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The Role of Life Cycle Sustainability Assessment in the Implementation of Circular Economy Principles in Organizations

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Abstract

Some of the targets included in the UN Sustainable Development Goal 12 "ensuring sustainable consumption and production patterns" are aligned with the circular economy vision of decoupling economic growth from resource constraints. However, only limited guidance is available to companies on how to make circular economy operational in their activities. The British Standard BS 8001:2017, "Framework for implementing the principles of the circular economy in organizations" provides guidelines to organizations in the transition towards a more circular and sustainable mode of operation. This paper discusses how the six principles and eight-stage flexible framework proposed in the standard can benefit by the integration with the Life Cycle Sustainability Assessment framework and what are the challenges for the food and drink sector.

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Keywords: circularity; food; beverage; life cycle assessment, life cycle costing, social LCA, sustainable developoment; sustainble consumption and production; corporate; standard

1. Introduction

Two of the targets included in the UN Sustainable Development Goal 12 ensuring sustainable consumption and production patterns focus on the reduction of waste generation (target 12.2), and the promotion of more efficient and sustainable resource management (target 12.5) [1]. Such targets are aligned with the circular economy (CE) vision of decoupling economic growth from resource constraints [2]. Although no single shared definition of CE is available [3], unlike the traditional linear take-make-consume-dispose approach, the objective of CE is to maximize value at each point in a product's life, since its overall aim is to keep products, components and materials at their highest utility at all times [4]. The roots of the CE concept can be traced back to different approaches, ranging from Industrial Ecology to Performance Economy, including cradle-to-cradle, Biomimicry and Blue Economy [5]. The Ellen MacArthur Foundation (EMF) has been instrumental in showing the opportunities that a shift to CE could bring for companies [1, 6] and for policymakers [7]. For instance, the Chinese government has formally accepted the concept of CE as a new development strategy in 2002 and approved the first law "Circular Economy Promotion Law of the People's Republic of China" in January 2009 [8]. According to the EU Action Plan for the CE "*the transition to a more circular economy, where the value of products, materials and resources is maintained in the economy for as long as possible, and the generation of waste minimized, is an essential contribution to the EU's efforts to develop a sustainable, low carbon, resource efficient and competitive economy*" [9].

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Despite the growing attraction of the CE vision in the business agendas, only limited guidance are available to companies on how to make circular economy operational in their activities. Most of the available decision support frameworks address CE strategies at the product level. Ronnlund et al [10] developed an eco-efficiency indicator framework based on Life Cycle Assessment (LCA) covering ten important issues of product environmental sustainability, including some key aspects for implementing CE, such as material efficiency and reutilization of secondary raw materials. Niero et al [11] defined a framework combining LCA and the Cradle to Cradle® (C2C) certification program to identify which actions should be prioritized to achieve a continuous material loop for beverage packaging, both from an environmental and an economic point of view.

Only a few examples of framework addressing the implementation of CE at the organization level are available. Within the scientific community, Mendoza et al [12] developed the so-called BECE (Backcasting and Eco-design for the Circular Economy) framework, to ensure that businesses can tackle the CE holistically by embedding the concept into corporate decision making and by bringing operational and systems thinking together, thus increasing the likelihood of successful implementation. As far as international standards are concerned, British Standard recently released the BS 8001:2017 standard [13] titled "Framework for implementing the principles of the circular economy in organizations". Such standard provides guidelines to organizations in the transition towards a more circular and sustainable mode of operation, based on an eight-stage flexible framework "*to assist organizations to develop a road map for continual and transformational improvement"* [13].

As pointed out by Geissdoerfer et al [14], there are both similarities and differences between CE and sustainability concepts; so far in the literature, CE has been identified as a condition for sustainability, a beneficial relation or a trade-off. For a circular economy to be sustainable, both the environmental, economic and social aspects of circularity strategies need to be accounted for. Niero and Hauschild [15] recommend using the Life Cycle Sustainability Assessment (LCSA) framework to evaluate circular economy strategies, since it is the most comprehensive and still operational framework as well as the best at preventing burden shifting between stakeholders in the value chain.

The LCSA framework, developed by the United Nations Environment Programme (UNEP) [16] provides guidelines to help with the integration of the three dimensions of sustainability – environmental, economic and social - to avoid shifting impacts from one dimension to another. This guideline combines the three existing frameworks of the aforementioned aspects, i.e. Environmental Life Cycle Assessment (E-LCA), Life Cycle Costing (LCC) and Social Life Cycle Assessment (S-LCA). The former two have been extensively used at product and organizational levels, however the latter remains the biggest challenge, as it is mainly used at organizational or sectoral levels [17, 18]. However, more efforts have been made to integrate the three-dimensional sustainability approach, exhibiting more examples across the literature, e.g. [19-21].

The Food and Drink sector (FDS) is the greatest manufacturing sector in Europe, with a turnover of €1,092 billion and 4.25 million employees in 2013 [22]. Similarly, in economies like China and the US, this sector also generates a substantial contribution with over €900 and €600 billion in turnover, respectively [22]. The FDS has acknowledged its role and concern about climate change and the challenges towards sustainable food and drink production and consumption, defining a list of priorities towards sustainability. These priorities focus on increasing energy efficiency, managing resources (e.g. water, packaging) and food waste, developing sustainable supply chains, protecting biodiversity, and increasing commitment on corporate social responsibility [23, 24]. Hence, the food and drink sector represents and will remain a key sector for both LCSA applications and CE implementations. Many applications of the LCSA framework indeed refer to both the drink, e.g. beer [25], and food sectors [26]. With regard to the agri-food sector, Pagotto and Halog [27] developed a framework based on Input-Output approaches for analyzing resource efficiency and competitiveness potential towards a CE in the Australian agri-food industry. Alike, the food and drink industry in one of the four priority areas defined by the Scottish Government in its CE strategic plan, where they specifically defined their ambition, priority areas, and skill training and monitoring plans [28]. This plan was based on a previous assessment executed by EMF [29], which highlighted the opportunities and challenges that Scotland would phase towards the implementation of circular economy.

Given the potential synergies of CE and LCSA at the organization and sectorial levels, this paper proposes an operational guideline, describing how organizations aiming to implement CE in their activities can integrate the BS 8001:2017 standard with the LCSA framework. We use two cases in the food and drink sector to illustrate the challenges and opportunities arising from the implementation of this integrated framework.

2. Framework for implementing the principles of the circular economy in organizations

2.1. British Standard 8001:2017

BS 8001:2017 is a voluntary guidance standard like ISO 14040 [30], meaning that it is not intended nor suitable for certification purposes but envisioned to be used by organizations as a support when considering and implementing more circular and sustainable practices within their businesses. It has been developed by capturing the latest thinking and practice amongst experts in CE and draws on the experiences and lessons learned from a range of organizations, both large and small, which are already attempting to become more circular [13]. Circular economy is defined in the standard as "an *economy that is restorative and regenerative by design, and which aims to keep products, components and materials at their highest utility and value at all times, distinguishing between technical and biological cycles"*.

The aims of the BS 8001:2017 standards are two-fold:

- To define what the CE is and why moving towards a more circular mode of operation might be beneficial and relevant to an organization - both now and in the future;
- To explain how to implement the principles of the CE within an organization to create value through process, product, service or business model innovation.

As stated in the BS 8001:2017 standard, there is no exhaustive list of the principles of the CE, but as a minimum six guiding principles are identified, see Table 1.

Table 1. List and description of guiding principles of the circular economy according to BS 8001:2017 standard [13].

Principle	Description	Aim
1 – System thinking	Taking a holistic approach	To understand how individual decisions and activities interact within the wider systems they are part of
2 - Innovation	Taking anything that results in something new or changed which realizes and redistributes value	To create value by enabling the sustainable management of resources through the design of processes, products/services and business models
3 – Stewardship	Managing the direct and indirect impacts of organizations´ activities within the wider system they are part of	To take into account the economic, environmental and social impacts determined by the organization both in its supply chain and customer base
4- Collaboration	Internal and external collaboration through formal and/or informal arrangements	To create mutual value among organizations
5 – Value optimization	Keeping all products, components and materials at their highest value and utility at all times	To reconsider what might be seen as waste or system losses and identifying opportunities to realize new potential from them
6 - Transparency	Being open about decisions and activities that affect the transition towards CE and willingness to communicate these in a clear, accurate, timely, honest and complete manner	To build trust, both internally and/or externally

2.2. Integrating BS 8001:2017 and LCSA frameworks

A link between the six guiding principles for CE listed in the BS 8001:2017 standard [13] and the LSCA framework [16] can be identified:

1. *System thinking:* core of the life cycle thinking approach;
2. *Innovation:* environmental, economic and social value creation through analysis and further implementation of improvement opportunities to achieve specific sustainability targets;
3. *Stewardship:* quantification of economic, social and environmental impacts, including the assessment and acknowledge of trade-offs;
4. *Collaboration*: stakeholders (and stages) interaction and dependencies, trade-offs across the stages;
5. *Value optimization:* iterative characteristic of life cycle thinking, which enables the constant benchmarking and assessment of improvement opportunities as increasing efficiencies, yields, resource optimization, among others.
6. *Transparency:* core characteristic of the analysis as stated on standards (e.g. ISO 14040/44, PAS 2050) and certification (e.g. environmental product declarations).

The six guiding principles can be used to determine the relevance and state of CE for the organization, i.e. the first stage (framing) of the eight-stage flexible framework described in the BS 8001:2017 standard [13]. Figure 1 summarizes the 8 stages and shows the links with the LCSA framework.

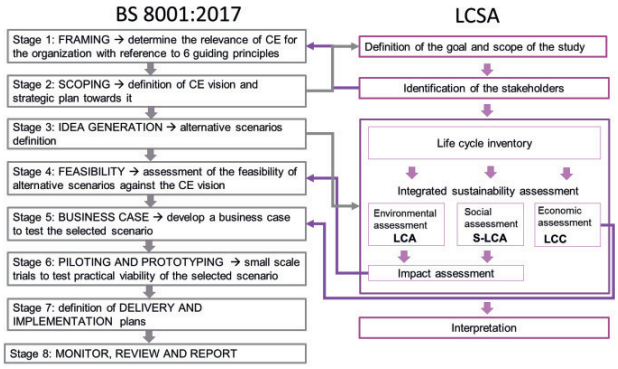

Fig. 1. Operational guideline describing how organizations aiming to implement CE in their activities can integrate the BS 8001:2017 standard [13] with the LCSA framework [16].

According to BS 8001:2017 [13], during stage 1 (Framing) the organization should:

a) Identify the most relevant resources for its long term success and resilience (e.g. through a materiality assessment);
b) perform a stakeholder mapping; and
c) create internal engagement and awareness raising.

The identification of the stakeholders is also part of the LCSA framework and as suggested by the S-LCA guidelines [31] five stakeholder categories should be considered: worker, consumer, local community, society and value chain.

Once the relevance of CE for the organization has been identified, during stage 2 (Scoping) a vision and strategic plan towards CE should be outlined. Such vision will influence the definition of the goal and scope of the LCSA, which should be aligned with the long-term vision of the organization and definition of most relevant stakeholders. The following activities should be performed during stage 2:

a) identify opportunities for CE implementation;
b) understand how CE can influence the long term vision of the organization; and
c) define high-level strategy, objectives and roadmap to achieve them.

During stage 3 (idea generation) the possible initiatives aiming at implementing CE in the organization should be identified and prioritized according to the CE vision and

strategic plan. This translates in the definition of alternative scenarios that will be the object of the integrated sustainability assessment, i.e. LCA, S-LCA and LCC. To facilitate the identification of the feasible options (stage 4, feasibility) we suggest to focus in first instance on the assessment of the environmental and social impacts of the alternative scenarios through LCA and S-LCA, respectively. The selection of the most relevant life cycle environmental and social indicators, i.e. the impact categories, will be facilitated by the choices done during stage 1a and 1b. By linking the feasibility assessment with the vision defined in stage 2 (scoping) it will be easier to deal with potential trade-offs arising in the selection of the environmental and social indicators, thus enabling the selection of the most feasible scenarios to be further analysed in the following stage. Moreover, we suggest using LCC as a screening tool, to identify on which scenarios the business case (stage 5) should be developed. Once the business case of the selected scenarios has been developed, small-scale trials to test their practical viability should be performed (stage 6, piloting and prototyping). Then, the definition of the delivery and implementation plan (stage 7) and monitoring, reviewing and reporting (stage 8) should be carried on. The performance indicators used for the monitoring should include not only the economic indicators used in the business case definition (stage 5), but also those identified in stage 4, i.e. the environmental and social indicators aligned with the CE vision of the organization.

3. Case studies

This section presents two examples in the FDS. First, we introduce a case showing how previous life cycle sustainability assessments or sustainability practices might facilitate the assessment of the six CE principles described in the BS 8001:2017 in the UK ready-made meal sector. Second, we present a case in the packaging sector to illustrate how the integrated BS8001:2017 - LCSA framework can be applied.

3.1. The UK Ready-made meal sector

The UK ready-made meal sector has been growing rapidly, around 11% since 2010. Although nor specific neither explicit commitment has been found towards circular economy, the commitments towards sustainability are clear, mainly stated by the associations: Chilled Food Association (CFA) and British Frozen Food Federation (BFFF), and specified by each company. Stakeholders have been promoting several initiatives and assessments related to sustainability [32-34], which, as discussed before, implicitly refers to some of the six core CE principles mentioned in Table 1. Some of the examples are described below:

- *System thinking:* sustainability action plans include initiatives in their whole supply chains, which are sometimes translated as 'from farm to folk' actions;
- *Innovation:* with the aim of increasing energy efficiency and reducing carbon emissions, the ready-made meal sector has been investing in new technologies and promoting new practices, for instance new packaging designs to increase shelf life and increase recyclability (e.g. bioplastic), new refrigerant (e.g. CO_2) and cabinet designs (e.g. doors in chill cabinets), reducing and utilising food waste (e.g. waste oil into biofuels), sustainable sourced raw materials (e.g. palm oil);
- *Stewardship:* constant product development is an important characteristic of this sector, and although is not compulsory, a big amount of companies are incorporating sustainability and social assessments into their practices [35, 36];
- *Collaboration:* sustainability commitments across associations (e.g. FDF, BBBF, CSA), food sector commitments as The Federation House Commitment [37] and 'Ambitions 2015' from FDF [36];
- *Value optimisation:* although this varies between companies, evidence of re-using 'waste' are mainly focussing on production and recovering of energy (e.g. electricity and heat) from anaerobic digestion (biogas), use as composts (fertiliser replacement) and less so animal feedstock [38]. Evidences of bio economies as reutilisation of waste are also seen (e.g. biofuels from used oil [33]. Economic terms are not always specified.
- *Transparency:* certifications and voluntary commitments, mainly towards carbon emission and waste reduction, and energy and water saving, promote the openness across the sector (e.g. progress and yearly reports), however this might vary across companies.

As seen, the UK ready-made meal sector has been indirectly worked towards circular economy principles, which could be used as starting point for a thorough and comprehensive CE plan across the sector and the industry.

3.2. Carlsberg Circular Community

The Carlsberg Circular Community (CCC) is a cooperation platform launched in January 2014 between Carlsberg (currently the third largest global brewer) and a selection of global partners, aiming at rethinking the design and production of traditional packaging material. This initiative was a response to the need to act on the increasing demand for consumer goods, which combined with resource scarcity, places further demands on businesses to use materials more efficiently and to remain profitable [39]. Thus CE was deemed to be relevant for the organization (cfr. stage 1), particularly in connection with the interests of consumers, society and value chain. The CCC was inspired by the C2C design framework [40] with the ambition to develop packaging products that are optimized for recycling and reuse, while retaining their quality and value. This vision has been translated in a strategic plan including four actions targeting different stakeholders (stage 2) [11, 40]:

- *Assessment & optimization* is addressed to suppliers and consists in material assessment ratings based on the hazards of chemicals in products and their relative routes of exposure during intended use and end-of-use phases;
- *Communication and information* oriented toward customer, for example, using the C2C certification scheme;
- *Behavior change* for consumers, for example, through the participation to campaigns for used beverage packaging collection in events like festivals (see the "Every Can Counts initiative" in the UK) to educate end users to

dispose the packaging material in the appropriate collection bin;
- involvement of partners aiming at packaging *upcycling or ecosystems re-entry* , which refers to redesigning ingredients or additives so they improve the quality of materials with respect to maintaining or improving value in continuous loops.

These four actions are partially aligned with the six guiding principles of CE outlined in the BS 8001:2017. The CCC is indeed an initiative that is oriented at *transparency* through a *collaboration* among suppliers and external partners aiming at *value optimization* and *innovation*. The *stewardship* and *system thinking* elements could be strengthening by the combination with the LCSA framework, as outlined in section 2.2.

Different packaging are considered in the CCC initiative, e.g. glass, plastic, new wood fiber based packaging [41]. Here the focus is on aluminum cans, with alternative scenarios identified to implement CE (stage 3) and assessed by means of LCA [42] and LCC in different geographical contexts [43] (stage 4). As discussed in section 2.2, LCC can be used as a screening economic tool to identify the most feasible options to be further explored in the business case (stage 5). In the case of aluminum cans it emerged that most of the environmental and economic burdens are connected with the primary aluminum production phase [42, 43], so this is where the focus should be placed in terms of definition of alternative business model options. The environmental impacts of different technologies for material circularity have already been quantified [44], meanwhile the analysis of challenges in closing the loop for aluminum can is current under development, using the framework developed by Stewart et al. [45].

It should be noted that the CCC was initiated before the release of the BS8001: 2017 standard, but is currently running and could benefit from the proposed integrated framework. For example, the quantification of the social impacts of the alternative scenarios could be performed by means of S-LCA, to identify the impacts on the identified most relevant stakeholders' categories (consumer, value chain, society). The inclusion of the S-LCA could potentially lead to the definition of further alternative scenarios still aligned with the CE vision.

4. Concluding remarks

The BS 8001:2017 standard provides a comprehensive framework that link the CE vision to strategic plan, and is adapted to different level of maturity of the organization. The importance of adopting flexible tools that can be adapted to the level of maturity of an organization has been already recognized, e.g. in the case of eco-design practices [46]. For companies to take decision there is a need of operational tools, so our suggested integrated framework contributes to fill such gap. The importance of linking a vision to implementation tools in the context of CE has been outlined in the case of LCA and C2C [11], as well as in the case of backcasting and eco-design [12]. In contrast to the BECE framework [12], which supports in building and implementing CE business models, our integrated BS8001.2017-LCSA framework provides an operative tool to prioritize the selection of the most feasible options to implement the CE vision of an organization. The initial selection of the most relevant scenarios for CE implementation should be performed according to the environmental and social indicators, which are aligned with the long-term vision and selection of most relevant stakeholders. This will allow concentrating the efforts in the definition of the business case for the alternatives that are not just "easy win" but truly aligned with the identified long term CE vision and strategy of the organization. The main challenge in the implementation of the integrated BS 8001:2017 framework lies in the acquisition of the expertise with regard to both CE and LCSA. However, as seen in the case of the ready-meal sector in UK, the incorporation of sustainability targets and sometimes the life cycle assessment of environmental and social aspects have cemented a base to help the sector and industries to start a commitment towards circular economy. Elements in LCSA have already been implicitly included in the core guiding principles of CE, which means that the implementation of the eight-stage flexible framework of circular economy might be a less hazard step forward, as emerged from the case of the aluminum cans within the Carlsberg Circular Community.

Finally, there are still challenges that need to be addressed to foster CE implementation in industry, e.g. how to accurately apply a systemic perspective, where crucial issues as the interdependencies between the different aspects of the systems, the time and economic (growth, constraint, etc.) interaction, are also included. A key aspect to address is the handling of trade-offs, e.g. in cases where a circular solution leads to higher environmental impacts or increased costs. The Multi Criteria Decision Analysis (MCDA) methodology [47] provides an integration approach to aggregate results of different methods and indicators, enabling consideration of the complex and interconnected range of environmental, social and economic issues in one common index; moreover, it incorporates both qualitative and quantitative data, and allows the ranking of alternative scenarios. Studies testing the inclusion of other tools and approaches such as MCDA to help to answer these uncertainties are thus highly encouraged.

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