



Leverage points for sustainability transformation: Identifying past and future changes in the Finnish (circular) plastic packing system

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ABSTRACT

The circular economy is hailed in the policymaking and industrial communities as a key solution to reduce material and energy throughput in our economic system. The “leverage points” concept helps to understand how sustainability transformations can be accelerated. Leverage points are places to intervene in a system. The concept postulates that transformative change is unlikely if only shallow leverage points are acted upon, while recognizing that intervening at deep leverage points is difficult in practice, even if the benefits might be substantial. This article refines the leverage points concept and applies it to the circular economy, exploring the mechanisms for transformative change. First, we examined what kind of leverage points have been identified in scientific literature in general and how they are said to introduce changes in the system. Second, we examined what kind of leverage points towards circularity were identified in the Finnish plastic packing system through a collaborative workshop with practitioners. Our results show that such leverage points vary from concrete ones at the parameter level (e.g., incentives, regulations), societal ones at the design level (e.g., increased collaboration at industry level, reformulation of company strategies) to abstract ones towards the system intent (e.g., renewed environmental values, changing ways of thinking). Regarding the packaging system, practitioners found it easier to think within existing structures rather than to come up with disruptive amendments. Thus, leverage point research requires creative thinking that challenges both stakeholders' and scientists' worldviews.

1. Introduction

A key tension in tackling sustainability problems is the urgency for solutions on one hand and the need for systemic changes on the other (Dasgupta, 2021; IPBES, 2019; IPCC, 2022). In the past decade, this has spurred efforts to study and implement solutions enabling a substantive and palpable societal transformation which would allow humankind to operate within planetary ecological boundaries while meeting social needs for all (Hölscher et al., 2018). One effort to study how to foster sustainability transformation is the concept of “leverage points”. Leverage points (Meadows, 1999) represent places in a complex system in which a small shift may lead to fundamental changes in the system as a whole. This approach aspires to describe how one type of change in a system causes a chain of other changes that are potentially fundamental and permanent (cf. Riechers et al., 2022).

The concept of leverage points has received growing interest in

sustainability sciences due to its versatility, strong communicative power and wide applicability (Abson et al., 2017; Fischer and Riechers, 2019; Folke et al., 2021). However, more research is needed to understand how to intervene concretely in systems, and which actors have the agency to do so. The circular economy, proposed as a set of solutions aimed at kick-starting sustainability transformations through a quasi-closed system of material and energy flow (Velenturf and Purnell, 2021), can be a valuable case study to assess the real-world potential of the leverage points concept. The circular economy is currently one of the main solutions mainstreamed in EU and international policy-making with the aim of addressing pressing sustainability challenges such as resource depletion, pollution and climate change (Ellen MacArthur Foundation, 2021; European Commission, 2020a). In opposition to a linear take-make-waste economy, the circular economy aspires to separate economic goals from environmental pressure, at least in relative terms, by reducing inputs (material, energy) and outputs (waste and

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emissions) in production and consumption systems. To attain a higher degree of circularity, reduce environmental impacts and improve resource efficiency, different circular approaches, or so-called circular economy (or R-) strategies have been developed, which comprise refuse, rethink, reduce, reuse, repair, refurbish, remanufacture, repurpose, recycle and recover (see, e.g., [Circle Economy and MVO Nederland, 2015](#); [Potting et al., 2017](#)). Often this list is considered as an order of priority, according to which the first ones (e.g., refuse, rethink and reduce) are to be prioritized as opposed to the latter ones (e.g., recycle, recover). The development of the circular economy is largely industry-driven, with many economic sectors showcasing circular solutions in the form of innovative products, services, processes and business models (e.g., [Lazarevic and Valve, 2017](#); [Velenturf and Purnell, 2021](#)).

Despite a growing body of work on leverage points, only a handful of articles have specifically focused on understanding or applying leverage points in the context of the circular economy. However, circular economy approaches have already brought about important changes in various sectors, and this calls for and creates opportunities for deeper analyses of the leverage points behind such changes. This study thus aims to further refine the leverage points concept and apply it to the Finnish plastic packaging system in order to explain the mechanisms for transformative change in that context. We pose the following research questions:

1. What kind of leverage points have been identified in sustainability literature, and how do they introduce change in the system?
2. What kind of changes towards the circular economy have occurred or would be needed in the Finnish plastic packaging system and how can they be classified according to the leverage points concept?

This article combines a review of scientific literature on leverage points with a case study focusing on the Finnish plastic packaging sector, where we apply the leverage points concept as an analytical tool in order to study shifts towards a circular economy. We focus on the packaging sector at a general level and do not discuss its specific sectors (e.g., food packaging) in detail.

The role of our case study is to confirm the existence of certain leverage points by taking a retrospective view of the shifts that have already occurred in the plastic packaging sector. The case study also takes a forward-thinking view by identifying leverage points for further efforts towards the circular economy. Plastic packaging was chosen as a case study due to its high demand volumes, short life cycles and the heavy environmental burden associated with the materials ([Dahlbo et al., 2018](#)) – not disregarding the many important services that the sector offers ([PlasticsEurope, 2020](#)). The packaging sector has undergone multiple changes towards sustainability in recent years ([European Commission, 2020b](#)), these changes include, for example, increasing recycling targets for different waste streams as well as bans that were enacted for certain single-use plastic products, but broader circular economy policies aim for more ambitious targets within a short timeframe.

In addition to its empirical findings, this study contributes to interdisciplinarity in sustainability science by bridging leverage points and circular economy communities. We also offer insights for policy and practitioner communities working with the circular economy.

2. Conceptual background

2.1. Leverage points in system thinking

Leverage points are places in a complex system where a minor shift may lead to large changes ([Abson et al., 2017](#); [Fischer and Riechers, 2019](#); [Meadows, 1999](#)). This concept draws on system thinking to understand interactions of system characteristics and identify places of intervention to change the overall behaviour in a system over time ([Abson et al., 2017](#)). The system in question may be a corporation, an

economy, a living body, a city or an ecosystem. The leverage points concept can provide tools to analyse whether given interventions are adequately deep to bring about changes to transform unsustainable systems. Thus, they can be distinguished as “shallow” or “deep” ([Meadows, 1999](#)). Shallow leverage points refer to interventions that are relatively easy to implement but have a limited potential to lead to transformative change. Deep leverage points, on the other hand, are more difficult to act upon, but have greater transformative potential ([Abson et al., 2017](#)).

[Meadows \(1999\)](#) has identified twelve leverage points that [Abson et al. \(2017\)](#) have aggregated into four types of system characteristics that interventions can target, namely parameters, feedbacks, design and intent (from shallowest to deepest). First, *system parameters* encompass relatively mechanistic and modifiable constants. They include taxes, incentives, standards and physical elements of a system, such as stock sizes and rates of material flows. Second, *system feedbacks* describe weakening and reinforcing interactions between system elements. They drive internal dynamics or provide information about desired outcomes, for example, on the effectiveness of a subsidy. Moving towards deeper leverage points, *system design* characteristics imply social structures and institutions that manage feedbacks and parameters. They concern the structure of information flows, rules, power and self-organization. Finally, the *intent of the system* encompasses the underpinning values, goals and worldviews within the system of interest and the underlying paradigms. [Abson et al. \(2017\)](#) see intent as the emergent direction towards which the given system is oriented.

The concept of leverage point has common characteristics with other concepts and theories aiming to explain transformation at the system level. For example, the three spheres of transformation identified by [O'Brien \(2018\)](#) – practical, political and personal – resonate with leverage points and the four levels of system characteristics. The practical sphere represents specific actions, interventions, strategies and behaviours that directly contribute to a desired outcome. The political sphere represents the systems and structures that facilitate or constrain practical responses. The personal sphere of transformation represents the subjective beliefs, values, worldviews and paradigms that influence how people perceive, define or constitute systems and structures, as well as their behaviour and practices.

2.2. The circular economy and the plastic packaging sector

Over the past decade, the circular economy has emerged as a popular concept ancillary to sustainability. In part, the circular economy consists of a renaissance and reconceptualization of 1960s and 1970s ideas of industrial ecology/metabolism and system optimization. The concept has been largely driven by the business and practitioner community (e.g., the Ellen MacArthur Foundation), which values its potential to generate cost reductions and improvements at the process/products level, opportunities for sector renewal (e.g., new business models, intersectoral collaboration), as well as environmental gains. Policy-making has also been a force in further establishing the circular economy, with key cases being the passing of the 2008 Circular Economy Promotion Law of the People's Republic of China (issued August 29, 2008 by Standing Committee of the National People's Congress) and the EU circular economy action plans ([European Commission, 2020a, 2015](#)). Today, the circular economy is at the heart of the European Green Deal to create a more sustainable Europe, including its ambitious target to achieve climate neutrality in the continent by 2050 ([European Commission, 2020a, 2019](#)).

The circular economy aims at “slowing, closing, and narrowing material and energy loops” ([Geissdoerfer et al., 2017](#)) to keep “products, components, and materials at their highest utility and value at all times” ([Ellen MacArthur Foundation, 2015](#)). This is achieved by a set of measures, such as designing and manufacturing products to last, using renewable energy sources, improving efficiency of products/processes, cascading energy flows, reusing and remanufacturing products and recycling

(Kirchherr et al., 2017; Korhonen et al., 2018; OECD, 2019; Reike et al., 2018). Such measures are listed in order of priority and in the R framework, which represents one of the key heuristics for the circular economy. Despite its broad academic conceptualization, however, the practical implementation of the circular economy is often limited to a narrow approach of efficiency improvements, material recovery and waste management (Barreiro-Gen and Lozano, 2020; Calisto Friant et al., 2021; Ghisellini and Ulgiati, 2020; Kirchherr et al., 2017). Hence, the world was only 8.6% circular in 2021 and declining, according to the Circularity Gap Report (Circle Economy, 2021, 2023). Nevertheless, there are some practical examples in the past, in which circularity related changes have been instigated, e.g. recycling rate increase due to regulatory demands (EuRIC, 2020), collection rate increase due to deposit schemes (Linderhof et al., 2019) and second-hand textiles reuse due to social structures of younger generations (Gazzola et al., 2020). The first one can be considered to represent a deep leverage point, the two latter one shallow ones.

The circular economy encompasses several sectors, but packaging represents a strategic industry because of its recent growth and because it serves and connects to several if not all other industries (e.g., food, clothing, pharmaceutical). The volume of global plastic production has nearly doubled in the last two decades, growing from 200 million tonnes in 2002 to 368 million tonnes in 2019 (PlasticsEurope, 2020, 2021), subsequently also leading to a significant increase in plastic waste. Within the EU, the targets for recycling plastic packaging have been tightened (in the amending Directive (EU) 2018/852 of the packaging and packaging waste), and plastics are also identified as a priority in the European Commission's Circular Economy Action Plan (European Commission, 2020a). However, especially in packaging applications, plastics have an important function as they extend the life cycle of the packaged good (and a strong substitute is not yet available). The challenges of plastics relate foremost to the end of the life of plastic packaging, due to the large quantities of single-use items (Chen et al., 2021). Directive (EU) 2019/904 on single-use plastic products lays down different kinds of instruments including product bans, awareness raising and labelling requirements. From an environmental point of view, it is preferable to reduce the production of virgin plastics and to promote the re-use of plastics (European Commission, 2013; Ragaert et al., 2017), thus, a system is needed to keep the material value as high as possible and avoid reducing the material's quality and functionality.

3. Materials and methods

3.1. Review of the literature

For the purposes of the literature review (Fig. 1), the following searches were conducted in the Web of Science database: “leverage point and sustainability”, “leverage point and systems thinking”, “leverage point and circular economy” and “leverage point and sustainable production and consumption”, resulting in 327 articles. The search was carried out in March 2022. To narrow down the number of relevant articles, the following criteria were used in the screening phase. First, only the articles within the timeframe of 2018–2022 were selected for review, as almost all the papers with leverage points and sustainability were published in 2018 or afterwards. Second, duplicates were removed, and third, articles that did not concern sustainability-related topics were excluded. Fourth, the remaining articles were screened to include only those papers in which Meadows (1999) or Abson et al. (2017) leverage points terminology. To complement the search, we added to the sample eight articles we deemed particularly relevant, including Abson et al. (2017) and Meadows (1999) (due to their impact on the scientific discussion in this field) and six articles as from the special issue Leventon et al. (2021) (see the Fig. 1).

The scale in the articles varied from regional projects (van Rooyen et al., 2020) to review articles on food and energy systems (Dorninger et al., 2020) and marine and coastal pollution (Riechers et al., 2021a). The topics in the articles varied from environmental education (Raatikainen et al., 2020), indigenous knowledge in environmental management (Burgos-Ayala et al., 2020), gender equality (Manlosa et al., 2019), biodiversity conservation (Davila et al., 2021) and climate change (Rosengren et al., 2020) to socio-ecological fluvial dynamics (Graziano et al., 2021) and local wool production (Tourangeau and Sherren, 2020), to name a few. Many of the reviewed papers were published in 2021, due to two special issues being published that year (Leventon et al., 2021; Riechers et al., 2021b).

Qualitative content analysis (see e.g., Maxwell, 1992) was conducted on selected papers with the help of NVivo qualitative research software. First, the leverage points identified in the papers were coded according to the four system characteristics leverage points: parameters, feedback, design and intent (Abson et al., 2017). After this, the second round of coding included the thematization of the coded leverage points under each of the system characteristics by focusing on their ability to bring about change. This was done by looking at the similar characteristics of the leverage points if they aimed at introducing something new, shutting

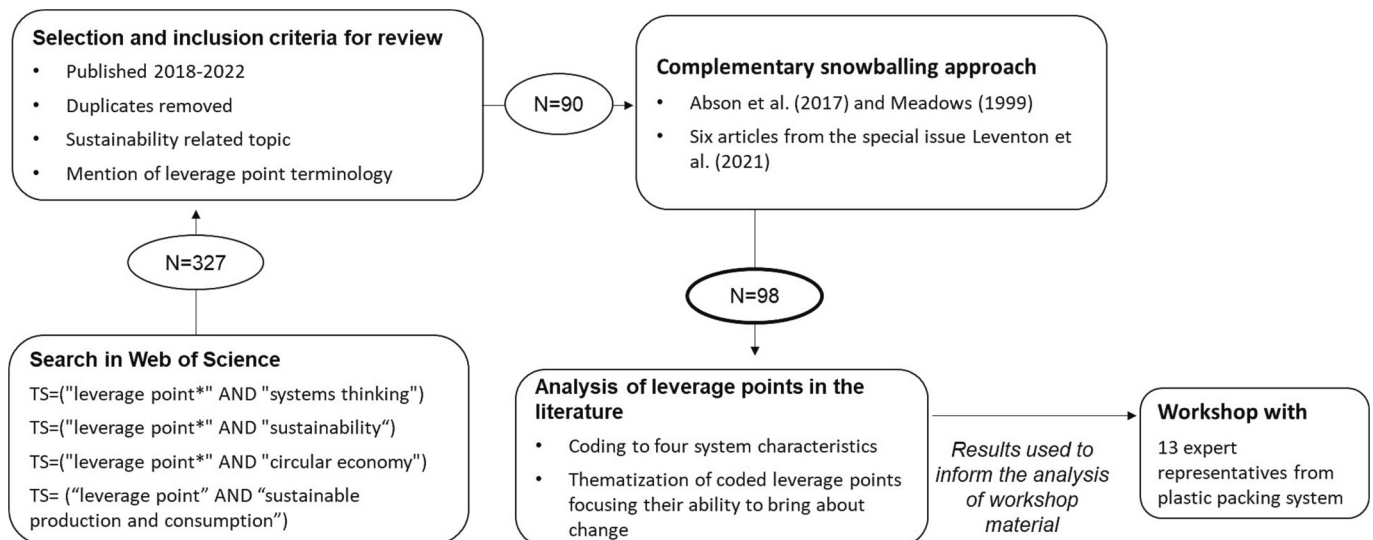


Fig. 1. Selection process of the papers for the review.

down something old or adjusting existing activities, for example. The thematization based on reviewed papers was used in the analysis of the workshop material. The review search had the limitation that we only focused on peer-reviewed articles from Web of Science. An analysis of other databases (Scopus database, Google Scholar) and inclusion of grey literature could show different results. Furthermore, by using the systematic review protocol the depth of the review process would have improved.

3.2. Stakeholder workshop on plastic packaging system

To enable a more concrete and pragmatic approach to assessing leverage points, a case study approach was selected. The case study regarding the circular economy development within the plastic packaging sector was carried out via a workshop. Relevant experts and other stakeholders were invited to identify the most important past interventions and possible future ones that have led or will lead to system-level changes. The aim of the workshop was to detect as many existing and potential future interventions for the circular economy shift of the packaging sector as possible. Overall, 44 people were invited to the workshop, 15 people registered for the workshop, and 13 participated in it. The workshop was organized onsite in Helsinki, Finland in September 2022. This may have reduced the number of participants due to time or travel constraints, but it enabled trust and more varied, joint discussions than an online format. Before the workshop, participants were asked on the registration form to identify changes within the plastic packaging sector. This preliminary data was used in the workshop as a starting point of the work. The workshop built on these notions and discussed them further. The workshop participants represented producers of plastic packaging products or services, bioplastics producers, recyclers of packaging waste, extended producer responsibility organizations, developers of new packaging materials, the Ministry of Environment of Finland as well as national research organizations (see Table 1 for details on participants' background and fields of specialization). The participants were divided into three groups in the workshop and all groups had one facilitator. The groups were compiled to capture different expertise and approaches to packaging systems in each group. The workshop groups worked together for 70 min and then the main results of each group were discussed jointly with the rest of the groups. The workshop was recorded and transcribed.

During the workshop, the participants were asked to write down ideas related to two questions and position the answers throughout different package lifecycle stages. In the first round, the participants were asked the open question "What changes have promoted the circular economy in the Finnish plastic packaging system?" The participants had five minutes of quiet time to think and write down changes on sticky notes. The ideas were then discussed in the group and allocated to the different lifecycle stages of plastic packaging. The lifecycle stages were virgin raw materials, material production, design and production, distribution, use, disposal, recycling and removal. The workshop participants could also signal if the note applied to two or more of the stages. During the discussion, the participants were asked to think about

Table 1
Backgrounds of the participants.

Organizational background	Specialization field	Number of participants
Industry association	Plastic packages	1
Government	Plastic policy	1
Research institute	Environment	3
Extended producer responsibility organization	Waste	1
Company representative (large)	Polymers, packaging procurement	2
Company representative (SME)	Reuse solutions, biobased plastics	5

reasons that they thought had led to the changes. Finally, every participant was asked to prioritize the changes they considered the most relevant. In the second round, the participants responded to the question "What changes in the Finnish plastic packaging system need to take place to achieve a circular economy?" Again, the participants had five minutes to write down their thoughts, followed by a group discussion and a prioritization of their ideas. After both rounds, the facilitator asked if there was something missing from the sticky notes. The facilitators picked one or two prioritized issues from both rounds and classified them according to the four types of system leverage points. The participants were not asked to classify their ideas according to leverage points nor to distinguish between deep and shallower leverage points. This kind of analysis was carried out later by the facilitators and the project researchers. Workshop results were analyzed with the frame developed in the literature review.

4. Results

4.1. Overview of the literature on leverage points and sustainability

Abson et al. (2017) have identified four system characteristics of leverage points: system parameters, feedbacks, design and intent. From a total of 98 reviewed articles, parameter-level leverage points were identified in 42 articles. Feedbacks were reported in 37 articles, whereas design and intent-level leverage points were dominant, the former were reported in 61 and the latter in 67 articles. Yet, most of the leverage points identified in the literature were classified in the articles as potential ones, while only a minority of the papers (e.g., Manlosa et al., 2019) showed evidence of the changes that had taken place. In other words, current literature on leverage points focuses on potential deep leverage points.

Based on a qualitative content analysis of the reviewed papers, we developed a thematization of each of the four system characteristics through the way they leverage change (see Fig. 2).

Leverage points on *parameters* level leverage change through a variety of ways, namely *decrease, increase, adjust, maintain, incentivize and obligate*. Very often parameter-level leverage points increase or improve something in the material structure of the system. Improving livestock farming yields or optimizing the use of forest resources, for example. Or they incentivize system change, through payments or environmental taxes, or obligate system activities through laws and regulations.

Considering leverage points addressing *feedbacks*, the change mechanisms operate through *time, innovations, redirect resource flows, knowledge flows and telecoupling*.¹ Improvement of energy efficiency or technological innovation may counteract the additional CO₂ emissions that result from economic growth (decoupling), for example. Most feedback loops have inherent delays that may lead to both unwanted and desired system fluctuations.

Leverage points in the system *design* introduce change through *collaborating, re-formatting, activating agencies, maintaining stability or introducing new order*. When looking at food systems, for example, the presence and maintenance of formal and informal institutions are both potentially useful to enhance food security, and possible leverage points may occur, in particular, where institutions interact (Jiren et al., 2021). Moreover, the ability of farmers to collaborate among themselves enhances the possibilities for sustainable food systems.

When considering the *intent* of the system, the change mechanisms resemble activities that change people's mindsets and understandings. These include *exploring boundaries, implementing justice, coping with crises, and introducing new meanings and understandings*. These change mechanisms might push the boundaries of what we have now and explore the

¹ Telecoupling refers to environmental and socioeconomic interactions between distant human and natural systems, like trade, migration or technology transfer (Hull and Liu, 2018).

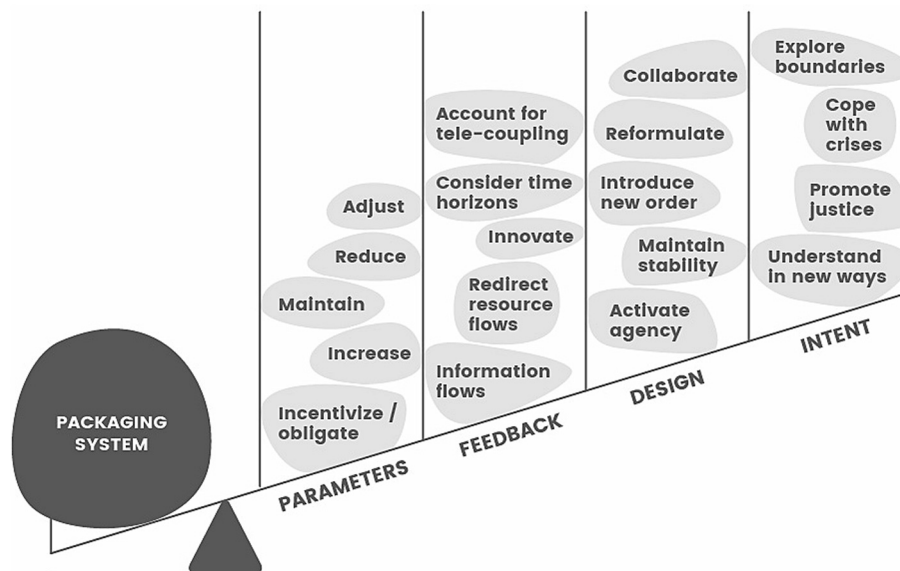


Fig. 2. Leverage points identified in the scientific literature on sustainability, system thinking and the circular economy.

edges of what might be possible. In addition, crises may lead to people mobilizing their agency to both navigate the effects of the crisis and to open up new opportunities, all of which then lead to deep individual transformations in people's values, sense-making and actions (Riechers et al., 2021c).

4.2. Findings from the workshop on the plastic packaging sector

The case study on the plastic packaging sector consisted of identifying various circular economy solutions within the sector that could be regarded as (a) already implemented or (b) potential interventions that strengthen a circular economy and therewith sustainability. These past and potential future interventions were mainly collected during the workshop, but they also included the findings of the pre-questionnaire. The results were subsequently categorized in line with the four system characteristics and themes identified in the literature review (Fig. 2). The case study confirms certain leverage points by taking a retrospective view of the previous system-level shifts in the plastic packaging sector. Moreover, it takes a forward-thinking view by identifying leverage points for further efforts towards a circular economy. In addition to providing valuable data on the leverage points concept, the case study also identifies relevant interventions that have promoted and are likely to promote a circular economy as well as how these chains of leverage may unfold in the plastic packaging sector (cf. Riechers et al., 2022).

4.2.1. Past changes and leverage points in the plastic packaging sector

In general, the workshop participants were easily able to identify past changes in the Finnish plastic packaging system that had led to considerable system-level impacts (Fig. 3). The identified changes related mainly to shallow leverage points, especially to parameter-level changes. Here, the points increasing or improving circular economy efforts were, e.g., the availability of clear recycling instructions, easy access to recycling points and improved sorting capabilities for various packaging waste flows. On the other hand, the use of black plastics as packaging material was seen to have hindered circularity efforts, as they are technically difficult to recycle and sort, and may, for example, include hazardous substances. As for issues that have incentivized or obligated a circular economy, the beverage package deposit refund system was seen as an efficient change in the past that had induced tangible and system-wide impacts.

The assessment of feedback-level leverage points highlighted various innovations at different levels of the value chains, such as designing

easily recyclable materials and products, products from recycled raw materials, or novel, more resource-efficient processing technologies. The other issues raised in the workshops mainly concerned external requirements or drivers, such as increased market demand for secondary materials and increased awareness of the negative effects of primary raw material availability and exploration.

Deep leverage points (design, intent) were less often identified by the workshop participants and were present at a more abstract level. The design-related leverage points were, e.g., larger policy packages such as the EU's Circular Economy Action Plans and the Finnish national plastics roadmap, the implementation of extended producer responsibility requirements, or the reformulation of business strategies at a company level. The intent-related leverage points mentioned by the participants comprised large and comprehensive issues, such as increases in consumer awareness and motivation and – subsequently – consumer demand, or educational programs and how the circular economy is implemented in them. Moreover, maintaining traditions related to the environment and a sufficiency-oriented way of life was considered to be something that had advanced the circular economy at large and had led to system-level impacts with regard to the plastic packaging sector.

4.2.2. Future changes and leverage points in the plastic packaging sector

The workshop participants were also asked to identify future interventions that would be needed to support the packing sector's transition to a circular economy (Fig. 4). Similarly, as in past changes, the identified potential interventions in the future related mainly to parameter-level changes (provision of clear sorting instructions, material identifiers, ensuring availability of good-quality and safe secondary raw materials and developing recyclability of various materials and products, and focusing on increasing and improving). Moreover, the incentivizing or obligating leverage points were frequently mentioned. These included tightening mandatory requirements for different life cycle stages (producing, collecting and recycling) as well as implementing taxes, fees or sanctions for barriers to a circular economy, such as using primary raw materials or designing non-recyclable products.

The leverage points related to feedbacks covered innovations at the material, product and process level, much like past changes in the plastic packaging sector. Certain resource flows were seen by the participants to deserve more attention, such as food contact materials and agricultural plastics. The participants also highlighted the widening of the deposit refund systems with regard to new material flows. On the other hand, information flows and the feedback permitted by the increased use of

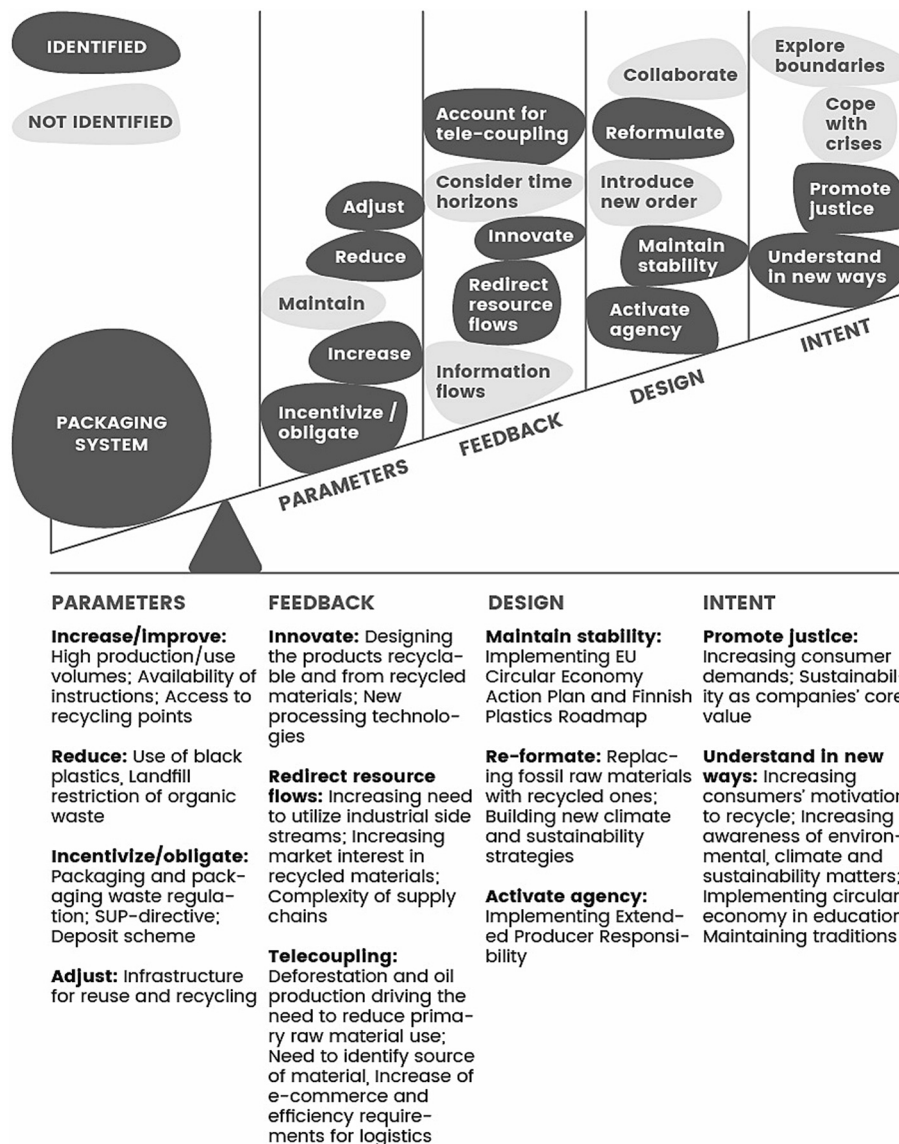


Fig. 3. Leverage points occurred in the Finnish plastic packaging system, identified in a workshop involving experts, researchers, policymakers and practitioners. The “stones” in lighter grey were not identified in the case study.

resource data were named as potential future leverage points. Few considerations of potential deep leverage points in the future emerged in the workshop discussions. The design-related issues mentioned by the participants included the development of new business models, ecosystems, or infrastructure, as well as novel, more comprehensive means for collaboration along the value chain and with different actors. More concrete measures were, e.g., developing solutions to increase reusability in the packaging sector by offering easier return logistics through local delivery companies. The participants were unable to identify new or unmentioned leverage points concerning intent – mentions were largely related to new ways of thinking, increasing education and changing attitudes in general within society.

5. Discussion

To aid the identification of leverage points in the Finnish plastic packaging system, and in particular to clarify how change occurs through identified leverage points, we refined the leverage points concept based on a literature review. We then applied this concept to the Finnish case and elicited data about changes in the plastic packaging system through a workshop with experts (Fig. 1). In assessing the results,

it should be kept in mind that the participants represented companies from different value-chain phases, industry associations and public actors. Hence, the proposed interventions may not be fully in line with each other or form a synergistic entity. The mechanisms of change identified in the workshop are not comprehensive, but this case study allowed an empirical assessment of the leverage points concept in a real-life context, confirming that multiple mechanisms of change have been in place in the Finnish plastic packaging sector. These ranged from rather concrete but shallow change mechanisms at the parameter level (such as incentivizing or obligating) to mechanisms at the design level (such as increasing collaboration or introducing new order) and at the feedback level, to more abstract ones at the system-intent level (exploring the boundaries and introducing new understandings).

These notions resemble O'Brien (2018) three spheres of transformation – practical, political and personal. Our study focuses on the change mechanism within these spheres – or levels of leverage. Our notions of how change takes place may help to understand and design future intervention within different spheres to mobilize their potential to further accelerate transformation. Similarities can also be found with the Framework for Strategic Sustainable Development (Broman and Robert, 2017), which describes five interdependent levels of analysis to

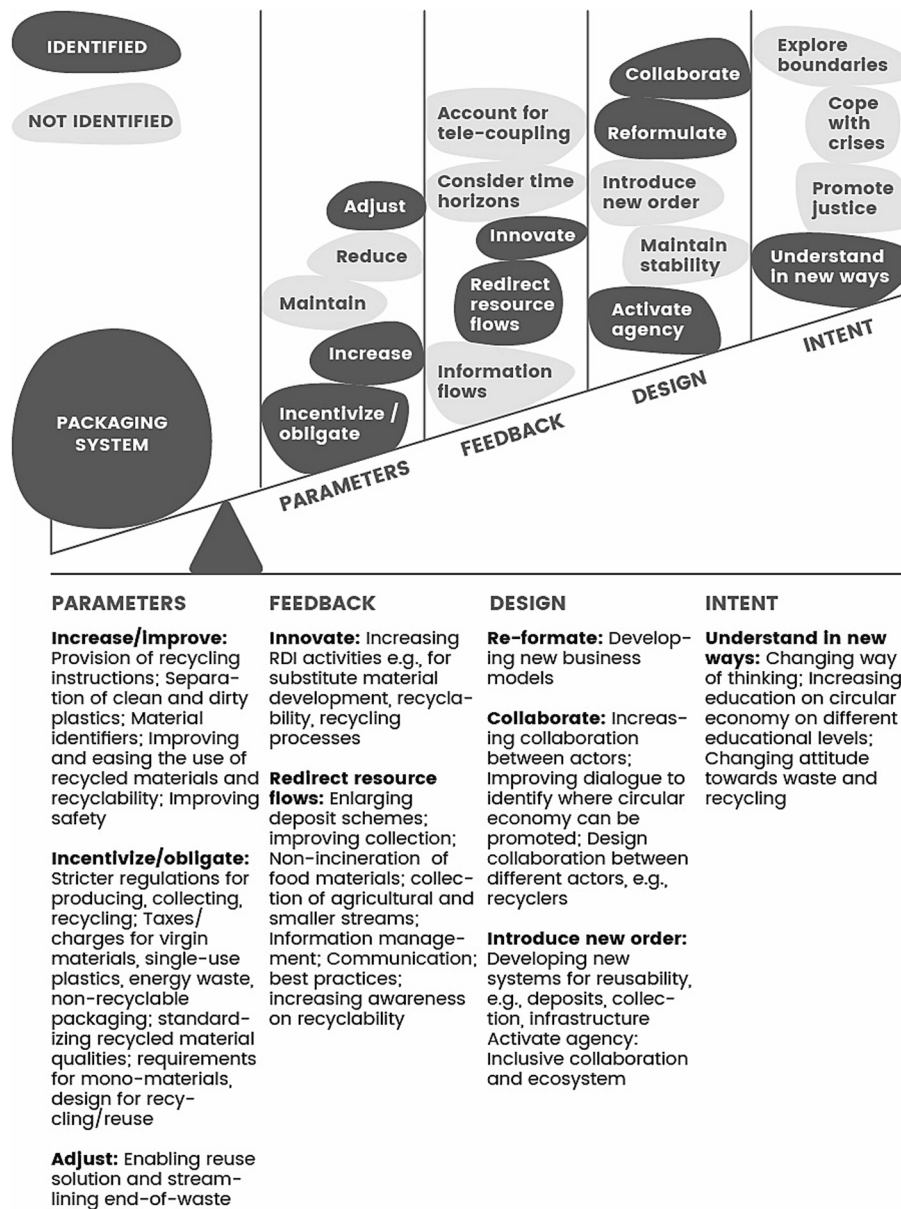


Fig. 4. Potential leverage points for the future of the Finnish plastic packaging system, identified in a workshop involving experts, researchers, policymakers and practitioners. The “stones” in lighter grey were not identified in the case study.

plan system change from the current status quo to a desired and more sustainable system, including change in the context of the circular economy (D’Amato and Korhonen, 2021). The five levels identified in the Framework for Strategic Sustainable Development range from more abstract levels related to the functioning and the goal of the system, to more concrete levels concerned with strategies, concrete actions and monitoring of progress. Considerations drawn from the papers by O’Brien (2018) and Broman and Robèrt (2017) strengthen the idea that to achieve system transformation, change needs to occur at various levels of a system. The leverage points concept helps us to identify the specific mechanisms for such changes at all levels.

At least in theory, the circular economy can serve multiple values and worldviews, or in other words, system intents or goals (e.g., profitability vs sustainability; growth vs de/postgrowth) (Ghisellini et al., 2016; Giampietro, 2019). For example, Korhonen et al. (2020) study on the Finnish plastic packaging sector has shown how the circular economy means different things to different actors, from a repackaging of old ideas to a vision of a sustainable future. Although this is a valuable

feature in providing a discussion platform and is a lingua franca for diverse societal actors, if the system goal is unclear or too narrow, the potential for sustainability transformations is diminished. Some scholars have recently attempted to expand the system intent of the circular economy by means of more radical conceptualizations beyond technological circularity, drawing from notions such as the sharing economy (shared-ownership, product multifunctionality), the performance-based economy and servitization (providing outcomes and services rather than mere goods), and sufficiency (mindful consumption, focusing on well-being and fundamental needs rather than wants, improving individual and organizational self-sufficiency) (Calisto Friant et al., 2020; Merli et al., 2018). Some of these transformational ideas (e.g., sufficiency, new ways of thinking, changing attitudes and citizens’ awareness) were, albeit tentatively or marginally, also raised in our workshop.

Admittedly, examples of how these radical concepts could be realized in the plastic packaging sector in terms of the design of social structures and institutions may be difficult to envision at first. In the workshop, changes that occurred in the Finnish plastic packaging sector

were mentioned, such as those related to extended producer responsibility requirements and to the reformulation of business strategies at the company level. Moreover, developing new systems for reusability in the packaging sector was also suggested among the future changes at the design level. For comparison, other highly creative examples emerging from the circular economy grey literature include eliminating excess packing material and weight, intelligent packaging that extends the shelf-life of products (sufficiency), industry-wide shared packaging, and design that promotes the reuse of packaging beyond its intended original use (which could even outlive the product delivered with the packaging). The need for new business models, collaborative ecosystems and infrastructure were also voiced in the workshops, representing additional future-oriented changes at the design level.

The feedback-level leverage points highlighted in the workshop focused on the interactions between local/national industries and sectors, such as market demand for secondary materials that have been recovered. Feedback related to a broader system on a global scale were mentioned as drivers for the circular economy (e.g., increased awareness of resource exploitation caused by sourcing for primary raw material). In the circular economy literature, a number of additional issues related to feedbacks, which were not recorded in our workshop, have been highlighted by several authors who have considered both the environmental and social dimension. Environmental gains achieved through circular solutions may be countered by phenomena called rebound and leakage effects, where the saved resources are simply reallocated to other sectors or geographic areas because of changed individual behaviour (e.g., cheaper prices inducing increased consumption) or strategic decision-making at the administrative level. In order to truly foster sustainability, the circular economy should thus result in net environmental gains rather than relative gains (Hart and Pomponi, 2021; Korhonen et al., 2018). However, empirical studies currently show little evidence of the absolute decoupling of economic growth from environmental degradation (Giampietro and Funtowicz, 2020; Ward et al., 2016). Social issues, which remain generally poorly addressed in discussions about the circular economy, include, among other things, feedback dynamics such as inequalities in rural-urban and global North-South relations concerning material sourcing, value chains and waste disposal.

Even though the workshop participants were also encouraged to think about radical changes, in the workshop, parameter-level leverage points dominated, such as further facilitating recycling, packaging deposit schemes, incentives and tightening regulatory processes. Our case study, like other empirical studies on the circular economy, suggested that policies and practice mainly emphasize those circular economy strategies, such as recovery and recycling, that have a limited effect on circularity (Morseletto, 2020). In order to foster system transformations, the focus should also be on powerful circularity strategies, like rethinking and reducing, which showcase deeper leverage points. Nonetheless, the findings cannot be interpreted as such that the participants did not understand or value the impact of deep leverage points; rather they reflect the practical orientation of the participants as they see the value chain and how it operates on a day-to-day basis. For practitioners, it is often easier to identify pragmatic past changes and future needs (cf. Termeer and Metzke, 2019), rather than thinking in more abstract terms. This also allows them to detect practical pain points in the system that hinder certain larger changes from occurring. Leverage-points literature also recognizes that acting on deep leverage points is difficult in practice, even though the benefits could be substantial (Abson et al., 2017; Ehrlich and Kennedy, 2005). Focusing exclusively on the deeper and more abstract leverage points may not generate sufficient information to implement concrete actions as such, but could instead perhaps be viewed as the inspirational visions and goals of the more concrete actions (Leventon et al., 2021).

This study applied a transdisciplinary methodology where practitioners were involved in the research process (see e.g. Morton et al., 2015 and Seidl et al., 2013 for transdisciplinary). The transdisciplinary part of the study focused on very specific questions in a field in which the

participants were experts. We noticed the attractiveness of the leverage-point approach for the practitioners as it is relatively easy to understand, and it provided a fresh framing to issues that the participants were familiar with and where they were able to attach their own experiences. In sustainability science is an ongoing debate whether transdisciplinary research is able to produce transformative outcomes together with actionable knowledge and the results so far show little evidence for such a transformation (e.g., Jagannathan et al., 2020). One can argue whether transdisciplinary research with a transformative goal is even needed if the practitioners and solutions are very much tied to the specific field and are unable to go beyond the system boundaries. For practitioners, it is easier to think within existing structures and systems than to come up with disruptive amendments. However, practitioners are well aware of the common day-to-day and practical barriers in their sector and their perspectives on the future are therefore often extensions of previous system-level changes or at least they follow the same basic assumptions along a certain path-dependency. Consequently, for practitioners, identifying deep or shallow leverage points that have not been previously tapped in and activated can be quite complicated.

Apart from the complexity of identifying deep leverage points, in the workshop an important issue emerged to be the actors who may have the agency to implement or interact with leverage points especially related to system design. Agency is currently largely technology-mediated in the current understanding of the circular economy (Hobson and Lynch, 2016). In order for a circular economy to foster sustainability transformations, inclusive and active participation of a broad range of societal actors is needed, such as consumers and citizens, large companies and small and medium enterprises, regulators and other governing actors (Calisto Friant et al., 2020). An important aspect is also the synergic intersection between the circular and bioeconomy, where the latter is expected to bring about important future developments in the packaging sector by means of innovative bio-based plastic replacements for fossil-based plastic (Korhonen et al., 2020). This will require the participation of farmers, foresters and landowners, as well as the forest and agri-food industry. An important remaining gap is the lack of cooperation with the actors related to the development, manufacturing and retailing of packaged products (i.e., the food industry, the chemical industry) where products ultimately determine the functional value of the plastic packaging and whether its use can be reduced and re-thought.

6. Conclusions

This study refined the leverage points concept by developing a thematization of the four system characteristics through the way they leverage change and applied it to the case of plastic packaging systems in order to explain the mechanisms for transformative change in this context. Our practical case focused on the Finnish packaging sector – mainly plastic packaging – within the larger scope of packaged goods or circular economy activities at large. The considerations generated in this study can be extrapolated to inform future research and practice in the context of sustainability science and the circular economy. Based on our findings, we can conclude that ideas about the circular economy as such represent leverage points towards transformation at all levels of the plastic packaging systems. In practical level, this might be an inspiration for practitioners to understand wider systemic change. However, still we found that it is easier for practitioners to think within existing structures and solution-types; thus, shallow leverage points were more often identified compared to abstract deeper ones. Nevertheless, links between shallow and deep leverage points exist and they should consequently be analyzed. We believe that the mechanisms of change defined in this study for each level of leverage will help to conceptualize the way change is expected to happen – and can be used in future studies on leverage points in other contexts and systems. The future lines of research should attempt to assess empirically interactions between shallow and deep systemic changes including “chains of leverage”, i.e., how shallow, mid-level and deep systemic changes interact with one

another. An important avenue forward to uncover these interactions is the framing of transdisciplinary research to encourage out of the box, creative thinking that challenges both stakeholders' and scientists' worldviews to go beyond business as usual.

Informed consent

The participants in this study, those who took part in the workshop, provided their consent to utilize the results for scientific research when they signed up for the workshop. The research's purpose was clearly outlined in the invitation. All participants were informed that their involvement was voluntary, and they had the option to decline participation in this project. All workshop data was anonymized, with no inclusion of personal information. Handling of any personal information adhered to GDPR regulations. The study was conducted in accordance with the ethical principles published by the Finnish Ethical Research Committee.

Author contribution

All authors contributed to the study conception and design. Material preparation, data collection and analysis were performed by Kaisa Korhonen-Kurki, Susanna Horn, Hanna Entsaló, Topi Turunen and Juuli Närhi. The first draft of the manuscript was written by all authors and all authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

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Kaisa Korhonen-Kurki: Conceptualization, Formal analysis, Funding acquisition, Investigation, Methodology, Project administration, Resources, Supervision, Writing – original draft, Writing – review & editing. **Susanna Horn:** Conceptualization, Data curation, Investigation, Methodology, Supervision, Validation, Writing – original draft, Writing – review & editing. **Hanna Entsaló:** Conceptualization, Data curation, Formal analysis, Investigation, Validation, Visualization, Writing – original draft, Writing – review & editing. **Topi Turunen:** Conceptualization, Formal analysis, Investigation, Methodology, Supervision, Validation, Writing – original draft, Writing – review & editing. **Dalia D'Amato:** Methodology, Supervision, Validation, Writing – original draft, Writing – review & editing. **Maraja Riechers:** Methodology, Supervision, Validation, Writing – original draft, Writing – review & editing. **Juuli Närhi:** Investigation, Project administration, Visualization, Writing – original draft, Writing – review & editing.

Declaration of competing interest

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Data availability

Data will be made available on request.

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