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Macarena Beltran
Coventry University
Benny Tjahjono
Coventry University

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Macarena Beltran^{1*}, Benny Tjahjono¹,

¹Centre for Business in Society, Priory Street, Coventry University, Coventry, UK

* Corresponding author: macarena.beltran@coventry.ac.uk

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Summary

While social innovation labs have been gaining relevance in addressing environmental and societal issues, critical questions concerning whether social innovation labs could offer an adequate and robust methodology for reconfiguring supply chains towards achieving a bio-circular economy (BCE) remain unanswered. We conducted a case study on the bio-packaging supply chain to explore whether a social innovation lab (SIL) methodology can provide solutions to improve the reconfiguration and linkages of this supply chain towards BCE. We find that SIL methodology can shed light on the configuration of supply chains to move from fossil-based plastics to bio-packaging by focusing on the societal goals and improvement of supply chain linkages that circumscribe the supply chain, emphasising communication with consumers, certification standards and guidelines for waste management and end-of-life. However, whether the solutions proposed by the stakeholders can be implemented is still open to question and requires further research.

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1. Introduction

The supply chain management field is becoming increasingly interested in the development, implementation and/or management of sustainable supply chains (SSCs) as hybrid arrangements between traditional (firms) and non-traditional actors (NGOs, social enterprises, local communities, and multi-stakeholder initiatives) to address sustainability challenges as well as by non-traditional actors (Carmagnac, 2021; Gold et al., 2013; Gualandris & Klassen, 2018; Pagell et al., 2017; Rodríguez et al., 2016). For example, the role of multi-stakeholder meta-organisations in the diffusion of environmental principles and cooperation was studied in a palm oil supply network (Carmagnac & Carbone, 2019). The boundaries between non-traditional and traditional actors are increasingly blurred, as non-traditional actors assume roles traditionally associated with companies (e.g., Oxfam intervention regarding knowledge transference and networking in small-scale female farmers across African countries (Gualandris & Klassen, 2018)). In this context, supply chains' (SCs) responses to sustainability can no longer be left only to firms. Montabon, Pagell and Wu (2016, p. 23) capture the essential elements of these changes when they suggest that instead of focusing on pushing the SC towards “win-win” opportunities, the firms should focus on an “ecologically dominant logic supply chain”, which considers “a wide range of stakeholders and outcomes and forces the supply chain to focus on doing no harm”.

Across diverse SCs, tools and strategies are being developed to support a broader transition to sustainability. Social innovation lab (SIL) is one of the emerging tools, which, broadly speaking, can be defined as a safe space for collaboration between non-traditional and traditional actors, which could lead to innovative and transformative improvements through the design and development of SSCs. SILs have been gaining relevance in addressing societal and sustainability challenges (Hassan, 2014; Westley et al., 2015). Indeed, collaborative learning processes facilitated by social innovation labs could play a central role in changing existing societal cultures, structures, and practices (Bos & Brown, 2012). Yet, so far, it has not been sufficiently clarified whether social innovation labs provide an adequate and robust methodology to facilitate the creation of a strategy for sustainable transition (McCrory et al., 2020) and, thus the extent to which SIL can address these SC challenges remains to be explored.

Thus, drawing on a SIL methodology, we aim to enhance our understanding of the future solutions that can be implemented for reducing and mitigating plastic pollution. In particular, through a case study with the biobased biodegradable plastic packaging (hereafter bio-packaging) SC, this paper seeks to address whether SIL methodology actually contributes to forecasting configurations of a SC under the concepts of bio-circular economy (BCE) and whether different solutions can be created to improve the linkages of SSC.

We argue that forging a critical and constructive dialogue between insights from SILs and the nature of SC governance is regarded as a critical step for research in SSCs. This dialogue could lead to jointly developing innovative solutions for managing SSCs towards a configuration from fossil-based plastics to bio-packaging by focusing on the societal goals and improving

SC linkages that circumscribe the SC under BCE concepts. Moreover, we argue that SIL methodology facilitates a multi-stakeholder perspective; however, whether the solutions proposed by the stakeholders can be implemented, is still open to question and requires further research.

This paper is structured into five sections. The next section provides a brief overview of the reasons for reconfiguring the bio-packaging SC. Section 3 explains the SIL methodology used, and Section 4 discusses the interconnected cluster solutions proposed by the stakeholders. Section 5 discusses the practical implications of the methodology and provides concluding remarks.

2. Understanding the reconfiguration of the bio-packaging supply chain

In recent years, there has been increasing societal pressure to reduce the use of plastics in numerous applications, primarily driven by the recognition of the negative environmental impacts of fossil-based plastics. By 2050, this sector is expected to account for 20% of total oil consumption and 15% of the global annual carbon budget (WEF, 2016). To address these concerns, there has been a push to reduce single-use plastics, and many companies have committed to using alternative materials such as bioplastics.

Bioplastics may provide advantages for reducing fossil fuel dependence and supporting the domestic economy (Hogan et al., 2015). While bioplastics have potential benefits, their production and end-of-life also come with environmental and social challenges. There is concern about its biodegradability (Purkiss et al., 2022) and its impacts on the food supply and the environment. There is a need for clear labelling of bioplastics to help consumers make informed decisions (Allison et al., 2021), to establish closer links to other SCs, such as the agro and biofuel industries (Beltran et al., 2021), and to improve the level of compostable waste management (Kędzia et al., 2022).

In this context, the configuration of the bio-packaging SC is essential for reducing environmental and social impact. The current linear model of this SC with weak links with the end-of-life (Beltran et al., 2021; Kędzia et al., 2022) is not sustainable in the long term as it contributes to environmental degradation. Under the concept of a BCE, this means rethinking and linking the entire SC from sourcing raw materials to composting and digestion of bio-packaging products. This involves collaboration between stakeholders to create a system that prioritises sustainability and resource efficiency at every stage of the SC.

3. Methodology

Social innovation labs (Hassan, 2014; Westley et al., 2015) could be instrumental in helping to reshape SCs. Nevertheless, whether SIL provides a robust methodology for proposing reconfigurations in a BCE supply chain has not been adequately clarified. Thus, the SIL methodology was adapted and extended from Westley et al., (2015) to study whether it could shed light on the potential configurations and solutions to improve the bio-packaging SC linkages in the United Kingdom (UK) (see Figures 1a and 1b). A similar methodology was applied in parallel to different bioplastics projects in Poland (Kędzia et al., 2022), Canada (Springle et al., 2022), and Brazil.

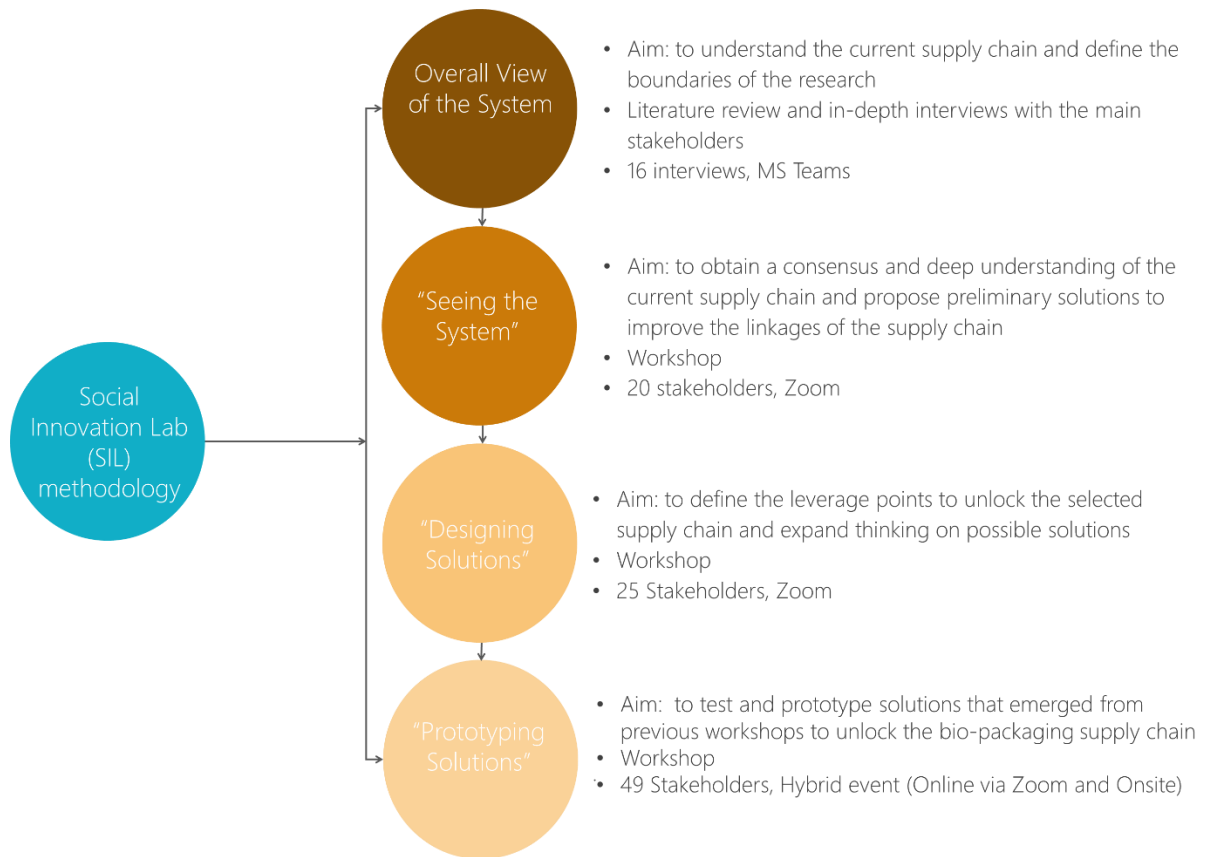
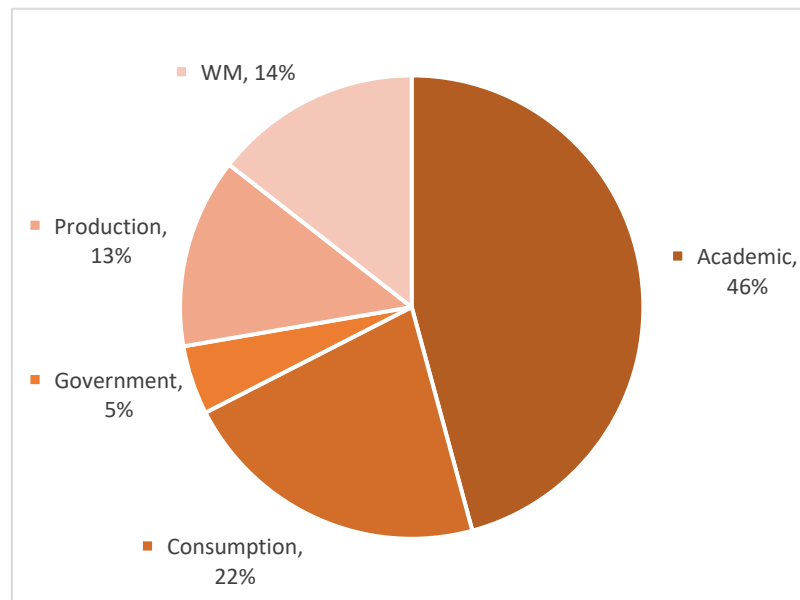


Figure 1a. Social Innovation Lab (SIL) methodology



Notes:
83 participants.
Consumption sectors include consumers and retail.

Figure 1b. The sectors represented by participants in the SIMBIO SIL

There is no doubt that one of the biggest challenges for many SILs is incorporating all the relevant stakeholders and considering their voices and interests. A SIL can make a significant

contribution to SC sustainability and low-carbon transitions if it is designed and implemented correctly. The following paragraphs provide a brief description of the methodology at each stage, please refer to more details in: Beltran, Tjahjono, et al., (2023), Beltran, Wieteska, et al., (2023), Tjahjono et al., (2022), Tjahjono, Beltran, et al., (2021), Tjahjono, Lazell, et al., (2021).

Overall View of the System: a literature review (Beltran et al., 2021) and in-depth interviews were conducted in this phase (Beltran, Wieteska, et al., 2023). The in-depth interviews were conducted between November 2020 and February 2021 with 16 expert stakeholders to understand the current SC, following a constructivist approach (Yin, 2018). Thematic analysis was used to analyse the interviews using NVivo qualitative data analysis software. As a result, a list of drivers and barriers related to the development of the UK bio-packaging SC was compiled, and the boundaries of the research were defined. A preliminary SC was drawn to be tested in the next research phase. More information can be found in Beltran, Wieteska, et al., (2023).

Seeing the System. This is the first workshop that took place online in March 2021 to obtain a consensus and deep understanding of the current SC and propose preliminary solutions to improve the linkages of the SC. Twenty stakeholders were recruited. The workshop consisted of two parts. First, expert stakeholders shared their views on the bio-packaging system. Second, three parallel breakout sessions were conducted covering the production, consumption, and waste management parts of the SC. Participants identified their place in the system, barriers and opportunities for achieving growth, and envisioned solutions aided by detailed diagrams (see Figures 2, 3 and 4). A thematic analysis was used to analyse the data. The potential solutions that emerged from this workshop were the starting point for the implementation of the next phase of the research. More information in Tjahjono, Lazell, et al., (2021).

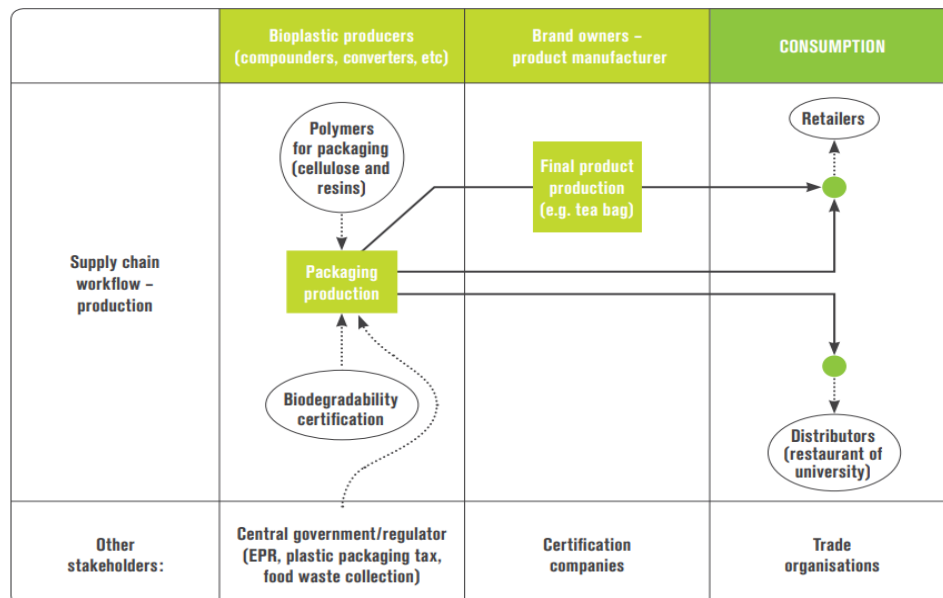


Figure 2. Bio-packaging supply chain diagram for the production break out group. Source: Tjahjono, Lazell, et al., (2021).

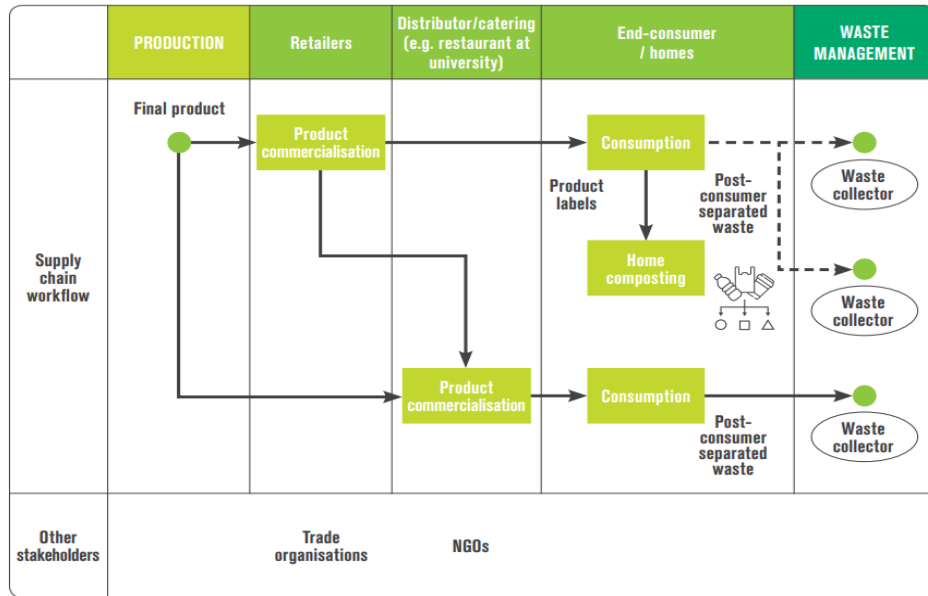


Figure 3. Bio-packaging supply chain diagram for the consumption break out group. Source: Tjahjono, Lazell, et al., (2021).

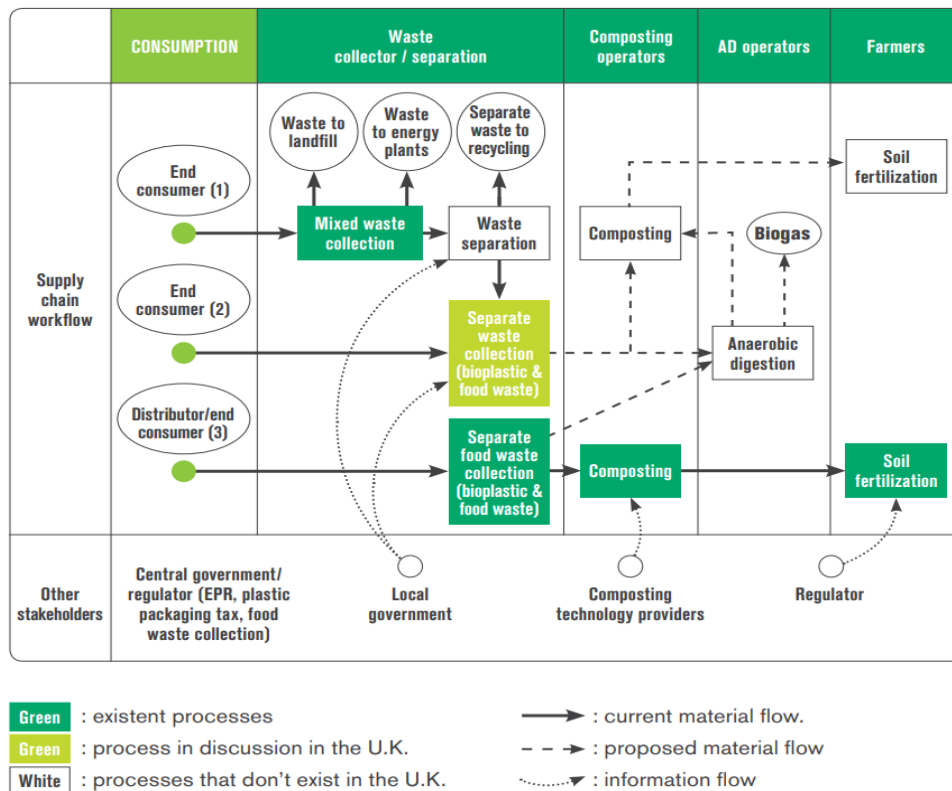


Figure 4. Bio-packaging supply chain diagram for the waste management break out group. Source: Tjahjono, Lazell, et al., (2021).

Designing Solutions. The second workshop was conducted online in June 2021 to define the leverage points to unlock the selected SC and expand thinking on possible solutions. 25

participants were recruited. The workshop consisted of four parts. First, representatives of the SC discussed regulatory and consumer perspectives. Second, participants prioritised areas for solutions under "Thinking in Systems" concepts (Meadows, 2008). Thirdly, participants discussed the most "infuriating" plastic packaging they encounter in their daily lives and suggested ways to improve it. Lastly, the participants discussed how solutions would be implemented in the future. A thematic analysis was used to analyse the collected data. As a result of this workshop, cluster solutions were prioritised and forecasted. See more details in Tjahjono, Beltran, et al., (2021).

Prototyping Solutions. The third workshop was conducted online and onsite in November 2021 to test and prototype solutions that emerged from previous workshops to unlock the bio-packaging SC. The workshop recruited 49 participants and was organised in three parts. First, SC representatives shared their views on the solutions. Second, participants evaluated the solutions considering feasibility, practicality, and impact. Third, a serious game (see Figure 5) was conducted for implementing specific compostable products (i.e., ready meal trays, coffee pods, and food caddy liners) (Beltran, Tjahjono, et al., 2023). Solutions from previous workshops were considered resources in this game. A thematic analysis was used to analyse the data. As a result, cluster solutions from the previous workshops were applied to the development of specific bio-packaging products. See more details in Tjahjono et al., (2022).



Figure 5. SIMBIO Serious game.

4. Results

Stakeholders identified that communication with consumers, certification standards, and guidelines for waste management and end-of-life have the greatest potential for the reconfiguration of the bio-packaging SC. *Communication with consumers* was a major issue raised by the SILs participants since bioplastics are unknown and poorly understood by consumers. SILs participants believe the opportunity lies in developing clear and consistent terminology supported by labels and packaging information, which would allow consumers to determine which types of bioplastics they are purchasing (biobased and non-biodegradable,

non-biobased and biodegradable, biobased and biodegradable - the focus of this study) and whether those packaging can be composted at home or collected by local authorities for industrial composting.

The second priority was given to *certification standards and guidelines* for waste management. Stakeholders recognise the importance of EN 13432 certification, which sets minimum biodegradability, disintegration, and biological treatment requirements. Nevertheless, the voluntary nature of certifications and the different labels hinder the widespread adoption of bio-packaging. Several participants expressed concerns regarding oversight, so to make this solution feasible, there must be greater accountability to prevent negative consequences related to self-regulation. In this context, the majority of stakeholders prioritised mandatory certification standards and homogenous labelling.

Stakeholders also called for an *industrial end-of-life management strategy* due to the limited evidence that biodegradable bioplastics can degrade completely via home composting (e.g., into CO₂, H₂O, and biomass). There is currently no industrial infrastructure in place for processing these materials at the end of their life in the UK unless they are commercialised through an integrated 'product to compost' solution (e.g., the Vegware business model). The stakeholders emphasised the need for an appropriate waste management system (infrastructure and processes) and consistent collection of compostable plastic packaging and food waste.

Solutions prioritised by stakeholders should be analysed as part of an interconnected system, including education programmes, R&D, and policies. This is consistent with the proposed development of ready-meal trays, coffee pods, and food caddy liners. However, closing the loop was a critical barrier. This issue extends beyond end-of-life processing; to digest and compost bio-packaging, upstream production processes must work in harmony with waste management supported by certifications and labels, communication, policies, education, and R&D.

5. Discussion and Conclusion

This SIL perspective offers several insights into facilitating the configuration of BCE SCs, but two are particularly pertinent in relation to the bio-packaging SC. Firstly, it shifts from a non-participatory model to one that recognises that solutions are constructed through stakeholders which traverse traditional boundaries of the SC, state, and society. Learning, interaction, integration, and experimentation are essential to solving long-term societal problems (Loorbach, 2010). Secondly, our research findings suggest that there is certainly scope for more SILs, because they facilitate the creation of wider and new configurations of BCE SCs. Bio-packaging is seen as one part of a broader solution to mitigate plastic pollution, which includes linkages with other SCs and other materials. However, participatory forms to configure BCE SCs seem to be the exception rather than the rule.

This situation offers the opportunity to consider a complementary tactical approach by deploying composting technologies or supporting community composting groups. Co-learning enables firms to acquire implicit knowledge from their local partners as well as identify/develop new markets (Mirvis et al., 2016). Many large corporations have adopted collaborative approaches, and certainly, some bio-packaging producers may fit into this

category; however, at the moment, the feasibility and capability of the bio-packaging industry to partner in those activities are unclear. The study acknowledges that the investigation is particularly important for the bio-packaging SC but cannot be generalised to other SCs. Further research is needed to investigate this methodology and develop configurations for achieving BCE in various SCs.

In conclusion, the findings suggest that SIL can shed light on the configuration of the bio-packaging SC by focusing on the societal goals and SC linkages that circumscribe the bio-packaging SC, emphasising communication with consumers, certification standards, and guidelines for waste management and end-of-life. The SIL methodology could also be important for other SCs to address sustainability challenges using a participatory process and to provide a wider strategy to face the challenges focusing on barriers to solutions.

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