business models for the circular economy? Identifying micro-foundations of dynamic capabilities. *Business Strategy and the Environment*, *31*(4), 1308–1333. https://doi.org/10.1002/bse.2956

Scarpellini, S., Marín-Vinuesa, L. M., Aranda-Usón, A., & Portillo-Tarragona, P. (2020). Dynamic capabilities and environmental accounting for the circular economy in businesses. *Sustainability Accounting, Management and Policy Journal*, *11*(7), 1129–1158. https://doi.org/10.1108/SAMPJ-04-2019-0150

Schöggl, J.-P., Stumpf, L., & Baumgartner, R. J. (2020). The narrative of sustainability and circular economy—A longitudinal review of two decades of research. *Resources, Conservation and Recycling*, *163*, 105073. https://doi.org/10.1016/j.resconrec.2020.105073

Siems, E., Land, A., & Seuring, S. (2021). Dynamic capabilities in sustainable supply chain management: An inter-temporal comparison of the food and automotive industries. *International Journal of Production Economics*, *236*, 108128. https://doi.org/10.1016/j.ijpe.2021.108128

Sonnemann, G., Gemechu, E. D., Remmen, A., Frydendal, J., & Jensen, A. A. (2015). Life cycle management: Implementing sustainability in business practice. In G. Sonnemann & M. Margni (Eds.), *Life cycle management, LCA compendium – The complete world of life cycle assessment* (pp. 7–21). Springer Netherlands. https://doi.org/10.1007/978-94-017-7221-1_2

Stewart, R., & Niero, M. (2018). Circular economy in corporate sustainability strategies: A review of corporate sustainability reports in the fast-moving consumer goods sector. *Business Strategy and the Environment*, *27*(7), 1005–1022. https://doi.org/10.1002/bse.2048

Stumpf, L., Schöggl, J.-P., & Baumgartner, R. J. (2021). Climbing up the circularity ladder? – A mixed-methods analysis of circular economy in business practice. *Journal of Cleaner Production*, *316*, 128158. https://doi.org/10.1016/j.jclepro.2021.128158

Teece, D. J. (2007). Explicating dynamic capabilities: The nature and micro-foundations of (sustainable) enterprise performance. *Strategic Management Journal*, *28*(13), 1319–1350. https://doi.org/10.1002/smj.640

UNEP. (2015). Guidance on organizational life cycle assessment. Life-cycle initiative, United Nations Environment Programme and Society for Environmental Toxicology and Chemistry. https://wedocs.unep.org/xmlui/handle/20.500.11822/32072

Vegter, D., van Hillegersberg, J., & Olthaar, M. (2020). Supply chains in circular business models: Processes and performance objectives. *Resources, Conservation and Recycling*, *162*, 105046. https://doi.org/10.1016/j.resconrec.2020.105046

Walker, A. M., Opferkuch, K., Roos Lindgreen, E., Raggi, A., Simboli, A., Vermeulen, W. J. V., Caeiro, S., & Salomone, R. (2022). What is the relation between circular economy and sustainability? Answers from frontrunner companies engaged with circular economy practices. *Circular Economy and Sustainability*, *2*, 731–758. https://doi.org/10.1007/s43615-021-00064-7

Walker, A. M., Opferkuch, K., Roos Lindgreen, E., Simboli, A., Vermeulen, W. J. V., & Raggi, A. (2021). Assessing the social sustainability of circular economy practices: Industry perspectives from Italy and the Netherlands. *Sustainable Production and Consumption*, *27*, 831–844. https://doi.org/10.1016/j.spc.2021.01.030

Walker, A. M., Opferkuch, K., Roos Lindgreen, E., Simboli, A., Vermeulen, W. J. V., & Raggi, A. (2022). Assessing sustainability across circular inter-firm networks: Insights from academia and practice. In M. Wojnarowska, M. Ćwiklicki, & C. Ingrao (Eds.), *Sustainable products in the circular economy: Impact on business and society* (pp. 154–171). Routledge. https://doi.org/10.4324/9781003179788-10

Walker, A. M., Vermeulen, W. J. V., Simboli, A., & Raggi, A. (2021). Sustainability assessment in circular inter-firm networks: An integrated framework of industrial ecology and circular supply chain management approaches. *Journal of Cleaner Production*, *286*, 125457. https://doi.org/10.1016/j.jclepro.2020.125457

Walzberg, J., Lonca, G., Hanes, R. J., Eberle, A. L., Carpenter, A., & Heath, G. A. (2021). Do we need a new sustainability assessment method for the circular economy? A critical literature review. *Frontiers in Sustainability*, *1*. https://doi.org/10.3389/frsus.2020.620047

WBCSD. (2018). Landscape analysis. World Business Council for Sustainable Development. https://www.wbcsd.org/9gzry

WBCSD. (2020). *Circular transition indicators V1.0 – Metrics for business, by business*. World Business Council for Sustainable Development (WBCSD). https://www.wbcsd.org/cemmcti

WBCSD. (2021). Circular transition indicators V2.0. World Business Council for Sustainable Development (WBCSD). https://www.wbcsd.org/qctel

WBCSD. (2022). *Circular Transition Indicators v3.0 – Metrics for business, by business*. World Business Council for Sustainable Development (WBCSD). https://www.wbcsd.org/Programs/Circular-Economy/Metrics-Measurement/Resources/Circular-Transition-Indicators-v3.0-Metrics-for-business-by-business

WBCSD, & Circular IQ. (2020). CTI tool. https://ctitool.com

WBCSD, & WRI. (2004). The greenhouse gas protocol. In *A corporate accounting and reporting standard* (Rev. ed.). World Business Council for Sustainable Development and World Resources Institute https://ghgprotocol.org/corporate-standard

Xie, L., & Lu, X. (2022). Circular economy and eco-industrial park. In L. Xie & X. Lu (Eds.), *Suzhou Industrial Park: Sustainability, innovation, and entrepreneurship* (pp. 33–59). Springer. https://doi.org/10.1007/978-981-16-6757-2_3

Yin, R. K. (2018). *Case study research and applications: Design and methods* (Sixth ed.). SAGE.

Yu, C., Dijkema, G. P. J., de Jong, M., & Shi, H. (2015). From an eco-industrial park towards an eco-city: A case study in Suzhou, China. *Journal of Cleaner Production*, *102*, 264–274. https://doi.org/10.1016/j.jclepro.2015.04.021

Zero Waste International Alliance (ZWIA). (2021). *Zero waste declaration*. https://zwia.org/zero-waste-declaration/

Zinck, S., Ayed, A.-C., Niero, M., Head, M., Wellmer, F.-W., Scholz, R. W., & Morel, S. (2018). Life cycle management approaches to support circular economy. In E. Benetto, K. Gericke, & M. Guiton (Eds.), *Designing sustainable technologies, products and policies: From science to innovation* (pp. 3–9). Springer International Publishing. https://doi.org/10.1007/978-3-319-66981-6_1

How to cite this article: Walker, A. M., Simboli, A., Vermeulen, W. J. V., & Raggi, A. (2023). A dynamic capabilities perspective on implementing the Circular Transition Indicators: A case study of a multi-national packaging company. *Corporate Social Responsibility and Environmental Management*, *30*(5), 2679–2692. https://doi.org/10.1002/csr.2487