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Assessing Product Circularity in Practice: Insights from Industry

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Abstract: The use of the concept of 'circularity' within government, policy, industry, and academia, has grown exponentially in the last decade. As part of the European Commission's Horizon 2020 funded project, ORIENTING, The Centre for Sustainable Design ® at the University for the Creative Arts conducted 21 in-depth qualitative interviews with companies that claimed to have a core circular economy business strategy. The data collected from the interviews was analyzed using a thematic coding methodology to 1) gain insights into how product circularity (PC) is understood by industry, PC strategies currently being implemented across various sectors; 2) identify barriers for implementation that can enable further discussions for theoretical and conceptual innovations for remanufacturing, reuse, refurbish and repair and new ways for production and consumption, and 3) contribute to the development of methodologies and tools for measuring product circularity beyond recycled inflows and outflows. A key finding was the lack of harmonization of the concept of PC and CE more generally across different sectors. Moreover, to date, the development of methodologies that seek to quantitively assess PC performance for internal decision making and external communications, have focused primarily on assessing the use of recycled material inflows and outflows; thus, positioning circularity as synonymous to recycling. Conversely, measuring use phase related PC issues e.g., repair, reuse, etc. is still in the early stages due to a lack of data on customer use by companies.

Introduction

The use of the concept of Circular Economy (CE) within government, policy, industry, and academia has grown exponentially in the last decade. The CE concept builds on multiple schools of thought, some of which date back to the 1960s, including: industrial ecology, industrial symbiosis, performance economy, biomimicry, cradle to cradle, blue economy, regenerative design, and natural capitalism [1]. CE became mainstream because of the policy attention given to it by the European Commission's (EC) 1st Circular Economy Action Plan launched in December 2015 (CEAP 1.0). Additionally, the Ellen MacArthur Foundation (EMF) has played an important role in raising awareness and in engaging business [2].

At present there is no internationally agreed definition of the CE concept, as shown by Kirchherr et al. (2017 [3]), which identified 114 circular economy definitions in different sources of literature. This proliferation of CE conceptualizations constitutes a serious challenge to policy makers, business and researchers working on this topic. In this regard, ISO is working on a consensus-based definition of CE within ISO TC323 which will be an important step towards increased understanding.[1] Aligned to this, there is growing interest in the measurement of CE at various levels (e.g., products, organisations, regions). However, while currently there exists a plethora of PC metrics, indicators, and tools to measure circularity [2] as indicated within the ORIENTING report, *Critical Evaluation of*

[1] As of November 2022, CE has been defined within the work of ISO TC323 as: "A state of a specified system, organization, product or process where resource flows and values are maintained whilst benefiting sustainable development and approach to promote the responsible and cyclical use of resources."

[2] For example, the Ellen MacArthur's Material Circularity Indicator (MCI) and the WBCSD's Circularity Transition Indicator (CTI).

Material Criticality and Product-Related Circularity Approaches, the focus is primarily at an organization level rather than at a product level [4]. Moreover, the awareness and usage of PC indicators, metrics and tools by industry remains limited. In this context, the research presented in this paper aimed to gain insight into if and how PC is understood, implemented, and measured by industry. To do this, 21 in-depth interviews were completed.

Methodology

The research employed semi-structured qualitative interviews with a blend of closed and open-ended questions. Qualitative interviews were used to facilitate a 'learning approach' with the interviewees, allowing for the recognition of emerging themes and patterns related to the research topic. The pilot and full interviews were planned for 45 minutes up to 1 hour and were divided into two main topics: 1) General questions to assess the interviewee's level of decision making related to PC and 2) PC specific questions, to probe into more detailed aspects related to measurements, metrics, indicators and the use of eco-design strategies and tools.

Four CE expert interviews helped scope, frame, and check the content of questionnaire and acted as pilot interviews. The participants for the main interviews were selected based on the authors knowledge of companies as being actively developing CE activities. Building on the learnings from the 4 CE expert interviews, the following research strategy was developed: for large companies that have various Business Units and corporate functions ('line and branch'), the aim was to initially interview corporate Sustainability Directors to provide an overview of PC issues across the Business Units. For start-ups and micro, small and medium enterprises (MSME's) the aim was to interview the Founder/Managing Director (MD) as responsibility for sustainability and PC related issues within MSME's are likely to be carried out by these functions.

Prior to each interview, background research was conducted by reviewing the company's sustainability reports and website. The interviews were then recorded and transcribed. At 21 interviews, no further PC related topics had emerged for more than 2 consecutive interviews. It was then agreed by UCA and ORIENTING leadership that interviews would be capped at 21. **Table 1** shows the industry sectors interviewed, as well as product categorization, company size, geographic location, and PC awareness level.

No.	Industry Sector	Size	Product Category
1	Fashion/Apparel	SME	Final
2	Footwear	Start-up	Final
3	Infrastructure	Start-up	Hybrid
4	Whitegoods	Multinational	Final
5	Toys	Multinational	Final
6	Automotive	Multinational	Final
7	Outdoor footwear	SME	Final
8	Textiles	Start-up	Intermediate
9	Furniture	SME	Final
10	Hardware & Software	Multinational	Final
11	Engineering /Aerospace	Multinational	Final
12	Fashion	Start-up	Hybrid
13	Footwear	Start-up	Final
14	Flooring	Multinational	Final
15	Automotive	Multinational	Final
16	Fashion/Apparel	Multinational	Final
17	Consumer goods	Multinational	Final
18	Software & Hardware	Multinational	Final
19	Textile	Start-up	Intermediate
20	Construction	Multinational	Intermediate
21	Automotive	Multinational	Final

Table 1. Sample Information

Analysis of Data: Thematic Coding

The data from the 21 interviews was analysed using thematic coding, which consisted of categorising and assigning different values to the key themes and topics that emerged from each interview. Labels were assigned to words or phrases that represented important and recurring themes related to PC issues. While the interview questionnaire was adapted and improved after each interview, the core questions were maintained for comparability. The interviews were initially transcribed, whilst simultaneously adding notes related to the themes and topics that were repeated or emphasised throughout the interview. Subsequently the key themes were categorised and arranged to produce a summary which was discussed between the authors to identify further areas of enquiry that were addressed with follow-up questions via email and/or in subsequent interviews.

Multilevel Awareness Descriptors

Aligned to the thematic coding analysis, a multilevel PC awareness descriptor was developed based on the ZBIA model which describes levels of awareness that range from zero to basic, intermediate, and advanced [5]. Additionally, the WBCSD's 2018 report, 'Circular Metrics Landscape Analysis' [3] was used to support the development of the awareness descriptor shown in **Table 2**. It is pertinent to highlight that from the ZBIA model, level "zero" was removed as the selection of the interviewed companies was based on them being on a CE journey.

Circularity Strategy Stage	Description
Level 1/ *Basic*	Company has started to research, explore CE strategies but has not yet defined a product and/or company strategy. 1-2 years' experience within the remit of circularity.
Level 2/ *Intermediate*	Company has started to implement CE strategies but has not yet integrated CE indicators and metrics. 2-3 years' experience within the remit of circularity.
Level 3/ *Advanced*	CE trailblazers or 'advanced' CE companies with 4+ years' experience in developing company and product level CE strategy and has started to implement some CE indicators and metrics.

Table 2. Multilevel Awareness Descriptor (Source: authors' adaptation of WBCSD 2018 report)

As a result of assigning awareness levels to each participant, needs and requirements related to the implementation of PC strategies, metrics and indicators were identified per level.

Results

Defining Circularity

The interview findings suggest that an understanding of how to implement circularity and what this entails is fragmented. In this sense, the concept of CE at a product level varies depending on the type of product and industry. At a product level, the most common focus areas for addressing circularity, are the use of recycled content and biobased materials, along with ensuring that product components can be easily recovered and recycled through eco-design strategies such as design for product life extension that includes standardization, compatibility, and design for disassembly (Appendix A).

It is pertinent to highlight that few companies interviewed appeared to use the term eco-design. This was surprising to the authors as many of the companies had previously been actively engaged in ecodesign. The responses from the interviewees also indicated that whilst CE and within it, PC was seen as part of the companies' sustainability strategies, CE activities were somewhat compartmentalized perhaps indicating "newness" of CE and PC in many organisations. In addition, where eco-design was recognized as a practice in companies, PC aspects were considered separately to eco-design, despite being inherently aligned with eco-design strategies.

For interviewees with 'basic' and 'intermediate' PC awareness levels, circularity appeared to be mainly used to refer to the use of recycled materials. Additionally, the interviews revealed the emergence of new concepts and terminology such as circular by design' and 'circular-ready design', which are synonymous with specific design strategies and products that are aligned with Design for Material Sourcing, Design for Manufacturing and Design End-of-life (Appendix A). A potential consequence of organisations' directly associating circularity with the use of recycled material and design for disassembly, is that other PC strategies such as re-use and repair remain excluded from CE discourses amongst the interviewed companies. In turn, the exclusion of such strategies from industry discourse can potentially lead to some companies, particularly MSME's, to remain unaware of the existence of PC strategies that related to the use phase of the lifecycle.

However, some of the more 'advanced' companies' as per **Table 1** have started to move beyond a focus on recycling as a means towards circularity by differentiating for example, '*Material sustainability*

[3] The WBCSD's report is based on 38 company interviews and the assessment of 140 sustainability reports, which highlights three CE strategy levels.

initiatives'[4], from *'circularity initiatives'*[5] and appear to be assigning a hierarchy to circularity strategies. In this context, 9 of the companies categorized as level 3 or 'advanced', indicated a shift in their circularity ambitions towards product and part reuse through designing for repair, maintenance, and upgradability as well as exploring product service systems (PSS) such as 'pay-per-use', 'product leasing' and 'take back' schemes.

This highlights the differing understanding of PC amongst interviewees as it shows that the precise definition of the concept varies from one company and product to another, and perhaps based on the level of awareness/understanding/experience of PC/and CE more generally.

The findings above highlighted some of the concepts and nuances that are emerging within industry when defining circularity. Regarding the development of PC assessments, findings highlighted the importance of considering how circularity is interpreted from a myriad of perspectives, which will ultimately affect the approach adopted for measuring PC.

The following section aims to offer insight into how companies are currently measuring PC or considering PC measurements and indicators based on the available PC tools and methods.

Measuring Circularity

Interviewees were asked about the specific use of The Ellen MacArthur Foundation's MCI (2021) and the WBCSD's CTI tool.[6] From the 21 companies interviewed only 2 companies claimed to measure circularity at a product or business level using the EMF's MCI, whilst no participant mentioned the use of the WBCSD's CTI tool.[7] Therefore 19 companies interviewed were not using these or any other PC tools to support the development of their circularity strategy. One of the companies identified as using the EMF's MCI, [Participant 10] stated that the circularity percentage highlighted in their annual sustainability report refers to the company's '*total annual product and packaging content by weight, that will come from recycled and renewable materials and reused products and parts'.* As this company has been classified as 'advanced' in terms of PC strategies, this highlights that for companies with this level of awareness, the focus of PC measurement remains on quantifying inflows of recycled content or the use of biobased materials within a product and outflows through recovery percentages. This is likely to be due to companies perceiving this is what they can pragmatically control, measure and report; with the use phase often seen as outside their control in current business models. Nonetheless, as [Participant 15] indicated, some companies are seeking to explore the feasibility of measuring PC beyond the use and recovery of recycled content by developing *'KPI's for circularity'* that could potentially include indicators such reuse rates through take-back schemes or repair and refurbishment, as well as methods for quantifying disassembly times in relation to economic viability.

[4] 'Sustainable materials initiative' in the context of the interview appears to refer to strategies that focus specifically on reducing the environmental impact of a products materials. As per the eco-design checklist presented in Appendix A, this strategy focuses primarily on 'Design for Material Sourcing' that includes the reduction of weight and volume of a product, increase use of recycled materials to replace virgin materials, the elimination of hazardous substances and the use of materials with for example, lower embodied energy and/or water, which do not necessarily lead to PC.

[5] 'Circularity initiative' appears to focus more on strategies that enable material and product extension at the 'end-use phase' through 'Design for Manufacture and Assembly' and 'Design for Use (including installation, maintenance and repair)' as per Appendix A. These eco-design strategies for example avoid designs that are detrimental to material recycling, reduce the amount of residual waste generated within their D&D process, avoid designs that are detrimental to reuse and enable design for disassembly to ease repair, recycle and reuse.

[6] The EMF's MCI and WBCSD's CTI were included in the questionnaire in alignment to the 2 PC indicators selected for ORIENTING project.

[7] The numbers presented here are based on the interviewee's awareness of the use of either the EMF's MCI or the WBCSD's CTI 2.0 within their company and background research into company sustainability reports. Since most of the interviewees formed part of D&D units, it is possible that more companies are looking into these PC measurements and indicators, but this information is held elsewhere within the company.

In addition, companies appear to be '*working on how to integrate circularity into design and development, while figuring out where the boundaries are for measuring circularity.*' In this sense, the boundaries for circularity appear to be driven by product type and industry sector. For example, a toy manufacturer that designs for longevity where their products are rarely recycled (as there is significant reuse of the products), would have to assess the trade-offs associated with replacing the current materials used with recycled or bio-based materials, which would then have to be measured during the *use* phase. Aligned to the extension of the system boundaries, [Participant 5] had started to explore ways to incorporate the *use* phase by conducting '*internal investigations to gain insight into what happens to the product once it has left the manufacturer'* and what influence it might bring to the *use* phase through design decisions that 'nudge' or 'educate' the user to make decisions that have a lower environmental impact during the use phase.

Other companies appear to be measuring the recycled content that is reintroduced within their production line as an indicator of a products' circularity. However, due to the nature of some businesses, measuring the inflow of recycled content within a product is challenging for some companies as they do not have access to this data. Considering the current work being undertaken by companies at different circularity readiness stages and/or levels of awareness, it is important to promote the importance of a multilevel approach within sustainability assessment methodologies. In this sense, companies classified as zero to basic might start by measuring the inflow of recycled content as an initial step toward implementing PC. While the more 'advanced' companies that have started to explore PC considerations within the use phase, will potentially be interested in measuring beyond the use of recycled material and towards a 'cradle to cradle' perspective. A further issue identified was that the extensive number of frameworks, assessment tools and methodologies available often provide limited guidance for users about the benefits of one over the other. Based on the myriad of internal tools being used by interviewees for assessing sustainability concerns, and within this PC, a key learning from this section is that there is a need for the development of sustainability assessments to be flexible and adaptable to existing industry processes. However, to measure PC, organizations will first need to overcome barriers associated with the implementation of PC strategies, some of which are presented in the following section.

Identified Barriers for the Implementation of PC

A key barrier identified for the implementation of PC, was the siloed nature of communication across business functions. It was identified that connections between the various business functions (e.g., environmental, CSR, supply chain, marketing…) and those directly or indirectly involved in the design and development (D&D) process, depends on the culture of the company and individual company policies. For example, [Participant 15] indicated that '*there is no natural connection between [business functions], it is something I established because it is within my job and my network that I'm going to bring these people in'*. Thus, as recognised in the literature, it is key to establish a common language and a shared vision of PC, which can ultimately assist in communicating PC strategies across an organisation's various business functions. This is seen as fundamental for the implementation of eco-design and PC [6].

Moreover, the costs associated with material substitution, development of new infrastructure and business models was also mentioned by most interviewees as a barrier. For some of the smaller companies interviewed, the scalability of PC strategies such as the production of materials utilising bi-products from other industries appears to also be an issue of concern. With regards to material substitution, it is not only cost that represents a barrier, but also maintaining product functionality, performance and consumer expectations whilst using an alternative material such as recycled PET or biobased materials.

Finally, a key area that was also mentioned by the interviewees, is the aesthetics of sustainability and how these need to align to customer/market demands. This includes consumer willingness to accept aesthetic/external product changes associated with PC interventions such as the 'feel' or 'look' of recycled materials or plantbased materials e.g., 'vegan leathers'. Some of the companies interviewed are addressing concerns related to the potential impact of PC strategies on a product's aesthetics by, using recycled materials only on non-consumer facing product surfaces. If the barriers to implementing PC are to be overcome, it is recommended that PC assessment methodologies and tools address how to effectively communicate and present results across business functions. Additionally, strategies should aim to educate/raise awareness of sustainability decisions being made that may potentially have an impact on the product aesthetics and price to increase market acceptability.

Conclusions

Drawing on the findings documented in ORIENTING's *Critical Evaluation of Material Criticality and Product-Related Circularity Approaches* report [4], which identified and evaluated over 100 methods and tools that aim to measure circularity, this paper shows how companies remain in the very early stages of PC implementation and measurement. Moreover, the research highlights that there is a disconnect between existing literature and research, and the awareness, and understanding of PC indicators and metrics within industry. The interviews further showed that not only are companies not measuring PC, but that they are unaware of existing methods and tools available to them. While those that are aware of existing tools, have highlighted that they do not find they meet their product/industry requirements, or address the goal of assessing a circularity strategy within the use phase. As such, this research sheds light on key areas that require attention for achieving an effective transition towards the CE at a product level and the need to bridge the gap between academia, policy, and industry requirements. Below is a summary of the key findings:

It is important to promote the importance of a multilevel approach within sustainability assessment methodologies. In this context, UCA has developed a PC starter checklist to assist relevant stakeholders in starting their product circularity journey. The PC starter is currently being piloted by 2 case studies.

Methodology and tool development should offer guidance for adapting PC measurements and indicators to meet industry specific requirements or at a basic/entry-level, help companies to define a starting point for their PC journey.

PC assessments should be flexible and adaptable to existing industry processes.

There is a need for increased focus on consumer's needs and requirements to effectively participate in the CE.

The dilemma between accessing user data whilst simultaneously complying with data privacy needs to be tackled, as this is key for including the use phase within PC indicators and metrics.

It is also recommended that PC assessment methodologies and tools address how to effectively communicate results across business functions.

Lastly, if the barriers to implementing PC are to be overcome, focus is also needed in educating and raising awareness of the impact of PC strategies vis a vis product aesthetics and price to increase market acceptability.

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