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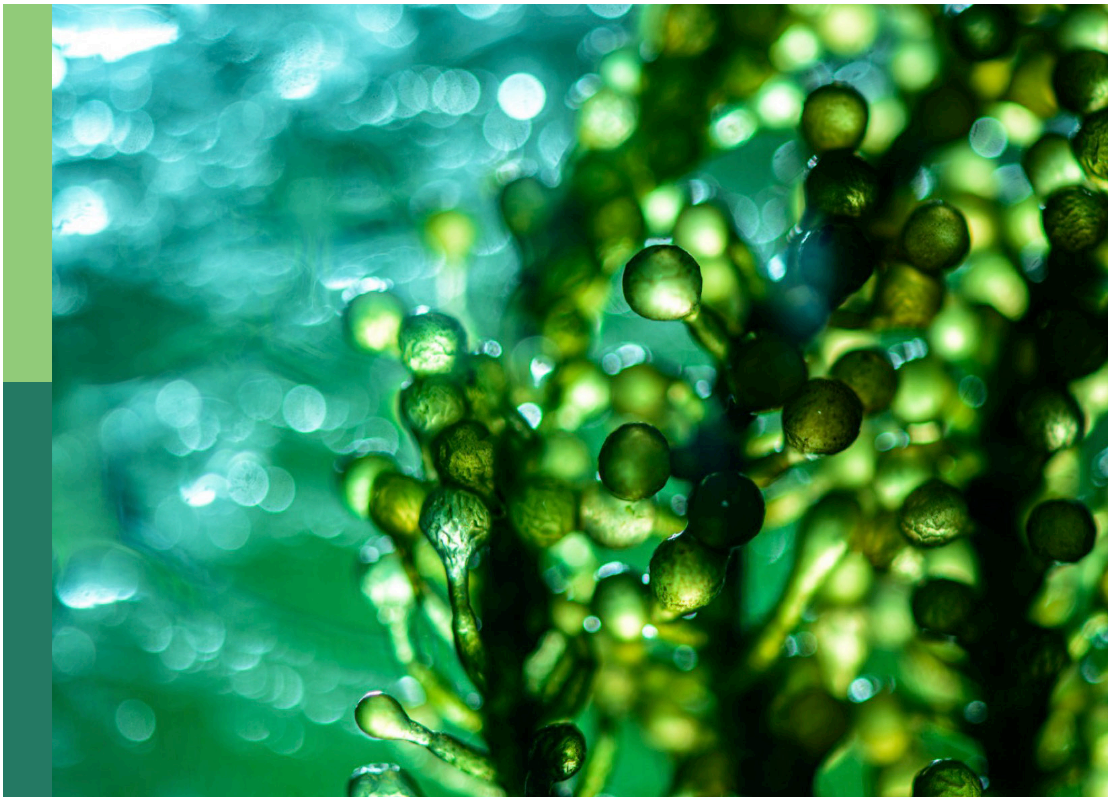
Global excellence in sustainability: Europe

Edited by
Maria Alzira Pimenta Dinis, Elisabeth Süßbauer
and Nikos Kalogeras

Published in
Frontiers in Sustainability



ISSN 1664-8714
ISBN 978-2-8325-7507-9
DOI 10.3389/978-2-8325-7507-9

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Global excellence in sustainability: Europe

Topic editors
Maria Alzira Pimenta Dinis — University Fernando Pessoa, UFP, Portugal
Elisabeth Süßbauer — Institute for Ecological Economy Research (IÖW), Germany
Nikos Kalogeras — Zuyd University, Netherlands

Citation
Dinis, M. A. P., Süßbauer, E., Kalogeras, N., eds. (2026). *Global excellence in sustainability: Europe*. Lausanne: Frontiers Media SA.
doi: 10.3389/978-2-8325-7507-9

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frontiers | Frontiers in Sustainability

TYPE Editorial
PUBLISHED 29 January 2026
DOI 10.3389/frsus.2026.1784792

OPEN ACCESS

EDITED AND REVIEWED BY
Sylvia Lorek,
Sustainable Europe Reserch Institute, Germany

*CORRESPONDENCE
Maria Alzira Pimenta Dinis
madinis@ufp.edu.pt

RECEIVED 10 January 2026
REVISED 15 January 2026
ACCEPTED 15 January 2026
PUBLISHED 29 January 2026

CITATION
Dinis MAP, Süßbauer E and Kalogeras N (2026) Editorial: Global excellence in sustainability: Europe. *Front. Sustain.* 7:1784792.
doi: 10.3389/frsus.2026.1784792

Editorial: Global excellence in sustainability: Europe

Maria Alzira Pimenta Dinis[1,2]*, Elisabeth Süßbauer[3] and Nikos Kalogeras[4,5]

[1]Fernando Pessoa Research, Innovation and Development Institute (FP-I3ID), University Fernando Pessoa (UFP), Porto, Portugal, [2]Marine and Environmental Sciences Centre (MARE), University of Coimbra, Edifício do Patronato, Rua da Matemática, Coimbra, Portugal, [3]Institute for Ecological Economy Research (IÖW), Berlin, Germany, [4]Zuyd University, Heerlen, Netherlands, [5]Commodity Risk Management Expertise Center, Wageningen University & Research, Wageningen, Netherlands

KEYWORDS

Europe, global advancement, global excellence, resilience, social justice, sustainability, sustainable consumption, sustainable supply chain management

Editorial on the Research Topic
Global excellence in sustainability: Europe

It is increasingly evident that sustainability challenges cannot be addressed in isolation. Global crises such as climate change (Leal Filho et al., 2023a; Pfenning-Butterworth et al., 2024), biodiversity loss, resource depletion, and social inequality demand collaborative efforts that transcend borders and disciplines (Leal Filho et al., 2024). Scientific progress in sustainability depends not only on technological innovation, but also on cultural, social, and political perspectives that can guide transitions toward more just and resilient societies (Fisher et al., 2022). In recent years, research in Europe has provided valuable insights into these transitions, reflecting both ambitious policy frameworks and grassroots initiatives that seek to accelerate the move toward climate resilience and the energy transition (Ribeiro et al., 2025). Yet sustainability is a global endeavor, and comparative perspectives from other regions are indispensable to ensure that knowledge is transferable, adaptable, and inclusive.

Several themes have emerged as particularly urgent. Transformations in consumption and production patterns continue to expose the unsustainability of prevailing models, highlighting the need for systemic change (Leal Filho et al., 2022; Kazantsev et al., 2025). Circular economy approaches are increasingly recognized as innovative pathways to reduce waste, enhance resource efficiency, and decouple growth from environmental degradation (Ribeiro et al., 2025). In parallel, climate change adaptation and resilience strategies are advancing, requiring the integration of technological solutions with governance structures and community-based approaches (Leal Filho et al., 2025, 2023b; Qudrat-Ullah, 2025).

Social equity has become central to sustainability debates, underlining the importance of aligning environmental goals with social justice and inclusivity (Törnblom et al., 2024; Effiong, 2025). Efforts to address inequalities, whether in access to resources, exposure to environmental risks, or participation in decision-making, are essential to ensure that sustainability transitions are fair and broadly supported (Ribeiro et al., 2025; López Cifuentes et al., 2026). Finally, the reduction of dependence on non-renewable resources, the development of sustainable alternative materials, and the safe management of waste remain critical components of sustainable development agendas worldwide (Dinis et al., 2023, 2022; Leone et al., 2025).

Considered together, these perspectives underscore the need of a holistic and interdisciplinary approach. Combining insights from the natural sciences, social sciences, and the humanities, and by fostering cooperation across regional and national boundaries, sustainability research can generate the transformative knowledge required to meet today's pressing environmental and societal challenges.

This Editorial introduces the Research Topic "*Global Excellence in Sustainability: Europe*," which brings together empirical, conceptual and review contributions examining sustainability transitions across diverse European contexts, while also engaging with global and comparative perspectives. The collection addresses key dimensions of sustainability, including governance, social justice, circular economy practices, technological innovation and everyday consumption behaviors. The articles included in this Research Topic reflect a diversity of methodological approaches and disciplinary perspectives, and collectively aim to advance understanding of how sustainability challenges can be addressed in context-sensitive and inclusive ways.

Against this background, the contributions gathered in this Research Topic explore how these challenges are being addressed across different sectors, scales and socio-cultural contexts.

Siirilä and Salonen argue that humanity now faces a polycrisis, i.e., a set of interconnected social and ecological crises whose combined impact is greater than each on its own, and that a holistic, collective transformation is urgently needed to address it. The authors propose a new social contract, "Society's Commitment to Sustainable Development," which unites civil society, the private sector, the public sector and decision-makers around the 2030 Agenda for Sustainable Development to foster collaborative action at local, regional and global scales. They contend that each societal actor has distinct roles, from governance and innovation to advocacy and coordination, and that widespread commitment across sectors can drive substantive progress toward sustainability. The perspective highlights the necessity of inclusive engagement, systemic change and shared responsibility to navigate complex crises and build a sustainable future, emphasizing that humans not only cause but also have the power to transform these challenges.

Matti et al. present a novel methodological approach that integrates strategic foresight with sustainability transitions frameworks to explore how different forms of agency shape transition pathways for a sustainable EU 2050. Strategic foresight is a structured and systematic approach of exploring plausible futures to anticipate and better prepare for change. The findings reveal that successful transitions require balancing the agency of established institutional actors with emerging stakeholders who may lack formal authority but bring crucial perspectives and capabilities. The study emphasizes the importance of agency of multiple actors in sustainability transitions, highlighting their capacity to act and collaborate in shaping a sustainable future. This study stresses the need for a strong government leadership, multilevel coordination, the roll-out of systemic policy mixes and a new social contract underpinned by democratic governance.

Vasconcelos et al. use a systems thinking approach with causal loop diagrams (CLDs) to explore how employee perceptions, attitudes, and behaviors toward organizational sustainability initiatives evolve over time. By integrating neo-institutional, sensemaking, and attribution theories with 46 prior studies and 50 qualitative data points, they identify two reinforcing feedback loops that either support or hinder engagement, and a balancing loop where increased knowledge and scrutiny can lead employees to become more critical. Initial symbolic sustainability efforts can foster early engagement, but this momentum may shift into a "vulnerability period" of frustration if perceived impacts fall short of expectations, following a "Fixes that Fail" pattern. The analysis challenges the simple positive/negative view of sustainability actions and suggests that sustaining long-term employee engagement requires consistent, impactful actions that "walk the talk."

Colley et al. argue for a person-centered perspective on circular behaviors to advance circular economy transitions. The authors contend that while technical innovations and business models have dominated circular economy research, everyday behaviors of individuals and households, such as reducing consumption, extending product lifespans, repair and reuse, are central to achieving systemic change. They suggest that conceptualizing people merely as consumers obscures their broader roles and that behavioral research needs deeper theoretical development beyond traditional models like the Theory of Planned Behavior. The article outlines a future research agenda advocating systems-oriented approaches, refined typologies of circular behaviors, and interdisciplinary integration of behavioral theories to better understand the psychological, social and contextual drivers of behavior. This agenda aims to enhance policy and intervention design that supports meaningful shifts toward circular consumption and resource use.

Pencheva et al. investigate how United Kingdom (UK) citizens engage with household repair and maintenance of electrical and electronic equipment (EEE) as a key activity within the circular economy. Using a citizen science approach, the study collected nearly 6,000 survey responses and 473 detailed repair logs to explore attitudes, behaviors and barriers to repair, revealing a significant gap between consumer expectations of product lifespan and current legislation, alongside challenges related to cost, accessibility of repair services, and the availability of repair information and spare parts. The authors highlight the importance of supporting local repair economies, improving legislation such as statutory warranty periods and Right to Repair laws, and enhancing transparency around diagnostics and parts access. By fostering a stronger culture of repair, the work aims to inform policy and industry action to reduce electronic waste and advance sustainable consumption practices in the UK.

Dionizi et al. investigate how prepared Albanian consumers are to adopt circular economy practices, a key pillar of sustainable consumption in emerging economies. Drawing on a cross-sectional survey and structural equation modeling (SEM) in North Albania, the authors find that employment status, income and education significantly predict knowledge and engagement with circular practices, such as sufficiency-driven consumption and donation of goods, whereas motivational influences and

 10.3389/frsus.2026.1784792

preferences have less predictive power. Their SEM results highlight that consumer knowledge and concrete behaviors are stronger determinants of readiness than abstract influences or preferences, underscoring persistent intention–behavior gaps in contexts with structural barriers like limited infrastructure and awareness. The study suggests that policy and business strategies in emerging economies should prioritize education and enabling environments to strengthen consumer readiness for circular economy adoption.

Eg et al. identify distinct consumer segments in Norwegian workplace canteens based on food choice motives and sustainability orientations. Using a mixed-methods approach with surveys and qualitative analyses, they classify three segments: one primarily driven by personal benefits, a second by a mix of personal benefits and animal welfare, and a third strongly motivated by sustainability concerns. The results reveal significant variations in how different groups prioritize food preferences, sustainable options and potential plant-based offerings, with implications for how canteens might tailor interventions to effectively promote sustainable consumption. The authors suggest that versatile strategies addressing diverse preferences could make canteens effective platforms for testing and encouraging sustainability interventions that might extend to households and wider society. This segmentation approach highlights the complex interplay between personal motives and green intentions in driving food-related sustainability transitions.

Nifatova et al. provide empirical insights into consumers' motives for choosing organic food and the role of the packaging. Based on a survey of 497 consumers in Ukraine, they found that there is no clear distinction between internal and external consumer motives in the perception of organic food—the packaging's organic quality is considered part of the food's organic quality. However, organic packaging can be an indicator of external consumer motives, because it is less related to health care and more to altruistic motives. Consumers who are driven by external motives may expect the product to be organic at all stages of its life cycle and they are more likely to rely on the producer's commitment to environmental responsibility. Organic producers should consider this in their marketing strategies to meet consumer expectations and avoid the risk of greenwashing. These findings help in the search for ways to improve mutual understanding between consumers and producers regarding shared responsibility for the environment.

The review article by Toebast-Wensink et al. analyses 100 empirical articles on predictors of sustainable fashion purchasing among consumer samples with and without purchasing experience. The review reveals that, amongst others, that habits occur more frequently as significant predictors for experienced consumers compared to general consumers; and experience can shift barriers into motivators. The authors conclude that experience should be highlighted as a transformative factor for sustainable fashion purchasing. Through gaining experiences, consumers' attitudes evolve and influence their decisions. It also emphasizes the potential of goal framing, suggesting that effective goal frames can encourage initial sustainable fashion purchases among general consumers. These findings are indicative for marketers and retailers: to effectively engage each group and enhance purchasing, they should employ distinct tactics for first-time and experienced sustainable fashion consumers.

Santala et al. investigated the role of close social communities in implementing sustainable mobility behavior in Finnish households. Using a Climate Puzzle game, 12 households from Espoo, Finland, were engaged in discussions among household members about their daily mobility practices. The findings show that, within the framework of the existing infrastructure, people's close social community influences the way they relate to their surroundings. For example, grandparents were helped by giving them lifts and combining trips, young people were driven to leisure activities using carpooling, and so on. The authors conclude that design interventions toward sustainable mobility should target larger social communities rather than just individuals in order to achieve the 2.5 ton target. The study also indicates that socially tailored interventions and low-carbon solutions should be developed and targeted at city districts to help households create and maintain lifestyle changes.

Bitzenis et al. provide a systematic bibliometric analysis of how artificial intelligence (AI) and machine learning (ML) support production efficiency and sustainable development. Using the Scopus database and Bibliometrix R package, the authors map global research trends, key collaborations, and thematic advances in the application of AI and ML to optimize industrial processes, improve resource management, and reduce environmental impacts. They highlight the integration of AI with sustainable energy management, circular economy practices and precision agriculture as emerging fronts, and identify ethical considerations such as data privacy and labor-market implications as underexplored areas. The analysis reveals that research output is dominated by countries like China, the United States and the United Kingdom, whilst also emphasizing the need for deeper engagement with small and medium-sized enterprises (SMEs) and developing economies in future research. Overall, the review underlines the growing importance of AI/ML in advancing sustainable production.

The study by Karimzadeh examines the meanings and practices of ethical consumption in Iran. It is drawn on 19 in-depth qualitative interviews with urban residents in the midsized city of Urmia, Iran. Findings show that ethical consumption is conceptualized by consumers through human-centered values, such as care, responsibility, and generosity, rather than through environmentalism or formal regulation. For example, the avoidance of *heyf-o-meyl* (wastefulness and unnecessary consumption), practiced by participants, reflects values that are rooted in traditional and cultural teachings. These results contribute to the literature on sustainable consumption by highlighting culturally embedded, locally meaningful forms of ethical engagement that constitute a moral microeconomy.

The above-mentioned articles employ diverse methodological approaches to examine sustainability transitions across Europe while also drawing on global and comparative perspectives. Collectively, they advance knowledge on how governance frameworks, organizational dynamics, technological innovation and everyday practices shape pathways toward sustainability. Empirical studies from the United Kingdom, Finland, Norway, Albania and Ukraine demonstrate how circular economy practices, sustainable mobility, food choices and consumer behavior are embedded in specific socio-economic and cultural contexts. Complementary conceptual and global analyses further deepen understanding of systemic challenges and opportunities, particularly regarding institutional change, behavioral dynamics and digital innovation. Importantly, the inclusion of evidence from Iran broadens this collection by illustrating how ethical consumption is shaped by culturally embedded values beyond European contexts, strengthening the comparative dimension of the Research Topic. Overall, the contributions underscore the urgency of context-sensitive, participatory and interdisciplinary approaches to support just and resilient sustainability transitions within Europe and beyond.

Author contributions

MD: Conceptualization, Project administration, Supervision, Writing – original draft, Writing – review & editing. ES: Writing – original draft, Writing – review & editing. NK: Writing – original draft, Writing – review & editing.

Acknowledgments

MD acknowledges the support of the Foundation for Science and Technology within the framework of the UID/04292/MARE - Marine and Environmental Sciences Centre.

Conflict of interest

The author(s) declared that this work was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

The author MD declared that they were an editorial board member of Frontiers at the time of submission. This had no impact on the peer review process and the final decision.

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Publisher's note

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frontiers | Frontiers in Sustainability

TYPE Perspective
PUBLISHED 18 June 2024
DOI 10.3389/frsus.2024.1423912

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OPEN ACCESS

EDITED BY
Idiano D'Adamo,
Sapienza University of Rome, Italy

REVIEWED BY
Magnus Boström,
Örebro University, Sweden

*CORRESPONDENCE
Kathryn Colley
✉ Kathryn.Colley@hutton.ac.uk

RECEIVED 26 April 2024
ACCEPTED 06 June 2024
PUBLISHED 18 June 2024

CITATION
Colley K, Hague A, Chen J, Lorenzo-Arribas A, Wooldridge T, Somervail P, Martínez Sánchez G, Assefa S, Bender F and Craig T (2024) Putting people at the centre of the circle: an agenda for behavioural research on the circular economy.
Front. Sustain. 5:1423912.
doi: 10.3389/frsus.2024.1423912

Putting people at the centre of the circle: an agenda for behavioural research on the circular economy

Kathryn Colley[1*], Alice Hague[1], Jianyu Chen[1], Altea Lorenzo-Arribas[2], Tami Wooldridge[1], Phoebe Somervail[1], Graciela Martínez Sánchez[2], Samuel Assefa[3], Fiona Bender[1] and Tony Craig[1]

[1]Department of Social, Economic and Geographical Sciences, The James Hutton Institute, Aberdeen, United Kingdom, [2]Biomathematics and Statistics Scotland, The James Hutton Institute, Aberdeen, United Kingdom, [3]Department of Information and Computational Sciences, The James Hutton Institute, Aberdeen, United Kingdom

In a discourse characterised by technical innovation, alternative business models and material flows, the seemingly mundane, everyday forms of individual action toward circularity that can and are being taken by members of the public can sometimes feel overlooked. Whilst the importance of behaviour change is often acknowledged, in-depth conceptual engagement around circular behaviours remains uncommon in the field of circular economy research. In this perspective article we advocate for a person-centred perspective on circular behaviours, viewing people as not just consumers or users of circular products, but as individuals, nested within social groups, whose everyday, yet complex, relationships with material goods must undergo a shift if a circular economy is to be achieved. Drawing on insights from the wider field of pro-environmental behaviour research, we explore how we conceptualise circular behaviours themselves and how the behavioural theories we apply may constrain the ambition of the policy action our research supports. In doing so, we set out a person-centred agenda for research on circular behaviours, recommending: (1) greater application of systems-oriented approaches; (2) conceptual development on categorising circular behaviours, and (3) interdisciplinary efforts to integrate theory from across social science disciplines to underpin behavioural analyses and public engagement and action on the circular economy.

KEYWORDS

circular behaviours, behaviour change, circular society, pro-environmental behaviour, consumption, waste

1 Introduction

Circular economy (CE) principles have become a central feature of environmental policy development, from the international to local levels (Steenmans and Lesniewska, 2023). The appeal of the CE to policymakers lies not only in its potential to address the global environmental challenges of halting the degradation of the natural environment and supporting the transition to climate neutrality by reducing resource use, but also in the promise of significant economic and social benefits (Stahel, 2016).

Moving toward a CE necessitates a whole system shift, yet this need for systemic change has often been overlooked within the CE discourse, at the expense of a focus on less ambitious recycling objectives, incremental efficiency measures and technological innovation (Casson and Welch, 2021). To understand how a genuinely transformational approach to implementing CE can be supported it is necessary to go beyond consideration of business models and production processes within the CE. To comprehend how systemic change might be possible, we also need to consider how people feature: what does life in a CE look like? What does a CE demand of us, as individuals, as households, as communities? What kinds of behavioural changes are necessary for circularity to happen, and will those changes enrich our lives or otherwise?

Whilst behavioural change is often acknowledged as an important element of transition, little attention has been paid to the conceptualisation of behaviour in the CE literature. In this perspective article, we argue the need for conceptual development in relation to the behavioural dimensions of the CE and draw on insights from the behavioural sciences to propose a future research agenda on circular behaviours. Specifically, we frame circular behaviours as a subset of pro-environmental behaviours (PEBs), highlighting what we can learn from environmental and social psychology and arguing for a more person-centred approach to behavioural CE research.

2 Behaviour change and the CE: a person-centred approach

Thus far, CE research has tended to focus on industrial and technical production-side problems, yet everyday consumption and waste-related behaviour will undoubtedly play a pivotal role in the success or failure of policy aiming to accelerate the transition to the CE (Georgantzis Garcia et al., 2021). Behaviour within households sits at the heart of systems of production and consumption, influencing the upstream decisions (e.g., in product design) and downstream processes (e.g., in enabling reuse and recycling) within businesses and institutions. At the same time, and individuals can exert agency through reducing their own consumption and extending the use/life of products. In short, people are central to all loops in the CE. However, whilst behavioural change on the part of householders is often acknowledged as necessary, little attention has been paid to the conceptualisation of behaviour in the literature (Muranko et al., 2018).

Behavioural aspects of the CE tend to be represented through investigations of consumers as actors in the economic system. Gomes et al. (2022) emphasise the importance of psychology and behaviour in circular consumption systems, i.e., 'the systems in which consumers meet their needs through circular transactional processes: the acquisition, use and post-use of circular products and services' (p. 1). However, to develop understanding of circular behaviours and, importantly, how to promote behaviour change, we must go beyond conceptualising circular behaviours in transactional terms. Rather than considering behaviour purely within the context of the economic system, there is value in a perspective which considers behaviours pertaining to resource use as embedded within complex social-ecological systems (Ostrom, 2009). This necessitates greater consideration of the social, cultural and environmental contexts in which behaviour occurs, and recognition that behaviour is not only shaped by rational decision-making processes through which consumers seek to meet material needs but also by emotions, values, identities and automatic processes that may have little to do with consciously maximising utility. This understanding of circular behaviour is in line with an emerging narrative in the CE literature refocusing attention on the 'circular society', emphasising the role of actors across society in the transition to circular systems of resource use (Jaeger-Erben et al., 2021). In this paper we focus in on the role of private citizens or members of the general population in the circular society, although it should be recognised that private citizens also exert agency within their roles in organisations, within communities, or as public figures. Furthermore, whilst we frame questions around the agency of individuals in terms of 'behaviour', we also recognise that this is but one of many ways to centre the 'people' part of circular systems, with insights from across social science disciplines contributing to understanding of what we discuss as circular behaviour. This includes, for example, work on practises, habits and social action, and perspectives focusing more explicitly on group processes and place than behaviour at the individual level.

In moving from a transactional, economic, focus on behaviour in the CE, the default use of the term 'consumer' to denote a person acting as a private citizen becomes problematic. Hobson and Lynch (2016) critiqued the predominant conception of the individual as a passive consumer whose role is to accept or reject circular business models and the products and services they generate. Transitioning to a CE, it is argued, demands a much more fundamental shift in our everyday existence and relationship with the material world. Furthermore, the lines between consumption and production become blurred in the CE, with householders acting both as producer and consumer, in a process of 'prosumption' (Ritzer, 2014). This dual role can be seen in the creative repurposing of items or materials, and the repair, transformation and exchange of used goods.

Another role commonly assigned is as 'user' of products. Whilst 'consumer' centres the commodity, 'user' centres the product; both terms prove deficient when the focus is on describing a circular society, or socio-ecological system of resource use. Korsunova et al. (2021) describe a plurality of roles for those living in a circular society (including as repairer, maker, trader and benefactor), moving away from the narrower view of individuals as consumers/users. Some researchers have moved towards the term 'circular citizen' to describe members of the public (Hobson, 2021; Korsunova et al., 2021), recognising these broader active and social roles people can play as participants in the circular economy.

3 Circular behaviours—definitions and classification

3.1 Defining circular behaviours

The terms 'circular behaviour'/'pro-circular behaviour' are increasingly adopted to describe behaviours that are relevant to the CE transition. Whilst many sources exploring behavioural aspects of the CE fail to define such terms, a few authors have sought to do so (see Table 1).

Muranko et al. (2018) provide an early definition, upon which Gomes et al. (2022) draw on in their framing of circular behaviour. Whilst the Muranko et al. (2018) definition is most expansive, it raises important questions relating to *goal-direction* and *consequences* of

TABLE 1 Definitions of (pro)circular behaviours in literature.

Muranko et al. (2018)	An action which is brought about due to prioritising resource-efficiency. This behaviour benefits or at least reduces damage to the environment, economy and society (p. 133)
Gomes et al. (2022)	Circular consumer behaviour is one that promotes resource efficiency, as well as the flow of circular value, in consumption systems (p. 2).
Arias et al. (2022)	Those consumer behaviours necessary in a circular economy (p. 3)
Zibell et al. (2021)	Consumer behaviour aligned with circular economy goals and principles (p. 3)

behaviours. Circular behaviours are proposed as an expression of conscious prioritisation of resource efficiency over other goals. The centrality of goal-direction has been contested within the wider literature on pro-environmental behaviours (PEB) (Gatersleben, 2018). Not only are PEBs (including circular behaviours) liable to be motivated by multiple goals, of which reducing environmental impact is only one, they are often underpinned by psychological processes that are neither conscious nor rational. Similarly, incorporating consequences of behaviours within their definition also becomes problematic. Whilst CE is purported to serve all three pillars of sustainability—economic, environmental and social—in practise trade-offs between these multiple objectives will inevitably arise and action in one context will have different impacts to the same action performed in another context.

Others define circular behaviours with respect to their alignment to CE specifically (Zibell et al., 2021; Arias et al., 2022). Given the proliferations of different conceptualisations of CE itself (Kirchherr et al., 2017) and imaginaries of the future CE which shape present day policy and action (Casson and Welch, 2021), any definition which classifies a behaviour as circular only on the basis of its alignment with achieving a CE or CE principles leaves too much room for interpretation.

With these considerations in mind, we define circular behaviours as *those behaviours that align with a wider system change towards circularity and resource efficiency in everyday life*. This definition avoids assumptions about the goal-directedness or multiple outcomes of behaviours, instead emphasising more proximate impacts on resource use, as well as situating circular behaviours as part of everyday relationships with material goods. It is important, however, in conceptualising circular behaviours to avoid solely concentrating on increasing efficiency—'Jevons Paradox' (Jevons, 1871) highlights the risk of rebound effects whereby increasing efficiencies can lead to a net increase in resource use due to efficiency gains being outstripped by increasing demand. Thus, behaviours aligning to a rejection of overconsumption and consumerism have a central role to play achieving sustainable circular systems of production and consumption.

3.2 Aligning behaviours and resource flows—typologies of circular behaviours

Behaviours relating to consumption and waste are commonly conceptualised within frameworks that broadly correspond to the waste hierarchy, with activities prioritised according to their impact or desirability. Such hierarchies are dominated by 'R-terms' (e.g., 'reduce', 'reuse' and 'recycle'). Reike et al. (2018) recorded 38 different R-terms in use in the academic literature on CE, creating a typology of 10 R-terms representing different processes through which resource value can be retained in a circular system (see Figure 1). It is important to note that these R-terms *do not represent behaviours in themselves*, rather processes that may include a behavioural element to a greater or lesser degree. The R-terms at the top of the hierarchy (R0:Refuse to R3:Repair) refer to 'short-loop' processes, where the product stays with users in a 'loop back' to use (rather than undergoing further processing as part of production or waste management processes) (Reike et al., 2018). These 'short-loop' processes are where householders have a primary role in driving circularity, and which require little re-framing to isolate the behavioural component of the processes described by the R-terms. R-terms lower down the hierarchy (e.g., R5: remanufacture etc.), tend to fall more within the domain of producers and the waste management sector, yet householder behaviours can still influence these processes through demand-creation (e.g., for refurbished or recycled products) and material supply (e.g., of sorted waste for recycling).

Circular behaviours can also be conceptualised in relation to temporal stages of consumption from the perspective of the consumer (Zibell et al., 2021; Arias et al., 2022). These stages include *acquisition* behaviours (purchasing or otherwise acquiring items), *use* behaviours (actions taken to prolong the lifespan of a product), and *disposal* behaviours (discharge of used products, e.g., through returning to producers, reselling, sorting for recycling etc.). This conceptualisation, although more linear in nature, arguably start from a more behaviour-oriented position (as opposed to the more resource-flow/process centred R-term hierarchies) as it takes into consideration the temporality of product lifespans as they are experienced by the individual and highlights the multiple points at which people can exert agency on the processes encapsulated in R-term hierarchies.

There is potential value in combining these two approaches to conceptualising circular behaviours, to develop frameworks which represent both vertical (hierarchical, relating to resource flows) and horizontal (temporal) dimensions. Further research will, however, be needed to explore the utility of such frameworks for analysing behaviours.

4 Behavioural theory in circular economy research

We have argued that defining and classifying circular behaviours is important. However, to better understand circular behaviours and promote behaviour change, behavioural models are needed to provide theoretical grounding for the development of hypotheses and design of interventions. Whilst it is not uncommon for behavioural research within the CE domain to employ existing behavioural theories, we would argue that overall, theory has been applied in a rather limited and uncritical way.

A review of consumption-focused CE literature by Camacho-Otero et al. (2018) observed that the most commonly adopted theoretical models by far are the Theory of Planned Behaviour (TPB) (Ajzen, 1991) and related models, e.g., Theory of Reasoned Action (Fishbein and Ajzen, 1975) and extensions of TPB such as the pro-circular Change Model (Muranko et al., 2018). The dominance of TPB as a theoretical framework in behavioural CE research appears to continue to date, reflecting an increasing use of the TPB in

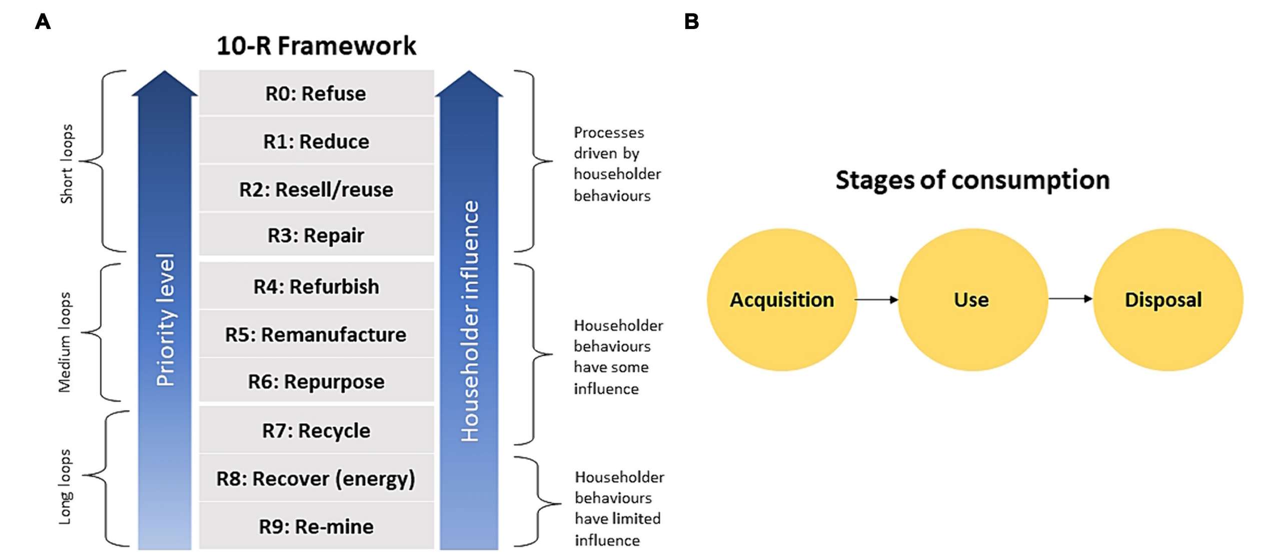

FIGURE 1
Vertical **(A)** and horizontal **(B)** classifications of circular behaviours. 10-R framework adapted from Reike et al. (2018).

consumption research more broadly (Rozenkowska, 2023). The reliance on the TPB may be limiting progress, as the model has been widely critiqued. It is not well suited to understanding habitual behaviours in which there is a significant element of automaticity, rather than reflection and conscious decision-making (Verplanken and Whitmarsh, 2021). Similarly, a reliance on the TPB underplays the role of emotions in motivating behaviour (van Valkengoed et al., 2022). Other criticisms also apply to other behavioural models commonly employed in PEB research—contextual factors and temporal dimensions of change are often poorly represented, and the linearity of many behavioural models leads to overly reductionist and deterministic ways of thinking (Whitmarsh et al., 2021). The danger is that relying on the TPB results in an evidence base that poorly serves research users attempting to apply theory in good faith to behaviour change interventions in the real world.

In a broader sense, the dominant theoretical models of PEB research, originating in psychology and economics, have also been critiqued for their individualised approach. The individual is taken as the primary unit of analysis, yet the outcomes of many consumption, conservation and waste disposal behaviours are expressed at the household (rather than individual) level. This problem of mismatch between individual-level theories and household-level outcomes can mean that important social dynamics within households, e.g., in the division of labour associated with 'consumption work' (Wheeler and Glucksmann, 2013) are overlooked. Despite long-standing calls from sociologists and geographers for a greater focus on the household as a meso-level locus of change (e.g., Reid et al., 2010), psychology-led pro-environmental behaviour research seldom incorporates theoretical insights from wider research paradigms which could support the integration of individual-level and household-level analyses, as well as better representation of other group-level processes pertinent to understanding the 'people' dimension of circular economy. There is, therefore, considerable potential for greater application of multi-level perspectives and integrative interdisciplinary approaches combining psychological theories of behaviour with, e.g., social practise theory and critical theory including feminist theory.

5 Discussion

How we frame behaviour, and the theoretical models we use, influence the type of behaviour change interventions and target behaviours prioritised in research and policy. In this perspective article we have advocated for a person-centred perspective on behaviour change in the circular economy field, viewing people as not just consumers or users of circular products, but as members of society whose everyday relationships with material goods (and maybe with each other) will need to change if a CE is to be achieved. To imagine life in a circular society, and how we might reach that point, we need greater attention to how we conceptualise and understand (pro-)circular behaviours, as well as a more critical application of behavioural theory to explore the psychological, social, and environmental factors influencing their performance. Drawing on (often long-standing) debates and more recent conceptual developments within the wider pro-environmental behaviour literature, we suggest the following priorities for a person-centred future research agenda on circular behaviours:

5.1 Adopting a systems perspective in framing behaviour change in the CE

Transitioning to a circular economy represents a large-scale system change that will require technical solutions and industrial innovation, and widescale behaviour change, amounting to a transformation in consumption and waste culture in civil society. Consumption can be viewed as an everyday activity—we are all involved in some way in the acquisition, use and disposal of goods or materials such that it is part of everyday life. Research seeking to support sustainability transitions, including the shift to more circular economy, would benefit from paying greater attention to behaviour, and the complex social and psychological factors underpinning environmentally (un)sustainable consumption behaviour.

At the same time, critics have long argued that a narrow focus on behaviour change risks deflecting responsibility away from powerful institutions and on to individuals (Shove, 2010; Kaufman et al., 2021). Behavioural research on the CE, in common with pro-environmental behaviour research more generally, could benefit from a more systems-oriented approach. Such an approach focuses less on persuading individuals to behave differently, and more on questioning which components of the existing system could be leveraged to provide supportive structural conditions for behaviour change. The adoption of a systems perspective also entails consideration of behaviour with reference to multiple units of analysis (nesting individuals within multiple social) and interactions at a range of scales. Such perspectives require more integrative theories (see point 3 below) as well as research methods that admit and reflect complexity. Social simulation using agent-based models is an example of a method that offers significant opportunities for analysing behaviour and multilevel social phenomena from an interdisciplinary systems perspective (Alonso-Betanzos et al., 2017).

5.2 Developing and applying typologies for classifying circular behaviours

Hierarchical frameworks have the potential to help shift attention from 'easy' yet low-impact behaviours, to more challenging high-impact behaviours. However, behavioural literature on the CE has arguably placed too much focus on recycling and less on the more challenging reduce and reuse behaviours higher up the waste hierarchy. At the same time, conceptualising behaviours solely in terms of resource flows fails to represent key behaviourally-relevant dimensions, including (but not limited to) whether a behaviour relates to acquisition, use or disposal of items, whether we expect the outcome of a behaviour to be expressed at the individual or household level, and the extent to which we might expect a behaviour to be driven by rational, reflective processes or automatic, habitual drivers. Further conceptual development is required to pave the way for more robust analyses of circular *behaviours*, as opposed to circular resource flows, in the future. Advancing typologies of circular behaviours could also help support development of behavioural CE indicators. Such social indicators could be used alongside key economic indicators such as private investment in circular business supporting recycling, repair, reuse and rental/leasing models and the value these add to economies (D'Adamo et al., 2024) to inform CE decision-making with a goal of creating systems that support fundamental changes in consumption patterns.

5.3 Developing integrated theoretical models to underpin design of interventions

Behaviour change interventions should be informed by theories appropriate to the types of behaviour targeted, the context and target population. Importantly, we should recognise the role of the dominant behavioural models implicitly shaping the framing of policy and practise about behaviour change. A narrow focus on knowledge deficits and motivational processes has resulted in an overreliance upon information-giving and persuasive communication in interventions, both within the CE field (Zibell et al., 2021) and in the wider pro-environmental behaviour literature (Whitmarsh et al., 2021). A recent review of theoretical development within the PEB literature by Tian and Liu (2022) identifies theoretical integration as the next important step for PEB research. We argue that such integration, drawing on disciplines including psychology, sociology, geography, politics and economics, is likewise a necessity for behavioural research on consumption and the circular economy. Whilst this is no small endeavour, genuine efforts to develop truly interdisciplinary understandings of our everyday material consumption and waste are necessary if we are to move towards the vision of the circular society at the speed required to respond to the climate and biodiversity crises we currently face.

Data availability statement

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author.

Author contributions

KC: Conceptualization, Funding acquisition, Writing – original draft, Writing – review & editing. AH: Conceptualization, Funding acquisition, Writing – original draft, Writing – review & editing. JC: Writing – original draft, Writing – review & editing. AL-A: Writing – original draft, Writing – review & editing. TW: Conceptualization, Writing – original draft, Writing – review & editing. PS: Conceptualization, Writing – original draft, Writing – review & editing. GM: Writing – original draft, Writing – review & editing. SA: Writing – original draft, Writing – review & editing. FB: Writing – original draft, Writing – review & editing. TC: Conceptualization, Funding acquisition, Writing – original draft, Writing – review & editing.

Funding

The author(s) declare that financial support was received for the research, authorship, and/or publication of this article. This work was funded by the Rural and Environment Science and Analytical Services Division of the Scottish Government for project JHI-C4-1.

Acknowledgments

The authors would like to thank the reviewer for their valuable suggestions to improve the manuscript.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

The author(s) declared that they were an editorial board member of Frontiers, at the time of submission. This had no impact on the peer review process and the final decision.

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frontiers | Frontiers in Sustainability

TYPE Perspective
PUBLISHED 26 August 2024
DOI 10.3389/frsus.2024.1436740

OPEN ACCESS

EDITED BY
Hamid Doost Mohammadian,
Fachhochschule des Mittelstands, Germany

REVIEWED BY
Aleksandra Figurek,
University of Nicosia, Cyprus

*CORRESPONDENCE
Jani Siirilä
✉ jani.siirila@haaga-helia.fi

RECEIVED 22 May 2024
ACCEPTED 01 August 2024
PUBLISHED 26 August 2024

CITATION
Siirilä J and Salonen AO (2024) Towards a sustainable future in the age of polycrisis. *Front. Sustain.* 5:1436740.
doi: 10.3389/frsus.2024.1436740

Towards a sustainable future in the age of polycrisis

Jani Siirilä[1]* and Arto O. Salonen[2]

[1]Haaga-Helia School of Professional Teacher Education, Haaga-Helia University of Applied Sciences, Helsinki, Finland, [2]Department of Social Sciences, University of Eastern Finland, Kuopio, Finland

Our generation lives in an age of polycrisis. Polycrisis is a phenomenon where various single crises interact in ways that lead to an overall negative impact that is more significant than the sum of each issue. The age of polycrisis poses a considerable threat to humanity. Since the age of polycrisis results from human actions, humans are responsible for addressing it. As such, an ultimate roadmap and in-depth sustainability transformations are needed across all sectors. This raises a quest for a unified social contract that can engage everybody to promote the well-being of people and the planet locally, regionally, and globally. Our paper explores a holistic picture of a social transformation process to address the challenges of the age of polycrisis. We put together a new social contract, different actors (civic society, private sector, public sector, decision-makers), and specific focus areas of actors to implement the goals of Agenda 2030. Each societal sector has a unique role to play in this transformation. The private sector can drive innovation and investment, the public sector can provide governance and regulation, civic society can advocate for change and hold other sectors accountable, and decision-makers can provide leadership and coordination. A new social contract called "Society's Commitment to Sustainable Development" can foster societal transformation towards sustainability with the involvement of these different societal sectors. The widespread commitment of public and private sectors as well as civil society can be an effective driver when implementing Agenda 2030 goals to build a more sustainable future. We, the current generation, have power to make a difference regarding international collaboration, national decision-making, industries, households – even down to the choices we make in our everyday lives. The future is shaped by the decisions we make today.

KEYWORDS

age of polycrisis, Society's Commitment to Sustainable Development, social contract, Agenda 2030, sustainable future

Introduction

The world is undergoing multiple long-term structural transformations, including the rise of AI, a shift in geopolitical power distribution, and demographic transitions. However, the most crucial future challenge is caused by planetary development, where natural resources continue to be depleted while climate stability declines and biodiversity suffers (World Economic Forum, 2024). These problems are intertwined so that they are linked to increasing inequality and social instability. The whole picture is diverse including also pollution. In 2015, human-made pollutants tragically caused 9 million premature deaths worldwide, a figure that is three times more than the combined toll of AIDS, tuberculosis, and malaria, and 15 times more than war, terrorism, and other forms of violence (Landrigan et al., 2017). The economic impact of these preventable deaths, caused by pollution, is a significant 6% of the world economy today (Fuller et al., 2022).

New vision for development and progress in society is very much needed because simultaneously negative local, global and planetary developments refer to a *polycrisis*. Polycrisis is associated with challenges "where disparate crises interact such that the overall impact far exceeds the sum of each part" (World Economic Forum, 2023). Polycrisis poses an existential threat to humanity on Earth (Steffen et al., 2015; Richardson et al., 2023). Polycrisis is rooted in deeply intertwined systems with people and the planet, or more explicitly the global economy and Earth's life support system. Polycrisis is human-made, and so solving it humans' duty. We will see a better future if we make it happen. Harnessing the entire human potential is, therefore, crucial in building a sustainable future.

Agenda 2030 goals build the bridge for more sustainable future on Earth. The challenge is, however, how to mainstream the realization of the sustainability transformations in society in such a way that everybody is on board. In this paper, we discuss how human potential can empower society through a collaborative effort. We give an example from Finland where a new social contract called Society's Commitment to Sustainable Development has applied (National Commission on Sustainable Development, 2016; Finnish National Commission on Sustainable Development, 2022a). The novelty of this paper is based on a holistic vision of how just social transformation can be implemented in society so that everyone is on board.

New development qualities are needed

During the last 200 years, the industrial age has improved our possibilities to have a good life in many ways. Humankind has progressed intensively due to cheap fossil energy (International Energy Agency, 2023). Increasing citizens' consumption opportunities has been a way to improve people's living standards over the last decades (Benkler, 2006; Botsman and Rogers, 2010; Belk, 2014; Davidson and Infranca, 2016). This progress is called *development*.

Positive development can have adverse side effects and externalities. The current climate change is an example of such externalities that positive societal development may cause. Fossil energy is the main cause of the current human-induced climate change which is "the biggest environmental market failure in human history" (Auffhammer, 2018, p. 33). In addition to climate change, we are currently living in the sixth extinction era in Earth's history (Barnosky et al., 2012). This is another example of the negative side effects of positive societal progress. A third negative side effect is linked to the depletion of natural resources. A dependency on ever-increasing consumption is linked to economic growth, which would not be a problem if it were possible to decouple it from the depletion of natural resources, climate change, and the loss of biodiversity. An absolute decoupling in terms of gross domestic product (GDP) is highly unlikely, which has caused economic growth as a societal aim to be increasingly bought into question (Raworth, 2017; Hickel and Kallis, 2020; Vadén et al., 2020; Vogel and Hickel, 2023).

The negative side effects raise a need of new qualities of development. *Sustainable development* brings together development and its quality—*sustainability*. The World Commission on Environment and Development presented sustainable development as a model of holistic social change—"[…] that meets the needs of the present without compromising the ability of future generations to meet their own needs" (WCED, 1987, p. 46). Relating to the circumstances of the finite planet, the definition of sustainable development underlines the fact that the vitality of an ecological foundation is a prerequisite for humanity's existence (Hediger, 1999; Ott, 2003; Marshall and Toffel, 2005). This definition is also associated with the dignity that each human being possesses as their birthright, as agreed worldwide with 196 nations in the Universal Declaration of Human Rights (United Nations, 1948).

Sustainable development can help countries pull in the same direction by building more sustainable governance and policies (Eckersley, 2004; United Nations Development Programme, 2015; Schneider et al., 2019). In 2015, the United Nations General Assembly adopted the 2030 Agenda for Sustainable Development, as a new global framework to redirect humanity towards a sustainable path (United Nations, 2015). At the core of Agenda 2030 are 17 universal, transformational and inclusive Sustainable Development Goals (SDGs) which describe the major complex challenges humanity faces in the midst of the current polycrisis. Agenda 2030 is, therefore, an ultimate goal that can engage citizens, private and public sectors, and decision-makers to make appropriate decisions needed to attain a sustainable future. In Europe for example, even solid juridical support already exists as the EU Climate Act aims to ensure that carbon emissions will be cut in half by 2030 in the EU (European Commission, 2021). However, the challenge remains in bringing everyone on board.

Bringing everybody on board

The solution-oriented approach to development refers to in-depth sustainability transformations that are needed across all sectors, together with their scales and the societal actors involved. A solution-oriented approach in society means that some industries need to be expanded as soon as possible, and some run down on justified and safe grounds. For instance, energy industries relying on fossil fuels have no future on a carbon-neutral planet because global warming is likely to exceed the critical 1.5°C threshold by early 2030 if ongoing path continues (IPCC, 2023).

A better future for all on Earth means eliminating dirty energy production by stopping the burning of coal, oil, gas and trees. This calls for bold political decision-making because bringing the majority on board is important to do, regardless of their political view, socioeconomic background, or age group (Dixson-Declève et al., 2022, p. 9). Every political decision opens up new possibilities, while ruling out others. With the help of financial markets, people's savings can be targeted toward companies that have concentrated on solving sustainability challenges, such as the renewal of the energy sector. Fossil fuels can be replaced, for example, by de-centralized electricity production in the form of wind turbines and solar plants. The finance sector is crucial in targeting capital towards sustainable investments (Boffo and Patalano, 2020), and the public sector can also support households by offering state guarantees for their loans when renewing energy solutions or updating the insulation of their properties.

The emerging role of *civic activism* can also be an essential driver of a sustainable future (Anttiroiko, 2016; Youngs, 2017). Digitalization platforms such as social media enable citizens to find new ways to create and use self-organizing networks. Civic activism is a self-organized and self-motivated cooperation between citizens, usually outside of organizational activities, and based on integral, constructive and proactive collaboration. So, whether it is establishing urban plantations or a food circle, the purpose is primarily for shared thinking and collective action. Specifically, it is a direct action to improve one's urban environment and its facilities, offerings and functionalities and civic activism can be a key driver for building self-organizing networks and functional communities aiming to foster cooperation between self-defined goals (Young et al., 2018; Rask et al., 2020).

Society's Commitment to Sustainable Development as a practical solution

Finland was one of the first countries to implement a national commitment to sustainable development, in a statement entitled "*The Finland we want in 2050*" (National Commission on Sustainable Development, 2016). The strategy for 2022–2030 aims to realize this vision, and is based on the six areas of change identified in the Agenda 2030 roadmap and seeks to support other countries in advancing sustainable development. The strategy serves as a long-term target framework and tool for policy coherence in the strategic and program work of different administrative branches and stakeholders in society (Finnish National Commission on Sustainable Development, 2022a,b). The six areas defined in the commitment that is a promising start to make a new social contract (UNRISD, 2022). The focus areas are:

1. Economy and work promoting wellbeing and sustainable consumption
2. Education, competence and sustainable lifestyles
3. Wellbeing, health and social inclusion
4. Food system promoting wellbeing
5. Forest, water and land use promoting biodiversity and carbon neutrality
6. Sustainable energy systems

Societal commitment is a practical tool to bring together the public sector, companies, civil society actors, organizations and citizens in a unique way. These commitments are public commitments. Each citizen, organization, business or public sector operator in Finland can commit to the identified initiatives for a sustainable future, while urging others to do so at the same time. The commitments varies from responsible safety and equality initiatives to a more efficient use of energy and resources, training young people, improving access to the labor market for people with partial work capacity, and strengthening democracy to increasing transparency in government (Finnish National Commission on Sustainable Development, 2022a,b). Also, the SDGs platform is open to all stakeholders, including civil society, local authorities, private sector, scientific and technological communities and academia, to register a voluntary commitment or multi-stakeholder partnership which aims to drive the implementation of the Agenda 2030 (United Nations, 2024).

Discussion

Agenda 2030 aims to establish a common baseline for worldwide development with new qualities of development and progress. The key question for a sustainable future is how everybody can be brought on board when implementing Agenda 2030 goals in society. Any hope for the future will crumble if people stick to the business-as-usual logic without a comprehensive turning point and societal transformation. In this paper we identified Society's Commitment to Sustainable Development as a practical tool to start for making a new social contract that can engage civil society and activism, together with private and public sectors and policymaking, and implement Agenda 2030 goals to build a more sustainable future in the age of polycrisis (Figure 1).

During the age of polycrisis, a unified social contract is needed to promote the wellbeing of people and the planet (UNRISD, 2022). The widespread commitment of public and private sectors as well as civil society can be an effective driver when implementing Agenda 2030

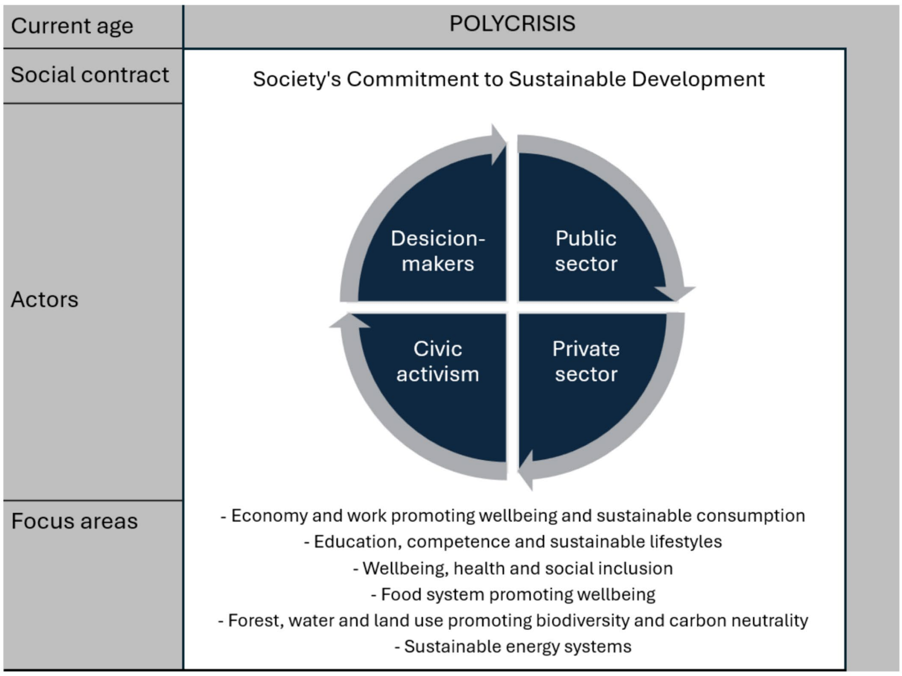

FIGURE 1
The social transformation process to a sustainable future in the age of polycrisis is based on the social contract that commits actors from different sectors of society to act on specific focus areas (sustainability transformations) from their own perspective.

goals to build a more sustainable future. Society's Commitment to Sustainable Development can be such an effective tool to engage the whole society in implementing the Agenda 2030 goals as it spurs different sectors in society together towards s sustainable future in the age of polycrisis. Each societal sector has a unique role to play in this transformation. The private sector can drive innovation and investment, the public sector can provide governance and regulation, civic society can advocate for change and hold other sectors accountable, and decision-makers can provide leadership and coordination.

However, even in democracy there is a gap between the citizen and the policymaker. The citizen's own possibilities of influence are real but limited. The prevailing societal conditions determine an individual citizen's means to act. Citizens' limited positive impact in society can be supported to become more widely influential via civic activism. By taking part, people feel they are involved actors that can make a sustainable future. In a democratic society, citizens can impact the circumstances in which they live. The understanding of polycrisis is grounded in systems thinking that includes the fact that a small change in one area may have a big impact on the whole system.

The cycle of good begins when citizens share ideas about how we can renew lifestyles, rethink operating cultures, or upcycle products. We humans are social beings connected to each other. We always influence each other. The power of the Society's Commitment to Sustainable Development lies not just in strengthening the voice of the individual citizen or civil society, and the business and education sectors are also innovating in different ways to build a future that inspires confidence. At its best, the power of citizens, organizations and institutions can create a cycle of good. The Society's Commitment to Sustainable Development initiative provides an opportunity to transform society in a citizen-driven way from the bottom up.

Tomorrow is a result of the choices we make today. In the age of polycrisis, a good life is founded on "optimistic people with hope for a better future" (Dixson-Declève et al., 2022, p. 167). Flourishing is more than simply material wealth or a standard of living, and also consists of non-material things that improve the quality of life by giving it good reason, meaning, and purpose. Particularly, the non-material quality of life includes meaningful living, personal growth, engagement and positive relations with others (Salonen et al., 2024).

The current era of polycrisis can cause societies and the whole planet to face significant challenges, including increasing inequality, social instability, and environmental devastation. Because human activity is causing climate change, a loss of biodiversity, and the depletion of natural resources, humans have a responsibility to confront the consequences of their actions, but they also have the power to act. As later citizens, societies, and humankind come to realize this, the more difficult and expensive it will become to live in the age of polycrisis. Large-scale systemic change, driven by a collective effort of progressive political leaders, inclusive coalitions, active citizens, and social movements can solve this dire situation. Together, we can pave the way for a sustainable future. As polycrisis poses an existential threat to humanity, our generation needs to do everything we can regarding international collaboration, national decision-making, industries, households, and also the choices we make in our everyday lives. After all, building a sustainable future is all about making future generations proud of our generation's decisions.

Data availability statement

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author.

Author contributions

JS: Writing – original draft, Writing – review & editing. AS: Writing – original draft, Writing – review & editing.

Funding

The author(s) declare financial support was received for the research, authorship, and/or publication of this article. The article was funded by the Strategic Research Council of Finland (Grant No. STN/2023/358763, Sufficiency Solutions for a Resilient, Green, and Just Finland), and Ministry of Education and Culture, Finland (Grant No. OKM/117/523/2020, Ethical Competencies for Sustainability in Higher Education and Working Life).

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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frontiers | Frontiers in Sustainability

TYPE Original Research
PUBLISHED 06 January 2025
DOI 10.3389/frsus.2024.1483298

OPEN ACCESS

EDITED BY
Maria Alzira Pimenta Dinis,
Fernando Pessoa University, Portugal

REVIEWED BY
Cristian Matti,
European Commission, Joint Research Centre, Spain
Laurent Bontoux,
European Commission Headquarters, Belgium

*CORRESPONDENCE
Ragnhild Eg
✉ ragnhild.eg@nofima.no

RECEIVED 19 August 2024
ACCEPTED 03 December 2024
PUBLISHED 06 January 2025

CITATION
Eg R, Gonera A, Grini IS, Pedersen ME and Varela P (2025) From personal benefits to green motives: consumer segments for targeted sustainability transitions in workplace canteens.
Front. Sustain. 5:1483298.
doi: 10.3389/frsus.2024.1483298

From personal benefits to green motives: consumer segments for targeted sustainability transitions in workplace canteens

Ragnhild Eg*, Antje Gonera, Ida Synnøve Grini, Mads Erling Pedersen and Paula Varela

Department of Innovation, Consumer and Sensory Sciences, Norwegian Institute of Food, Fisheries and Aquaculture Research (Nofima), Ås, Norway

This study came to life through a collaboration between researchers and the service and food industries, aiming for nuanced consumer insights that may inform future sustainability interventions in workplace canteens. The study applied a mixed-methods approach to evaluate consumers' attitudes, motives, and preferences within the canteen setting and with respect to the sustainability of food choices. Analyses of the quantitative data identified three distinct consumer segments that demonstrate the variability of consumers in food preferences and sustainability orientations. One segment was motivated by personal benefits, a second by both benefits and consideration for animal welfare, and a third was more markedly oriented toward sustainability. The qualitative analyses contributed additional viewpoints on feasible and desirable changes to canteen menus and operations. Combined, the findings highlight the necessity for canteens to consider the diversity of their clients and adopt versatile strategies tailored to distinct motives and preferences. This can in turn transform the canteen into an arena for testing sustainability interventions, yielding further insight into the efficacy of a range of means. The ambition is to extend outcomes of canteen interventions to other arenas, commencing with the household and culminating with society at large.

KEYWORDS

sustainability, plant-based, consumer segments, food choice motives, canteen interventions

1 Introduction

Despite decades of warnings, it seems that many have only recently come to realize that the world cannot sustain our current level of consumption. Among other consumer habits, research has highlighted the importance of changing the way we eat (de Boer and Aiking, 2019). Combined, the world's food systems contribute to one third of humankind's global greenhouse gas emissions; in addition, agricultural production is responsible for the majority of humanity's freshwater use and occupation of habitable land (Crippa et al., 2021). Of course, food consumption patterns vary globally, and the consumption of animal-based proteins is particularly skewed, in favor of the European and American nations (Henchion et al., 2021) and those with high incomes (de Boer and Aiking, 2019). Relatedly, the production of red meat is a prominent source of emissions and land and water use (Crippa et al., 2021). Still, red meat constitutes one of the food products we could feasibly reduce or even replace with more sustainably produced proteins (de Boer and Aiking, 2019; Willett et al., 2019), and vegetarian replacements can reduce greenhouse gas emissions by approximately 30% (Boyano Larriba et al., 2019). Switching to more plant-based diets is only one of several known and accessible ways to lessen the impact of our food systems, we just need to make the choice and guide others down the same path.

The realization that we need to change the way we eat is neither comfortable nor easy to act on, as it impedes our way of life. However, change need not be forced, it can come from gradual exposure or instant inspiration, and the food service industry can provide the stage for this change. Aiming to uncover what is needed on such a stage, we set out to examine food choice motives that may characterize different segments of canteen customers, investigate their respective attitudes and behaviors in connection to food and sustainability, and finally, address consumer perspectives on plant-based dishes and how the workplace canteen might improve operations to potentially influence food habits at home.

1.1 Theoretical background

1.1.1 Who will go green?

Making a food-related decision can be a complex process, where policies, economy, contexts, environmental cues, social norms, personal preferences, knowledge, and internal states weigh in Lorenz and Langen (2018). Individual factors are often assessed through personal values or motives, which cover a variety of categories such as taste and appearance, price and convenience, mood and familiarity, health and naturalness (Onwezen et al., 2019), as well as sustainability considerations concerning the climate and environment, seasonal and local produce, social justice, and animal welfare (Onwezen et al., 2019; Verain et al., 2021). Nevertheless, the food choices we make are often driven by spontaneous and sometimes unconscious reminders (Papies et al., 2020). There also seems to be a general tendency to overestimate how much weight is placed on different motives in the moment of choosing, among them hunger, price, habits, social and traditional aspects, along with natural concerns (Wahl et al., 2020). The latter category includes concerns about the naturalness and safety of food products, fair trade, and environmental impact (Renner et al., 2012), none of which appear to have much bearing on in-the-moment food choices (Wahl et al., 2020). The implication is that sustainability-oriented food choices are left to the most vigilant consumers, whereas the majority are presumably more likely to let other motives and situational factors dominate their decisions. This acknowledgement comes with an upside, related to the potential susceptibility of less aware consumers to external cues and choice contexts.

Not everyone is likely to be swayed toward more sustainable choices; studies and reports have demonstrated significant individual differences between those who are willing to modify their diets and those who are not. For instance, health considerations and animal compassion can both be internal drivers for reducing or avoiding meat products (Milford and Kildal, 2019; Pohlmann, 2021). Moreover, dietary choices vary across age, gender, and other demographics. A Norwegian public health report showed a larger share of young, female, urban, and university-educated respondents among those who had altered their diets for reasons related to the climate and sustainability (Abel and Totland, 2021). Similar results have been reported for Danish and Dutch samples (Hielkema et al., 2022), while a German study found young age, social and flexible lunchtime habits, and environmental attitudes to predict sustainable food choices (Lorenz-Walther and Langen, 2020).

The reduction of animal proteins and transition to plant-based alternatives is of particular interest in the sustainability, dietary shift (Willett et al., 2019), again with studies demonstrating differences in acceptance and adoption across demographical groups. In short, men (Gonera et al., 2021; Hielkema and Lund, 2021; Lacroix and Gifford, 2020; Modlinska et al., 2020), older generations (Gonera et al., 2021; Hielkema and Lund, 2021), and rural inhabitants (Gonera et al., 2021; Hielkema and Lund, 2021) are over-represented in groups that are reluctant to change their meat consumption. Less knowledge about and interest for food sustainability among blue-collar workers makes this also a consumer group harder to reach and change (Bayram and Kiziltan, 2024). That is not to say that all efforts should aim for those demographics. Instead, more detailed insight about different consumer groups can facilitate the design of interventions that target other prominent motives, alongside sustainability, for instance the willingness to try out new food, to socialize over a meal, or to feel compassion with an animal.

1.1.2 How do canteens go green?

The food sectors are also showing interest in plant-based alternatives to animal-based proteins (Bianchi et al., 2018; European Vegetarian Union, 2023; Lombardini and Lankoski, 2013); across Europe, public canteens and schools are embracing plant-based options with green public procurement as a tool to boost the green shift (Boyano Larriba et al., 2019). A number of cities and towns have already adopted national or local strategies; to name a few, Portugal and France are mandating plant-based choices in public procurement, while Copenhagen is the first city with 100% organic public canteens (European Vegetarian Union, 2023). Against this backdrop, we foresee a so-called contextual spillover (Verfuerth et al., 2021) where canteens' encouragement of sustainable food choices might generalize to other domains, starting with the household and over time broadening to more sustainable eating patterns on a societal level. This behavioral spillover from one arena to another has previously been reported by canteen guests who were exposed to a social marketing campaign that promoted the canteen's reduction of red meat (Verfuerth et al., 2021). Similarly, when supplying university students with free fruit and vegetables on campus, a Belgian study found a contextual spillover with larger amounts of greens eaten for subsequent meals (Lachat et al., 2009). Another two studies have investigated how offering take-away meals in workplace canteens can bring about a spillover effect to healthy meal habits at home, but these did not consider other members of the household (Lassen et al., 2011; Poulsen and Jørgensen, 2010). In other words, the potential spillover from sustainable canteen lunches to sustainable family dinners is a topic that warrants attention from food service, food production, consumer, and innovation researchers alike.

The potential of canteens as platforms for dietary shifts has not gone unnoticed by researchers delving into the effects of sustainability-oriented interventions (Bianchi et al., 2018; Pandey et al., 2023; Sullivan et al., 2021; Velema et al., 2018), with studies demonstrating the promise inherent in situational factors such as nudging and choice settings, strategic menu design, availability of alternatives and information, and the presentation of options, including portion sizes and preparation (Lorenz-Walther and Langen, 2020; Pandey et al., 2023; Perez-Cueto, 2021; Taufik et al., 2022; Zhang et al., 2022). Several have also documented positive effects, such as heightened food literacy and pro-environmental values, as well as behavioral changes related to food consumption and food waste (Sullivan et al., 2021).

Two opposing approaches to boosting plant-based choices are either to restrict the offer of meat or to make the plant-based options more readily available (Lombardini and Lankoski, 2013; Ohlhausen and Langen, 2021; Zhang et al., 2022). Although the former may lead to non-compliance at first, there are indications that reactive behaviors decline over time, eventually leading to acceptance (Lombardini and Lankoski, 2013). However, reactance may be avoided by providing options instead (Lombardini and Lankoski, 2013), and canteen consumers are seemingly united when it comes to prioritizing spontaneous choices over pre-orders, as well as having a variety of alternatives (Ohlhausen and Langen, 2021). Others have highlighted the efficacy of different types of meat-reduction interventions. Among the approaches that have demonstrated a reduction in sales and consumption of meat products are the offer of dishes with meat alternatives, the downsizing of meat portions, the repositioning of food or menu items, and the manipulated appeal of a meat- or plant-based dish (Attwood et al., 2020; Bianchi et al., 2018; Langen et al., 2022; Taufik et al., 2022; Zhang et al., 2022). Repositioning is a common strategy to boost the sales of plant-based foods, typically by placing them at the most prominent spot in the canteen and first on the menu so that they become the easiest choice (Hielkema et al., 2022; Langen et al., 2022; Taufik et al., 2022; Zhang et al., 2022). Although some researchers have concluded that descriptive manipulations do little to reduce sales of meat-based dishes (Bianchi et al., 2018), others recommend the use of sensory, geographic, or nostalgic names to boost taste expectations (Ohlhausen and Langen, 2020). Indeed, something as simple as the description on a menu or a label can be sufficient to nudge consumers toward a more sustainable option, for instance by describing a dish as environmentally friendly (Krpan and Houtsma, 2020) or coming from sustainable agriculture (Ohlhausen and Langen, 2020).

1.2 Harnessing insight to guide consumers

Canteens can set the stage for studying natural consumption patterns during sustainability transitions; many of the external and internal factors that steer our food choices are free to mix and mingle in the everyday setting of a canteen, also providing an isolated environment for these interactions. However, the majority of studies on canteen interventions and nudges are based on the researchers' input rather than on canteen guests and their attitudes, motives, values, and specific needs; the consumers involved only partake at the moment of choice and purchase. Lorenz-Walther and Langen (2020) argue for the importance of considering customer opinions at an early stage, prior to making changes to canteen operations; in their study, they demonstrate the viability of a weekly vegetarian day, but mostly among those already oriented toward sustainable consumption. This work covers the early stage of an innovation process toward more sustainable canteen food choice, seeking insight that may guide future implementations. The objective is to study canteen consumers' attitudes, behaviors and perspectives on food, sustainability and canteen meals, guided by three research questions:

1 What are the distinguishing food choice motives of different consumer segments?
2 What do consumers prioritize in the canteen setting and how do they consider the food's sustainability?
3 How do consumer preferences align with more plant-based canteen offers?

2 Methods

We relied on a mixed methods approach to first survey food choice motives and sustainability priorities among larger samples of canteen regulars, followed by focus group interviews for in-depth understanding of different segments' perceptions of sustainability-oriented initiatives and their inputs on desired alternative offers in their workplace canteen. The conceptual framework is depicted in Figure 1.

2.1 Study 1. Survey

To scope the food-related motives and attitudes to sustainable products and practices among regular canteen consumers, we ran a

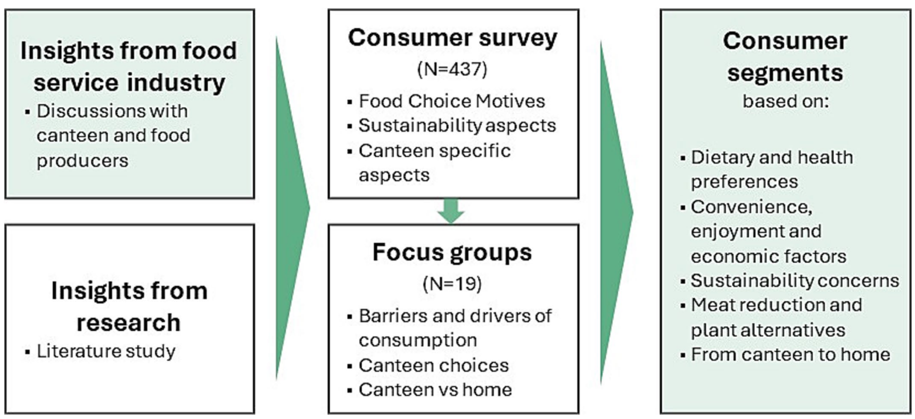

FIGURE 1
Conceptual framework of the study.

survey with workplace canteen guests frequenting one of 19 different canteens in Norway in November and December, 2022.

2.1.1 Participants

Recruitment was done through the internal communication platforms of two canteen management companies, with messages going out to employees of companies whose worksite canteen was operated by them. Participants were invited to partake in the study through one of three options: Volunteers could sign up for an online survey, a focus group interview, a food diary program, or all of the above. Initially, 491 signed up for the survey. After excluding those who visited the canteen less frequently than 1–2 times per week, as well as those who worked in directly relevant departments (e.g., product development or catering), with the final sample comprising 437 survey respondents (Table 1).

2.1.2 Measures

The survey consisted of four parts, with a total of 55 questions and statements. The first addressed the background information presented in Table 1, as well as food and shopping responsibilities in the home. The following three sections assessed food choice motives, subjective connotations to food and sustainability, and food behavior at-home and in the canteen; the details of these sections are provided in Table 2. The items adopted from Onwezen et al. (2019) and Verain et al. (2021) were translated to Norwegian and back-translated to English for validation and adjustments.

TABLE 1 Demographical details for the 437 survey participants.

Demographic	Level	Number
Gender	Female	239
	Male	198
Age group	≤ 29 years	76
	30–39 years	118
	40–49 years	129
	50–69 years	114
# adults in household	1	132
	2	245
	3 or more	60
# kids in household	None	241
	1 or more	196
Educational level	High school, or below	72
	University degree, Bachelor or above	346
	Other/undisclosed	19
Individual income level	< 1.000.000 NOK (≈ €87.000)	300
	≥ 1.000.000 NOK (≈ €87.000)	112
	Undisclosed	25
Work type	Mainly office work	357
	Mainly hands-on work	28
	Combination	52
Length of current employment	< 1 year	53
	1–3 years	123
	4–10 years	143
	> 10 years	118

2.1.3 Procedure and material

Everyone who signed up for the survey, received a subsequent e-mail with direct links to the online EyeQuestion form; respondents could choose to follow the link to either the Norwegian or English version. The survey commenced with general information about the study, along with a consent form, before proceeding to the questions and statements. All respondents were offered the choice to enter a lottery for the chance to win a food basket.

2.1.4 Data analyses

The survey data were first summarized with descriptive statistics (demographics). Principal component analysis (PCA) was performed on the average food choice motive scores (section 2, Table 2), followed by a hierarchical clustering analysis (HCA) on the PCA factors to study consumer segments across the measures related to sustainability and plant-based food (sections 3 and 4, Table 2). ANOVA was run with segment taken as an effect (statement ~ gender + age group + segment, $p < 0.05$), followed by group-wise comparisons between segments using Tukey's HSD. To investigate respondents' most important sustainability terms in the context of food, from their selection and ranking, we summated the number of selections for each term; these were similarly analyzed across segments with ANOVA and Tukey's HSD. Chi-square tests were performed to investigate effects of socio-demographics across segments.

2.2 Study 2. Focus groups

The survey was followed by focus groups with the same population as in study 1. The purpose of the focus groups was to gain deeper qualitative insights on the survey findings, including prevailing attitudes, drivers, and barriers to choosing plant-based meals in canteens. Input from participants for possible desired changes around the offering of plant-based food was sought. The focus groups were carried out in March 2022.

2.2.1 Participants and canteens

An invitation form was sent to participating canteens in Norway, asking for voluntary participation in a digital or in-person group discussion. Initially there were 29 who agreed to participate in a focus group, yet 10 individuals were unable to attend. The final 19 participants were aged between 25 and 54 years and comprised nine females and 10 males; participants were regular frequenters of the seven canteens summarized in Table 3.

2.2.2 Procedure and material

We ran three focus groups with 6 to 8 participants of both genders; each session lasted approximately 90 min. Due to restrictions enforced by the COVID-19 pandemic at the time, participants were offered options for attendance so that two focus groups were conducted in-person and one was online (Menary et al., 2021). The online group (3 males, 3 females) was attended by employees from six companies, thus representing six different canteens. The two in-person groups (4 females, 3 males; 2 females, 4 males) represented two canteens. All

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TABLE 2 Detailed questionnaire content.

Section content	Source of included items	Measure framing	Measure assessment
Section 2. Motives underlying food choices, evaluated as the importance of different food attributes	11 statements from the Single-Item Food Choice Questionnaire (Onwezen et al., 2019), plus six items specific to the local and national context	"It is important to me that the food I eat on a typical day is …"	7-point Likert scale, ranging from 1 "not at all important" to 7 "very important"
Section 3. Sustainability meaning, by identifying subjective connotations to sustainability and food	11 terms related to food and sustainability, adapted from the Sustainable Food Choice Questionnaire (Verain et al., 2021) and refined through project discussions	"When you hear the word 'sustainability' in the context of food - what do you think about?"	Selection and ranking of the five subjectively most important terms
Section 4. Preferences for sustainable and plant-based food, evaluated as food behavior in the canteen and at home	23 items developed by the project members and pilot tested prior to the survey	"Think about the food you eat in the canteen and the food you eat at home:"	7-point Likert scale, ranging from 1 'completely disagree' to 7 'completely agree'

canteens follow a proposed menu plan from the head office but have local adaptations.

The study applied a phenomenological research design, allowing for open questions to gain deeper insight into participants' experiences and reflections on plant-based meals. The focus groups were conducted according to a predetermined interview guide to facilitate semi-structured data collection. Two researchers developed the interview guide, informed by the survey results and from related studies on canteen interventions, and two other researchers provided inputs and suggestions.

The focus groups started with "warm up" exercises, word associations with food photos and the terms "sustainability" and "plant-based," before moving on to the actual interview. Discussions were facilitated and led by one of the authors, while two additional researchers took notes; the on-site sessions were audio recorded and the online session was video recorded in Teams. The facilitator made sure that all participants were active in the discussion and shared their thoughts. All participants received a gift voucher of 300 NOK (≈€25) as compensation for their time.

The interview guide was structured around the following three topics and research questions:

- What influences the choice of plant-based dishes in the canteen?
- How to promote and communicate plant-based food in the canteen?
- How can serving dishes in the canteen affect food choices and cooking at home?

2.2.3 Qualitative analysis

The focus group recordings and notes were transcribed and read independently by three researchers to assure internal validity. The following steps of analysis were performed by adopting the approaches from Braun and Clarke (2012) and Castleberry and Nolen (2018): (1) familiarization with the data and identification of initial themes according to the interview guide, (2) agreement on themes by three researchers, (3) writing descriptive summaries, making initial interpretations, and clustering the themes within and across focus groups, and (4) discussion among researchers and summary of results including selection of quotes to illustrate the findings. We relied on a phenomenological approach to thematic analysis, permitting both expected and unexpected patterns to emerge from the data (Castellini and Graffigna, 2022); as an exception, we structured the analysis of results pertaining to the canteens' promotions of plant-based food according to Attwood et al. (2020) behavioral change interventions. All analyses were carried out in the original language (Norwegian) and then translated to English; although the translations may have been modified to ensure readability, we have strived to preserve their original meaning.

3 Results

Our analyses uncovered distinct food choice motives, canteen preferences and sustainability considerations across three consumer segments.

3.1 Distinguishing food choice motives of different consumer segments

The survey data on food choice motives were first visualized with a principal component analysis, displayed in Figure 2, and the three identified consumer segments were further refined through cluster analysis and HCA. The majority (201 respondents) seems to converge on the same motives in cluster 2, while there are fewer respondents in segment 1 (98) and segment 3 (138). When delving into their food choice motives, segments 1 and 3 appear distinct; where the former prioritize individually oriented motives, such as pleasurable sensation or weight control, the latter place importance on sustainability aspects. Segment 2 seems to balance these motives, along with more emphasis on animal welfare and convenience than the other two segments. Figure 3 provides a full summary of the most highly rated food choice motives for each segment.

Table 4 shows the segments' demographics and differences in their compositions. Overall, age, income level, and household composition do not vary significantly across segments. Conversely, gender differs significantly between segments 1 and 3, with more males in the former and more females in the latter. Educational level is also significantly different, though between segments 1 and 2; segment 2 comprises more respondents with university degrees, nearly 90%, while there are more who finished their education after high school (or earlier) in segment 1. Going by these demographics, females appear more prone to consider sustainability motives and those with university degrees may be less likely to only consider personal benefits.

TABLE 3 Overview of canteens frequented by focus group participants.

	Canteen 1	Canteen 2	Canteen 3	Canteen 4	Canteen 5	Canteen 6	Canteen 7
Focus group	*Physical*	*Physical & online*	*Online*	*Online*	*Online*	*Online*	*Online*
Location	Stavanger	Oslo	Bergen	Greater Oslo	Greater Oslo	Greater Bergen	Stavanger
Price model	Buffet	Per piece/meal	Per piece/meal or weight	Per piece/meal or weight	Per piece/meal	Per piece/meal or weight	Per piece/meal or weight
Warm meal portioning	Self-service	Pre-portion	Pre-portion	Self-service	Pre-portion	Self-service	Pre-portion
Guests daily	400–500	300–350	250	260	250	200	650
Opening hours	10:30–13:00	10:45–12:45	11:00–13:00	10:30–13:00	10:30–13:00	Not provided	10:45–13:00

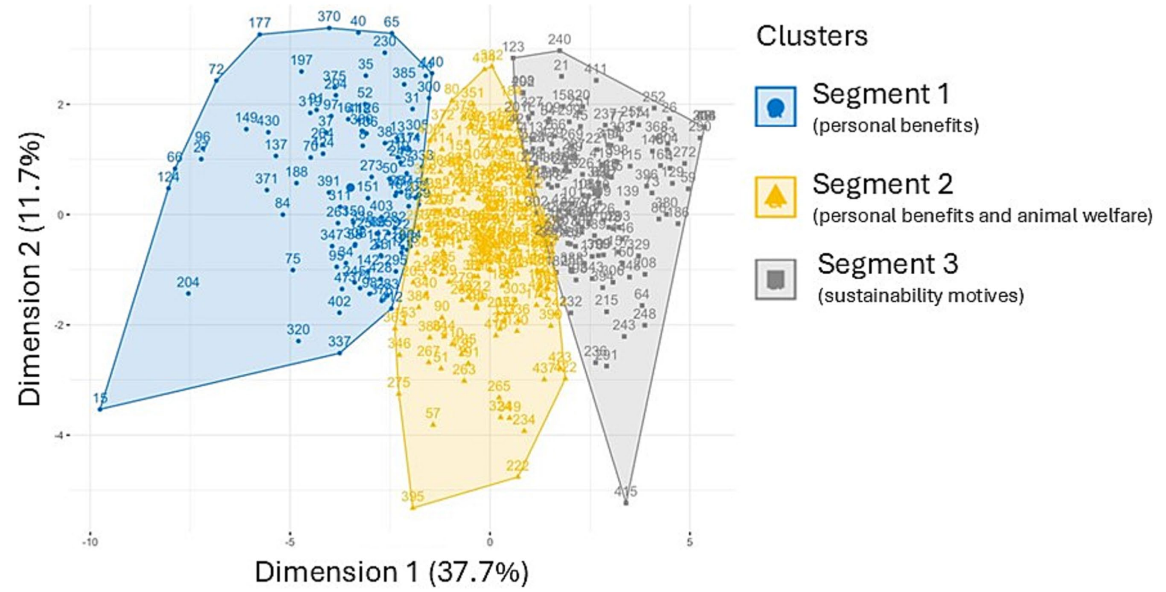

FIGURE 2
Plot from principal component analysis of average food choice motive scores, with highlighted clusters obtained through hierarchical clustering analysis.

3.2 Consumer priorities and sustainability considerations in the canteen

3.2.1 Dietary and health preferences

The three identified consumer segments differ not only in their general food choice motives, they are also distinct in what they prefer the canteen to provide and how it relates to their food habits at home (Table 5). Respondents in segment 1, with their general focus on personal benefits, seem less prone to trying out new types of food and are less concerned about cooking healthier meals at home, compared to the other two segments. Segment 3, who are oriented toward sustainability in their motives, are also the most influenced by the food in the canteen and the most concerned about healthy cooking at home, when it comes to trying out new dishes they seem in line with the respondents in segment 2.

3.2.2 Convenience, enjoyment, and economic factors

The distinction in canteen preferences between the three segments extends to their perspectives on how easy, practical, enjoyable, and affordable the meal offers should be (Table 6). Somewhat surprising are the lower scores for the personal benefit consumers in segment 1, on the preference for a relaxing and enjoyable meal, compared to segment 3. Additionally, segment 2 rated offers, promotions, and price in general as significantly less important than segment 3, which again seems at odds with the segment's profile. With that said, the consumers in segment 3 were generally scoring all aspects higher than the other two segments.

3.2.3 Sustainability concerns

Again, the three consumer segments are distinct in what they consider important in the context of the canteen (see Table 7). Food choice with regards to sustainability is consistent between canteen and at home—where segment 3 rates highest on "trying to eat sustainable food" and segment 1 has the lowest rating. Consistent with the initial clustering, segment 3 placed the highest importance on the different sustainability aspects of the canteen's offerings, along with the food eaten at home. Segments 1 and 2 were fairly aligned in their preferences for pricing, ordering, and portion sized, yet segment 2 was generally more concerned about the sustainability and origin of their food. In contrast, respondents across segments reported similar association to sustainability in the context of food, as seen in Table 8.

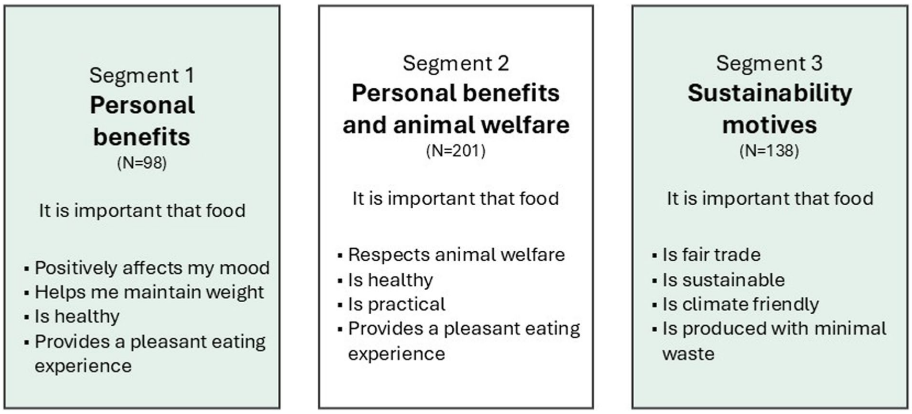

FIGURE 3
Food choice motives characteristic of the three consumer segments identified through clustering.

TABLE 4 Segment demographics, significant differences ($p < 0.05$) between segments are indicated by contrasting letters (A vs. B).

		Segment 1 Personal benefits	Segment 2 Personal benefits and animal welfare	Segment 3 Sustainability motives
Gender	Male	57.1%^{A}	45.3%^{AB}	36.9%^{B}
	Female	42.9%^{B}	54.7%^{AB}	63.1%^{A}
Age group (in years)	≤ 29	19.4%	16.9%	16.7%
	30–39	27.6%	26.4%	27.5%
	40–49	26.5%	30.3%	30.4%
	50–69	26.5%	26.4%	25.4%
Individual income level	<1.000.000 NOK (≈ €87.000)	73.5%	66.2%	68.8%
	≥ 1.000.000 NOK (≈ €87.000)	19.4%	28.9%	25.4%
	Undisclosed	7.1%	5.0%	5.8%
Educational level	High school, or below	25.6%^{A}	12.8%^{B}	18%^{AB}
	University degree, Bachelor or above	74.4%^{B}	87.2%^{A}	82%^{AB}
# adults in household	1	35.7%	25.9%	32.6%
	2	50.0%	59.7%	55.1%
	3 or more	14.3%	14.4%	12.3%
# kids in household	None	58.2%	54.2%	54.3%
	1 or more	41.8%	45.8%	45.7%

The only significant differences in these ranked associations were observed for health and plant-based produce, with the first prioritized by more respondents in segment 1 and the latter by fewer respondents in the same segment, compared to the other two segments.

3.3 How do consumer preferences align with more plant-based canteen offers?

3.3.1 Meat reduction and plant-based alternatives

The survey respondents' preferences for plant-based offers align well with their animal welfare and sustainability orientations, or lack thereof. As seen in Table 9, those in segment 1 were consistently less positive to plant-based food in the canteen than segments 2 and 3, including vegetables, meat replacers, and meat-free days, even when price could be an incentive. At the same time, segment 1 provided the highest ratings on the wish for more meat in the canteens. Although these scores do not tap into the consumers' motives, they are consistent with segment 2's consideration for animal welfare and segment 3's sustainability concern.

3.3.2 Drivers for choosing plant-based dishes in the canteen

The focus groups uncovered that the most important drivers for choosing plant-based food in the workplace canteen are current eating habits, that is, consumers with a vegetarian or vegan lifestyle naturally chose these options in the canteen. Also, eating healthy and considering one's wellbeing can also motivate

TABLE 5 Respondents' dietary and health preferences and attitudes, grouped by segment.

	Segment 1 Personal benefits	Segment 2 Personal benefits and animal welfare	Segment 3 Sustainability motives
I try to eat healthier in the canteen than at home	3.56	3.47	3.79
I try to cook healthier at home than what I eat in the canteen	3.43^{C}	4.01^{B}	4.72^{A}
What I eat in the canteen influences what I eat at home	3.06^{B}	3.49^{B}	3.94^{A}
I usually eat the same type of food at home as in the canteen	3.20	3.12	3.32
My colleagues inspire me to try new foods in the canteen	2.71^{B}	2.98^{AB}	3.37^{A}
I dare to try new dishes if available in the canteen	4.87^{B}	5.60^{A}	5.64^{A}

All items were rated on Likert scales ranging from 1, not important, to 7, very important; significant differences ($p < 0.05$) across segments are indicated by contrasting letters (A vs. B vs. C).

TABLE 6 Respondents' preferences and attitudes related to convenience, enjoyment, and economic factors, grouped by segment.

	Segment 1 Personal benefits	Segment 2 Personal benefits and animal welfare	Segment 3 Sustainability motives
What I eat in the canteen is usually driven by offers and promotions	3.09^{AB}	2.90^{B}	3.47^{A}
What I eat in the canteen is usually driven by price	3.35^{AB}	3.01^{B}	3.72^{A}
It is important to have a fast meal when I eat in the canteen	4.13	3.99	4.17
I want to be full (satiated) after eating in the canteen, so that I do not need such a big meal at home	3.82	3.95	3.98
I relax and enjoy the meals in the canteen	4.34^{B}	4.66^{AB}	4.94^{A}

All items were rated on Likert scales ranging from 1, not important, to 7, very important; significant differences ($p < 0.05$) across segments are indicated by contrasting letters (A vs. B).

food choices. Several men highlighted the importance of proteins, both for satiety and building muscles. Particular to the canteen setting, appearance, taste, color and food consistency are central drivers in the choice of plant-based dishes, along with being able to see the ingredients and not just a "mash" of something unrecognizable. One woman said: *"It has to look good and inviting, then it does not matter, I would not choose it because it says vegan but because it looks good."* Clearly colorful and tempting dishes were preferred and could contribute to choosing even more plant-based meals.

The participants who ate little vegetarian food appreciated the mouthfeel and texture of meat, and many wanted meat substitutes to look like familiar products. Their largest barriers to choosing plant-based dishes in the canteen are the liking, affinity and familiarity with meat, "*when you eat meat, you know what you get*," together with the small selection of vegetarian dishes on offer. Tradition, well-established food habits and skepticism to trying something new were also mentioned multiple times in the focus groups. Furthermore, several consumers said that they did not choose vegetarian dishes because they were too heavy with cream and cheese. The fact that plant-based dishes are often placed less prominently than the meat appears as an additional barrier. Conversely, those who already adhered to a plant-rich diet would rather avoid meat replacers and pre-processed products. Instead, these consumers would like to have nutritionally complete meals made from scratch.

3.3.3 Encouraging plant-based food choices in the canteen

Following a proposed structure to behavioral change interventions (Attwood et al., 2020), the focus groups touched on outcomes related to promotion, placement, presentation, and product. The participants suggested the following activities for *promotion* of plant-based dishes: Using internal digital channels (Yammer, FB@work) to talk about the food, share recipes from the canteen, run campaigns/hand out taste samples, and not having a separate "vegetarian" section on the menu but integrate plant-based. In terms of *placement*, the consumers suggested placing plant-based dish first and highly visible and making self-service stations, like the salad bar, more engaging. Regarding *presentation*, the canteen guests would have liked better descriptions of vegetarian dishes using positive adjectives such as tasty or spicy. More tempting and colorful dishes should also motivate plant-based choices, along with communications highlighting climate and sustainability. As for the actual *product*, the participants thought they would be encouraged by dishes that contained pulses, more Norwegian and seasonal ingredients, and did not have strange raw materials and ingredient combinations. Several participants wanted better nutritional content and information for the plant-based dishes. A larger variety of vegetarian dishes would also encourage canteen guests to choose these more often.

3.3.4 Contextual spillover from the canteen to the home

One of the important areas of inquiry in this study was whether and how the canteen can influence consumers' food choices at home and thus contribute to an even bigger change. In the focus groups, we found that guests are inspired by others who choose vegetarian, even tempting them to try the same at home. If canteens supplied recipes for good vegetarian dishes, some thought it would be easier to cook these at home. While consumers make the choice only for themselves in a canteen, several participants described

TABLE 7 Respondents' sustainability concerns, preferences, and attitudes, grouped by segment.

	Segment 1 Personal benefits	Segment 2 Personal benefits and animal welfare	Segment 3 Sustainability motives
I try to eat sustainable food at home	2.92[C]	4.80[B]	5.50[A]
I try to eat sustainable food in the canteen	2.67[C]	4.32[B]	4.94[A]
The origin of the food, or whether it is organic, is important to me when I choose food in the canteen	2.23[C]	3.57[B]	4.62[A]
Pre-ordering lunch in the canteen could help me choose more sustainable	2.85[B]	3.25[B]	4.05[A]
Weight-based pricing of meals in the canteen would help me in reducing food waste	3.60[B]	3.84[B]	4.38[A]
Offering different portion sizes in the canteen would help me in reducing food waste	4.36[B]	4.62[B]	5.25[A]

All items were rated on Likert scales ranging from 1, not important, to 7, very important; significant differences ($p < 0.05$) across segments are indicated by contrasting letters (A vs. B vs. C).

TABLE 8 Most frequently selected respondents' associations with sustainability in the context of food, presented as the overall number of respondents selecting an item as one of the five most important aspects, and as the share of respondents within a segment.

	Number of respondents selecting item as top five (n = 437)	Segment 1 Personal benefits (n = 98)	Segment 2 Personal benefits and animal welfare (n = 201)	Segment 3 Sustainability motives (n = 138)
1. Less food waste	304	66	136	102
2. Local food	277	66	127	84
3. Ethical production/farming	265	61	126	78
4. Carbon footprint	232	49	113	70
5. Health	228	63[A]	95[B]	70[B]
6. Animal welfare	217	51	94	72
7. Norwegian raw materials	176	46	73	57
8. More plant-based food	166	26[B]	84[A]	56[A]
9. Less meat	164	31	85	48
10. Organic	124	24	55	45
11. 100% vegetarian/vegan	32	7	17	8

Significant differences ($p < 0.05$) across segments are indicated by contrasting letters (A vs. B).

their family situation steering what lunch and dinner option at home. People who live alone often had their main meal at the workplace canteen while couples or families with children had their main meal at home, after work: *"Having three children, we traditionally eat hot dinners, so it is usually a salad in the canteen."* As several participants pointed out, Norwegian tradition also speaks for a lighter lunch and a more filling meal later on: *"Salads are more lunch food. More vegetarian at work than at home."* The quality of the meat led some to reserve it for meals at home *"I eat some meat, do not prioritize it in the canteen."* An interesting comment about ethnic food also highlighted that the canteen may have shortcomings regarding good dishes and recipes that are familiar to all of their guests: *"At home, I would have chosen traditional ethnic food; Lebanese, Indian."*

4 Discussion

Food choices can be influenced by external factors, such as policies, social norms, and environmental cues, they are also guided by internal states and other individual factors (European Vegetarian Union, 2023; Lorenz and Langen, 2018; Onwezen et al., 2019). Accordingly, the motives behind food choices vary both across situations and across individuals, which extends to the importance placed on the sustainability of food options available in the food sectors (Onwezen et al., 2019; Verain et al., 2021). In this context, workplace canteens can provide controlled environments for studying the effects of situational factors on individuals' food choices, also setting the scene for interventions to steer food choice motives toward sustainability. While some real-life implementations have yielded promising outcomes (European Vegetarian Union, 2023), these types of interventions do not always lead to the desired outcome; some consumers remain unaffected (Bianchi et al., 2018), others may even engage in reactive behavior (Lombardini and Lankoski, 2013). Following the sound advice of including the opinions of those involved at an early stage (Lorenz-Walther and Langen, 2020), we addressed canteen consumers' perspectives on current canteen offers, which changes could encourage more sustainable food consumption behavior, and whether canteen habits transferred to the household. Our findings showcase individual differences in food choice motives, both across gender and segments, and they shed light on potentially fruitful means to incorporate

TABLE 9 Respondents' preferences and attitudes related to meat reduction and plant alternatives.

	Segment 1 Personal benefits	Segment 2 Personal benefits and animal welfare	Segment 3 Sustainability motives
I wish there were more plant-based foods in the canteen	2.76[B]	4.32[A]	4.67[A]
I wish there were more vegetable based dishes in the canteen	3.38[B]	4.73[A]	5.06[A]
I wish there were more dishes with plant-based meat replacers (e.g., vegetarian burgers) in the canteen	2.54[B]	3.63[A]	4.02[A]
One meat-free day a week in the canteen is a good idea	3.91[B]	5.24[A]	5.48[A]
If the plant-based alternatives were cheaper than the meat-based ones, I would choose plant-based more often	3.12[B]	3.92[A]	4.34[A]
I wish there were more meat-based foods in the canteen*	3.74[A]	2.64[B]	2.91[B]

All items were rated on Likert scales ranging from 1, not important, to 7, very important; significant differences ($p < 0.05$) across segments are indicated by contrasting letters (A vs. B). *Note the reverse formulation.

sustainability interventions in workplace canteens and other food outlets.

4.1 Food choice motives and sustainability orientations across consumer segments

Three consumer segments were identified from the surveyed food motives, spanning from the food's healthiness, climate impact, and moral implications to its convenience, affordability, and enjoyment; the profile of each segment aligned with the consumers' respective concerns regarding sustainability. The first, and smallest, segment was characterized by motives related to pleasantness and positive mood, as well as healthiness and maintaining weight. The second, and largest, segment was similarly characterized by health and pleasantness motives, but also practicality and animal welfare. Finally, the third segment stood out with its sustainability motives, related to fair trade, climate impact, and waste reduction. Consistent with their motives, consumers in this third segment rated their sustainability concerns higher than the others, both with respect to their food preferences, in the canteen or at home, and with respect to their attitudes to means that might reduce food waste. On items directly addressing eating sustainable or organic food, segment 1 stood out in the opposite direction, while consumers in segment 2 covered the middle ground.

Consumers are not a homogenous group, although some food motives are common to most, others are more variable (Wahl et al., 2020) and likely linked to internal factors such as personal preferences and values (Lorenz and Langen, 2018), as well as external factors such as social norms and environmental cues (Lorenz and Langen, 2018; Onwezen et al., 2019). The consumer segments identified in this work corroborate earlier findings, with only a smaller share of the respondents prioritizing sustainability motives such as climate impact, production waste, and fair trade. This was also the segment with the largest share of female respondents (two thirds). This is consistent with earlier works on gender differences in prioritizing sustainability and choosing alternatives to meat (Abel and Totland, 2021; Hielkema et al., 2022). While age and educational level did not stand out for the sustainability segment, there were fewer respondents with university degrees in the personal benefits segment (Abel and Totland, 2021).

4.2 Canteens going green: encouraging plant-based food choices

Diets oriented toward sustainability should reduce meat consumption and increase the intake of plant-based alternatives (Willett et al., 2019), which was reflected in the consumer segments' attitudes to plant-based meals. Segments 2 and 3, aligned, respectively, toward animal welfare and sustainability, were more positive to all the plant-based canteen offers, vegetables, meat replacers, or meat-free days; conversely, segment 1 expressed a comparatively stronger wish for more meat in the canteen. The focus groups corroborated these results. Participants expressed that current eating habits were their main dietary drivers, with those opting for vegetarian or vegan lifestyles making consistent choices in the canteen, and those motivated by healthy and nutritious diets doing so across food settings. Alongside their seeming reluctance to embrace a more sustainable diet in the workplace canteen, segment 1 also reported significantly lower willingness to explore new dishes in the canteen compared to segments 2 and 3. These observations uncover a potential pitfall for canteens transitioning toward a more plant-based selection, they may run the risk of losing consumers due to reactance (Lombardini and Lankoski, 2013).

With respect to promoting new options, the focus groups spoke in favor of emphasizing the positive aspects of plant-based dishes, much in line with recommendations to enhance the visual or descriptive appeal (Attwood et al., 2020; Bianchi et al., 2018) and to use sensory, geographic, or nostalgic name labels (Ohlhausen and Langen, 2020). The prevailing opinions were also to avoid promoting the vegetarian status of a dish, or grouping these options in a separate menu section, particularly when the goal is to include omnivorous consumers in the dietary shift. This feedback coincides with previous studies that encourage the use of nudging and social marketing strategies (Bianchi et al., 2018; Krpan and Houtsma, 2020; Langen et al., 2022; Ohlhausen and Langen, 2020), and which have shown that effects can be lasting (Bianchi et al., 2018; Lombardini and Lankoski, 2013; Velema et al., 2018). Also consistent with earlier findings, the focus groups highlighted the placement and selection of plant-based dishes, with some participants expressing preferences for familiar foods rather than meat replacers (Varela et al., 2022) and some arguing for making them more prominent (Bianchi et al., 2018; Langen et al., 2022).

4.3 Consumers going green: taking the message home

One of the important questions of this study was whether and how the food offered in workplace canteens can influence consumers' food choices at home. With such a contextual spillover, the change toward more sustainable, healthy, and plant-based foods would go beyond the canteen setting. So far, research in this domain has mainly inquired about how the offered meal choices influence nutritional and sustainability related aspects in the canteen (Attwood et al., 2020; Hielkema et al., 2022; Lorenz-Walther and Langen, 2020). However, a few studies have demonstrated contextual spillovers from the canteen to the home both for healthy (Lassen et al., 2011) and meat-reduced food options (Lachat et al., 2009; Lassen et al., 2011; Poulsen and Jørgensen, 2010; Verfuerth et al., 2021). Not surprisingly, the connections between consumers' food-related behavior and sustainability concerns were consistent between the canteen and home setting, across all segments; this suggests that their attitudes to sustainability do not depend on the context but are likely founded in personal values. Consumers who are oriented toward sustainability in their choice motives, are also the most influenced by the food in the canteen and the most concerned about healthy cooking at home, particularly for segment 3. At the same time, many are open to trying new dishes in the canteen and at home. Inspiration from colleagues who follow a vegetarian diet can motivate others to choose more plant-based dishes. Because of the better quality of meat consumers can buy and prepare themselves, some do not eat meat in the canteen but only at home.

Participants' family situation and food preferences strongly influenced choices in the canteen and at home, consistent with earlier studies (Lorenz and Langen, 2018; Onwezen et al., 2019; Varela et al., 2022). Single households rely more on the canteen for their main meal, whereas those who live with a family may choose a salad for lunch and instead prioritize a warm dinner in commensality with the household. Hopefully, choosing the green option in the canteen will not serve as a justification for a sufficient daily plant intake, which could have negative bearings for the family meal. Still, canteens can contribute to a positive dietary change through several means, for example offering new dishes that may spur curiosity of canteen guests or handing out recipes on plant-based or ethnic dishes. This might however not work for consumers in segment 1, as they are less interested in trying out new dishes and are less concerned about cooking healthy or sustainable meals at home. This opens the door to investigate the interplay between canteen and in-home consumption further.

4.4 Recommendations, implementations, and future research

By grouping consumers into segments based on distinct sustainability orientations, food choice motives, and meal preferences, our study accentuates the potential benefit of adopting multiple strategies when planning sustainability interventions, in canteens and elsewhere. The many means available have been thoroughly documented by others, including appealing, positive, and varied presentations and descriptions, and nudging through strategic menu design, default options, and re-structured environments (Attwood et al., 2020; Bianchi et al., 2018; Krpan and Houtsma, 2020; Langen et al., 2022; Lorenz-Walther and Langen, 2020; Ohlhausen and Langen, 2020; Pandey et al., 2023; Perez-Cueto, 2021; Taufik et al., 2022; Zhang et al., 2022). Our findings also showcase that males are over-represented in the segment prioritizing personal benefits, indicating a need to emphasize benefits other than a product's climate-friendliness, for instance the food's origin, quality, sensory appeal, or sociocultural significance. Our focus groups corroborated the importance of sensory and nutritional quality, suggesting that canteen guests' interest in plant-based dishes could be drawn by appealing, positive, and varied presentations and descriptions. To better understand which interventional means hold the most potential for persuasion, we need to extend the current body of research with studies that take the step from consumer segmentation to targeted interventions. Because the limitation of food choices may create tensions, there is also need for careful planning, monitoring, and stakeholder involvement in the food sectors (Mikkelsen et al., 2021). This underscores the important role that canteens can play in testing interventions and mandating vegetarian offerings in canteens and other outlets, promoting consumer autonomy while shifting dietary behaviors. The EU, and other authorities, acknowledge the potential of canteens in the green shift, through existing strategies built on evidence-based information for promoting green and plant-based meals (Boyano Larriba et al., 2019). Informed by the insights derived from this and related works (Attwood et al., 2020; Lacroix and Gifford, 2020; Langen et al., 2022), future research could consider innovation adoption approaches to facilitate sustainable and plant-based food choices; in so doing, canteens and other food venues will be equipped to uncover and endorse the relative advantage, compatibility, trialability, and observability of sustainable options, as well as reducing their complexity (Gonera et al., 2021). Involving consumers in a co-creative process has the potential to make the canteen change more interesting and relevant (Bentsen and Pedersen, 2021; Sijtsema and Snoek, 2023).

5 Conclusion

There exists no single consensus among consumers on the importance of different food choice motives, nor in preferences for sustainable and plant-based options. The three consumer segments identified in this work are generally motivated by personal benefits, by both benefits and animal welfare, and by sustainability. While the latter segment will presumably only need available options to make environmentally friendly choices, the other two may need targeted and distinct approaches to facilitate food choices and behaviors that lessen the planetary impact. One thing that most seemed to agree on, was the advantage of promoting a dish's appeal over its lack of meat. Regardless of the approach, we have observed that effective communication regarding food offerings is crucial and presents significant room for improvement in workplace canteens. By incorporating the consumer perspective in future innovations that promote the green shift, canteens can boost their potential as arenas for change, hopefully extending beyond the workplace over time.

6 Limitations

Methodologies that rely on subjective memory and tap into self-representation are vulnerable to omissions and biases, yet they are also the best suited for scoping out the preferences and perspectives of specific target groups. In this work, we sought out the food-related motives, attitudes and preferences of regular canteen customers and their responses should not be generalized to other populations. Furthermore, since workplace canteens host people that work together, their viewpoints may be similar; this potential issue we have strived to diminish by recruiting from 19 different canteens. Another challenge in this type of research is that the recruited sample could reflect the most eager, engaged, and/or dutiful, it can be hard to reach those who do not normally expose themself in their work situation or have no opinion or obligation toward the topic (Lucas and Buzzanell, 2004). We were unable to recruit blue-collar canteen guests to the survey and focus groups, which is reflected in the much larger number of office workers than hands-on workers in Table 1. In consequence, this adds further limitations to the study's generalizability.

Data availability statement

The datasets presented in this article are not readily available because of reasons related to GDPR and proprietary information. Depending on the purpose, parts of the data set may still be shared upon request. Requests to access the datasets should be directed to antje.gonera@nofima.no.

Ethics statement

The studies involving humans were approved by Nofima's Ethical Board. The studies were conducted in accordance with the local legislation and institutional requirements. The participants provided their written informed consent to participate in this study.

Author contributions

RE: Conceptualization, Formal analysis, Writing – original draft. AG: Conceptualization, Formal analysis, Funding acquisition, Investigation, Project administration, Writing – review & editing. ISG: Formal analysis, Investigation, Methodology, Writing – review & editing. MEP: Formal analysis, Investigation, Methodology, Writing – review & editing. PV: Conceptualization, Investigation, Methodology, Writing – review & editing.

Funding

The author(s) declare that financial support was received for the research, authorship, and/or publication of this article. This project was funded by the Research Council of Norway through the IPN project "Food(R)evolution" (# 321532) and the Norwegian Fund for Research Fees for Agricultural Products (FFL) through the project "FoodForFuture" (# 314318).

Acknowledgments

The authors acknowledge the valuable collaboration with the project participants Coor Service Management AS, Orkla Foods Norge AS, HOFF SA, Foodback AS, and Æra Strategic Innovation AS, which has paved the way for future innovations in the food service domain. The authors also extend their gratitude to the many canteens, their employees, and their guests, who have contributed with their time and inputs.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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frontiers | Frontiers in Sustainability

TYPE Original Research
PUBLISHED 06 January 2025
DOI 10.3389/frsus.2024.1469285

Designing social behaviour change in households: sustainable mobility intervention and follow-up study

Saga Sofia Santala[1,2]*, Merja Honkanen[3], Michael Lettenmeier[2,4,5], Jari Kolehmainen[4] and Salla Lahtinen[4]

[1]Strategic Foresight, Strategy and Transformation, KONE Corporation, Espoo, Finland, [2]NODUS Sustainable Design Research Group, Department of Design, School of Arts, Design and Architecture, Aalto University, Espoo, Finland, [3]Strategic Design, Technology and Innovation, KONE Corporation, Espoo, Finland, [4]D-mat Ltd., Helsinki, Finland, [5]Division of Sustainable Consumption, Wuppertal Institute for Climate, Energy and Environment, Wuppertal, Germany

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EDITED BY
Elisabeth Süßbauer,
Technical University of Berlin, Germany

REVIEWED BY
Bhavana Vaddadi,
Royal Institute of Technology, Sweden
Aya Yoshida,
National Institute for Environmental Studies (NIES), Japan

*CORRESPONDENCE
Saga Sofia Santala
saga.santala@aalto.fi

RECEIVED 23 July 2024
ACCEPTED 05 December 2025
PUBLISHED 06 January 2025

CITATION
Santala SS, Honkanen M, Lettenmeier M, Kolehmainen J and Lahtinen S (2025) Designing social behaviour change in households: sustainable mobility intervention and follow-up study.
Front. Sustain. 5:1469285.
doi: 10.3389/frsus.2024.1469285

Limiting global warming to 1.5 degrees requires consistent action by people to change their lifestyles in order to limit annual household-related carbon emissions to 2.5 tonnes per person by 2030. As the required mobility reduction measures have already been identified, the challenge remains in scaling up the changes into a mainstream practice. Our study explored whether the involvement of close social communities, especially households, in the change process could be effective in achieving the required measures. Through a Climate Puzzle game intervention and a six-month follow-up study with 12 households in Espoo, Finland, we investigated the role of close social communities in implementing the planned sustainable mobility behaviour change. The findings are presented through 12 household narratives. These narratives show that the adoption of new sustainable mobility behaviours is influenced by both (infra)structural and social relationship factors and that close social communities can hinder or facilitate the shift of everyday mobility behaviours towards being more sustainable in diverse ways. The findings suggest that design interventions should target larger social communities rather than just individuals in order to achieve the 2.5 tonne target. The study also indicates that socially tailored interventions and low-carbon solutions should be developed and targeted at city districts to help households create and maintain lifestyle changes.

KEYWORDS

1.5 degree lifestyles, sustainable mobility transition, household travel behaviour, close social community, design for behaviour change, design game, intervention, follow-up study

1 Introduction

To respect planetary boundaries, an annual lifestyle carbon footprint (LCF) limit of 0.7 tonnes CO_2e per person must be achieved globally by 2050, with an interim target of 2.5 tonnes per person by 2030 (Akenji et al., 2021). In Finland, achieving the 0.7 tonnes target will require a 93% reduction in the current CO_2e footprint. Mobility—referring here to moving from A to B—accounts for 38% of the current LCF and therefore necessitates specific mitigation measures. As the required mobility emission reduction measures have already been identified, such as switching to electric vehicles, shared mobility and remote work, the remaining challenge is to scale up the adoption of these sustainable mobility practices.

Research on sustainable mobility behaviour change and related interventions have primarily focused on individual behaviours and approaches to change, which practice theorists have critiqued for not addressing the complex dynamics of socially interconnected (mobility) practices and achieving the required change (Spurling et al., 2013; Shove et al., 2012). It has been suggested that identifying and engaging influential communities is a potential means of shifting mobility practices towards more sustainable (Nielsen et al., 2021; Brynjarsdottir et al., 2012). However, comprehensive knowledge and methods to understand the impact of social communities on promoting sustainable mobility practices are still needed.

This paper explores whether the involvement of close social communities could effectively achieve the required change. Close social communities are defined as groups that are in regular contact and that have a sense of belonging. Using a Climate Puzzle game intervention (Nielsen et al., 2021), 12 households from Leppävaara and Espoonlahti in Espoo, Finland, were engaged in discussions among household members about their daily mobility practices. Leppävaara, an established district with rail connections, and Espoonlahti, a developing district with a new metro extension, were chosen for their high car use rates as well as diverse socio-economic demographics and transport infrastructure. Followed by a six-month follow-up study, we examined the role of the close social community, especially the household community, in implementing the planned sustainable mobility behaviour changes and assessed the potential of the Climate Puzzle intervention to drive the required change.

The paper first reviews the discourse on sustainable mobility behaviour change, emphasising the influence of close social communities on achieving a 2.5 tonne lifestyle by 2030. It then describes the design for behaviour change approach using the Climate Puzzle intervention and a mixed-method follow-up study. This illustrates the impact of close social (household) communities in shaping people's daily mobility practices through narrative descriptions of 12 households in Espoo. Finally, implications are drawn for designing sustainable mobility behaviour by discussing the social factors that affect mobility behaviour at different levels, from the close social community to the broader district and city level.

2 Background

Here we describe the current discourse on 1.5 degree lifestyle targets in the context of sustainable mobility. We frame the problem space and highlight the need for understanding mobility behaviours, and what is required to change them, from a social perspective for achieving the required change towards a 2.5 tonne lifestyle by 2030.

2.1 Requirement for lifestyle changes

The international climate debate has increasingly recognised the role of lifestyle changes in meeting the goals of the Paris Agreement (UNEP–United Nations Environment Programme, 2020). Current lifestyle carbon footprints (LCFs) far exceed the levels needed to meet the 1.5 degree climate target, particularly in high-income countries (Akenji et al., 2021). In Finland, a 74% reduction in average LCFs is required by 2030, with similar reductions required in other high-income industrialised countries and significant reductions required in many middle-income countries. Mobility, a major contributor to LCFs, often exceeds one-third of the total LCF in high-income countries. This means that mobility alone could exceed the target level of 2.5 tonnes per person per year for total LCFs by 2030. The high share of private vehicle emissions is due to a significant overall demand for transportation with a high reliance on car use and carbon-intensive air travel. In Finland, the average reduction target for private transport is over 80%, with car use being a major contributor to the current unsustainable situation. Car use comprises the greatest share (55%) of the average personal transport carbon footprint in Finland, and car use alone accounts for 21% of the LCF of the average Finn (Akenji et al., 2021).

Sustainable mobility seeks to ensure that transport systems fulfil society's economic, social and environmental requirements while minimising negative impacts (Council of European Union, 2006). Traditional sustainability models, which distinguish between economic, environmental and social dimensions, have been critiqued for understating the environmental significance, the foundation of all human activity (Giddings et al., 2002; Kuhlman and Farrington, 2010). This has led to the concept of ecological sustainability, which emphasises that human activities should remain within nature's carrying capacity, thereby preserving vital ecosystems (e.g., Hirvilammi, 2015).

Finland's public transport infrastructure is well-developed. It includes a variety of modes such as buses, metro networks, light rails, city bikes and special mobility services for elderly people and people with severe disabilities. The country places a strong emphasis on sustainability and efficiency in its transport system, which is known for its punctuality and comfort. Depending on trip length, a single ticket for adults costs EUR 2.95–4.50 and a season ticket EUR 55–100 per month. In comparison, the total monthly costs of owning and using a car in Finland is estimated to be approximately EUR 500, including expenses such as fuel, insurance, maintenance and depreciation. Espoo, located in the capital area, is the second largest city in Finland. It has a long tradition of private car ownership which is strongly supported by its road infrastructure and rooted in local social norms. In 2023, the mode share for trips in Espoo was 40% by private cars, 20% by public transport, 30% by foot and 9% by bicycle. Annually, there are a total of 1.6 billion kilometres of car journeys in Espoo (City of Espoo, 2024).

Reducing car-based mobility and encouraging a shift to more sustainable travel modes is essential for lowering transport-related LCFs (IGES–Institute for Global Environmental Strategies, Aalto University, and D-mat Ltd, 2019). The transition to sustainable mobility patterns, especially in high-income countries, is long overdue, when considering the urgency of limiting global warming to 1.5°C. This transition involves understanding how individual mobility is a practice that is shaped by cultural influences rather than solely focusing on individual decision making (Barr, 2018). Examining how society affects mobility and promotes hypermobility reveals how provisioning systems have steadily increased the level of car dependency (Barr, 2018; Mattioli et al., 2020), of which Espoo is a good example. Brand-Correa et al. (2020) explain that the development of provisioning systems has made mobility a particularly challenging sector for climate change mitigation. In highly mobile, car-oriented OECD countries, changes in personal mobility are often restricted by real or perceived external constraints (Moriarty and Honnery, 2021). However, since most mobility-related emissions occur during the use phase (Sala and Castellani, 2019), considering mobility practices on a behavioural level is crucial in order to achieve a transition to sustainable mobility. Encouragingly, studies show that many people experience improved quality of life when adopting a 1.5 degree lifestyle (Leiviskä, 2021; Vänttinen, 2021).

2.2 Importance of social community-based research

Previous attempts and established policy approaches to decarbonise transport have targeted especially individuals as responsible for their actions. Here human action is framed as a matter of individual choices, and behaviours are seen to result from attitudes (Shove, 2010). The limited success of interventions following from this framing and failure to drive broader sustainable mobility transitions, calls for 'an alternative approach to human action to inform interventions' (Watson, 2012). We follow the suggestion to address the broader social structures and environments that shape actions (Hoolohan and Browne, 2020; Schwanen et al., 2012) by exploring a less researched close social community approach in the attempt to decarbonise mobility practices. Next, we build our argument by highlighting the potential of such an approach based on existing literature.

Previous research on changing travel behaviour has focused on predicting individuals' mobility behaviour based on diverse factors such as age, gender, income, reason for travel, travel time and cost, and transportation environments (Ding and Zhang, 2016; Le et al., 2018; Cools et al., 2010). Subsequent studies have included personal habits, emotions, inertia, perceptions, attitudes, preferences, the role of satisfaction and past behaviours in mobility mode choice, and other socio-psychological factors to better predict mobility behaviour (De Vos et al., 2016; Légal et al., 2016; Rieser-Schüssler and Axhausen, 2012; Şimşekoğlu et al., 2015; Wang et al., 2021). Finally, the requirement to understand how social relations shape travel behaviour has been emphasised (Wang et al., 2021, para. 1), and theories of social practice have been suggested as an alternative way of understanding human action and transitioning towards sustainable mobility practices (Watson, 2012).

Research indicates that mobility behaviours are strongly associated with close social communities, such as households and families (Berg and Henriksson, 2020; Rau and Sattlegger, 2018), in which various boundaries and interdependencies influence daily mobility practices (Santala et al., 2024). For instance, a study by Chakrabarti and Joh (2019) shows that couples in dual-earning heterosexual households with young children use cars more often and use active travel modes (walking and cycling) and public transport less compared to those couples without children. A specific decline has been identified when couples transition to parenthood, with a further decline when their children turn school age (Chakrabarti and Joh, 2019). This shows that the constant flux in community compositions expose community members for changes in practices. On the other hand, Lin et al. (2018) highlight that also residential relocation and changes in social surroundings (personal networks and neighbourhood environments) can also expose individuals to changes in mobility practices.

Also, travelling as a group exposes individuals to different mobility practices. Zhang et al. (2018, p. 42) have investigated group travel behaviour, defined as 'two or more persons intentionally travelling together from a single origin to a single destination'. They suggest that group travel behaviour differs from individual travel behaviour across time and space. They also identified that group travel typically occurs during weekends, afternoons and on public holidays. Lorenzo et al. (2012) demonstrate the advantages of incorporating group travel histories into individual travel predictions. Gardner (2014) investigated how neighbourhoods as social and physical environments influence community mobility—moving from one community to another (Highton, 2000)—and highlights identity and social engagement as important social factors and strong motivators in community mobility, especially among older adults.

Also, norms and practices are highlighted as social aspects that form people's mobility patterns. For example, materials, meanings and competences are introduced as relevant elements that shape human action in practice theory (Shove et al., 2012). From a social perspective, meanings in particular can be seen to result from social encounters, motivating spatio-temporal movement. Then again, many competences are transferred from generation to generation, such as ways of refuelling a car or repairing a bicycle. Also, materials, such as a shared family car, are made available by community members. Accordingly, people's mobility practices are interconnected and influenced by their life situations and close social communities, such as family, friends and colleagues (Rau and Sattlegger, 2018; Santala et al., 2024).

The examples above show that transitioning to sustainable mobility is not solely an individual choice but is influenced by socio-cultural processes and personal and social factors (Gifford and Nilsson, 2014). Hence, building on this existing literature and a practice theoretical approach to human action, we frame behaviour as a matter of a performance of a socially shaped practice bound to an individual's close social community context. We take the stance that individuals' practices cannot be changed as separate from their social context, including the interdependencies among close community members and their interlinked practices. However, new knowledge and methods are needed to understand how travel behaviour (change) unfolds within social communities to identify both social matters that tie people to unsustainable patterns of travel as well as potential points of intervention into these practices. Our paper advances this knowledge by showing how social dynamics, interdependencies and interaction among close social community members in the context of Espoo impact how they implement new collaboratively negotiated mobility patterns in their daily lives.

2.3 Design for behaviour change approach

Studying behaviour change in the highly dynamic mobility and close social community context is challenging and methods for this are lacking. Taking an interventionist approach and intervening into communities' practices allows identifying how interdependencies among close social community members support (un)sustainable ways of travelling and can thereby reveal 'foothold for change' (Kent, 2022). Therefore, we adopt a Design for Behaviour Change (also behavioural design) approach to explore how to facilitate the transition to sustainable mobility practices within close social communities. Unlike traditional design approaches that focus on creating products to satisfy needs, behavioural design aims to influence behaviour through targeted interventions (Cash et al., 2020; Khadilkar and Cash, 2020). These interventions can range from micro-scale interventions (e.g., apps targeting individual behaviour) to macro-scale interventions (e.g., taxation or changes to cultural norms).

For our study, meso-scale interventions, which target social communities, are particularly compelling. We have identified the community-targeted intervention called Climate Puzzle as a novel method for investigating how (un)sustainable mobility behaviours unfold through social interaction within close social communities such as households. This design game incorporates gamified elements (Vaajakallio, 2012) and serves as a tool for dialogue, negotiation and collaborative planning among community members. Members select actions and design pathways to implement sustainable lifestyle practices in their daily lives. As behaviour change fundamentally includes a transformation of practices on a time continuum, the game is especially useful for our (follow-up) study as the incorporation of pathways allows investigating the implementation of selected actions and thus communities' sustainable practice transitions over time.

Originally developed to support households achieve a 1.5 degree lifestyle (Nielsen, 2020), the puzzle format and negotiation-based community engagement allow us to also explore how transport practices connect to other practices such as shopping, parenting and caring in the selected communities. This approach identifies the complex interlinkages between practices that bind community members to unsustainable mobility patterns. As such it can reveal new opportunities for effective interventions that consider the broader social community, an aspect that is often missing in existing interventions (Brynjarsdottir et al., 2012; Niedderer et al., 2014). The game also represents a multifaceted practice-based 'sustainable mobility intervention' (Santala et al., 2024) aimed at reducing car use and promoting alternative sustainable mobility practices. It influences households' current mobility practices and provides strategies and alternative behaviours that align with a 2.5 tonne lifestyle.

Simultaneously, taking an interventionist approach allows us to investigate the efficiency of an existing community-level intervention (the Climate Puzzle game) to explore whether a close social community approach can be effective in promoting transitions towards sustainable mobility practices. In general, the efficiency of behaviour change interventions is measured by their ability to shift behaviours in the desired direction. This raises ethical questions about what constitutes desirable change and who should decide this (Niedderer et al., 2014). Ethical considerations are crucial, particularly regarding who determines desirable behaviours and whose interests and responsibilities are involved in designing such interventions. Critiques of behavioural interventions often highlight the lack of user involvement in defining desirable changes, and the focus on individuals rather than communities, which can achieve more effective behaviour changes using collective approaches (Brynjarsdottir et al., 2012). The Climate Puzzle game shifts the power dynamics from top-down to bottom-up, giving those communities that are affected by change an active role in planning and implementing desirable changes. Hence, we approach ethics from an individual and community perspective, using a normative target for an overall reduction in lifestyle carbon footprint (IGES–Institute for Global Environmental Strategies, Aalto University, and D-mat Ltd, 2019).

Our study aims to shed new light on how close social communities affect the implementation of planned sustainable mobility behaviours and how this influences the design of sustainable mobility behaviour change. Firstly, this paper aims to describe ways in which close social communities enable or prevent individuals from changing their mobility behaviours. Secondly, we reflect on ways in which the social context should be considered in designing effective interventions for sustainable mobility practices.

3 Materials and methods

In this study, we used the Climate Puzzle game intervention (Nielsen et al., 2021; Nielsen, 2020) together with a follow-up study to understand how sustainable mobility practices unfold through interaction within close social communities. We begin by detailing the Climate Puzzle method followed by the mixed method (George, 2021) data collection and analysis process.

3.1 Climate Puzzle design game intervention

The Climate Puzzle game consists of a two-sided game board, a marker for target CF for 2030 and 2050, a marker for the players' current CF level (based on a preliminary CF survey) and lifestyle action cards (Figure 1). At the time of this study, the game included 101 different lifestyle actions, such as 'I work remotely' and 'I use muscle power for short trips'. The actions extend across four domains of consumption: housing; mobility; food; and goods, services and leisure. A total of 33 mobility action were available.

Before the game, the participants complete a preliminary CF survey via a weblink. Then, based on the survey results, during the game, the participants first mark their current CF level and the per person societal target CF level for 2030 and 2050 on the game board. They then choose lifestyle action cards and place them on the game board (Figure 2, left). The cards are in four different size

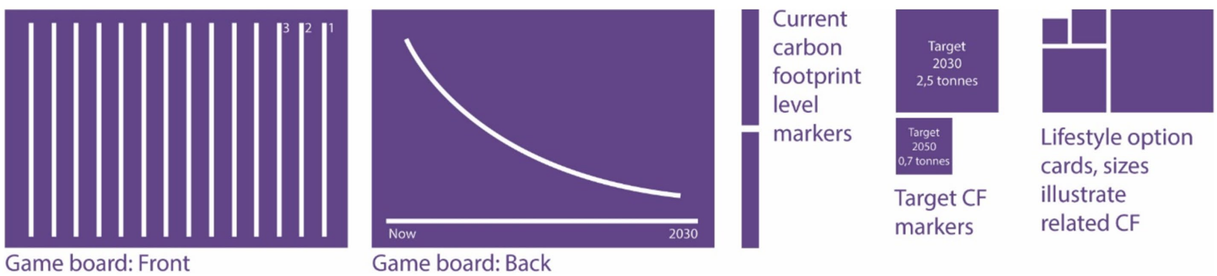

FIGURE 1
The Climate Puzzle game elements.

FIGURE 2
(Left) The household's baseline CF level is marked with two grey pieces on the left-hand side of one side of the game board. The per person societal target CF is represented by an orange card for 2030 (2.5 tonnes) and a black card on top of it for 2050 (0.7 tonnes). (Right) The collaboratively planned pathway of one of the households illustrates the order of implementation of the planned lifestyle actions from 2020 to 2030 on the other side of the game board. Mobility-related actions are represented by blue cards.

groups depending on their average CF impact. The aim is for the household to lay as many cards on the game board as necessary to reach the 2.5 tonne carbon footprint target by 2030 and 2050. Following this, the board is turned around, and the chosen cards are distributed on a timeline to create a pathway for the participants to implement these measures towards a sustainable lifestyle (Figure 2, right).

3.2 Data collection and analysis process

The data collection process comprised eight stages (Figure 3): (1) the recruitment of Leppävaara and Espoonlahti citizens, (2) a preliminary lifestyle CF survey with the selected participants (n = 26), (3) a separate Climate Puzzle workshop for Leppävaara (n = 12) and Espoonlahti (n = 14) participants with their household members, including a preliminary interview for a follow-up study with each household at the end of the workshop, (4) selecting households (n = 12) for the follow-up study, (5) a follow-up lifestyle CF survey and an implemented actions survey with the follow-up households, (6) a 30–60-min follow-up (group) interview with each follow-up household, (7) collaborative development of household narratives by seven researchers, and (8) a clustering activity to identify recurring themes.

First, 26 households from Leppävaara and Espoonlahti were recruited by a recruiting company through an invitation shared in selected Facebook groups including 31,400 members as well as with 600 panel members of the recruiting company. Purposive sampling was utilised to ensure diversity of demographics, household composition, and attitudes towards sustainable development.

Second, a carbon footprint survey was conducted with the 26 selected households to measure their current CF level. The survey consisted of 32 questions on five consumption domains—housing, mobility, leisure, food, and goods & other—plus background questions such as information on household members. The current CF was then calculated with the 'consumption x intensity' principle, where the survey responses provided the consumption behaviours and the (carbon footprint) intensities were based on national or city-level averages. Results were shared with participants, who were then invited to a workshop.

Third, two 2,5-h Climate Puzzle workshops were conducted in November 2021: one with Leppävaara households (n = 12) and one with Espoonlahti households (n = 14), involving 44 citizens. The workshops followed the Climate Puzzle design game structure described above. Each household sat among their own members and collaboratively selected actions and designed pathways for achieving carbon reductions in their daily lives. The game exercise focused on identifying actionable carbon reduction measures based on the societal per person target CF relative to their own levels. Short interviews were conducted at the end of the workshops with each household to discuss chosen actions and thoughts on the upcoming implementation phase.

Fourth, 12 households (six from Leppävaara and six from Espoonlahti) were selected for the follow-up study conducted in May 2022 (Table 1, participant demographics). These households were chosen because during the workshop they selected a high number of mobility-related lifestyle changes on their pathways for 2021 and 2022 (the follow-up phase) and demographic diversity (especially the type of household and family unit represented, age, and current level of sustainability). The sample, consisting of six families, four couples and two single households, reflects fairly well the household composition statistics of Leppävaara and Espoonlahti—Leppävaara with many single-person households and Espoonlahti with more families with children and elderly couples. This selection allowed us to examine how different types of social communities shape mobility practices and describe the mechanisms of change in diverse households in Espoo, including those of more isolated individuals. Rather than representing the average Finnish population, which increasingly consists of single-person households and smaller families, the study focused on the dynamics within these varied households.

Fifth, a follow-up lifestyle CF survey and implemented actions survey were conducted to identify the implemented lifestyle changes. In the implemented actions survey, households could estimate whether their actions were not implemented, partly implemented or wholly implemented. A comparison was performed between self-reported before and after CF values collected from November 2021

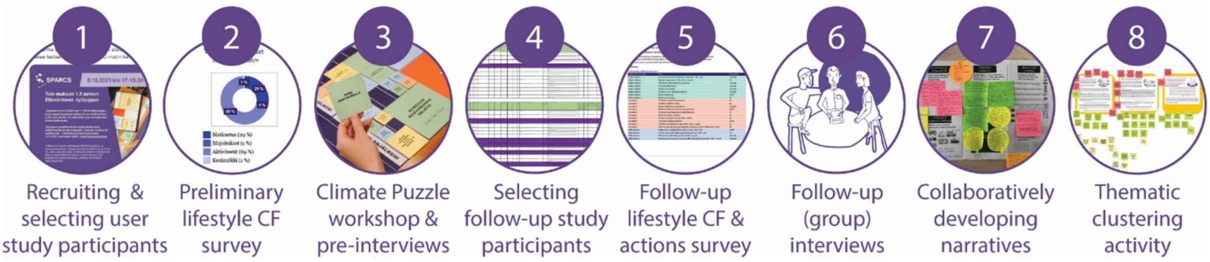

FIGURE 3
The eight stages of the data collection and analysis process.

and May 2022 from the households that played the Climate Puzzle game. The comparison provided an indicator that some changes occurred in the households' mobility patterns since they became aware of possible strategies to reduce their CF. The survey results and comparison provided a starting point to inform and guide the exploration of mobility behaviour during the qualitative interviews.

Sixth, at the end of the six-month follow-up period, semi-structured online thematic group interviews lasting from 30 to 60 min were conducted with each household. One to three household members participated in each interview. The purpose was to study the impact of the participants' social context on implementing their planned lifestyle changes. The thematic group interview method, suitable for gathering information on social environments (Hirsjärvi and Hurme, 2011), replicates real-life group interactions in which behaviours are formed. Both the design game and the interviews provided insights from the younger participants, supporting the inclusion of this often-marginalised group in studying social behaviour change.

Seventh, after the follow-up interviews, 12 household narratives were collaboratively developed in two co-analysis workshops held with seven researchers based on the collected research materials. These included images from the Climate Puzzle game activities, interview transcripts and the quantitative carbon footprint and implemented actions survey results. These researchers, who were familiar with the 1.5-degree lifestyle workshops and the follow-up interviews, analysed the materials using the Comparative Ethnographic Narrative Analysis Method (Saint Arnault and Sinko, 2021). Each researcher reviewed 1–2 interview transcripts, including the supportive material mentioned above, and marked the relevant content using a paper analysis template. The template included sections for identifying social communities, available mobility options, everyday mobility characteristics, CF measures, transitions related to the selected sustainable mobility actions and key quotes.

The dimensions that were identified and later compared included the participants' descriptions of their sociocultural context, i.e., the close social communities and everyday social interactions in which their mobility behaviours take place. To differentiate the behavioural changes between circumstances and active lifestyle changes, one researcher searched for similarities in the interview material for each observed carbon footprint change by placing the responses from the first and second questionnaires side by side in a table. Each change was reviewed using the interview data to determine the reason for the change and also validate and refine the CF data to increase its reliability. Only the changes that could not be attributed to circumstantial, seasonal or other similar factors were interpreted as changes resulting from the intervention. Based on the analysis, drafts for 12 household narratives were collaboratively developed and then finalised by two researchers (see Section 4, Results).

Eighth, a three-hour collaborative analysis using an online whiteboard platform was then held to identify recurring themes based on the narratives. Thematic clustering revealed factors that influenced changes in behaviour towards sustainable mobility at individual, household, community, district and city levels (see Section 5, Discussion).

4 Results

Here we provide narrative descriptions of the 12 households. The narratives illustrate the household members' close social community and ways in which their everyday mobility behaviours and related change unfold in relation to each other and their broader sociocultural environment. The narratives are built around the mobility actions chosen by each household in the Climate Puzzle workshops (see Appendix for list of selected actions). The households chose from 1 to 12 mobility actions for their pathway from 2021 to 2030. The paper focuses on the mobility actions in which the interaction among and the impact of the close social community were most present to highlight the social factors that maintain existing or shape new mobility practices, regardless of the original timeframe for implementation. These actions are presented in ***bold italics*** in the narratives, followed by households' follow-up survey answers about implementation of selected actions in ***(brackets)***.

4.1 Households in Leppävaara

First, we provide narrative descriptions of the six Leppävaara households. Leppävaara is an established urban area with good train connections. It is built around a large shopping centre, Sello, which includes a wide array of shops and services. The area is characterised by a high proportion of single households, including students and pensioners. With more public transportation options and less free parking space provision, Leppävaara has a relatively low mobility carbon footprint compared to Espoonlahti.

4.1.1 Household 1. Car-dependent trip-combiner

'Anni' (68) lives alone, and her close social community consists of her daughter, two granddaughters, and neighbours (Figure 4). She

TABLE 1 Leppävaara and Espoonlahti household demographics and change in mobility CF.

Household ID	Household members*	Household type	Type of housing	Modes of mobility	Mobility CF: baseline to follow-up (tonnes)	Mobility CF difference (%)
Leppävaara households						
H1	**Woman, 67**	Single	Own apartment (terraced house)	Car (driver)	10.7–8.9	↓ 16.8%
H2	**Woman, 35** **Man, 36** **(Child, 6)** **Child, 1**	Family	Rental apartment (apartment building)	Car (driver), micro-mobility (walking, cycling, electric scooter, other)	4.8–6.7	↑ 39.6%
H3	**Man, 37**	Single	Rental apartment (apartment building)	Car (driver)	1.9–0.6	↓ 68.4%
H4	**Man, 41** (Woman, 37) (Child, 8)	Family	Rental apartment (apartment building)	Micro-mobility (walking, cycling, electric scooter, other)	1.8–2.7	↑ 50%
H5	**Woman, 57** **(Child, 15)**	Family	Right-of-occupancy apartment (terraced house)	Car (driver), micro-mobility (walking, cycling, electric scooter, other)	2.5–1.9	↓ 24%
H6	**Woman, 25** (Woman, 19)	Couple	Rental apartment (apartment building)	Car (passenger), bus, train	1.7–0.4	↓ 76.5%
Espoonlahti households						
H7	**Woman, 35** **Child, 13** **Child, 11**	Family	Own apartment (apartment building)	Car (driver), car (passenger), bus, metro	4.5–4.8	↑ 6.7%
H8	**Woman, 53** **Man, 56** (Child, 16) (Child, 12)	Family	Own apartment (detached house)	Car (driver), car (passenger), micro-mobility (walking, cycling, electric scooter, other)	–	–
H9	**Woman, 28** **Man, 30**	Couple	Own apartment (apartment building)	Car (passenger), bus, micro-mobility (walking, cycling, electric scooter, other)	2.8–0.9	↓ 67.9%
H10	**Man, 62** **Woman, 59** (Child, 17)	Family	Rental apartment (apartment building)	Car (driver)	2.2–2.7	↑ 22.7%
H11	**Man, 41** (Woman, 35)	Couple	Right-of-occupancy apartment (terraced house)	Car (driver)	13.4–13.9	↑ 3.7%
H12	**Woman, 56** (Man, 59)	Couple	Own apartment (apartment building)	Car (driver), car (passenger), bus, metro, micro-mobility (walking, cycling, electric scooter, other)	7.2–3.9	↓ 45.8%

*Household members who participated in the workshop are shown in bold. Household members who did not participate in the follow-up interview are shown in parentheses.

visits her family once a month by car, and her neighbours multiple times a week.

I switch to a plug-in hybrid (no). Anni currently has a part-time job, which includes meeting with customers throughout the capital region of Uusimaa. Her employer requires work journeys to be done by car, so switching to public transport is not an option. At the same time, due to financial constraints she is unable to buy a low-carbon car. Her upcoming retirement also influences her decisions:

I'd buy a plug-in hybrid as soon as I had the money. I've still got something like 25,000 on the clock. My car's only worth five or six thousand euros because it's so old, and plug-in hybrids are at least 30 thousand. I just don't have the money. That makes me think about what I'll do when I'm no longer working. Am I going to live out here [Leppävaara outskirts] in the middle of nowhere, or should I move to the city and use public transport? I don't know. I can't decide. ('Anni', 68)

FIGURE 4
Illustration of Household 1.

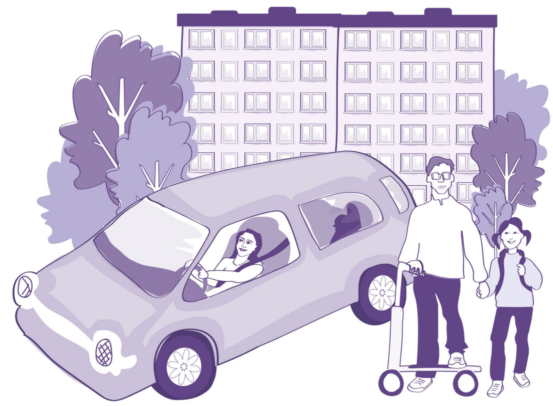

FIGURE 5
Illustration of Household 2.

I combine trips (yes). Anni combines her private long-distance journeys and work trips: she plans to visit her family according to wherever her working day will end, and she can also plan the last location. Similarly, her family combines trips when visiting her. She walks short distances, e.g., to the shops.

During the study, her household mobility carbon footprint decreased from 10.7 to 8.9 tonnes. As she did not report lifestyle changes during the study, the decrease is a result of seasonal or other changes in driving distance. Her travel distance and private driving practice are mostly affected by her employer, family and financial aspects.

4.1.2 Household 2. Disabled multi-located forerunner family

The family includes a mother (35), father (36), and two children (6 and 1) (Figure 5). The parents are private entrepreneurs who work at least partly remotely, and they have a wide close social community, including family in Northern Finland, kindergarten parents, neighbours, and the father's regular massage customers.

I use an e-scooter (partly). The father's visual impairment significantly affects the family's mobility. The mother is the 'designated driver' of their estate car, whereas available mobility options for the father are bicycle, personal e-scooter, and taxi due to the taxi vouchers he gets. These provide the father independence, for example, in taking the children to hobbies by himself:

> *We now go to parkour by taxi, as the kindergarten friend of [daughter, 6] also goes with us. (Father, 36)*

I order groceries home (partly). Ordering home delivered groceries was a new option the family adopted during the follow-up period. Instead of driving weekly to the supermarket, they successfully tested a robot grocery delivery:

> *Very funny and very chaotic—the robot came faster than it should have, I was in a video meeting. I had a little one yelling under one arm, a bigger child wanting to see, a robot playing me a serenade, and a meeting going on… (Mother, 35)*

The family is a group of forerunners interested in new sustainable innovations and practices and promoting them to others in practical, everyday ways with their close social community. They do not pressure others to change or get discouraged if their close social community criticises their progressiveness.

During the study, the household's mobility carbon footprint increased from 4.8 to 6.7 tonnes. The increase was due to flying to the north, where the family typically spends half of the year visiting extended family. However, the small carbon footprint of their everyday mobility continued to decrease, which can be seen as resulting from active change.

4.1.3 Household 3. Sparing public transport commuter

'Tomi' (37) lives by himself (Figure 6). His close social community consists of neighbours, colleagues (who also use public transport), and his relatives who live some distance away in the country (who use private cars).

I swap driving for public transport (yes). During the follow-up period, he switched to using public transport after his previous expensive rental car contract ended. For his IT support work, he now travels to customers by public transport when issues cannot be solved by phone. He finds this convenient. His employer affects his mobility choices significantly:

> *[Colleagues and friends] do not [affect my mobility choices]. I choose the cheapest option that works … But my employer has an influence, because they provide me with the public transport tickets. ('Tomi', 37)*

Giving up the car has made journeying to his hometown in the evenings slightly more challenging as local buses run infrequently, so a family member sometimes must get him from the station. He then prefers getting a lift instead of taking public transport. In general, his consumption choices are driven by his low salary and desire to live frugally. However, through the intervention, his attitude has changed, and, according to him, he has noticed that small things matter when aiming to live sustainably.

During the study, his household mobility carbon footprint decreased from 1.9 to 0.6 tonnes due to giving up private motoring. This was strongly affected by his employer and financial aspects.

FIGURE 6
Illustration of Household 3.

FIGURE 7
Illustration of Household 4.

FIGURE 8
Illustration of Household 5.

4.1.4 Household 4. Family with relatives in two countries

The household includes a father (41), mother (37) and daughter (8) (Figure 7). The family's close social community is formed by the household members, the father's mother living in another city, and the mother's family living abroad. The household did not plan or pursue many, if any, mobility actions during the study period.

As a household with relatives in two countries, they intend, and have already started, to travel abroad more now the COVID-19 restrictions are removed. The father considers flying to be contradictory to his environmental aspirations, but finds justification for the trips in their lower daily commuting emissions:

> *But here I just had an idea that if… As we have now moved closer to basic services, as a result we can then make longer holiday trips with a good conscience. Let's put it this way. It sounds reasonable as a whole, I guess. If you think of an ideal life. Like, living locally, and then everyday life would include as short trips as possible, and then holidays are a separate thing. (Father, 41)*

I work remotely (partly). Both parents study, the father remotely and the mother—after a recent shift from remote to onsite studying—in contact teaching in the centre of Helsinki. The mother travels there by train. The household does not have a car, which the father describes as possible due to good public transport connections in the city of Espoo.

During the study, the household's mobility carbon footprint increased from 1.8 to 2.7 tonnes. The increase was due to flying more and shifting from remote studies to studying on campus, both due to the removal of COVID-19 restrictions. Extended family strongly impacts their desire to travel abroad.

4.1.5 Household 5. Everyday cyclists

Mother (57) and daughter (15) form a two-person household, whose close community consists of the mother's own mother living in the same city, and the daughter's friends from school and sports (Figure 8).

I use supervised bike parks (yes). As everyday cyclists, the family experimented with cycling-related actions, broadening the opportunities and infrastructure that cycling offers in a city. The mother had been familiar with the guarded bike parks but chose not to use them previously. She describes her new attitude as follows:

> *Well, I don't constantly leave it in that exact bike park, but I don't remember using it before. It's not very attractive. I tend to prefer to leave my bike in a place where it can be locked and where people move around quite a lot, which is somehow visible. But it could be that it [using bike parks] has had a slight effect. (Mother, 57)*

I become a winter cyclist (partly). The family also experimented with winter cycling during the study. The mother and daughter considered the experiment problematic, mostly because the daughter's bike did not have winter tires. In addition, the mother fell and hurt herself while winter cycling, leaving her temporarily unable to cycle. The interview also revealed that the interest in winter cycling was not unanimous between the household members.

During the study, the household's mobility carbon footprint decreased from 2.5 to 1.9 tonnes. This was due to an overall reduction in everyday and leisure time mobility, such as less driving, less train use, and cycling and walking less. The results were due both to seasonal and situational changes in mobility routines, such as the mother's cycling injury, and to implementing planned changes. The material aspects of the cycling infrastructure and cycling equipment in the mother-daughter dynamics restricted the adoption of winter cycling as a new practice in the household.

4.1.6 Household 6. Couple travelling together with city bikes

'Jenni' and 'Eeva' (25 and 19) are an active dog-owning couple (Figure 9). Their close community includes parents living nearby, Jenni's 35-member sports team, and other friends. Most frequently Jenni meets her team members. The team has training at least four times a week. The most common way for the whole team to commute to training is carpooling.

I use muscle power for short trips (yes). Despite their minimal everyday mobility footprint, the household is looking for opportunities to reduce car use. The couple is accustomed to using city bikes for shorts trips, especially in summer. They cycle together. Also, their friends are active city bike users. Thus, Jenni would also prefer to cycle to training if there was a city bike station next to the sports hall, or if she got her own bike.

> *Well, I moved to Espoo about a year ago, and before that I lived in Helsinki. So back then I used to… I had my own bike there, and then I used to cycle all the way to work and hobbies and so on. But now that I live here in Espoo, my trips are a bit longer, and I haven't even brought the bike here yet. So I'm just relying on city bikes. ('Jenni', 25)*

I travel less, but I stay for longer (partly). During the study period Jenni experimented with a new approach to holiday travel. Her sports hobby includes travelling to competitions. The team members cannot influence how trips abroad are made as the coaches have chosen flying and are not open to other options. Nevertheless, Jenni and some of her team members decided to stay at the location for longer to combine competition and holiday travelling.

During the study, the household's mobility carbon footprint decreased from 1.7 to 0.4 tonnes. As the couple's everyday mobility carbon footprint was close to zero already in the first carbon footprint survey, and did not increase during the study, the reduction is solely due to changes in free time mobility routines, i.e., favouring a small amount of flying (from 0 to 2 h/y) and train travel (from 20 to 600 km/y) over trips via cruise ships (previously around 10 back-and-forth cruises from Helsinki to Tallinn or Stockholm per year). Shared values and interests among the couple and their friends, as well as the shared decision among team members to stay for longer at their competition destination supported the household members' sustainable mobility behaviours. Also, infrastructure plays a role.

4.2 Households in Espoonlahti

Here, we provide narrative descriptions of the six Espoonlahti households. Espoonlahti is a developing area going through extensive changes, including a new subway extension. A large new shopping centre, Lippulaiva, was opened during the follow-up study in Espoonlahti in March 2022. Espoonlahti has a high proportion of family households and the mobility carbon footprint is higher compared to Leppävaara due to a high level of private motoring.

4.2.1 Household 7. In-between two households

The household of three includes a mother (35) and her daughters (13 and 11) (Figure 10). Their close community includes the daughter's father, his partner, and their children living at a different address. The two households have recently established an every-other-weekend visiting system at the father's place, instead of a week-for-week living arrangement. The kids travel between households by car.

I switch to a smaller car (yes). The household downsized to a smaller car between the interviews, reducing its footprint. The mother had considered buying an electric car, but the tax reliefs offered were not sufficient. When asked if they have an electric car:

> *No, no. But if we could get some support for that, then maybe. Charging and so on. I was considering an electric car, but it seems a bit difficult. (Mother, 35)*

I travel by land (yes). The mother and daughters decided to spend their winter holiday in Lapland instead of travelling abroad. As a result, the family flew less and travelled more by coach. The family was

FIGURE 9
Illustration of Household 6.

FIGURE 10
Illustration of Household 7.

also still planning how they would spend the summer, and the mother estimates that they will, again, most likely stay in Finland.

During the study, the household's mobility carbon footprint increased from 4.5 to 4.8 tonnes. Holiday travel and travelling between two homes strongly impact this household's mobility carbon footprint.

4.2.2 Household 8. Espoo-typical car-driving family with children

The family consists of a mother (53), father (56), two sons (16, 12) and two dogs (Figure 11). Their close social community consists of both parents' mothers, living in the same greater district, and the children's friends.

I use muscle power for short trips (no answer). The parents visit their mothers several times per week, the father by car, the mother by car or walking. The walking ability of the mother's mother is restricted, so the car enables driving to beautiful locations for short walks. The mother also often does shopping for her mother when visiting her. Sometimes she also takes their two dogs with her. As the distance is too long for the dogs to walk or run, she has been considering buying a cargo bike. Both the dogs and her mother influence the mother's mobility choices when visiting her mother:

> *My mother and the dogs affect the choice of mode of mobility fifty-fifty when visiting my mother, as the dogs are very important to my mother. (Mother, 53)*

I switch to a smaller car (no answer). The family downsized one of their three cars during the follow-up period. They still plan to buy a more modern new car, but they will first purchase a temporary manual car for the older son to practice for his driver's licence with the father. Before their sons were born, the parents used to live without a car for some time. Since moving to Espoo they have had several cars, one bought by the mother's father.

I combine trips (–). The father drives to work three days a week and works remotely two days a week, saving him 65 km of driving per day. He uses a car to minimise his commuting time. The father often combines visiting his mother and food shopping with commuting.

No mobility carbon footprint data comparison was available as the family did not fill in the second survey. The family is an Espoo-typical car-driving family who uses the car as default because it makes life easy. There is little opportunity to question their car use, as the family is strongly tied to the existing system. However, the problems of car use are known and sometimes raised by the household, yet facilitating daily life overrules those concerns, including trips with dogs to the mother's physically restricted mother.

4.2.3 Household 9. Modern-day cottage nomads

'Tilda' (28) and 'Arto' (30) are an active couple, whose close social community consists of parents, siblings, and friends (Figure 12). Both sets of parents live close by, and the couple visits them at least once a month, often by car.

I travel less, but I stay for longer (no). The couple has access to five holiday cottages, each a 2–3 h drive away and owned and maintained by their parents and grandmother. The couple visits one of the cottages almost every weekend by themselves by car or with friends (usually carpooling) but not with their relatives. During a typical summer week, the couple drives to one of the cottages, stays there for the weekend, and then drives back for the working week. Otherwise, they could imagine staying longer at each cottage and visiting only one cottage a month. The cottage trips are the biggest reason for owning a car, along with Arto's work. Their social relationships also hinder changing this routine:

> *… we have a car, and it is not so ecological, but for our lifestyle, we couldn't get to the summer cottages [without the car]. So, we kinda have to have it. ('Tilda', 28)*

I use muscle power for short trips (no). The couple often travels together. Within the household, Arto normally drives and Tilda, who also tends to avoid driving alone, gets a lift. Car sharing is also a way of saving compared to buying public transport tickets for both. However, the couple has significantly reduced their everyday driving, and the opening of a new shopping centre close to home is mentioned as one reason. Car use for everyday trips has halved from 10,200 km to 5,100 km per year. The couple has increased walking and cycling by 13 km per week and decreased motoring by 100 km per week. The couple also started to cycle more after Tilda received her parents' old bicycle, enabling them to cycle together. Their parents who gave the bike are also described by the couple as inspirational.

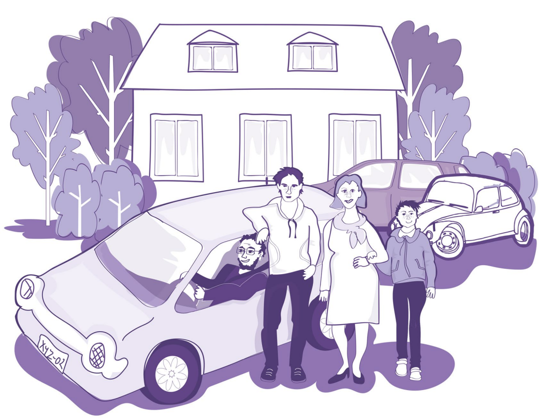

FIGURE 11
Illustration of Household 8.

FIGURE 12
Illustration of Household 9.

During the study, the couple's mobility carbon footprint decreased from 2.8 to 0.9 tonnes. This was mainly due to halving everyday mobility from 200 to 100 km per week. These changes can be linked to extended family, financial aspects, the opening of the new shopping centre in the district, and societal work rhythm and practices.

4.2.4 Household 10. Disability pensioned driver family

The father (62) and mother (59) are on disability pension, and with them lives a son (17) who does not have a driver's licence (Figure 13). Their close social community consists mainly of the parents' three children from previous marriages and two grandchildren, who they visit regularly by car.

I use muscle power for short trips (partly). The couples' typical mobility revolves around running errands and visiting family members. However, a recently opened large shopping centre has changed their mobility routines towards a 'what you cannot get from there, you do not need' ethos. Also, online shopping has reduced their supermarket visits. However, they find visiting the supermarket by car easier due to the father's restricted walking ability:

> *Osteophyte, one and a half years ago. It limits my walking. But the distances we walk are short, so those I manage. (Father, 61)*

I combine trips (yes). The couple always travels together. Household mobility is strongly affected by the father, who is the main driver of their 10-year-old combustion engine car and has an osteophyte that limits his ability to walk. Before the study, the father temporarily lost his driver's licence due to a seizure, but has since got it back. At that time, the couple travelled by bus, with masks, to laboratory tests and the pharmacy. The mother has a driver's licence, but is anxious about driving. With strong sustainability values, the couple negotiates ways to combine supermarket visits and several buying needs at one time, which they have been doing already prior to the study.

The mobility carbon footprint of the household increased from 2.2 to 2.7 tonnes during the study. The household's leisure mobility increased from 400 to 6,000 km and everyday mobility decreased from 6,120 km to 2,040 km. The decrease in everyday mobility resulted from seasonal and situational changes in mobility routines, such as the opening of the new shopping centre in the district, and to implementing planned changes. Extended family and interdependencies among household members strongly shape their mobility practices.

4.2.5 Household 11. Motorized husband and public transport wife

'Leo' (41) and 'Ella' (35) are a married couple (Figure 14). Ella's two sisters live with them temporarily. They have two cars, one from Leo's work and one of their own.

I travel closer to home and by land (yes). Before COVID-19, the couple used to fly a couple of times a year somewhere remote for holidays. Since the pandemic, they have been flying less. However, they are unsure whether this might change back to 'normal' in the future. During COVID-19 they also flew to Lapland, a journey they would have normally done by car. Their choice of domestic flights instead of car journeys is strongly influenced by elevated fuel prices:

> *Maybe during the summer holiday [some domestic car trips] are possibly an idea. But of course, the price of fuel has a bit of an effect, because it has risen so significantly. So if you get cheap flights to Lapland, it's cheaper than going by car. ('Leo', 41)*

I use muscle power for short trips (partly). Leo drives 70 km to work daily, and often goes food shopping after his workday with the work car. Sometimes he uses their own car in the evenings. He only uses public transport when he goes to Helsinki city centre, drinks alcohol, or when car parking is difficult at the destination. Ella mainly uses the subway and bus. She often phones for a lift, and Leo picks her up even when he feels tired after a workday. Leo is willing to combine walking and light shopping, but only in good weather.

The mobility carbon footprint of their household increased from 13.4 to 13.9 tonnes. The increase was mainly the result of increased driving to work. No changes were implemented and, based on the responses, motivation for change appears low. Each of the spouses have their own mobility practices, which sometimes overlap through the practice of caring. Financial aspects and existing routines seem to drive this couple's mobility behaviours more than their interdependencies.

FIGURE 13
Illustration of Household 10.

FIGURE 14
Illustration of Household 11.

FIGURE 15
Illustration of Household 12.

4.2.6 Household 12. Compelled car users and caretakers of the nearest and dearest

The household consists of a wife (56) and husband (59) (Figure 15). The wife's close social community includes her ageing mother and a network of colleagues she is in contact with daily or weekly. The husband's work requires travelling around the country by car to meet clients. Aside from work, the couple travels by car to their holiday cottage and to visit relatives in central Finland.

I work remotely (yes)/I swap driving for public transport (partly). The wife is in a high risk group for coronavirus and works partly from home. When she must travel to her workplace 2 days a week she therefore travels by car. A subway stop is close by, and she hopes to switch to using the subway and bus for commuting in the future. Her everyday mobility is also determined by her ageing mother's reduced mobility, which prohibits her from using public transport. She views transporting her mother to the doctor and to laboratory testing as her 'everyday responsibility' and justifies her car use:

> *No matter what you think about the environment, the climate, our actions, people must be able to care for their loved ones and use exactly the type of transport needed [for that]. (Wife, 56)*

I combine trips (yes)/I use muscle power for short trips (yes). The couple's car is now often unused. During the follow-up period, the wife switched to combining supermarket and pharmacy trips with her work journey and walking to pick up small groceries. She describes wearing a backpack and jogging clothes, so fetching groceries involves not only shopping but also maintaining fitness. The ease and speed of the car are now less prioritised.

During the study, the couple's mobility carbon footprint decreased from 7.2 to 3.9 tonnes. The reduction is due to executing planned actions as well as seasonal and situational variation, such as the improved COVID-19 situation. Social community strongly shapes the couple's travel needs and ways of travelling, whereas mobility practice changes seem to be more linked to personal aspects.

5 Discussion and conclusions

Here we discuss the role of the household and extended close social community in influencing the planned sustainable mobility behaviour change. Based on the narratives, several themes were identified that highlight the varying potential for change in the respective households. We discuss different spheres of measures and suggest that real-life behaviour change requires individual actions, shared actions within the household, as well as other kinds of action, for example, changes in local infrastructure or mobility options. We acknowledge that individual-level transformation to sustainable mobility is not an individual choice but, more importantly, is part of a sociocultural process and is facilitated by personal and social influences, as stated by Gifford and Nilsson (2014). Finally, we discuss the challenges of studying behaviour change and of designing interventions targeted at the community level in order to create mobility-related behaviour change within close social communities.

5.1 Aspects of district and infrastructure level impact on mobility behaviour

Based on the interviews, infrastructure and infrastructural changes emerge as key factors that affect mobility behaviour. People are limited by the options offered by the existing infrastructure and these limitations generally determine the options people perceive as viable. The newly opened shopping centre in Espoonlahti significantly reduced the need to drive to another shopping centre in another district. In turn, the dense urban structure of Leppävaara helps households to keep their daily trips short and provides better opportunities for using public transport. However, the road network in Espoo allows people to commute up to 35 km within an acceptable timeframe (by car). Similar observations can be made for other parts of the infrastructure or provisioning system in Leppävaara. At the time of the study, existing e-scooter or city bike schemes were available in Leppävaara, but not in Espoonlahti. Similarly, if city bike stations are not located close to leisure facilities, or if bus services are discontinued during public transport restructuring, for example, building a metro line extension, people have to choose other modes of transport, and the participants stated that the private car was often the easiest and most reliable option.

Anticipating new infrastructure and its effects appears challenging when planning personal and household transitions towards more sustainable modes and patterns of mobility. In the Espoonlahti workshop, the participants talked about the upcoming metro line extension (set to open 18 months after the workshop), yet were unsure about how it would change or ease their mobility patterns. As the previous metro line extension had not made mobility any easier but had actually reduced the number of existing bus connections, people were also rather cautious regarding the new extension. However, it was considered a potential game changer. In connection with the metro station, a new shopping centre was also established and opened 6 months after the workshop. Interestingly, although the interviews revealed that the new shopping centre had greatly reduced daily mobility, the shopping centre was barely mentioned during the workshop, even though the participants were aware that it would soon open.

5.2 Close social community members influencing each other's mobility behaviour

Within the framework of by the existing infrastructure, people's close social community influences the way they relate to their surroundings. Personal mobility within households was organised based on the needs of the close social community. Grandparents were helped by giving them lifts and combining trips, young people were driven to leisure activities using carpooling, relatives offered a lift or lent their cars to family members, divorced parents arranged their children's transfers between households, people commuted in various ways to work, daily shopping was done with other family members, and so on.

In some households a parent had a disability that impacted the mobility of the family as a whole. For example, in one household, shopping was done using a private car to avoid walking, and in another family the father had the option to use taxi vouchers because he was disabled. The ways in which mobility was organised around the needs of one household member had a marked effect on the mobility of other family members. Also, some of the participants had elderly parents who were unable to drive and were given lifts or visited by car by their adult children on a daily basis. These interdependencies based on physical condition and the provision of assistance are perhaps the most common social aspects to impact individuals' mobility behaviour.

Among couple households, mobility patterns were described as being either very similar or very varied in terms of daily choices based on whether people travelled together or separately. Adult couples typically had quite traditional roles regarding car use—the man drove and the woman was a passenger. If travelling alone, however, women tended to prefer public transport or cycling. Thus, the mobility behaviour of couples seemed to differ considerably when travelling either separately or together. The mobility carbon footprint of couple households was therefore unbalanced due to the higher amount of private driving by men compared to the use of public transport by women. The social interdependencies and roles that people naturally take influence their mobility behaviour, as also identified in Santala et al. (2024). Thus, social practices can stop people from giving up using their cars, as the practice of driving together has been shaped and stabilised over the years. In many households the know-how and motivation, for example, to use public transport when commuting alone already exists, at least partially. However, to bring about the required change, all household members would need to adopt similar CF reduction measures or at least be prepared to make meaningful changes to their personal preferences. This is in line with practice theory, which highlights how practices are motivated by comfort and convenience (Shove et al., 2012). The examples above show that changing behaviours is an extremely complex and time-consuming process, motivated by both social and individual factors.

5.3 Other social contexts and social interdependencies that influence mobility behaviour

For several of the participants, work or study was a major factor in the increasing amount of car use or daily commuting. The main reason for driving was not necessarily commuting, but the mobile nature of work, such as visiting customers, as well as returning to the office or place of study after the COVID-19 restrictions were lifted. In such cases, the work or study community can be perceived as a close social community that influences mobility behaviour. Business meetings could arguably be arranged remotely, but the company had made a decision and the line manager expected that physical meetings were preferable, if at all possible. Similarly, social reasoning could be seen to be at play when students were expected to attend studies in person after the end of the remote study period.

These social negotiations and ways of organising work and studies affect people's daily mobility needs. In some cases, mobility behaviour was defined by work more than an individual would have preferred. Also, owning a car had become the norm because work required an individual to have a car. However, there was one exception. One participant sold their car during the six-month period—despite their work requiring a considerable amount of travel—and used public transport to commute to work instead, funded by their employer, as well as to visit relatives in another city. While visiting his relatives, he was also more dependent on getting a lift from family members to/from the train station. Thus, living without a car is likely to increase dependency on family members and friends.

Social context can also impact people in other ways. For example, if parents drive their children to school and leisure activities, their children may inherit certain behavioural models from their parents that they take into their adulthood. As another example, friends who have mopeds create social pressure on their peers to get a moped in order to be included in the group. However, this also works the other way around. One participant received a bicycle from her parents, which created the desire to cycle more. She also viewed her parents as role models as far as cycling was concerned.

In arranging daily mobility, it appears that comfort and ease of life are the most important factors. Also, financial aspects were highlighted as relevant factors limiting the adoption of more sustainable options such as switching to an electric car or travelling by public transport. However, contrasted to the estimated monthly costs of owning a car in Finland (~EUR 500), people's perceptions of the actual expenses of specific modalities were not always realistic. A private car was often considered as a cheaper option compared to public transport (~EUR 100 per month). Then again, from a community aspect, the costs of public transport increase in relation to the amount of community members requiring a public transport ticket, whereas the expenses of a car stay the same. This highlights that specific mobility options and actions are more potential from a community perspective than others. In most cases, environmental concerns are of less importance but are readily adopted where appropriate. In some specific cases, environmental concerns have been a major driver of change, for example, in changing to a car-free lifestyle. Environmental considerations can also facilitate changes that are already under consideration, such as changing to a smaller car or an electric car, or giving up a remote holiday cabin.

5.4 The difficulty of describing and studying social behaviour change

Measuring the actual environmental effect of mobility changes proved more complex than we had anticipated. Carbon footprint calculations based on the same online survey before the workshop and 6 months later provided different results. While several changes in the carbon footprint calculations of the households were clearly due to the actions selected, other households seemed to have carbon footprint changes because of other factors, such as bigger life changes (e.g., moving house), seasonal variations, or post-Covid changes to their daily lives.

Implementation of the game-based interventions the participants had planned during the workshop had only partially started—which was to be expected as the Climate Puzzle game includes changes that must be implemented by 2030. However, for many households the workshop and the Climate Puzzle game provided an opportunity to re-evaluate their daily mobility needs, in either major or minor terms.

This also shows that the active provision of new infrastructure and mobility options combined with questioning existing patterns can incentivize people towards focusing on low-carbon mobility.

Previous research shows the potential of the Climate Puzzle game to contribute to 'low-carbon lifestyles through learning, knowledge sharing, and empowerment' (Vaajakallio, 2012). Yet, the results of this study indicated less behaviour change than anticipated. This could be due to mobility being a challenging context in which to achieve behaviour change. The differences in how people related to the metro line extension and the new shopping centre, both under construction in Espoonlahti at the time of the study, point to the unpredictability of the anticipated change. The impact of the metro line on mobility behaviour was more anticipated by the participants than the impact of the nearby shopping centre. This raises questions about the overall predictability of people's behaviour. While the ability to prediction has been one of the main approaches to sustainable mobility behaviour change (e.g., Ding and Zhang, 2016; Le et al., 2018; Wang et al., 2021), we question whether people can predict, plan and make personal changes in the long term if they are not even able to predict short-term (six-month) changes.

The difficulty in anticipating and reducing the amount of mobility has been highlighted by Moriarty and Honnery (2021). They describe several studies that show the difficulty of changing behaviours and the improbability of voluntary reductions in mobility. According to their study, the travel needs of residents who live closer to inner city services are less than the needs of those residents who travel from the suburbs. This might also explain the differences between Leppävaara and Espoonlahti, and especially reflect the high level of car use in the Espoonlahti area which, at the time of the study, was still lacking efficient rail transport to Helsinki city centre.

When examining the data, it became apparent that the observed differences were not necessarily evident of lifestyle changes, but a consequence of seasonal changes or reporting differently between surveys. In controlled circumstances, the effectiveness of an intervention can be determined by comparing changes between the original and follow-up measurements. However, a more-in-depth understanding of the reasons behind the observed changes by means of statistical methods in a real-life study would have required a much larger sample size, including control groups, random assignment to treatment and control in experimental settings, potentially combined with the automatic collection of mobility data. As this kind of setting was not feasible in our study, we also conducted follow-up interviews with the households and combined their results with the calculated survey results. On this basis, we found that a self-completed, technically oriented questionnaire can be challenging to answer consistently over time, and that in many cases, 6 months is enough time to lead to changes in household circumstances, such as friends moving further away, thereby increasing the demand for mobility. To improve accuracy in future projects, a larger sample size with a control group, a longer period between studies, preferably during the same season in each study, and a 'no change' checkbox alongside each follow-up question is recommended.

The identified factors could also have varied to some extent if different households (especially from different, maybe even less or more car-dependent, geographical areas) had participated in the study. As such, the results provide input to further research on the social factors that drive mobility behaviours. Immigrants in particular represent a highly relevant and, in the context of this study, underrepresented target group for such a study. So does people who are socially isolated or have not been able to build good relationships with their local communities. This highlights a relevant aspect to be considered in a close social community approach to sustainable mobility interventions. There is a risk that community-level interventions might not serve all people. On the other hand, there is also a possibility to provide socially more isolated people opportunities for interacting with people and feeling a sense of belongingness with their local communities.

Using only a workshop and a qualitative interview, it is also quite challenging to study and understand how the members of households influence each other's behaviour. The household members had difficulties identifying and describing the different phases of their change process and related interaction among community members along implementing planned actions. Therefore, the narratives are not either straightforward. In order to collect insights as changes unfold, ethnographic research methods such as field observations and self-documentation of social practices would support such a study. This could potentially lead to a greater clarity also in descriptions of practice change processes in communities.

The initial objective of the study was to understand the change process from the perspectives of different household members, which proved more challenging than expected. Some household members did not attend the workshop or participate in the interview for unspecified reasons. Therefore, in some households, we only heard the story and perspective of one person. For the study, it would have been worthwhile understanding and investigating how different household members related to, for example, the new metro line under construction or the shopping centre that was opened, and how the household members discussed these changes with each other. Studying and engaging multiple members from each household and from their extended close social communities would have required a different study setup and field trips over a longer period. A longer study period could also include prompts reminding the participants of their chosen mobility actions.

5.5 Practical proposals for interventions targeting larger social communities

The Climate Puzzle game offered a unique practice-focused intervention for studying and involving community members in the planning and implementation of sustainable mobility practices. The intervention raised awareness about the communities' own CF, as well as better alternative practices. The alternative practices made use of three strategies for changing mobility patterns, ranging from 'recrafting practices' to 'substituting practices' and 'changing how practices interlock' (Spurling et al., 2013), making the Climate Puzzle an especially interesting intervention for the complex domain of mobility. It also enabled a qualitatively interesting setting for studying behaviour change processes over time through dialogue among the community members facilitated by the chosen actions. However, the intervention and research process could also be developed by including the implementation of the planned change. This could mean sending reminders or motivating and encouraging community members to implement their planned actions.

Based on our research, we cannot say that the Climate Puzzle intervention in one workshop would be sufficient to achieve the 2.5 tonnes CF target by 2030. As the findings of this paper show, and which support the findings of Santala et al. (2024), each close social community has its own needs and characteristics. The Climate Puzzle intervention educated the participants about alternative options and their climate impact in an easily understandable and tangible way, tying the information to the communities' own context, thereby supporting actionable change.

Specific measures to be included in interventions targeting larger social communities could involve a facilitated change process that reminds, motivates and supports behaviour change. Similarly, policymaking should address job-related travel by making it easier to avoid private driving. For example, employers could organise shared rides for employees or offer benefits that promote more sustainable modes of mobility. Additionally, it is important to avoid the supply–demand gap, where people are expected to adopt more sustainable practices but lack the necessary options.

Based on our findings and supporting the findings of Ryöppy et al. (2022), we argue that community members should be involved in the planning, development and implementation of sustainable mobility interventions. This could enhance the success of an intervention through input and buy-in. Based on our findings, understanding and addressing the specific characteristics and interdependencies of close social communities in intervention design could help to scale up change in the domain of mobility. These kinds of actions also have the potential to contribute to more inclusive and flourishing urban environments.

Data availability statement

The datasets presented in this article are not readily available because of possibly recognisable and sensitive participant data. Requests to access the datasets should be directed to the main author.

Ethics statement

The studies involving humans were approved by the KONE data privacy counsel prior to conducting the research. Participants have been fully informed about the purposes of the research, the participants' rights regarding their participation, and how the research material is used, stored and published. The studies were conducted in accordance with the local legislation and institutional requirements. Written informed consent was obtained from the individuals, and minors' legal guardian, for the publication of any potentially identifiable images or data included in this article.

Author contributions

SS: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Writing – original draft, Writing – review & editing. MH: Formal analysis, Writing – original draft, Writing – review & editing. ML: Formal analysis, Methodology, Writing – original draft, Writing – review & editing. JK: Formal analysis, Methodology, Writing – original draft. SL: Formal analysis, Methodology, Writing – original draft.

Funding

The author(s) declare that financial support was received for the research, authorship, and/or publication of this article. This research was funded by the EU Horizon 2020 Sustainable energy Positive & zero cARbon CommunitieS (SPARCS) project, grant number 864242. The open access publication fee was financed by Aalto University's NODUS Sustainable Design Research Group.

Acknowledgments

The authors would like to especially thank Satu Niemi and Anri Liikamaa for supporting the research activities and the qualitative analysis, as well as Mikko Jalas for his valuable feedback regarding the paper, and Satu Niemi for assisting in the creation of the insightful visualisations. The Climate Puzzle game was originally developed by Sonja Nielsen, Viivi Toivio and Michael Lettenmeier (in collaboration with Sitra, Aalto University and D-mat Ltd.).

Conflict of interest

S-SS and MH were employed by KONE Corporation. ML, JK and SL were employed by D-mat Ltd.

Supplementary material

The Supplementary material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/frsus.2024.1469285/full#supplementary-material

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frontiers | Frontiers in Sustainability

TYPE Systematic Review
PUBLISHED 13 January 2025
DOI 10.3389/frsus.2024.1508647

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OPEN ACCESS

EDITED BY
Maria Alzira Pimenta Dinis,
Fernando Pessoa University, Portugal

REVIEWED BY
Inese Mavlutova,
BA School of Business and Finance, Latvia
Maximilian Espuny,
Independent Researcher, Guaratinguetá, Brazil
Alisa Kongthon,
King Mongkut's University of Technology Thonburi, Thailand
Liane Kipper,
Universidade de Santa Cruz do Sul, Brazil

*CORRESPONDENCE
Aristidis Bitzenis
✉ bitzenis@uom.edu.gr
Nikos Koutsoupias
✉ nk@uom.edu.gr
Marios Nosios
✉ marios.nosios@outlook.com

RECEIVED 17 October 2024
ACCEPTED 20 December 2024
PUBLISHED 13 January 2025

CITATION
Bitzenis A, Koutsoupias N and Nosios M (2025) Artificial intelligence and machine learning in production efficiency enhancement and sustainable development: a comprehensive bibliometric review. *Front. Sustain.* 5:1508647.
doi: 10.3389/frsus.2024.1508647

Artificial intelligence and machine learning in production efficiency enhancement and sustainable development: a comprehensive bibliometric review

Aristidis Bitzenis*, Nikos Koutsoupias* and Marios Nosios*

Department of International and European Studies (IES), University of Macedonia, Thessaloniki, Greece

This research presents a comprehensive bibliometric review of the role of Artificial Intelligence (AI) and Machine Learning (ML) in enhancing production efficiency and fostering sustainable development. With the increasing focus on sustainability, AI and ML technologies have emerged as pivotal tools for optimizing industrial processes, improving resource management and minimizing environmental impacts. The study analyzes key ML algorithms in various production settings. This study conducts systematic bibliometric analysis using the Scopus database and Bibliometrix R package, examining global trends, key collaborations, and thematic focuses on AI and ML applications in production efficiency and sustainable development. Novel contributions include uncovering underexplored ethical dimensions of AI adoption and emphasizing the pivotal role of SMEs and developing economies in advancing sustainable practices. Key research trends identified include the integration of AI with sustainable energy management, circular economy practices, and precision agriculture. Furthermore, the analysis reveals geographical contributions, with countries like China, the United States, and the United Kingdom leading in research output and impact. Despite the promising advancements, the review identifies gaps in ethical considerations, especially in data privacy and labor market implications, and suggests avenues for future research, including the implementation of AI and ML in developing economies and Small and Medium Enterprises (SMEs).

KEYWORDS

artificial intelligence, machine learning, bibliometrics, sustainable development, production efficiency

Introduction

Artificial Intelligence (AI) and Machine Learning (ML) technologies have become deeply embedded in our daily lives, transforming various industries, particularly in their influence on production processes. Despite the increasing integration of AI and ML in industrial settings, a significant gap exists in understanding their implications for small and medium-sized enterprises (SMEs) and developing economies. Furthermore, ethical challenges, particularly in data privacy and labor market disruptions, remain underexplored. This study's primary research question and purpose is to assess how AI and ML technologies can contribute to production efficiency and promote sustainable development and what gaps exist in their application, particularly in SMEs and developing countries.

To clarify the distinction between AI and ML, the former is a subset of computer science that is dedicated to developing systems, capable of performing tasks that would traditionally require human intelligence, such as visual perception, decision-making and problem-solving (Russell and Norvig, 2021). Contrarily, ML is a specialized area within AI that focuses on creating algorithms that enable computers to learn from data and enhances their performance autonomously without being explicitly programmed (Jordan and Mitchell, 2015).

Recent advancements in computational power and big data technologies have created fertile ground for the rapid development of AI and ML, making them increasingly applicable to production systems (Bitzenis and Koutsoupias, 2024). Moreover, based on specific attributes and desired outcomes, ML algorithms are typically classified into four main categories: supervised, unsupervised, semi-supervised, and reinforcement learning. Each of these categories offers unique applications within industrial processes, tailored to the nature of the tasks they address.

The first category, supervised learning, is one of the most widely used ML algorithms in the industrial settings. In this method, the algorithm is trained on labeled data where the desired output is already known hence the main task is to predict the correct outcome based on the input data. For instance, one application of this algorithm can be observed in predictive maintenance. In this case, the model is trained in historical data containing instances of equipment failure (outputs) and corresponding sensor readings (inputs). This allows the model to predict potential machine failures using real-time sensor data, enabling maintenance to be performed prior to an actual breakdown (Mawson and Hughes, 2019).

Opposite to supervised learning, unsupervised learning's primary focus is to recognize patterns and relationships within the data, as its training relies on unlabeled datasets, meaning that there are no predefined outputs to guide the learning process. Specifically in production efficiency, these algorithms are often used for their clustering techniques to identify patterns in machine performance and customer behavior or for anomaly detection to spot outliers in the data, such as unusual sensor readings that may indicate equipment malfunctions (Murphy, 2022). In addition to these techniques, semi-supervised learning combines a small amount of labeled data with a large volume of unlabeled data for model training. This approach can be beneficial in situations where acquiring labeled data is either time-consuming or costly or when only a few examples are available in a specific domain. On such occasions, a small and labeled sample can be effectively utilized alongside extensive unlabeled sensor data to enhance the model's predictive capabilities.

Lastly, in reinforcement learning, algorithms acquire knowledge by interacting with the environment and by receiving feedback in the form of rewards or penalties, thus enabling them to adjust their strategies and further enhance their overall performance (Sutton and Barto, 2018). Consequently, the primary objective of these algorithms is to maximize cumulative rewards over time, and they are frequently used to optimize processes, such as fine-tuning machine settings on a production line, to achieve optimal speed and energy efficiency while minimizing waste.

AI and ML technologies have emerged to become essential for optimizing production processes and fostering sustainable development. AI's contribution to supply chain optimization via fostering demand and streamlining inventory management, help reduce overstocking, waste and inefficiencies (Kelly, 2024). Other applications may include logistics improvements through enhanced routing and scheduling which lead to lower operational costs and reduced carbon emissions. Additionally, AI-powered robotic automation can enhance precision and speed on production lines hence contributing to resource efficiency and minimizing operational waste.

Moreover, the contribution of AI and ML to promoting sustainable development is crucial, particularly through optimizing energy usage in production processes. AI-based energy management systems can dynamically adjust power consumption to match real-time demands, thereby reducing energy waste, operational costs (Rane et al., 2024), and the carbon footprint of industrial activities. Furthermore, in the context of a circular economy, AI can be utilized in sustainable product design for eco-friendly production methods and material choices, as well as in identifying opportunities for material reuse and recycling, thereby minimizing raw material consumption and production waste (Sulich et al., 2023).

By leveraging advanced algorithms and real-time data, businesses can improve their operational performance while in the meantime aligning with the global sustainability goals. As industries continue to adopt AI and ML technologies, they are paving the way for a more resilient and eco-friendly future where resource utilization is maximized, waste is minimized and environmental stewardship is prioritized (Wang et al., 2023), signifying a major leap forward in the pursuit of a sustainable and efficient industrial environment. Future exploration of these technologies will be essential in unlocking further opportunities for improvement, ensuring that advancements in production not only contribute to economic growth but also support a sustainable future.

Ultimately, to provide a structured overview of the study, the article's structure is the following: section 1 is the Introduction, section 2 outlines the Methodology, section 3 discusses the results of the analysis and section 4 presents the conclusions, including insights into existing research gaps and directions for future endeavors.

Methodology

The choice of the Scopus database for our bibliometric analysis was driven by its comprehensive coverage of peer-reviewed literature across diverse disciplines, making it a valuable resource for our research. Scopus is renowned for its robust indexing of high-quality journals and conference proceedings, ensuring that our analysis incorporates a wide range of relevant publications in fields such as economics, business, social sciences, environmental sciences, and computer science. In addition to that, Scopus offers advanced search functionalities and analytical tools that facilitate the efficient retrieval of pertinent publications based on specified criteria (Pranckutė, 2021).

Building on this study's primary research question, which examines the role of AI and ML technologies in enhancing production efficiency and fostering sustainable development, the methodology was systematically structured to identify and critically analyze gaps in their application, particularly within the contexts of SMEs and developing economies. This central question served as the foundation for the selection of keywords, the formulation of inclusion and exclusion criteria, and the overall analytical framework.

Furthermore, and for the needs of this analysis, we adhered to PRISMA (2020) guidelines (Preferred Reporting Items for Systematic Reviews and Meta-Analysis) for the effective management and reporting of manuscripts as shown in Figure 1 (Haddaway et al., 2022).

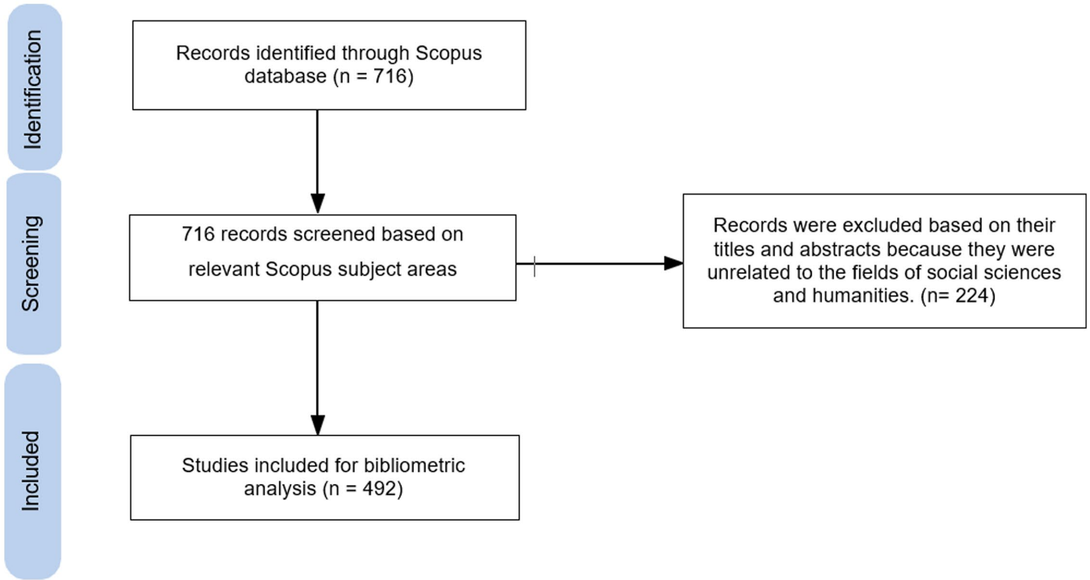

FIGURE 1
The PRISMA 2020 statement.

In this study, set of targeted search terms relevant to the research domain was utilized ("sustainable development," "machine learning," "artificial intelligence," "production efficiency" etc.), focusing on their occurrence in titles, abstracts and author keywords. The search was conducted across the fields of economics, business, social sciences, decision sciences, environmental sciences and computer science. The complete query that was used to construct the dataset is the following:

TITLE-ABS-KEY (("artificial intelligence" OR "AI" OR "machine learning" OR "ML" OR "AI applications" OR "ML applications") AND ("production efficiency" OR "manufacturing efficiency" OR "productivity" OR "process optimization") AND ("sustainable development" OR "economic sustainability" OR "sustainable growth")) AND (LIMIT-TO (SUBJAREA, "ECON") OR LIMIT-TO (SUBJAREA, "BUSI") OR LIMIT-TO (SUBJAREA, "SOCI") OR LIMIT-TO (SUBJAREA, "DECI") OR LIMIT-TO (SUBJAREA, "ENVI") OR LIMIT-TO (SUBJAREA, "COMP")) AND (LIMIT-TO (LANGUAGE, "English")).

Following data extraction, a bibliometric analysis was conducted with the Bibliometrix R package to assess and analyze literature, using statistical techniques to measure the impact, development, and trends within the research topic. Bibliometrics, which involves the quantitative analysis of academic publications to measure their impact and detect patterns in scholarly communication, is widely applied in fields such as education (Oraiopoulou et al., 2024), business and economics (Thomos et al., 2023; Bitzenis et al., 2023), health sciences (Van Nunen et al., 2017) etc., and was used to evaluate key indicators in this analysis. These include descriptive indicators, such as the number of publications, the annual growth rate of scientific production, and average citations, to provide an overview of research activity. The citation analysis sought to identify influential works, while co-authorship analysis explored collaboration patterns among researchers and institutions. Finally, a keyword co-occurrence analysis was performed to uncover key research themes, and the geographical distribution of research outputs was assessed to highlight global contributions (Donthu et al., 2021).

Results

In this section, the key findings of the study are presented, accompanied by comprehensive visual representations, including graphs and tables. These visualizations provide insights into the relationships between various concepts and reveal patterns that shed light on the broader themes within the dataset. The analysis highlights significant associations between specific terms and their underlying meanings, offering a deeper understanding of the textual data and its thematic structure.

Figure 2 shows the annual scientific publications over the years from 2000 to 2024. The data indicate a steady increase in the annual number of scientific publications with a sharp rise in recent years. From 2000 to 2018, the growth is relatively slow and stable, with a nearly flat trend, indicating limited research output during this period suggesting that research on the application of AI and ML in production efficiency and sustainable development was either in its early stages or not yet a major area of focus within the academic community. A discernible shift occurs in 2019, marked by a gradual increase in the volume of publications. This shift coincides with a growing recognition of AI/ML technologies as pivotal tools for addressing critical challenges in production and sustainability. The upward trend accelerates significantly post-2020, with the data reflecting an exponential surge in scientific publications. This marked increase is particularly prominent from 2021 to 2024, signaling an intensified research interest in this field.

As shown in Table 1, the dataset spans the period from 2000 to 2024, encompassing a total of 291 sources and 492 documents. The field exhibits a notable annual growth rate of 24.24% in scientific production, reflecting a consistent upward trend in research activity

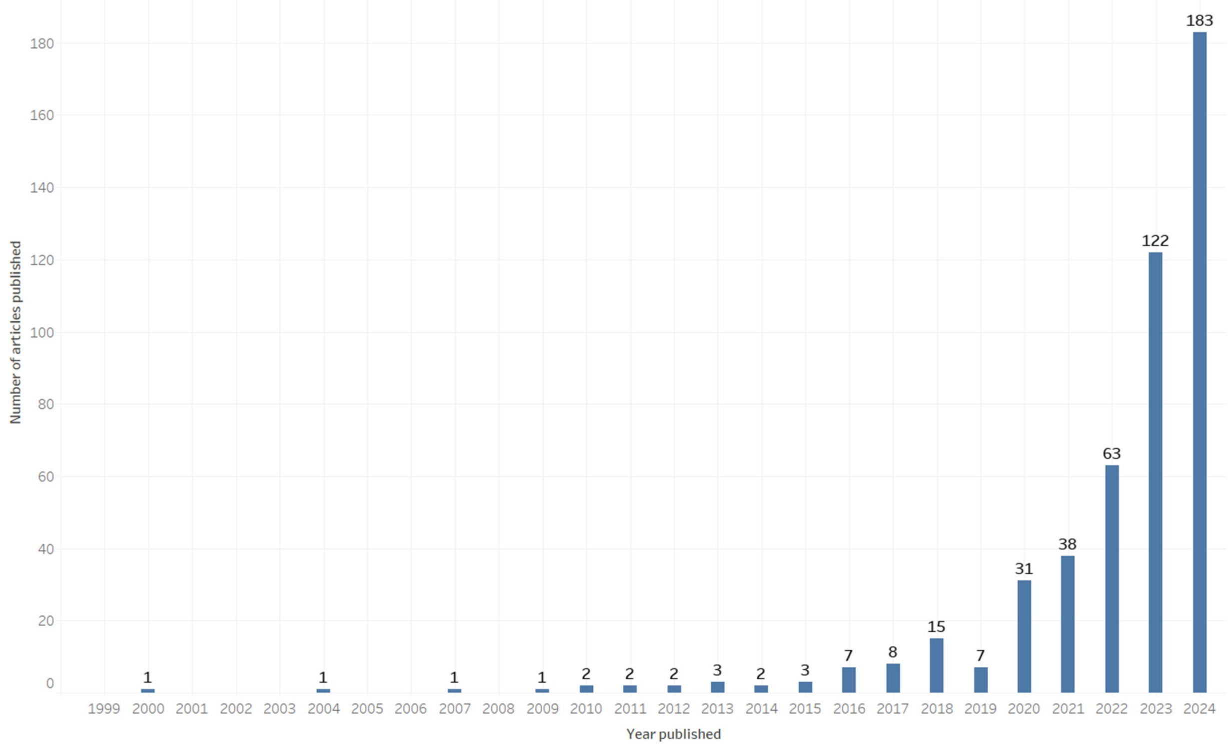

FIGURE 2
Annual scientific publications.

TABLE 1 Descriptive results.

Description	Results
Timespan	2000:2024
Sources (journals, books, etc.)	291
Documents	492
Annual growth rate %	24.24
Document average age	1.95
Average citations per doc	11.51
References	26,378
Keywords plus (ID)	4,945
Author's keywords (DE)	1,692
Authors	1905
Authors of single-authored docs	35
Single-authored docs	40
Co-authors per doc	4.27
International co-authorships %	24.59
Article	235
Book	3
Book chapter	26
Conference paper	165
Conference review	6
Letter	1
Review	55
Short survey	1

and the importance of AI and ML in sustainable production and environmental practices. Furthermore, approximately 24.59% of these publications involve international co-authorship, emphasizing the collaborative nature of research within this field. The relatively low average document age of 1.95 years suggests that this is an evolving field with much of the research being recent and potentially reflective of the growing interest in AI-driven solutions for sustainability. Each document, on average, has been cited 11.51 times, indicating a moderate level of engagement with the work published in this discipline (Table 1).

In this figure, the most relevant keywords used in research papers are presented, providing insights into the thematic focus of literature. The most frequently occurring term is "sustainable development" with 396 occurrences, confirming that the primary objective of AI and ML research in this context is to drive sustainability in production and industrial processes. Following closely is "machine learning" and "artificial intelligence" which appear 238 and 164 times, respectively. This reflects the technological backbone of the research, with AI and ML technologies at the core of strategies aimed at improving production efficiency. Also, the keyword "decision making" with 70 occurrences, further suggests that these technologies are being applied to enhance decision-making processes in production systems, which is crucial for optimizing resourcing and minimizing waste. Other terms such as "crops," "Internet of Things" (IoT) and "productivity," show that AI and ML applications in agriculture and IoT integration are significant subthemes in this research field, focusing on boosting productivity while adhering to sustainability principles. Finally, the presence of "China" as a relevant keyword, reflect the country's prominence in both the research and application of AI and ML technologies in this domain (Figure 3).

Figure 4 is a word cloud and serves as a valuable supplement to Figure 3, offering alternative visualization of term frequency within the dataset. While both visuals highlight the most frequently occurring terms, the word cloud extends the analysis by including additional terms that are not explicitly ranked in Figure 3 (e.g., "biomass," "deep learning," "optimization), providing deeper insights into the broader thematic landscape, showcasing the diverse subtopics present within the dataset.

Figure 5 represents a temporal analysis of the most frequent occurring terms in the dataset, offering insights into the evolution of research focus over time. The horizontal lines indicate the span of years during which each term has been prominent in the literature, the size of the bubbles represent the term frequency and the location of the bubble the time in which the term appeared most. Key terms such as "sustainable development," "machine learning," and "artificial intelligence" have maintained consistent relevance over an extended period, reflecting the sustained interest in these areas. The larger bubble sizes associated with these terms suggest their dominance in the field, with frequencies nearing or exceeding 300 occurrences.

Other terms such as "crops," "farms" and "environmental impact," have gained traction more recently, revealing a growing interest in their application within sustainability and agriculture contexts. Similarly, terms like "productivity," "process optimization" and "decision support systems," highlight the practical and solutions-oriented nature of recent research, particularly as these topics have gained attention in the past few years. Also, the presence of terms like "natural language processing systems" and "biogas," suggests emerging research directions that are gaining momentum but remain less frequent in comparison to dominant topics. This temporal distribution helps track the evolving priorities and trends in AI, ML and sustainability, demonstrating how some concepts have matured over time while others are still developing.

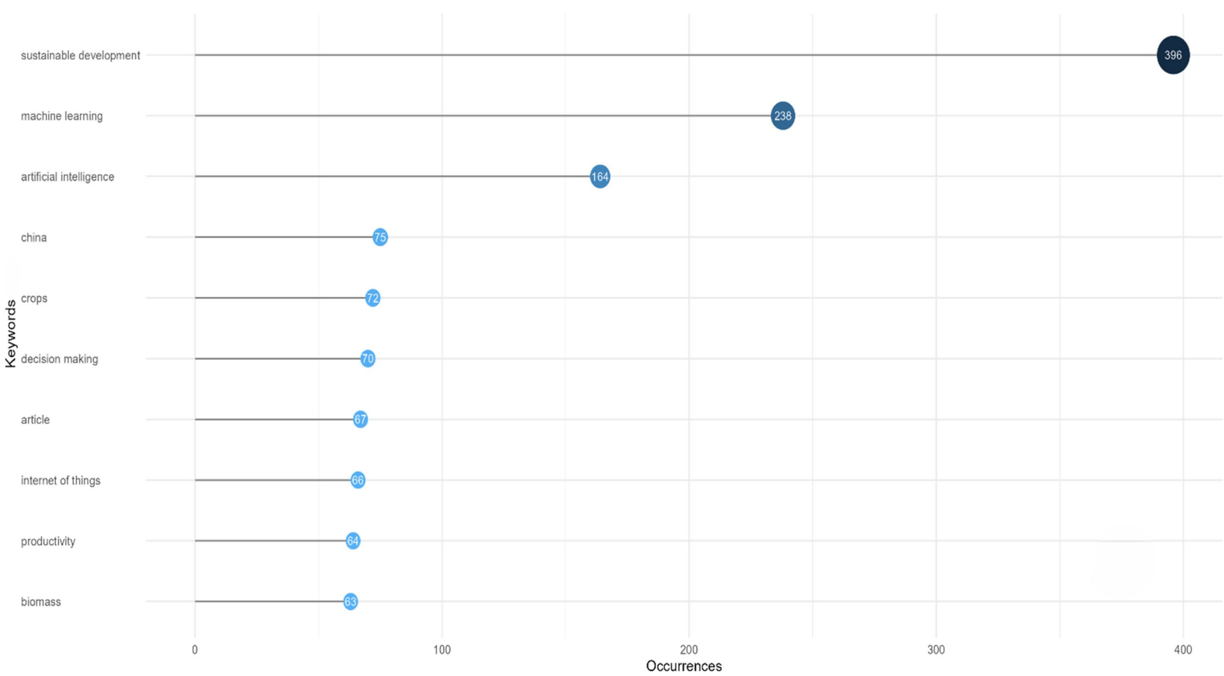

FIGURE 3
Most relevant words.

FIGURE 4
Wordcloud.

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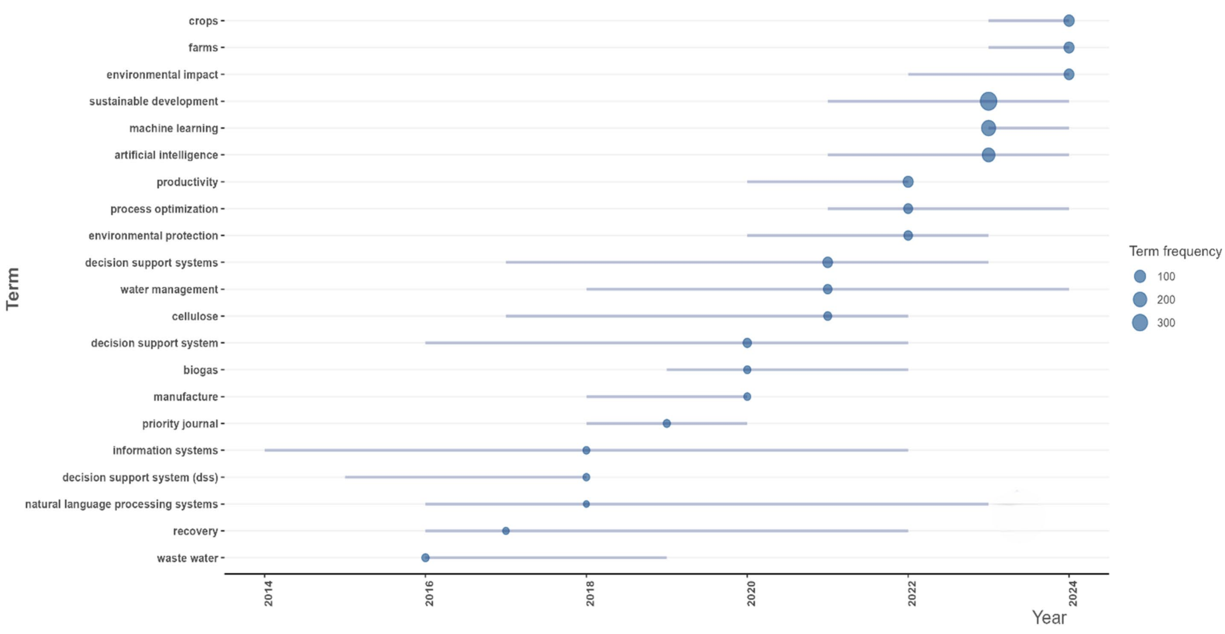

FIGURE 5
Trending themes.

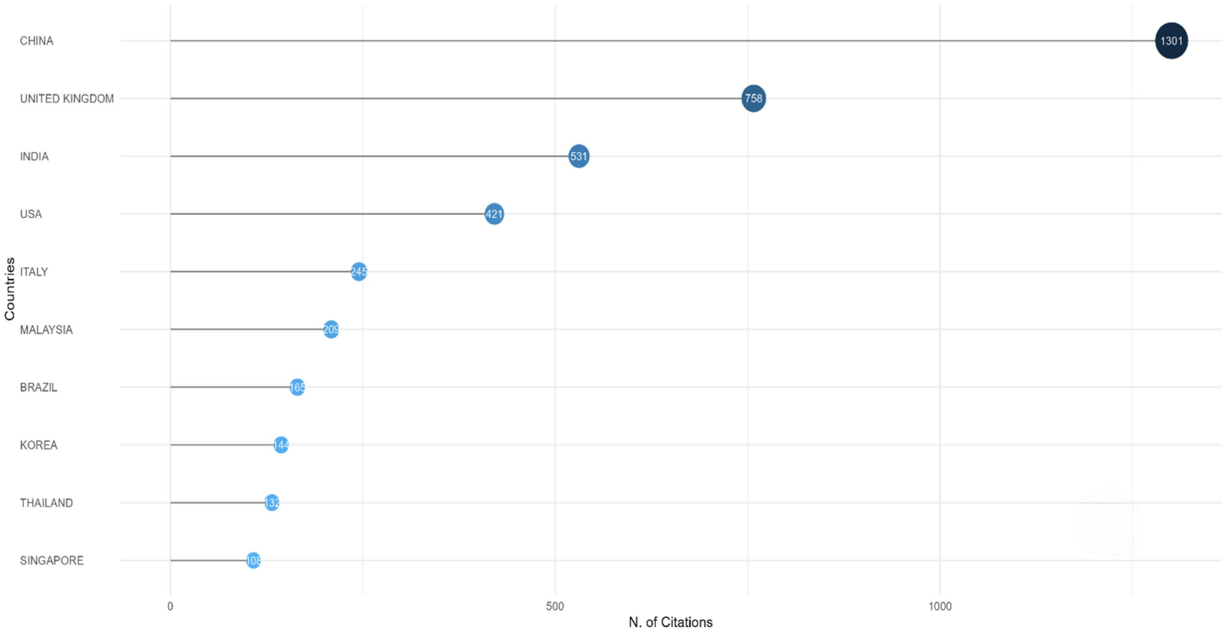

FIGURE 6
Most cited countries.

Figure 6 highlights the countries that have made the most impactful contributions to research on AI and ML for production efficiency and sustainable development, as measured by the total number of citations. The results reveal that China emerges as the predominant leader, with 1,301 citations, indicating a substantial influence on the intellectual discourse surrounding this topic. However, when examining the average citations per article, the United Kingdom emerges as the most influential with 58.30 citations per article, followed by Singapore (54) and USA (23.40) suggesting that although countries like China and India produce a high volume of research, countries such as the UK and Singapore produce more impactful studies (Table 2). This is followed by the United Kingdom with 758 citations, India with 531 citations and the United States with 421 citations. These figures highlight the substantial academic contributions from both established research hubs and emerging research economies. The prominence of Asian countries (Figure 6)

TABLE 2 Most cited countries.

Country	Total citations	Average article citations
China	1,301	13.60
United Kingdom	758	58.30
India	531	6.50
USA	421	23.40
Italy	245	17.50
Malaysia	209	16.10
Brazil	165	20.60
Korea	144	24.00
Thailand	132	26.40
Singapore	108	54.00

suggests that the region is at the forefront of integrating AI and ML technologies to address the dual challenges of production efficiency and promoting sustainability. These findings also suggest that AI and ML research is not confined to a specific region but has garnered significant attention across the globe.

Figure 7 illustrates a co-occurrence network, mapping out the relationships between key terms associated with the research topic. The connections between the terms reflect their frequency of appearance in the same documents, suggesting shared research contexts or themes. The central and the largest node is "Sustainable Development," signifying its critical role within the research landscape. This is further reinforced by its connections to a multitude of terms, including "Artificial Intelligence (AI)," "climate change," "carbon dioxide," and "economic development," demonstrating the centrality of sustainable development in addressing global environmental and economic challenges, with AI increasingly being recognized as a vital tool in these efforts. Also, the significant node for "Artificial Intelligence (AI)," which is closely linked to "Sustainable Development," emphasized the growing integration of AI in various sustainability-related fields.

Another major node, depicted in blue, is "Machine Learning" highlighting its emerging significance in sustainability research. The dense web of connections surrounding this node points to ML pivotal role in applications like "precision agriculture," "crop yield," "energy efficiency," and "data analytics." These terms illustrate how ML is being used to improve efficiency in sectors like agriculture and energy, which are central to sustainable development. Finally, the two major clusters relate to a network of gray lines, visualizing the increasingly interdisciplinary nature of research that merges AI and ML with sustainability efforts (Figure 7).

Table 3 presents the most cited publications within the dataset. For the purposes of this analysis, we will consider only the first four publications with an average of more than 30 citations per year, ensuring that our evaluation centers on the most impactful and widely recognized contributions to the field. Notably, leading this list is Sharma et al. (2022), published in Computers and Operations Research, with a total of 427 citations and an average of 85.40 citations per year. Sharma's research focuses on AI-driven optimization in manufacturing processes, particularly predictive maintenance and supply chain management. His work has significantly contributed to economic sustainability by demonstrating how AI can improve production efficiency, reduce costs, and optimize resource allocation, making it a crucial reference for AI and ML applications in industrial efficiency (Sharma et al., 2020). Other highly cited works include Li et al. (2021), with 99 citations, published in the Chemical Engineering Journal and contributing to environmental sustainability using AI in energy-intensive chemical engineering processes. Li's research explores AI's role in reducing energy consumption and optimizing carbon emissions management, which is vital for industries aiming to meet sustainability goals. His study is especially relevant to energy efficiency and resource optimization, critical aspects of sustainable

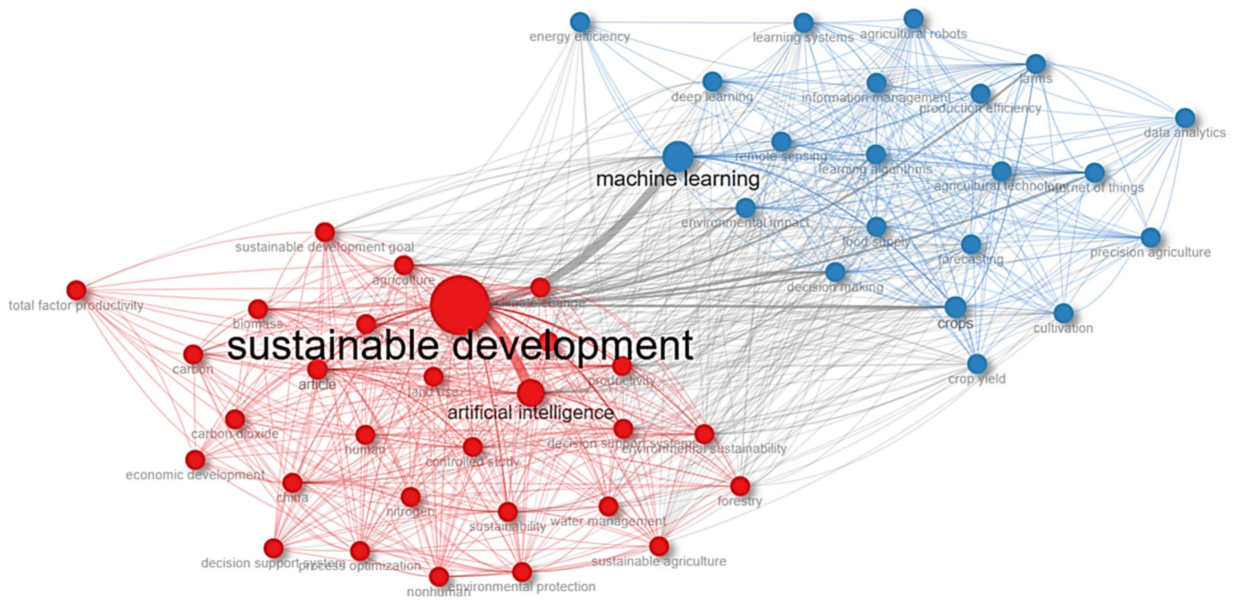

FIGURE 7
Co-occurrence network.

industrial practices (Li et al., 2021). In addition to the above, other notable works are Li et al. (2022), with 97 citations, published in Technological Forecasting and Social Change, addresses the integration of AI and automation in supply chain management, Hughes et al. (2020), with 95 citations, examining AI's role in production planning and control. These studies have significantly shaped the field of AI and ML applications in sustainable development, contributing to economic, environmental and social sustainability.

Figure 8 is a thematic map which provides an insightful visualization of the conceptual structure within the research domain of AI and ML in production efficiency enhancement and sustainable development. The map categorizes research themes into four quadrants based on their density (development degree) and centrality (relevance degree). Motor themes (upper-right quadrant) are well-developed and highly significant to the field, indicating their centrality in driving research and applications. Niche themes (upper-left quadrant) are specialized and well-developed but less critical to the core research agenda. Basic themes (lower-right quadrant) are fundamental to the domain, with high relevance but limited development. Lastly, emerging or declining themes (lower-left

TABLE 3 Most cited publications.

Paper	Total citations	Total citations per year
Sharma et al. (2020), Comp Oper Res	427	85.40
Li et al. (2021), Chem Eng J	99	24.75
Li et al. (2022), Technol Soc	97	32.33
Hughes et al. (2020), Prod Plann Control	95	31.67
De Lucia et al. (2020), Sustainability	95	19.00
Li et al. (2020), Int J Prod Res	91	18.20
Alahi et al. (2023), SENSORS	90	45.00
Sharma et al. (2018), Neural Netw	88	12.57
Da Silva et al. (2020), Comput Ind Eng	88	17.60
Sharma et al. (2022), Comput Electron Agric	82	27.33

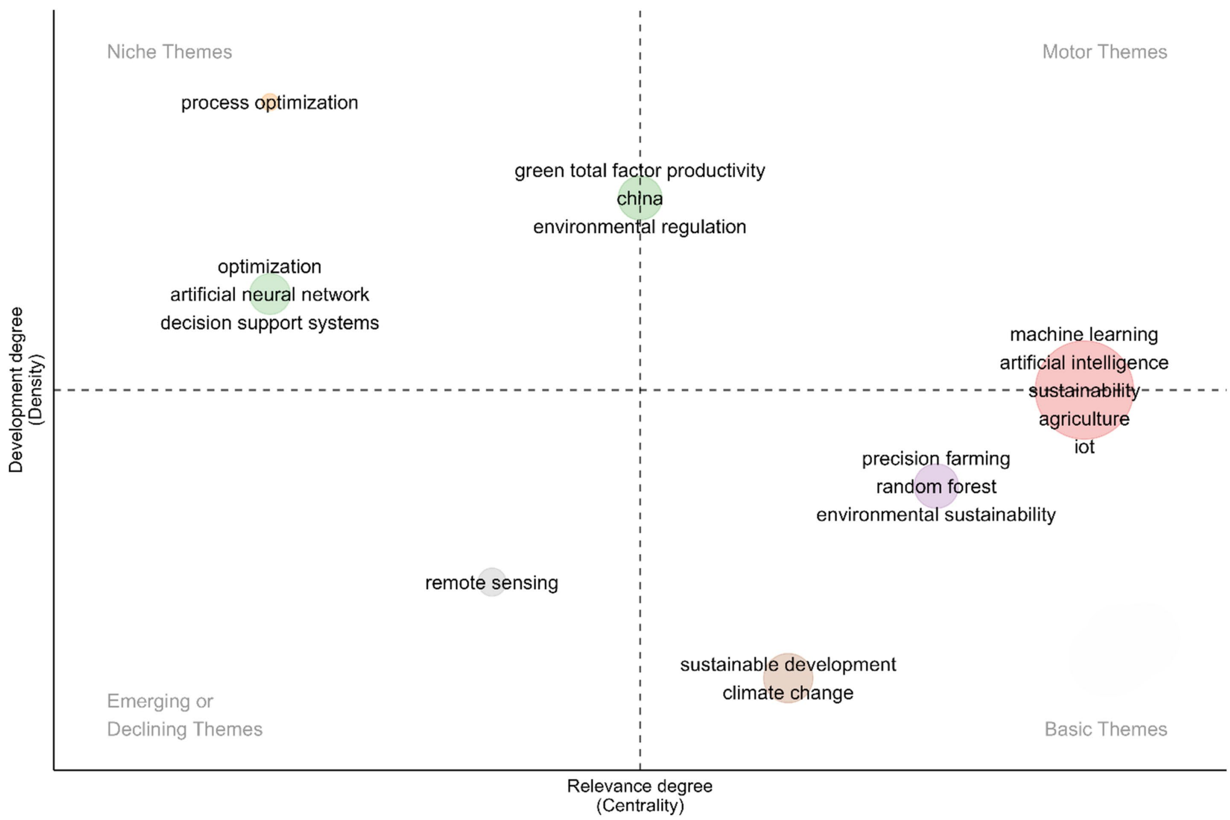

FIGURE 8
Thematic map.

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quadrant) represent areas with low centrality and density, signifying either nascent or diminishing relevance within the research landscape (Agbo et al., 2021).

As seen in Figure 8, in the Motor Themes quadrant, highly relevant and well-developed topics such as "machine learning," "artificial intelligence," "sustainability," "agriculture," and "IoT" dominate, indicating their pivotal role in advancing the field. In addition to the above, in the Basic Themes quadrant, foundation topics such as "environmental sustainability," "precision farming," and "random forest" are included, suggesting their importance in shaping the research area, even though they require further development. In the Niche Themes quadrant, specialized areas like "process optimization" and "decision support systems" highlight their depth and development but are more peripheral to the main research focus. Meanwhile, the Emerging or Declining Themes quadrant features "remote sensing," "sustainable development" and "climate change," reflecting their potential as burgeoning areas of interest or waning emphasis. These findings underscore the diverse focus areas within the field, ranging from core technologies and methods to evolving and specialized applications (Figure 8).

Figure 9 is a country collaboration map which visually highlights the global patterns of research collaboration in the field of AI and ML in production efficiency enhancement and sustainable development (Almulhim et al., 2021). This figure is further enhanced with Table 4 which shows the frequency of collaborative research between the top 10 pairs of countries within this field. As seen in Table 4, China emerges as the dominant hub of collaborations, leading the field with strong research ties to the USA with 8 collaborations, the United Kingdom with 6 and Pakistan with 5. These partnerships reflect China's significant investment in AI and sustainability-related research, positioning itself as a global leader. In addition to global partnerships, China also maintains a strong regional focus with collaborations involving Korea with 4 collaborations and Hong Kong with 3. Partnerships with nations such as Pakistan, Iran, Saudi Arabia, and Singapore (3 collaborations each) highlight China's strategic efforts to foster research ties within Asia and the Middle East. Meanwhile, the USA, another major player in the field, demonstrates its global influence with a notable of 5 collaborations with India, reflecting growing research contributions from developing economies. Furthermore, Figure 9 also highlights the limited participation from underrepresented regions like Africa and Latin America, signaling the need for more inclusive efforts to incorporate these areas into global sustainability research.

Overall, the map's darker shades over countries like China, the USA, and the UK emphasize their leadership in research output and collaborations. The connecting lines between Asia, North America, and Europe further illustrate the dominance of transcontinental research networks. However, the absence of strong connections in regions like Africa and parts of Latin America suggests an opportunity to foster greater inclusivity, ensuring global participation in addressing

TABLE 4 Frequency table of collaborative research.

From	To	Frequency
China	USA	8
China	United Kingdom	6
China	Pakistan	5
India	USA	5
China	Korea	4
China	Australia	3
China	Hong Kong	3
China	Iran	3
China	Saudi Arabia	3
China	Singapore	3

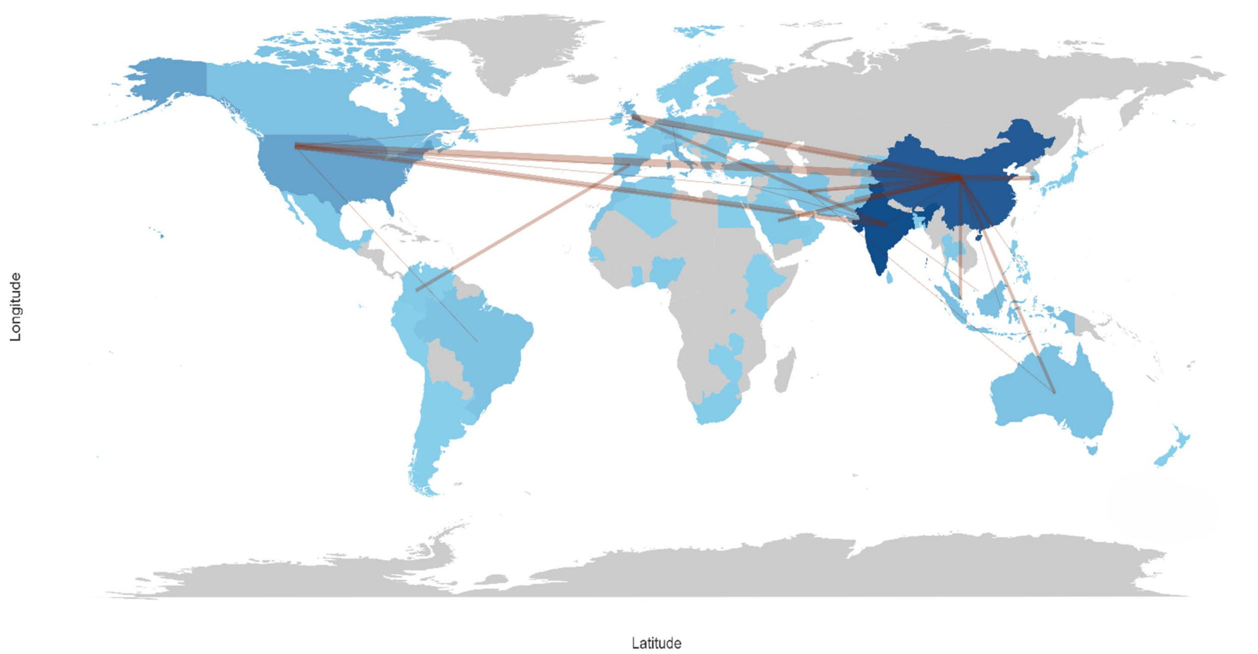

FIGURE 9
Country co-authorship network map.

critical challenges in production efficiency and sustainable development through AI and ML innovations.

Conclusion

In summary, the bibliometric analysis conducted on the application of AI and ML in enhancing production efficiency and promoting sustainable economic development revealed valuable insights on the progression and impact of these technologies. The findings indicate that AI and ML have become indispensable tools for optimizing production processes and managing resources, thereby fostering sustainable growth across diverse industries. Significant trends, including the rise of deep learning, data mining, and the Internet of Things (IoT), have emerged as crucial drivers of innovation (Figure 3). Moreover, collaborations among researchers, institutions, and countries have increased, highlighting the global character of research efforts in this field (Table 2).

Furthermore, the analysis also shows that China and the United States are the leading contributors in terms of research output and impact, with substantial contributions coming from the agriculture and manufacturing sectors (Table 2). Notably, the study also reveals the underrepresentation of EU countries in AI and ML research on sustainable production, despite their significant investments and initiatives in sustainable technology. This gap suggests that while countries like China have made substantial contributions, there is a need for more visibility and research output from the EU to ensure global representation in this field. Furthermore, there is a marked lack of research contributions from developing economies, particularly in Africa, South America, and parts of Asia, where AI and ML applications could have transformative impacts on local economies and sustainability initiatives. Key research themes that have emerged include productivity optimization, decision support systems, and environmental protection (Figure 5), highlighting the versatility and relevance of AI and ML in both economic and ecological contexts.

Despite these promising trends, notable gaps in literature continue to persist. For instance, the analysis underscores the need for further exploration of the ethical implications of AI in production, particularly concerning data privacy and labor market disruptions. Also, there is a noticeable gap in research regarding the long-term economic and social sustainability of AI-driven systems, especially in low-income and developing countries.

Additionally, this study has certain limitations that should be acknowledged. The analysis is based exclusively on publications indexed in the Scopus database, which might result in excluding relevant studies available in other databases, potentially narrowing the scope of the findings. Furthermore, the reliance on a descriptive bibliometric methodology limits the ability to draw causal inferences or predictive insights from the data. Despite these limitations, the findings contribute to existing literature by confirming the dominance of developed countries, such as China, the USA, and the UK, in AI/ML research while highlighting the underrepresentation of regions like Africa and South America. Additionally, the analysis reveals limited focus on AI/ML applications in industries beyond agriculture and manufacturing, such as healthcare and education, particularly in developing economies. These insights underscore the need for more inclusive research efforts that address geographic and sectoral disparities in the field.

Future research could focus on several directions. First, it is essential to examine the broader social and ethical implications of AI and ML in production, including their effects on labor markets, privacy concerns, and the potential for increasing inequality. Also, future research should address the existing geographic imbalances by promoting greater participation from EU countries and developing economies in AI/ML studies related to sustainable production. Encouraging collaborative research efforts and fostering cross-border partnerships will help ensure that AI and ML technologies benefit a broader range of regions, particularly those with unique socio-economic challenges. Investigating the potential of AI and ML in developing countries will not only help bridge this research gap but also provide tailored solutions that align with the sustainability goals of these regions. Other potential research avenues include interdisciplinary approaches that integrate ML with other fields for a more comprehensive understanding of sustainable production processes, longitudinal studies to assess the long-term impacts of AI and ML on production efficiency and sustainability, and investigations focused on Small and Medium Enterprises (SMEs) to explore how these technologies can be scaled to benefit them, given that large corporations often dominate this technological landscape. Lastly, considering the inclusion of other databases such as Web of Science or IEEE Xplore in future studies could provide a more comprehensive understanding of the field, ensuring a broader representation of research contributions.

To conclude, investigating these areas will deepen our understanding of the role of AI and ML assume in optimizing production efficiency and promoting sustainable development, while also facilitating equitable access to their benefits across various sectors and regions.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Author contributions

AB: Writing – original draft, Writing – review & editing. NK: Writing – original draft, Writing – review & editing. MN: Writing – original draft, Writing – review & editing.

Funding

The author(s) declare that no financial support was received for the research, authorship, and/or publication of this article.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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frontiers | Frontiers in Sustainability

TYPE Original Research
PUBLISHED 27 January 2025
DOI 10.3389/frsus.2025.1513954

OPEN ACCESS

EDITED BY
Elisabeth Süßbauer,
Technical University of Berlin, Germany

REVIEWED BY
Anna Trubetskaya,
Nord University, Norway
Aleksandra Figurek,
University of Nicosia, Cyprus

*CORRESPONDENCE
Yuriy Danko
✉ y.danko@snau.edu.ua

RECEIVED 19 October 2024
ACCEPTED 07 January 2025
PUBLISHED 27 January 2025

CITATION
Nifatova O, Bliumska-Danko K, Charreire-Petit S and Danko Y (2025) Packaging of organic food—the dilemma of consumers' internal and external motives. *Front. Sustain.* 6:1513954.
doi: 10.3389/frsus.2025.1513954

Packaging of organic food—the dilemma of consumers' internal and external motives

Olena Nifatova[1,2], Kseniia Bliumska-Danko[2,3], Sandra Charreire-Petit[3] and Yuriy Danko[2]*

[1]Barcelona Economic Analysis Team, University of Barcelona, Barcelona, Spain, [2]Research Department, Sumy National Agrarian University, Sumy, Ukraine, [3]Researcher, Networks, Innovation, Territories and Globalisation Laboratory, Université Paris-Saclay, Paris, France

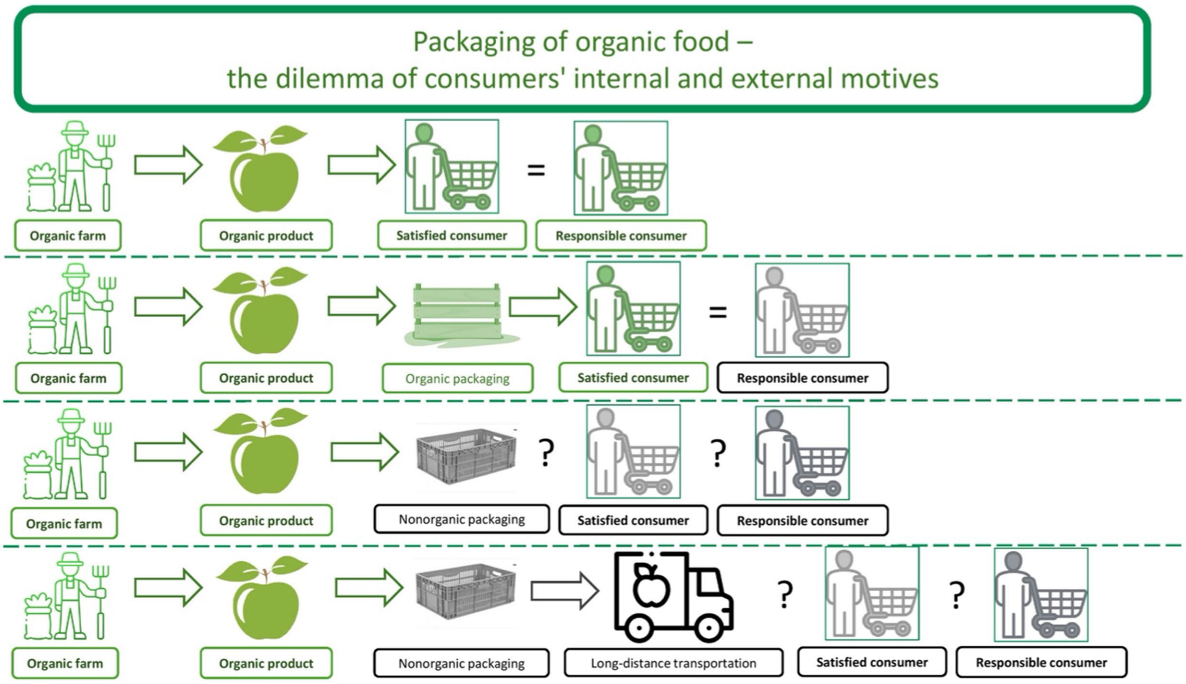
This study provides empirical insights to clarify consumers' motives for choosing organic food and the importance of the packaging of organic food in shaping consumers' perceptions of food organicity. Based on a survey of 497 consumers of organic food in Ukraine, we investigate the extent to which organic packaging can serve as an indicator of external (altruistic) consumers' expectations and whether the environmental friendliness of consumer choice is related to their expectations of sustainability (greenness) of organic food at all stages of their life cycle. We have found that there is no clear distinction between internal and external consumer motives in the perception of food organicity due to the perception of packaging organicity as part of food organicity. However, organic packaging can be an indicator of external (altruistic) consumer motives, subject to the limitations that organic packaging is less related to health care and more to altruistic motives. Consumers driven by external motives may expect produce to be organic at all stages of their life cycle and are more likely to rely on the producer's commitment to environmental responsibility. Organic producers should consider this in their marketing strategies to meet consumer expectations and avoid the risk of greenwashing. Our results can serve as a starting point for further exploration of ways to foster mutual understanding between consumers and producers regarding shared environmental responsibility.

KEYWORDS

packaging of organic food, consumers' expectations, organic food life cycle, organic producers, sustainability, green marketing, greenwashing

1 Introduction

The focus of researchers on studies related to the behavior of organic food consumers continues to grow. This interest is explained by the numerous dilemmas that arise in the process of rethinking both the motives of consumer behavior and strategic decisions related to the formation of food policies and meeting the interests of a society focused on sustainable development. Many recent studies reflect an important trend to find links between the consumption of organic food and the motives that drive consumers to do so. The study Singh and Khanwani (2023) and Krsnik and Erjavec (2024) develops a shift from demographic to psychographic criteria that determine environmentally conscious consumer behavior. Psychographic criteria for the consumption of organic food in many studies are associated with the existence of egoistic and altruistic motives in consumer behavior. As a rule, egoistic motives are understood to be related to the care for one's own health (Iyer et al., 2016), and altruistic motives to be related to the concern for the environment (Birch et al., 2018; Xu et al., 2021). The main debate is centered on the dilemma of what ultimately determines consumer



GRAPHICAL ABSTRACT

choice: internal security through the perception of organic food as safe and healthy, or external motivation through self-awareness of social benefit and social responsibility. Among the nine motives for purchasing organic food examined in Hughner et al. (2007), health and environmental concerns are also at the top of the list. Although there is still insufficient evidence that organic food is more nutritious (Pawar et al., 2022), some studies, for example Magnusson et al. (2003) suggest that egoistic motives are winning the battle for the best predictor of organic food purchase, putting personal health first compared to environmental concerns.

Increasingly, researchers are going deeper in their studies, paying attention to the motives of consumption, differentiating between egoistic and altruistic (Hansen et al., 2018), or in terms of human health, animal health (Hölker et al., 2019) and environmental impacts (Magnusson et al., 2003). For example, a study of Hansen et al. (2018) shows the relationship between organic food identity and consumers' personal values. The researchers showed a positive correlation between identity and the egoistic motive (understood as taking care of one's own health) and no correlation between the altruistic motive (understood as environmental awareness), which also proved the dominance of egoistic motives over altruistic ones in the formation of organic food identity.

Although many studies have highlighted environmental concerns (Steg and Vlek, 2009; Penz et al., 2019; Zammitti et al., 2023), as a motive for consumers to choose organic food, it remains unclear whether the altruistic motive is clearly understood by consumers and producers alike. Our starting point for the study is a couple of trivial questions: what makes a product "green," organic food "organic," and what kind of understanding exists between the consumer and the producer in this context? The preliminary literature review sheds some light through interpretations of the green marketing concept. Some authors (Sarkar, 2012; Reddy et al., 2023) consider green marketing as a promotion strategy based on the greenness of one of the 4Ps or a particular stage of the product life cycle. Accordingly, either the food or service itself is environmentally friendly, or the production process or packaging is modified to be more environmentally friendly. Given that organic production is subject to globalization trends (Hempel and Hamm, 2016a,b), in some European countries demand exceeds supply, which leads to the need to import organic food, which automatically raises the issue of logistics costs and calls into question the environmental benefits of such food. On the other hand, previous studies have shown that consumers often perceive local food as healthier and of higher quality, associating them with all the attributes of organic food (Jensen et al., 2019; Campbell et al., 2013; Abouab and Gomez, 2015; Ditlevsen et al., 2020). Thus, consumers demand food with health benefits, and the food industry, for its part, tries to meet the needs of large food sectors that see health as a potential growth area (Lang and Heasman, 2015). But is not a company that positions its produce as "green" or "organic" in this case involved in greenwashing? When offering a consumer, for example, to buy certified organic food delivered from another continent, is the seller misleading its consumer by claiming that they are organic and environmentally friendly, which the consumer may associate with a less destructive impact on the environment? Or, for another more obvious example, organic food sold in non-organic packaging (fresh organic berries in a plastic box), would this not be another example of abuse of consumer trust? In this context, we would like to focus on the packaging of organic food in

Abbreviations: EU, European Union; FA, Factor Analysis; SPSS, Statistical Package for the Social Sciences; EFA, Exploratory Factor Analysis; CFA, Confirmatory Factor Analysis; KMO, Kaiser-Meyer-Olkin Test; EACEA, European Education and Culture Executive Agency; GMO, Genetically Modified Organism; 4P, Product, Price, Place, Promotion; UAH, Ukrainian Hryvnia.

relation to altruistic (external) and egoistic (internal) motives of consumer behavior. The motivation for this study is based on contemporary environmental challenges that require society and businesses to reduce the negative impact of packaging on the environment. The European Union is actively developing policies and regulatory frameworks to address these challenges. In particular, Directive 94/62/EC on Packaging and Packaging Waste (European Parliament and Council, 1994) establishes general requirements for the sustainability of packaging, including its recyclability, reusability, and biodegradability. Additionally, Directive (EU) 2019/904 with European Parliament and Council (2019) emphasizes the importance of reducing the environmental impact of plastic products, requiring a gradual transition to more environmentally friendly alternatives, including biodegradable packaging. Positive developments in this direction are also taking place in Ukraine. Current reforms aim to harmonize national legislation on packaging and packaging waste management with European standards. The Draft Law of Ukraine on Packaging and Packaging Waste (No. 10066–2) with Verkhovna Rada of Ukraine (n.d.) proposes the establishment of a packaging management system based on the principles of a circular economy, marking a significant step towards alignment with European policies. Based on the directives and aligned with the discussion in Turkcu et al. (2022), "organic packaging" is defined as packaging materials that reduce the environmental impact throughout their life cycle. This includes recyclable, biodegradable, and compostable materials, as well as biobased plastics derived from renewable sources such as corn, sugarcane, or cellulose. Additionally, this definition encompasses non-plastic materials like paper or bamboo, provided they meet environmental sustainability criteria such as minimal greenhouse gas emissions, resource efficiency, and safe end-of-life disposal options. Biobased and biodegradable plastics, as well as paper and cardboard, are often considered ideal materials for organic packaging due to their lower environmental impact compared to conventional plastics (Caspers et al., 2023).

Nowadays, there are a lot of studies researching consumer attitudes towards organic packaging (Akin et al., 2023). In their paper Espinosa-Brisset et al. (2023) on consumer perceptions of fruit production and processing technology, they present survey results showing that most consumers indicate that organic food helps to preserve the environment. On the other hand, for both fresh and processed food, consumers consider the availability of packaging to be a minor problem, but the presence of packaging itself, along with the use of additives and loss of nutritional value, are considered to be disadvantages of processed food. This leads to the assumption that for a consumer of organic food, processing conditions and organic packaging will be more important than production conditions. It turns out that the importance of organic production for the consumer is lost at the processing stage, while the importance of organic packaging is increasing. Another aspect of the importance of organic food packaging is its information component. A study Chiew et al. (2023) shows the importance of ecolabels in predicting consumer intentions to buy organic food. Researchers view packaging as an element of supporting a sustainable consumption model, which makes packaging an important link not only in terms of communicating the benefits of organic food, but also in terms of consumption culture itself. However, consumer motivations for organic packaging vary. Some studies Koch et al. (2022) suggest that economic benefits, such as efficient use of resources, and normative motives, such as societal expectations, prevail over hedonic motives, such as emotional aspects of environmentally friendly behavior, when choosing eco-friendly packaging. However, the authors studied consumer behavior in online retail, which does not take into account the health aspect. A study of consumer behavior in the field of food packaging (Jurconi et al., 2022) has found a correlation in the understanding of 280 respondents of eco-friendly packaging as an opportunity to live in a less polluted environment. The issue of consumer awareness in identifying eco-friendly packaging materials also remains open. According to Nguyen et al. (2020) knowledge of packaging materials production technology remains low, and market attractiveness (design and good price) is considered a criterion for choosing environmentally friendly food packaging. Nevertheless, the results of the focus group discussions have shown that consumers are ready to adjust their consumption behavior towards environmentally friendly one. The market attractiveness of packaging in terms of its design is also mentioned in an earlier study Frýdlová and Vostrá (2014), according to which consumers mentioned this criterion as influential when choosing organic food along with health effects.

These research results indicate that there are at least three gaps in understanding consumer behavior in the field of organic food and their packaging. First, the clear motives for the choice remain unclear, namely: when buying organic food, is the consumer more inclined to take care of their own health or to take care of the environment? The first gap is likely to lead to the second uncertainty: is organic packaging considered equally important in shaping consumer perceptions of food organicity (given that organic packaging is less related to health concerns and more related to altruistic motives)? And finally, the dilemma that arises as a result: should the consumer be responsible for the environmental friendliness of their choices? By responsibility for environmental friendliness, we mean the consumer's expectations concerning the sustainability of organic food at all stages of their life cycle. By addressing these gaps, this study aims to contribute to a deeper understanding of consumer behavior. It also seeks to inform strategies to align consumer expectations with the principles of organic food development and sustainable packaging practices.

This study aims to find empirical answers to these gaps. The research objectives (RO) of this article are:

- RO (1): To analyze the primary motives behind consumer choices for organic food, distinguishing between health-related (internal) and environmental (external) factors.
- RO (2): To examine the influence of packaging on consumer decisions regarding organic food and evaluate how this role varies based on internal or external consumer motives.
- RO (3): To investigate consumer expectations regarding the sustainability of organic food throughout their life cycle and their alignment with perceived personal responsibility for environmental sustainability.

The problem addressed in this study centers on the lack of a clear understanding of how consumer motives-both internal (health-related) and external (environment-related)-interact in shaping perceptions of organic food, particularly the role of organic packaging in these perceptions. This uncertainty creates challenges for producers in aligning marketing strategies with consumer expectations and risks exacerbating issues such as greenwashing. By examining the interplay between these motives and the sustainability expectations throughout a product's life cycle, this study aims to fill a critical gap in the literature and provide actionable insights for stakeholders.

This research investigates consumer attitudes toward organic food without focusing on specific categories. The term 'organic food' was understood broadly by respondents as any goods labeled and marketed as organic. The surveys were conducted in supermarkets, allowing consumers to base their responses on organic items commonly available to them during their shopping experiences. This approach provides a general understanding of consumer perceptions without limiting the scope to a specific product category.

The structure of the paper is as follows: the second section describes the methodology, including survey design, target audience, and data collection process. In the third section, the results are presented, focusing on consumer perceptions of organic food, the role of packaging, and sustainability expectations. In the fourth section, the findings are discussed in the context of existing literature and their implications for stakeholders. Finally, in the fifth section, the study's contributions are summarized, and directions for future research are suggested.

2 Materials and methods

2.1 Study design and research framework

This study was designed to investigate motivational aspects of consumer behavior related to organic food, focusing on three key areas: (i) consumers' perceptions of food organicity; (ii) the role of packaging in shaping consumer choices; and (iii) expectations of sustainability throughout a product's life cycle. The research was conducted using a structured survey targeting a representative sample of 497 consumers from four Ukrainian cities (Kyiv, Odesa, Lviv, and Sumy), selected for geographic diversity. The survey comprised 33 questions, divided into blocks that explored socio-demographic characteristics, perceptions of organicity, attitudes towards packaging, and expectations of sustainability. Responses were collected through in-person interviews using digital questionnaires, ensuring accessibility and accuracy.

To analyze the collected data, we employed factor analysis to identify and differentiate internal and external consumer motives. This method allowed us to explore the relationships between respondents' motivations and their perceptions of organic food and packaging. Additional statistical techniques, such as correlation analysis, were used to link socio-demographic factors with behavioral patterns. The study's robust design ensured comprehensive insights into the interplay between consumer expectations, environmental responsibility, and the role of packaging in organic food selection.

2.2 Survey description and questionnaire design

We conducted a survey of the population of Ukraine to investigate the motivational aspects of consumer behavior towards organic food in the context of (i) perception of their organicity; (ii) importance of packaging; (iii) importance of sustainability (greenness) of products at all stages of the life cycle. The data was collected through a survey of consumers in supermarkets in four Ukrainian cities (Kyiv, Odesa, Lviv and Sumy). The survey was performed exclusively in large cities of Ukraine due to the following considerations: availability of certified organic food and higher purchasing power. In Ukraine, certified organic food is predominantly available in large cities, where supermarkets and specialized stores stock a broader range of such items. Smaller towns and rural areas often have limited access to certified organic food, which would have restricted our ability to collect data on consumer behavior. Certified organic food is generally more expensive than conventional ones, making them more accessible to consumers with higher income levels. Large cities typically have a higher average income and purchasing power among residents compared to smaller towns and rural areas. This ensures that the surveyed population is more representative of actual consumers of certified organic food in Ukraine. The main criterion for selecting the supermarket was the availability of organic food in the stock. Surveys were conducted in supermarkets where respondents interacted with a range of organic-labeled food. The term 'organic food' was deliberately left open for interpretation to capture general attitudes toward organic food. This approach allowed us to investigate overarching consumer perceptions without limiting the study to a specific product category. Respondents were selected randomly. Each respondent was asked to fill out a Google questionnaire with 33 questions on a tablet or on their own mobile device (Supplementary Table A1), which took 15 min on average. Due to the length of the survey, the main criterion for choosing consumers was the availability of free time and the willingness to participate in the survey. This survey was conducted in October–December 2023. The cities for the survey were chosen to be geographically representative of the sample, covering the center, east, west, and south of the country. When estimating the proportions of the sample, the total population of Ukraine was considered (sampling error ± 5% and credibility level 95.5%), the final sample size was 497 respondents. In order to ensure clarity during the interview, as well as to preliminarily estimate its duration, we used a pilot survey with 15 people before conducting research in the field. The questionnaire contained 4 blocks: general block - socio-demographic characteristics of respondents; block 1 - *"What food does the consumer consider organic?"* (3 multiple-choice questions, 5 questions with single choice); block 2 - *"What place does the consumer give to packaging when choosing organic food and does his/her choice depend on his/her motives (internal or external)?"* (1 question with multiple choice, 12 questions with single choice); block 3 - *"When buying organic food, does the consumer expect them to be organic at all stages of their life cycle?"* (5 questions with single choice). This questionnaire was used to identify the general context for the three blocks and to conduct an aggregate analysis of the relationship between conditional variables and respondents' answers to blocks of questions.

2.3 Factor analysis of internal and external motives (i) perception of organicity; (ii) importance of packaging; (iii) importance of sustainability ("greenness") of food at all stages of the life cycle

To analyze internal and external motives, we used factor analysis (FA). We considered various constructs and conducted an exploratory factor analysis, adapting respondents' answers to our research context (Supplementary Table A2). The FA was calculated in SPSS using the Principal component method with the estimation of the components of the correlation matrix and Varimax with Kaiser Normalization rotation by analyzing the components of the correlation matrix with absolute values of the components greater than 0.32 (Finch, 2020). We expected to get two factors that would correspond to the internal and external motivation of consumers. But the results with a limited selection of factors of 2 showed that the cumulative variance was only 50.2%. Thus, we removed the constraints and obtained three different factors (external motives, internal motives, mixed motives) that accounted for 70.7% of the cumulative variance.

2.4 Sample description

The socio-demographic characteristics of the sample and the population of Ukraine (Demographic Passport, 2023) are compared in Table 1. The sample was representative for the population in terms of age and level of income; partially representative in terms of marital status and place of residence. However, it should be noted that male respondents are underrepresented, which can be explained by several factors. First, the tradition of household purchases (women are more likely to visit supermarkets than men); second, many Ukrainian men aged 25 to 60 are currently mobilized. Also, the sample is characterized by an overrepresentation of respondents with higher education, but our sample is not an exception; similar trends are inherent in many empirical studies (Pérez y Pérez and Gracia, 2023; Verhoef, 2005) and can be explained by the fact that respondents with higher education are more likely to agree to be interviewed.

Thus, 75.3% of the sample were women. Most of the respondents were aged 18 to 49, live in large cities, have higher education, their average income ranges from 10 to 40 thousand UAH, mostly live with their families and have a child. Since one of the hypotheses of our study was to test the correlation between social and civic activity and the formation of motives for using organic packaging, we added questions about public activities and social activism of respondents to the standard questions of the socio-demographic profile. According to the survey, 41.5% of respondents said they were actively involved in social and civic activities, while 39.4% were not.

Socio-demographic characteristics are classified as conventional variables. As Table 2 shows, the coefficient of variation for each conditional variable is greater than 0.15, but the standard deviation for such variables as gender and living situation is less than 0.7, which indicates that these variables do not contain sufficient variation and are not significant for analyzing their impact on the search for internal and external motives in respondents' answers. Therefore, in order to avoid bias in our analysis, we used the criterion of variability (Holt and Smith, 1979). The variability of all other conditional variables, including public activities and social activism, can be considered sufficient to find such links.

TABLE 1 Socio-demographic characteristics of the sample and the population of Ukraine.

Population	Sample (*n* = 497)	Ukraine statistics[1] (*n* = 41.13 million)
Gender (in %)		
Male	24.7	46.4
Female	75.3	53.6
Age (in %)		
18–29	35.4	18.4
30–39	22.8	24.1
40–49	27.6	21.6
50–59	9.6	19.7
60–70	4.7	16.9
Living situation (in %)		
Big city (>200 000 inhabitants)	56.3	45.8
Small town (<200,000 inhabitants)	31.9	23.9
Countryside	11.8	30.3
Education (in %)		
Complete general education	16.3	22.3
Vocational education	4.9	26.3
Higher education	78.9	51.4
Income (in %)		
Below 5000 UAH per month	17.9	15.7
Between 5001 and 10 000 UAH per month	18.9	33.5
Between 10 001 and 20 000 UAH per month	33.3	32.2
Between 20 001 and 40 000 UAH per month	20.9	12.5
Above 40 001 UAH per month	8.9	6.1
Marital status (in %)		
I live alone	13.2	18.2
I live with my family	36.0	11.6
I live in a couple	16.9	32.4
I live in a couple and have children	33.9	37.8
Public activities and social activism (in %)		
I take an active part in social activities	41.5	n/a
I am socially active only during elections	19.1	n/a
I do not take an active part in social activities	39.4	n/a

Data expressed in percentage (%). *Not available: n/a. Demographic Passport (2023)[1].

3 Results

3.1 Consumers' understanding of organic food

This set of questions included a study of consumers' understanding of the category "organic food." Thus, most consumers understand organic food to be grown without synthetic fertilizers and pesticides, certified properly, and grown without the use of GMO seeds (Figure 1). Less than half of respondents consider food to be organic if it is grown using organic fertilizers (37.2%) and sustainable farming methods (36.6%). Characteristics such as organic packaging and production by local farmers are the least associated with consumers' identification of food as organic (25.8 and 16.1%, respectively).

To the question "How do you check whether food is organic?" 64.8% of respondents answered that they looked at the labeling on the package, 32% did not check at all, and 3.2% asked to see a certificate. Despite the fact that *organic packaging is not a decisive characteristic* *for consumers, its presence and information content proved to be important for the majority of respondents.*

The control question ranking the criteria for defining a food as organic by importance to the consumer confirmed the results, identifying the most important factors as the absence of chemical pesticides and the ban on the use of GMOs, special certification marks and a logo. Origin and trust in the producer were of medium importance. The question about the place of purchase of organic food revealed an almost proportional distribution between supermarkets (38%), specialized stores (25.2%) and local farms (23.3%). Only 13.5% of respondents stated that they did not buy organic food at all. Given that the survey was conducted in conventional supermarkets and the respondents were not previously identified as consumers of organic food, such a high percentage of organic consumption among Ukrainian consumers demonstrates a high level of interest. The country of production of organic food is not important for the majority of consumers (59%) when making a purchase, while the group of consumers who buy organic food only locally is also significant - 37.8%, and only 3.2% of consumers prefer imported organic food.

Despite the fact that 78.7% of all respondents believe that the production of organic food causes less damage to the environment, when asked "Which food is more organic for you?" only 20.9% said that the production and sale of which had minimal environmental impact, and 79.1% of all respondents considered food that was more beneficial (safe) for health to be more organic. In other words, there was a predominance of internal motives when choosing organic food. Among those consumers who were guided by external motives (i.e., chose organic food because it caused less environmental damage), 61.8% believed that organic production caused less environmental damage by reducing the amount of toxic substances released into the environment, 18.8% believed that organic production contributed to biodiversity and better supported ecosystems, 12.3% associated it with increased soil fertility and reduced soil erosion, and *only 7% drew attention to the reduction of packaging waste.*

TABLE 2 Population descriptive statistics.

Conventional variables	N	Mean	Std.	Variance
Gender	497	1.73	0.43	0.19
Age	497	2.26	1.17	1.37
Living situation	497	1.56	0.69	0.48
Education	497	2.63	0.74	0.56
Income	497	2.85	1.20	1.45
Marital status	497	2.71	1.07	1.14
Public activities and social activism	497	1.98	0.9	0.8

Std. Deviation and Variance use N rather than N-1 in denominators.

3.2 Role of packaging in consumer decisions

The questions in this block were aimed at identifying consumer habits and peculiarities of consumer behavior regarding organic packaging. The results showed that the culture of waste sorting is still not widely accepted. Only 44.5% of consumers have a strong sorting habit, 49.1% sometimes sort, and 6.4% never sorted at all. However, 61% of consumers indicated that they were in the habit of using reusable shopping bags when shopping, 18.7% preferred paper or biodegradable bags, and there is still a group of consumers who continue to buy bags in the store every time they shop and do not pay attention to the material of the bag. Studying the information on the packaging turned out to be a habit for 50.9% of respondents, while only 2.2% do not pay attention to the packaging to study product information at all. Sustainability of packaging proved to

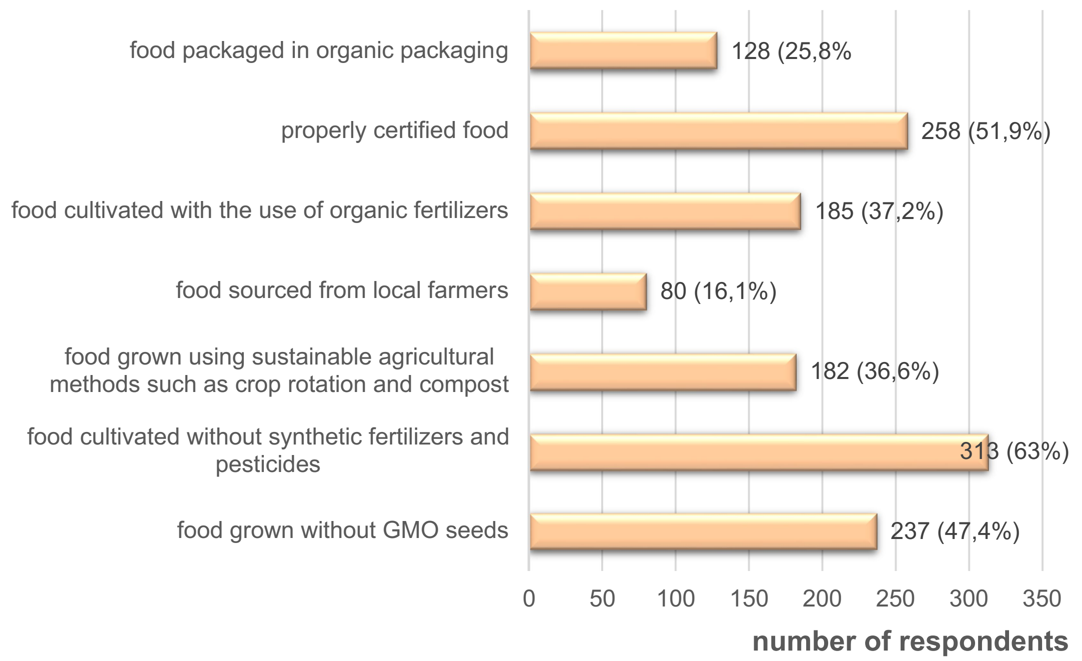


FIGURE 1
How do you understand the category of "organic food"?

be important for the majority of respondents among the general characteristics of packaging (Figure 2). 87.5% believe that organic packaging contributes to the preservation of the environment.

Consumers consider packaging to be organic for 44.3% because it is recyclable, for 27.2% because it reduces the use of plastic, for 26.6% because it does not contain harmful substances, and for 2% because of other characteristics.

The presence of organic packaging when choosing specific brands influences the purchase decision in 23.1% of cases, and for 30.4% of consumers, their loyalty to a particular brand outweighs their interest in organic packaging. To the question "If you are offered to buy organic berries in plastic packaging, what will you do?" 57.5% of respondents answered that they bought berries because they considered them organic, 33.4% said they would buy the food if the producer changed the packaging to eco-friendly, and 9.1% said that such behavior of the producer was a manifestation of greenwashing (thus, the percentage of respondents who consider the organic nature of the packaging to be part of the organic nature of the food itself was identified). Among all respondents, 46.3% of them noted their awareness of the concept of greenwashing, and after it was explained in the next question of the questionnaire, 47.9% of respondents recognized it as a violation of their consumer rights. The transition to organic packaging is considered important for producers by 78.1% of respondents, while 36.6% of respondents are willing to pay additional costs for organic packaging. And finally, 73% expressed their willingness to change their consumer habits in favor of organic packaging.

3.3 Sustainability expectations across the life cycle

The purpose of this set of questions was to identify consumer expectations regarding the organic nature of a food at all stages of its life cycle. In answering the question "How important is it for you that organic food is organic at all stages of its life cycle (growing, processing, transportation, packaging, consumption)" 42.1% of respondents indicated the highest degree of importance, and only 5% of respondents considered that characteristic to be of little or no importance (Figure 3).

To the question "Is it important for you that the packaging of organic food is also environmentally responsible?" 75.1% of respondents answered positively. However, the results of answers to the control question "How often do you pay attention to information about the environmental and social responsibility of the food producer?" (only 10.5% always pay attention, 47.1% usually do, 35.4% rarely do, 7% never do) suggest that consumers think about the environmental friendliness of packaging only if someone draws their attention to the importance of organic packaging as part of the product's overall environmental friendliness. Thus, by purchasing organic food, consumers can automatically consider the food organic at all stages of their life cycle. This is also confirmed by the results of respondents' answers to the question "If you had information that transportation of imported organic food leaves a large carbon footprint, would you continue to buy such organic food?" (41.6% of respondents answered negatively).

3.4 Aggregate analysis of the correlation between conditional variables and respondents' answers by question blocks

Table 3 shows an aggregate analysis of correlations between conditional variables and respondents' answers by question blocks. Respondents' age turned out to be the most influential conditional variable for all blocks. Our study is not exceptional and is in line with the results obtained in previous studies, e.g., (Magnusson et al., 2003). For younger consumers, organic food was most often associated with

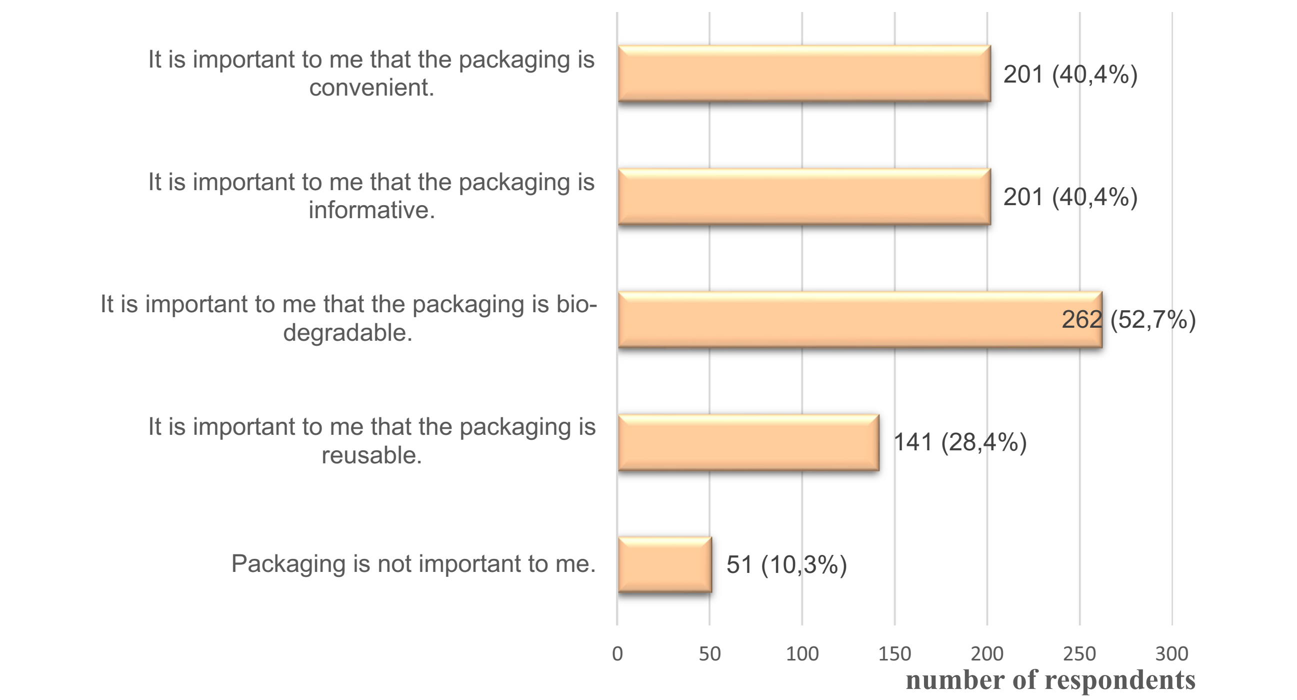


FIGURE 2
Which of the characteristics listed below is important to you in packaging?

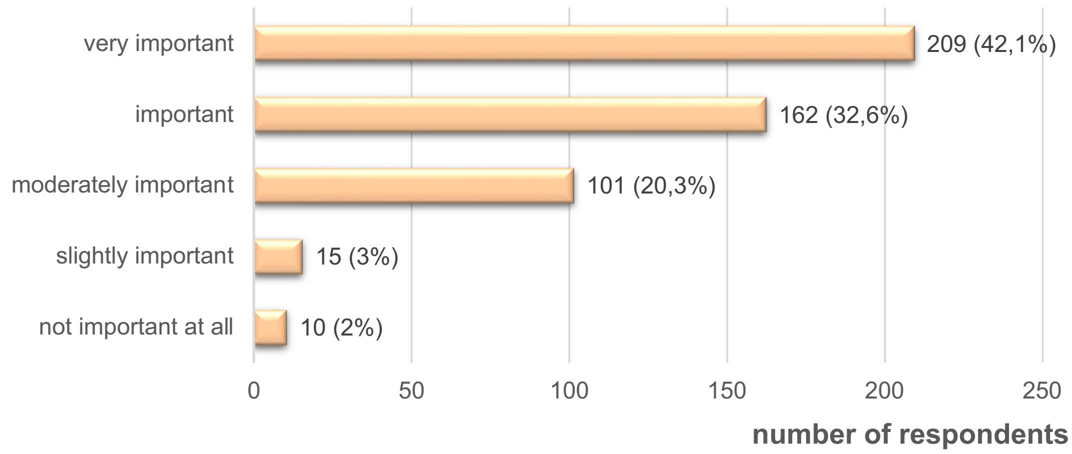


FIGURE 3
How important is it for you that organic food are organic at all stages of their life cycle (cultivation, processing, transportation, packaging, consumption)?

being grown without GMO seeds, by local farmers, and with organic packaging. The negative correlation coefficient of 0.494 indicates that younger people are more likely to pay attention to the environmental and social responsibility of a food producer, while older people are more likely to expect the producer to be sustainable at all stages of the life cycle (the partial correlation coefficient was positive at 0.316). In addition, younger consumers are more likely to sort their garbage, more likely to prefer food that come in organic packaging and are more willing to change their consumption habits in favor of organic packaging. This partially coincides with the results of the Funk et al. (2021) study, where the segment of "consistent pro-environmental consumers" more often included younger people, as well as with the results of an earlier study (Adamczyk and Adamczyk-Kowalczuk, 2022), which adheres to the opinion that younger people are more sensitive to environmental issues.

The level of education has also proven to be significant in shaping consumer expectations regarding the sustainability of organic food at all stages of their life cycle (Block 3). The study Hüppe and Zander (2021) describes a group of consumers called "organic traditionalists" who care for the entire value chain of organic food, including not only production and processing, but also environmental impact, energy costs, and logistical feasibility. In our study, respondents with a higher level of education were also more likely to expect a producer to be sustainable at all stages, from production to packaging. Also, the level of education had a certain level of correlation with the understanding of organic food as those grown with organic fertilizers and certified properly (Block 1). Consumers' interpretation of the term "organic" in our study showed quite significant differences by age and education. As Hughner et al. (2007) noted consumers can understand organic food in different ways and attach different contextual meanings to them. But in contrast to previous studies (Çoşkun and Kayışoğlu, 2018; Moruzzo et al., 2020), which tend to emphasize consumer skepticism about certification, our study finds greater trust among consumers with higher levels of education in labeling and certification.

The level of income proved to be the most influential in determining the willingness to pay extra for food in organic packaging. Respondents with higher incomes were more likely to choose packaging based on biodegradability criteria, while for respondents with lower incomes, the criterion was reusability (Block 2). In addition, the level of income proved to be significant when purchasing organic food in plastic packaging. People with higher incomes were more likely to refuse to buy organic food in plastic packaging and were also more likely to pay attention to the social responsibility of the food producer. Such results are supported by recent findings in a study of Hansen et al. (2018), which found a negative relationship between organic food identity, which in the study was defined as a person's self-definition of the role of an organic food consumer, and income. However, for example, in a study of Iyer et al. (2016) price and cost were not associated with intentions to buy green food (the study was conducted on the example of cosmetics), although environmental and social awareness were recognized as driving motives.

Marital status was more related to consumers' expectations regarding the sustainability of organic food at all stages of the life cycle (Block 3). Respondents with children were more likely to consider organic packaging as an important stage in the life cycle of organic food. An earlier study Wilson (2011) noted that many families start buying organic food with the arrival of a child, and our results extend this by providing information that families with children are more likely to take organic food more seriously, paying attention to organic packaging. A certain correlation was also observed in consumers' understanding of organic food depending on their family status (Block 1). For example, respondents who had children often mentioned personal acquaintance with and trust in the producer as the most important criterion, while for single consumers, the presence of certification marks on the packaging was the most important.

Public activity and social activism were also identified as a significant conditional variable in determining the role of packaging for the consumer (Block 2). This conditional variable was positively related to the perception of organic packaging as contributing to the preservation of the environment. Respondents who identified themselves as socially active were more likely to agree to fight against greenwashing and almost always paid attention to the social responsibility of organic producers. Again, the study of Hansen et al. (2018) rightly notes the existence of a negative correlation between social consciousness and consumer behavior towards organic food, referring to the tendency of consumers with lower social consciousness to focus more on selfish motives, with a greater degree of disregard for altruistic values related to environmental preservation. In

TABLE 3 Correlations.

Conventional variables	*Block 1* "What food does the consumer consider organic?"	*Block 2* "What importance does the consumer give to packaging when choosing organic food, and does their choice depend on their motivations (internal or external)?"	*Block 3* "When purchasing organic food, does the consumer expect them to be sustainable at all stages of their life cycle?"
Age	−0.228	−0.244	−0.494
Education	−0.178	−0.058	−0.294
Income	−0.132	−0.220	−0.152
Marital status	−0.252	−0.018	−0.282
Public activities and social activism	0.204	0.468	0.044

Missing value handling: PAIRWISE, EXCLUDE. C.I. Level: 95.0.

our study, the highest correlation among the partial variables in Block 2 was observed on the part of respondents with regard to consumers' assessments of the social responsibility of producers. In Block 1, the strongest correlations by partial variables were found in consumers' perception of organic food as less harmful to the environment. Among the most positive ones, socially active respondents were more likely to mention a reduction in the amount of toxic substances released into the environment and a reduction in packaging waste. Similar results can be found in the study of Iyer et al. (2016), where consumers' environmental awareness is noted as being directly related to green purchase intentions.

3.5 Results of factor analysis of internal and external motives (i) perception of organicity; (ii) importance of packaging; (iii) importance of sustainability ("greenness") of food at all stages of the life cycle

We start by testing the hypothesis that there are distinct motives in the behavior of organic consumers and use CFA, setting the number of factors to two and not using factor rotation. The results with a limited choice of factors of 2 have shown that the cumulative variance is only 50.2%. Thus, we switched to using EFA to determine the number of factors based on eigenvalues and the percentage of variance explained. The analysis of the correlation matrix and the value of its determinant, which is greater than 0.00001, showed the absence of multicollinearity. The results of Bartlett's Test and KMO Test are also acceptable (Table 4) for determining the reliability of the factor analysis results (Beavers et al., 2019). In the table of factor loadings, we left the values of the components greater than 0.3.

The explanation of the total variance showed that the three factors explained 70.7% of the correlations. Factor 1 (external motives) contributes 36.1% to the total variance; Factor 2 (internal motives) contributes 23.7%; Factor 3 (mixed motives) contributes 10.9%. Thus, our initial hypothesis about the existence of a two-factor model was adjusted, and as a result, an additional factor of motivational behavior was identified, the elements of which could not be clearly linked to external or internal motives in the behavior of organic food consumers. It concerned the perception of organicity and the importance of organic packaging. In addition, we were able to make sure that external motives prevailed in terms of the importance of product sustainability at all stages of the life cycle, which was confirmed by the partial factor loadings and the value of the total variance.

4 Discussion

4.1 Internal and external motives in the perception of organic food

In the perception of organic food, concern for one's own health was more influential than concern for the environment. When choosing organic food, consumers were mostly guided by internal motives, associating organic food with benefits for their health. These results are supported by several previous studies (Zanoli and Naspetti, 2002). In addition, Hansen et al. (2018) pointed out a positive relationship between organic food identity and selfish motives by studying the behavior of 1176 Danish consumers. Also, an earlier study of Swedish consumer behavior (Magnusson et al., 2003) identified concern for personal and family health as the main predictor of intention to buy organic food. We have also found that organic packaging is not necessary for the perception of food organicity, a finding that can be found in Koch et al. (2022). This finding is likely to be a reflection of the fact that consumers of organic food perceive organic packaging as part of the organic nature of the food.

4.2 Packaging sustainability as an indicator of external motives

In our research, we considered packaging sustainability as an external purchase motive that can reflect the consumer's desire to take care of the environment to a greater extent. However, factor analysis showed the prevalence of mixed motives in the perception of organic food. This is confirmed by the highest factor loadings for Factor 3 in the perception of organicity. Thus, the answer to the first question of our study, "what food do consumers consider organic," is that there is no clear distinction between internal and external consumer motives. It turns out that the consumer's simultaneous perception of organic food as both healthy and less harmful to the environment may subconsciously encourage the consumer to consider the packaging organic. This conclusion conceals the danger of manipulation of consumer behavior by organic food producers. Although it seems that consumers can clearly identify the motive for their behavior (internal, when they choose organic food because they are healthy, or external, when they choose organic food because they cause less damage to the environment), the lack of consumer perception of packaging sustainability as a separate element that contributes to the organic

TABLE 4 Rotated component matrix.

	Factor 1 (External)	Factor 2 (Internal)	Factor3 (Mixed)
(i) Perception of organicity			
PO1	***	0.729	***
PO2	0.603	***	***
PO3	***	***	0.856
(ii) Importance of packaging			
IP1	***	0.496	***
IP2	0.655	***	***
IP3	***	***	0.450
(iii) Importance of sustainability ("greenness") of products at all stages of the life cycle			
ISPSLC1	***	0.683	***
ISPSLC2	0.738	***	***
ISPSLC3	−0.746	***	***
Extraction Method: Principal component analysis. Rotation Method: Varimax with Kaiser normalization. a. Rotation converged in 5 iterations.			
Determinant	0.436		
Bartlett's test of sphericity	$p < 0.0001$		
Kaiser-Meyer-Olkin test of	0.673		

***Factor loadings < 0.3.

nature of the food calls into question the relevance of the request of those consumers who were guided by an external motive.

We found a completely different picture in the results of managing internal and external motives when assessing the importance of packaging as a separate element of food organicity. When we focused respondents' attention on the packaging of organic food, consumers seemed to be more clearly willing to be guided by external motives, preferring eco-friendly packaging over its convenience. Earlier, it was also reported that eco-friendly packaging can be associated by consumers as an external motive related to the opportunity to live in a less polluted environment (Jurconi et al., 2022; Wandosell et al., 2021). But, for example, unlike the study of Frýdlová and Vostrá (2014), which, along with health effects and environmental impacts of production, mentioned the design of packaging as a factor of purchase, our study found that consumers are more inclined to make their decision based on the environmental friendliness of packaging. Such results have certain limitations for comparison, as we did not take into account the attractiveness or design of the packaging in our study, but rather restricted it to its convenience and environmental friendliness as the criteria for distinction. The obvious differences between convenience and attractiveness may explain the discrepancy in the results. Thus, our research suggests that the environmental friendliness of packaging can be used to identify consumer motives more clearly. Again, taking into account the limitations that organic packaging is less related to health care and can be attributed to altruistic motives. Another limitation of our study should also be mentioned. It concerns the cultural peculiarities of consumer behavior related to subjective norms in collectivist cultures (Boobalan et al., 2022). Subjective norms in collectivist cultures emphasize the importance of social approval and group values. These norms encourage consumers to adopt behaviors that align with societal expectations, including environmental responsibility. For instance, consumers in collectivist cultures may prioritize eco-friendly choices not solely out of personal belief but also to conform to the perceived values of their community. We draw this conclusion based on the survey results showing that Ukrainian consumers are responsive to environmental narratives. While this tendency aligns with certain Western consumer behaviors, such as valuing sustainability, it also reflects the influence of collectivist cultural norms, where environmental responsibility is perceived as a collective good. However, we recognize that the cost factor, which plays a crucial role in Western markets, was not the focus of our study and requires further exploration to fully understand its interaction with these norms.

Another important conclusion we can draw from the survey results is related to the identification of a group of respondents (9.1% of the total sample) who considered the environmental friendliness of packaging to be part of the organic nature of the food itself. Such respondents pointed to the producer's behavior as a manifestation of greenwashing if organic food were packaged in non-ecological packaging. There was also another group of respondents, which made up 33.4%, whose respondents agreed to buy organic food only if the packaging was replaced with eco-friendly one. In response to the second research question, our results show that consumers of organic food may in some cases consider the environmental friendliness of the packaging to be part of the organic nature of the food itself, but the environmental friendliness of the packaging outweighs its convenience in most cases and can be seen as an indicator of external motives of consumer behavior. But this area also requires more specification, which creates room for future research that may choose to focus on other attributes of organic packaging.

4.3 Importance of sustainability across the product life cycle

Finally, we would like to discuss our third research question regarding the importance of food sustainability for consumers at all stages of the product life cycle. In the previous question, we already started this discussion by mentioning packaging. Here, we could observe an even greater predominance of a factor loading importance of the sustainability of organic food at all stages of their life cycle, even compared to the importance of environmental friendliness of packaging. It should be noted that prior to the survey, respondents were provided with explanations of the possible stages of the organic food life cycle, so their answers should probably be considered as different from their natural behavior, but that was our very goal. Once again, we were able to record changes in consumer decisions when the consumer had full information about the organic food, or rather, when we changed the focus of their attention. The country of origin of organic food was not important for the majority of consumers (59%) when making a purchase. However, 41.6% of respondents changed their minds when they learned that transportation of imported organic food leaves a large carbon footprint (Hüppe and Zander, 2021) were also able to identify a group of consumers for whom the entire value chain is important, but their results are more relevant to the processing stage of organic food. We tried to go even further, and not limit ourselves to the production process, but also take into account the peculiarities of eco-friendly packaging and consumption, which also has common points with the study in this context (Penz et al., 2019). Thus, consumer expectations can probably give us a picture to strengthen the discussion on the responsibility of the producer to the consumer, who is guided by external motives in his consumption behavior and wants to act environmentally. For producers, this finding is likely to signal that strategic decisions within the bioeconomic context when monitoring product life cycle assessment indicators (Lago-Olveira et al., 2024; Magdalena et al., 2024) should meet consumer expectations and justify their trust.

In addition, conditional variables also contributed to this study. First of all, the age of the respondents was significant in determining the importance of eco-friendly packaging and their willingness to change consumer habits in its favor. These results indicate that the preference for sustainable packaging is likely to grow as the younger generation has more of a concern for global climate change issues (Wandosell et al., 2021) and is therefore guided by external motives in their consumer behavior. And in conclusion, we would also like to mention public activity and social activism of consumers (another significant conditional variable that we studied). This variable had a correlation with the respondents' willingness to fight greenwashing and monitor the social responsibility of organic producers.

4.4 Economic and regulatory context of organic packaging in Ukraine

Another critical aspect to consider is the relationship between organic packaging, regulations, and cost, particularly in the context of Ukraine's current economic situation. While organic packaging aligns with global sustainability goals, its adoption is often tied to compliance with international regulations and certification standards, which can increase production costs. This cost factor (Danko and Nifatova, 2022) is especially significant in Ukraine, where the economic challenges caused by recent events, including war and inflation, have reduced the purchasing power of many consumers. As a result, even though there is growing environmental awareness among Ukrainian consumers, the higher cost of organic food and packaging remains a barrier to widespread adoption.

These economic constraints (Zambujal-Oliveira and Fernandes, 2024) highlight the need for balancing sustainability with affordability. Producers must carefully navigate the trade-off between meeting regulatory requirements for eco-friendly packaging and ensuring their food remain accessible to the average consumer. Exploring subsidies, incentives, or partnerships to reduce the cost of eco-friendly packaging could be a practical solution.

For Ukrainian consumers, organic packaging often implies eco-friendly materials with minimal environmental impact during disposal. However, the EU perspective integrates broader considerations, including the use of recycled or reusable materials, alignment with stringent regulatory frameworks, and life cycle assessments to ensure that packaging materials contribute to a circular economy. Bridging these differences over the next decade will require increased public awareness campaigns in Ukraine, integration of life cycle analysis into consumer education, and harmonization of national policies with EU regulations. This alignment will help mitigate the risk of consumer misinterpretation by providing clearer standards for what qualifies as organic or eco-friendly packaging and encouraging rational, informed decision-making.

This interplay between cost, regulations, and consumer behavior represents an important dimension for further research.

5 Final conclusions

This study makes an additional contribution to clarifying the motives for consumers' choice of organic food and the importance of organic packaging in shaping consumer perceptions of food organicity. Based on the results of previous studies and our own survey, we find that the perception of food organicity is dominated by internal motives that are intended to associate organic food with health benefits. Organic packaging is not necessary for the perception of food organicity, which may be due to the fact that consumers perceive the organic nature of the packaging as part of the food's organicity. For this reason, there is no clear distinction between internal and external consumer motives in the perception of organic food. On the other hand, the organic nature of packaging outweighed its convenience in most cases and can be seen as an indicator of external motives for consumer behavior, taking into account the limitations that organic packaging is less related to health care and can be attributed to external (altruistic) motives. The importance of the sustainability of organic food at all stages of their life cycle prevailed in terms of importance in the formation of factor loadings for identifying external consumer motives, which further clarifies the picture of consumer expectations. Thus, in their external motives, consumers of organic food are likely to rely on the environmental responsibility of the producer. This finding suggests that organic producers should take this into account in their marketing strategies to meet consumer expectations. Our findings highlight that while internal motives dominate the perception of organicity, external motives-such as the environmental sustainability of packaging-also significantly influence consumer behavior. This dual perception blurs the distinction between internal and external motives and suggests that organic packaging can serve as a key indicator of altruistic consumer behavior, provided that producers meet the expectations of sustainability across all stages of a product's life cycle. This study attempts to extend the existing context to address the dilemma of consumer and producer responsibility for environmental choices by using organic packaging as an indicator of internal and external consumer motives. We take this as a starting point in our further search for understanding between consumers and producers.

Despite these contributions, the study is not without limitations. First, the data was collected exclusively from Ukrainian consumers, which may limit the generalizability of the findings to other cultural and economic contexts. Second, the study relied on self-reported data, which may be subject to biases such as social desirability. Third, the research investigated consumer attitudes toward organic food without focusing on specific categories. The term "organic food" was broadly understood by respondents as any goods labeled and marketed as organic, which may obscure category-specific preferences or attitudes that could significantly affect the findings.

Future research could expand the scope by examining cross-cultural differences in consumer motives or exploring the impact of socio-economic factors on perceptions of organicity. Additionally, investigating consumer attitudes toward specific categories of organic food, such as fresh produce, processed food, or beverages, could offer more granular insights. Analyzing changes in consumer preferences over time, particularly following the implementation of eco-friendly practices or market shifts, could provide a dynamic perspective on the evolving relationship between consumers and producers.

The results of this study are intended to provide an informational basis for developing practical recommendations for producers and marketers on aligning their strategies with consumer expectations, fostering greater trust and transparency in the organic sector. In terms of practical implications, further studies could delve into the development of communication strategies that align with consumer expectations of sustainability and transparency. For instance, investigating the effectiveness of ecolabels or sustainability certifications in fostering consumer trust could provide actionable insights for producers and policymakers.

Data availability statement

The original contributions presented in the study are included in the article/Supplementary material, further inquiries can be directed to the corresponding author.

Ethics statement

Ethical review and approval was not required for the study on human participants in accordance with the local legislation and institutional requirements. Written informed consent from the [patients/participants OR patients/participants legal guardian/next of kin] was not required to participate in this study in accordance with the national legislation and the institutional requirements.

Author contributions

ON: Conceptualization, Methodology, Writing – original draft, Writing – review & editing. KB-D: Writing – original draft, Data curation, Investigation, Resources, Visualization, Writing – review & editing. SC-P: Writing – original draft, Writing – review & editing. YD: Writing – review & editing, Supervision, Writing – original draft, Visualization.

Funding

The author(s) declare that financial support was received for the research, authorship, and/or publication of this article. This study is co-funded by the European Union through the European Education and Culture Executive Agency (EACEA) within the project "Enhancing the organic farming educational content in Ukraine according to the EU Action plan" 101127349 -Organic-EU -ERASMUS-JMO-2023-HEI-TCH-RSCH https://organic-eu.snau.edu.ua.

Acknowledgments

The authors would like to thank those who responded to the questionnaire. We are also grateful for the comments from the reviewers of the manuscript which have improved its final quality.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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The author(s) declare that no Gen AI was used in the creation of this manuscript.

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Supplementary material

The Supplementary material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/frsus.2025.1513954/full#supplementary-material

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Frontiers in Sustainability

TYPE Methods
PUBLISHED 05 February 2025
DOI 10.3389/frsus.2025.1507708

OPEN ACCESS

EDITED BY
Elisabeth Süßbauer,
Technical University of Berlin, Germany

REVIEWED BY
Aleksandra Figurek,
University of Nicosia, Cyprus
Klaus Kubeczko,
Austrian Institute of Technology (AIT), Austria
Eckhard Störmer,
Future Impacts, Germany

*CORRESPONDENCE
Cristian Matti
✉ cristian.matti@ec.europa.eu

RECEIVED 08 October 2024
ACCEPTED 13 January 2025
PUBLISHED 05 February 2025

CITATION
Matti C, Bontoux L and Jensen K (2025) Strategic foresight framework for addressing agency in sustainability transitions: a co-creation approach.
Front. Sustain. 6:1507708.
doi: 10.3389/frsus.2025.1507708

Strategic foresight framework for addressing agency in sustainability transitions: a co-creation approach

Cristian Matti*, Laurent Bontoux and Kathrine Jensen

Competence Centre on Foresight, Joint Research Centre, European Commission, Brussels, Belgium

This paper presents a novel methodological approach that integrates strategic foresight with sustainability transitions frameworks to explore how different forms of agency shape transition pathways. The research methodology employed include the development of foresight scenarios addressing sustainability, the X-curve framework for mapping possible transition pathways for a sustainable EU 2050, and agency analysis to identify strategic areas of interventions and understanding systemic policy mixes over time. This work was performed in the context of the preparation of the European Commission's Annual Strategic Foresight Report 2023. Additionally, through empirical application across three distinct contexts, this paper demonstrates how strategic foresight can generate actionable knowledge for sustainability transitions while maintaining methodological rigor. The study advances the theoretical understanding of agency in sustainability transitions by showing how different actors can be strategically engaged through interventions aimed at shaping, navigating, and orchestrating transition pathways over time. Our findings reveal that successful transitions require balancing the agency of established institutional actors with emerging stakeholders who may lack formal authority but bring crucial perspectives and capabilities. The study emphasizes the importance of agency of multiple actors in sustainability transitions, highlighting their capacity to act and collaborate in shaping a sustainable future. The conclusions and recommendations stress the need for strong government leadership, multilevel coordination, the roll out of systemic policy mixes and a new social contract underpinned by democratic governance. The flexibility of the methodological approach allows adaptation to different institutional contexts through co-creation while maintaining coherence in how agency dealt with. This research contributes to both theoretical development and practical policy implementation by providing a structured yet adaptable strategic foresight approach to investigate how different forms of agency can effectively be combined to drive sustainability transitions.

KEYWORDS

strategic foresight, actionable knowledge, methods, sustainability transitions, agency, systemic policy mixes

1 Introduction

This paper presents a novel methodological approach, based on foresight, to foster the emergence of a deeper understanding of sustainability transitions for policymaking at EU level. It illustrates how foresight, by implementing structured and inclusive collective intelligence processes, can contribute to producing actionable knowledge for policymaking. This can take various forms, such as the construction of collective narratives of possible alternative transition pathways, each addressing different triggers and leverage points for transformative change. The study focuses on the design and implementation of a foresight process for the preparation of the EU Strategic Foresight Report 2023. Its scope was '*Sustainability at the heart of the EU's open strategic autonomy: what strategic decisions need to be made to ensure a socially and economically sustainable Europe with a stronger role in the world in the coming decades?*'

The starting point was the creation of a set of four foresight scenarios describing various versions of how the EU could be sustainable by 2050. Climate-neutrality was set as the central normative condition for all scenarios. A sustainability assessment framework was then applied to these scenarios to identify the structural economic and social changes that would have to take place to create future sustainable societies. The inclusive, participatory foresight process combined several methods and engaged in a simultaneous analysis, assessment and interpretation of the evolving results.

To create actionable knowledge that would be useful for policymakers to discuss sustainability transitions, the foresight process generated various interrelated outputs that can be further developed and applied by others in a wide range of settings, including to accommodate a regional or sectoral focus.

The novel approach designed for this project demonstrated the usefulness of incorporating concepts from sustainability transitions into a foresight process that took a systemic and long-term perspective. This paper draws on the knowledge collected in the JRC report (Matti et al., 2023) and additional insights gathered by the team when applying the approach to various policy requests.

The research design follows a systematic analytical progression to explore how strategic foresight can generate actionable knowledge for sustainability transitions through three complementary analytical levels: (1) the methodological aspects of the strategic foresight process in sustainability transitions by incorporating a sustainability assessment framework for scenario development and the X-curve framework for transition pathway mapping, (2) analysis of agency in sustainability transitions to understand systemic policy mixes over time, and (3) the comparative analysis of the use of the methodological framework in three different contexts.

The methodology explicitly examines agency – defined as the ability of actors to shape, navigate, and orchestrate change processes – both as an analytical lens within the foresight process and as an empirical object of study in different strategic intervention areas. This dual approach makes it possible to study how different actors' capacities to act evolve through transition processes, while maintaining methodological rigour through structured foresight tools. In this context, this study makes significant contributions to the literature on strategic foresight and sustainability transitions. First, it builds a bridge between these fields by developing an integrated foresight framework that combines foresight's ability to explore alternative futures with transition theory's understanding of systemic change dynamics. Second, it advances the discussion on agency in sustainability transitions by demonstrating how different actors can be strategically engaged through different type of interventions across transition pathways and policy mixes overtime.

The research also demonstrates the successful application of the framework across diverse contexts - from global environmental policy (UNEP) to EU sectoral policy (Single Market) to complex systemic challenges (food systems). This versatility enables identification and assessment of key contextual factors and critical intervention areas through collective intelligence processes. The framework's adaptability while maintaining methodological rigour makes it a valuable tool for developing actionable knowledge for sustainability transitions across governance levels. Over the next sections, the paper first presents a collection of definitions from the sustainability transitions framework that serve as lenses for the foresight process. It then describes the overall process and the combinations of methods that facilitated the interplay between foresight and the sustainability transitions framework. This is followed by a presentation of the lessons learned and the description of three additional examples where the framework was applied before drawing conclusions. Two appendices provide a detailed description of the overall protocol including the tools that were used.

2 Heuristics of transformative change, policy mixes, and agency in sustainability transitions

Sustainability is defined in this study as the capacity to meet the needs of the present while ensuring that future generations can meet their own needs. It comprises three dimensions: Economic, Environmental and Social. To achieve sustainable development, policies in these three areas must work together and support each other (European Commission, 2023).

Sustainability transitions are defined as an umbrella term for a range of changes that involve a radical shift toward a sustainable society in response to the existential challenges facing contemporary societies (Grin et al., 2011). They are transformation processes in which different actors jointly decide on the goals of a transition and play a role in bringing about gradual structural changes. They do this by identifying the totality of changes needed through long-term thinking, reflection and management of multiple policies that need to work together as part of a systemic policy mix, and the role and linkages between actors (society, government, business) at different levels through multi-level governance models (Bulkeley, 2005; Rotmans et al., 2001).

Systemic policy mixes are combinations of measures designed to trigger systemic change. They mobilize actors and set in motion processes of change that unfold through a complex web of interactions between interventions, actors and processes and over long periods. These interactions can be defined as horizontal between different types of instruments, policies or governments - and vertical - between different levels of objectives, policies and levels of government and across sectors (Howlett and del Rio, 2015).

A policy mix that is highly supportive of sustainability is a systemic policy mix that supports change, responds to a clear vision and addresses multiple dimensions of sustainability simultaneously. A policy mix employs a range of reinforcing policy instruments that increase effectiveness in achieving overarching goals. Systemic policy mixes have a top-down orientation due to a broader policy strategy such as the European Green Deal and the Sustainable Development Goals (SDGs). They also have bottom-up implementation challenges related to actors agency to steer change by experimenting and developing a systemic perspective on policy making to situate these priorities in a local context and build local commitment and shared ownership of the strategies (Joint Research Centre, 2021).

To support this systemic perspective, one must recognize that agency (capacity to act) varies from actor to actor and depends on context. A key to managing the transition to sustainability is understanding the capacity of actors to address these strategic areas together in complex and uncertain circumstances (Contesse et al., 2021). This understanding of actors' capacity to act can help develop comprehensive strategies and actions for the coming decades (Jørgensen, 2012). Societies can make sustainability transitions happen by harnessing the specificity of its capacity to act in different processes of change (Pesch, 2015). The development of actors' capacity to shape, navigate and orchestrate the change process over time will determine the scope and scale of possible interventions.

In this sense, and with a view to economic geography and innovation research, Grillitsch and Sotarauta (2020) have emphasized the diversity of contexts in which actors can steer transformative change by creating "opportunity spaces" by taking into account the time perspective, place-based systemic conditions and the capacity of different actors to act. These spaces are dynamic, shaped by systemic and contextual factors that enable or constrain pathways for change. Timing sets the boundaries of what is possible at any given moment, influenced by global knowledge, institutional readiness, and resource availability.

The 'capacity to act' could be shaped by past, present and future perspectives (Steen, 2016) mobilized through foresight processes to build capacity, shared vision and learning. It also aligns with political cycles, guiding the design and implementation of strategies like Smart Specialization or climate adaptation. Strategic timing enables actors to leverage critical junctures in governance and policy processes to maximize impact. Place-based conditions highlight the importance of context. Local resources, stakeholder engagement, and learning opportunities define what is feasible within a specific geographic and economic space. Finally, actors' capacity to act determines the range of possibilities within an opportunity space. Effective agency requires mobilizing resources, fostering collaboration, and navigating governance structures to influence decision-making (Grillitsch et al., 2024).

Together, these elements create opportunity spaces where systemic, temporal, and spatial dimensions converge, enabling actors to steer transformative change in sustainability transitions. Co-creation processes integrating forward-looking perspective can facilitate dialog and make these spaces compatible with the design of interventions addressing strategic issues through multi-level governance processes. The participatory nature of strategic foresight enables rethinking governance models in terms of establishing flexible roles and mechanisms of cooperation across European, national, regional, and local levels where regions and cities emerge as pivotal actors, building communities, fostering cross-actor cooperation, and enhancing the EU's capacity to act (Matti and Bontoux, 2024).

Furthermore, the development of anticipatory capacities enables the orchestration of systemic relationships in research and development, industrial transformations and cross-sector linkages, while fostering new public-private configurations to enable the shaping of conditions through the efficient use of public resources, the alignment of place-based innovation strategies with industrial and regional ecosystems, and thus the design of interventions to accelerate the reconfiguration of sectors within value chains (Izulain et al., 2024). In this way, the development of anticipatory capacity through co-creation process by integrating sustainability transitions and system change elements foster innovation and disruptive change, supports cross-sectoral policy reformulation (Tõnurist and Hanson, 2020; Matti and Bontoux, 2024) and strengthens the capacity of actors to reshape economic structures. Table 1 below summarises the different types of interventions for shaping, navigating and orchestrating change processes in sustainability transitions, by putting emphasis on the evolving development of actors' capacity to act.

Table 1 Three types of interventions to shape, navigate and orchestrate change in sustainability transitions. The 'shaping, navigating and orchestrating' interventions not only reinforce each other but also enable building new agency between the various actors. Simultaneity, reinforcement and feedback of the systemic intervention portfolio are key in understanding how agency might evolve over time in terms of its nature and distribution between actors and across governance levels. These three types of interventions have been addressed separately in several publications dealing with policy mixes for sustainability transitions from the perspective of innovation policy (Kern et al., 2019), transformative change (Ghosh et al., 2021) and system dynamics (Grubb et al., 2017; Alkemade and de Coninck, 2021). In this context, Weber and Rohracher (2012) have addressed the challenge of developing a policy mix for transformative change, highlighting the failure of transformational systems, including failure in addressing directionality, demand articulation, policy coordination and reflexivity. In this sense, the present study aims to contribute to the discussion on disentangling policy mixes in sustainability transitions by showing how to coordinate interventions aimed at shaping, navigating and orchestrating system transformation. To that end, the study, provides a space and time for reflection and deliberation on the evolving agency of actors through a novel use of strategic foresight for the co-creation of systemic policy mixes that consider the agency of diverse actors in sustainability transitions.

3 A strategic foresight framework for sustainability transitions

3.1 Structure of the framework

The process underpinning this study was designed to be inclusive and participatory to build meaningful collective intelligence, in line with good foresight practice. Concepts from academic research on sustainability transitions were applied in the design of the foresight process and the analysis of the results to develop a good understanding of the many simultaneous transformation processes required to achieve sustainability. This combination of foresight and sustainability transitions concepts resulted in a robust collective intelligence that helped the analysis and interpretation of the results to be relevant for European policy. To this end, the team explored the relationships between the findings using additional evidence from multiple sources.

For optimal results, the original foresight study combined two parallel and interlinked processes:

1 An open participatory process including two in-person workshops and exchanges with experts. While the in-person workshops provided a broader perspective from a variety of participants from policy, academia and society, the exchange with experts provided specific insights on the different dimensions on sustainability addressed in the foresight process.

TABLE 1 Three types of interventions to shape, navigate and orchestrate change processes in sustainability transitions.

Shaping change through systemic policy mixes	Steering change requires the capacity to act according to the objectives of systemic policy mixes including: • Mobilising resources and introducing new policymaking mechanisms to reorient and accelerate change (Ghosh et al., 2021); • Co-creating, planning and implementing comprehensive interventions, taking into account the complexity of sustainability transitions (Matti and Bontoux, 2024); • Shaping markets by enabling a vision for change and direction, supporting strategic investment in critical infrastructures and facilitating exchange of practices to foster new business models (Ottosson et al., 2020).
Navigating uncertainty and complexity	Navigating is understood as the ability of actors to deal with uncertainty and adapt (Jørgensen, 2012). It covers processes and practices such as: • Interpreting changing conditions on the way to sustainability transitions (Turnheim and Nykvist, 2019; Steen, 2016); • Introducing new practices such as forward-looking process aimed at analysing and managing available options and evolving conditions (Tõnurist and Hanson, 2020); • Taking decisions to maintain a course amid changing relationships and associated shifts in power dynamics (Fischer and Newig, 2016).
Orchestrating processes and relations	Orchestrating refers to the ability of actors to manage processes and relationships to bridge differences between conflicting interests. It covers: • Exploring strategically synergies and opportunities spaces (Grillitsch and Sotarauta, 2020) for 'orchestrating' a way forward through a systemic policy portfolio (Gomes and Barros, 2022); • Facilitating alignment of social and economic actors on a long-term vision (Steen, 2016) with interventions to complement financial support and regulation (Alvial Palavicino et al., 2023); • Organising a safe operating space for collaboration and experimentation (Pereira et al., 2015) between the public and private sectors (Izulain et al., 2024).

2 In-house analysis, assessment and interpretation activities involving secondary research and expert reviews.

Figure 1 shows the chronological sequence of the foresight process with the intermediate outputs and related analytical element that characterized each step: scenarios (contextual factors), transition pathways (transformative elements) and strategic areas of intervention (agency).

The process followed several steps and feedback loops to explore possible future changes. The work started in autumn 2022 with the creation of a set of four normative foresight scenarios[1] describing different variants of how the EU could achieve sustainability by 2050. The scenarios were validated in a workshop and through exchanges with experts[2]. One transition pathway per scenario were then co-created in workshops and validated with experts. Areas for intervention were jointly identified by comparing the pathways in an open participatory process. These areas were further elaborated and analyzed with the help of new experts and secondary research. This process facilitated a reflection on possible EU action to manage social and economic change as part of the transition to sustainability.

The process delivered a coherent sequence of outputs:

1 A set of four foresight scenarios for a sustainable EU 2050
2 A set of four corresponding transitions pathways
3 A set of four clusters of strategic areas of interventions addressing the necessary changes on the way toward sustainability across all pathways

The following sections describe the process by which these outputs has been developed, with a focus on gathering lessons from the use of foresight to develop new actionable knowledge for policy-making on sustainability transitions. It explores the different methods and practises that can help operationalize concepts and methods for innovation in policy making.

The steps of the foresight process applied different methods articulated into a coherent logical sequence. This section describes these individual methods in more detail.

3.2 Scenario building

The selected foresight approach required a set of foresight scenarios as a starting point to examine social and economic changes in possible, sustainable futures. To this end, the team took a deductive approach, setting climate-neutrality as the normative condition. The scenarios drew substantially on two sets of existing foresight scenarios that were developed with a focus on sustainability, namely those of a 2015 JRC study on the sustainable

1 Normative (or prescriptive) scenarios describe a prespecified future, presenting "a picture of the world achievable (or avoidable) only through certain actions. The scenario itself becomes an argument for taking those actions" (Ogilvy, 2002).

2 The JRC, in close collaboration with the Commission's Secretariat-General, involved a broad range of expertise in the open participatory process with:

1) Two face-to-face workshops with a broad range of experts from the European Commission, EU agencies, academia, think tanks, foresight professionals, social partners and civil society on 24–25 November 2022 (from scenarios to pathways) and 16–17 February 2023 (from pathways to cross-cutting areas),

2) Online workshops with experts from across the JRC covering relevant fields and

3) Consultations in the context of European Commission's networks on strategic foresight including representatives of Member States and Commission services, bilateral meetings on specific topics with experts from across the Commission, EU agencies, think tanks and other organizations.

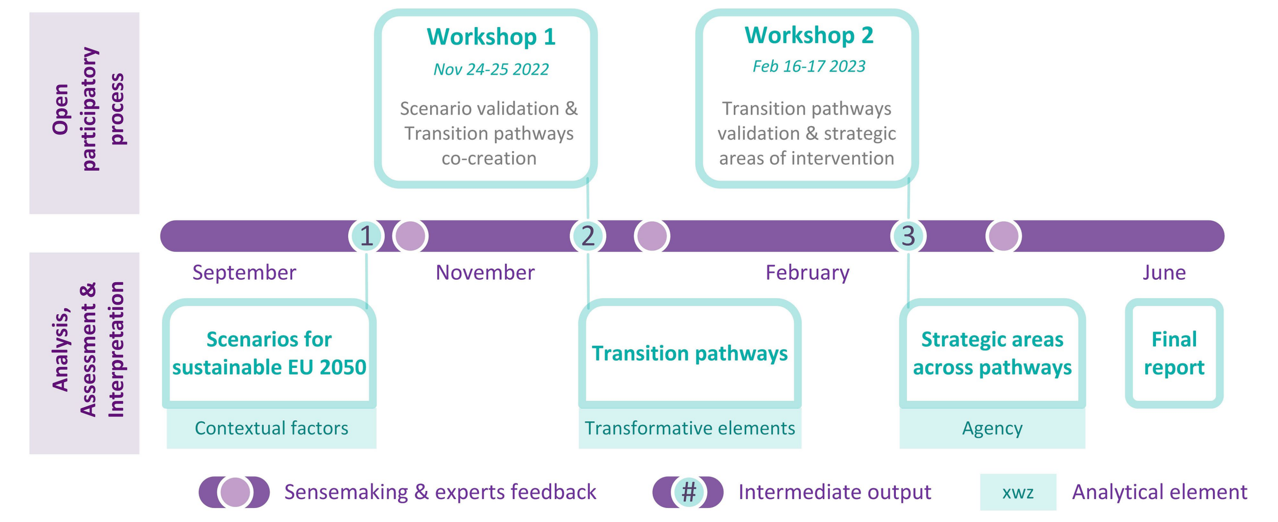


FIGURE 1
The foresight process and related timeline. Source: Matti et al. (2023).

economy (Joint Research Centre, 2015) and the European Environment Agency's (EEA) 'imaginaries' for a sustainable Europe in 2050 (European Environment Agency, 2022). Building on this work, two key dimensions were used to structure the scenarios in this study (see Figure 2). These were whether society would become more collaborative/collectivist or individualistic/competitive (vertical axis), and whether or not a broad policy mix would emerge to generate economic signals supporting a transformative shift toward sustainability (horizontal axis).

This scenario-building work used recent methodological developments in a sustainability assessment framework for scenarios SAFS (Arushanyan et al., 2017). The application of the SAFS framework enables the assessment of social, economic and environmental aspects through an inventory of data and assumptions on sustainability in future scenarios compared to the current situation based on the STEEP model (social, technological, environmental, economic, political including additional geopolitical aspects). This generates an inventory of contextual factors that provide a qualitative description of the economic and social risks and opportunities in a future society compared to today (see Supplementary Table A1).

In order to explore a wide range of social and economic changes and interactions, the scenarios were elaborated with the normative condition that the EU would achieve its headline goal of climate neutrality in 2050. As a result, each scenario reveals different trade-offs and synergies in the social and economic dimensions of sustainability.

The overall narrative of each scenario was then compiled by describing the new state of the various relevant contextual factors through a collection of situations resulting from a trigger for change, a specific course of action by a key actor and the associated impacts on the different dimensions of sustainability (social, economic, environmental) structured through the categories of the STEEP model. The foresight process can strengthen the analysis of the combination of interventions in different policy areas and in this way help to illustrate the systemic aspect of policy mixes that pave the way to a sustainable future along very different possible pathways (Bontoux and Bengtsson, 2016).

During the participatory scenario validation process, participants challenged and/or reinforced these narratives by introducing new inputs and additional causal effects in a structured way through three simple elements: (1) WHAT - Action/verb, (2) WHO - Actor and (3) HOW - Variable/Result (see Supplementary Table A2). The collective analysis of these elements allowed for new relationships and clustering of new themes that facilitated the subsequent identification of the changes in the transition pathways.

3.3 Backcasting to generate transition pathways

Identifying key areas of strategic policy intervention to spur a desired transition toward sustainability required understanding a range of possible transition dynamics. Such dynamics could be identified by building transition pathways for all the available scenarios. This is a classic exercise in foresight, performed by backcasting from the scenarios in a participatory process. In this context, a sustainability transitions pathway is defined following the application of the strategic foresight process and core concepts from the literature on sustainability transitions (Turnheim et al., 2015). It is considered as a narrative that integrates socio-technical analyses to project future scenarios, set explicit policy goals and assess pathways from the present to these goals. It emphasises synergies and trade-offs, emerging initiatives, system transformations and the scaling of experiments to enable transformative change and successful implementation.

To facilitate the analysis in a sustainability transition perspective, this was done using the X-curve, a sense-making tool that enables the co-creation of collective narratives about system change (Hebinck et al., 2022; Silvestri et al., 2022). This approach had the advantage of combining concepts from academic work on sustainability transitions with foresight as it connects closely to the 3-horizons framework (Wahl, 2017). The 3-horizons framework is an effective method for revealing the dynamics of transformation and exploring the diverging trends of the current system and the challenges to its sustainability

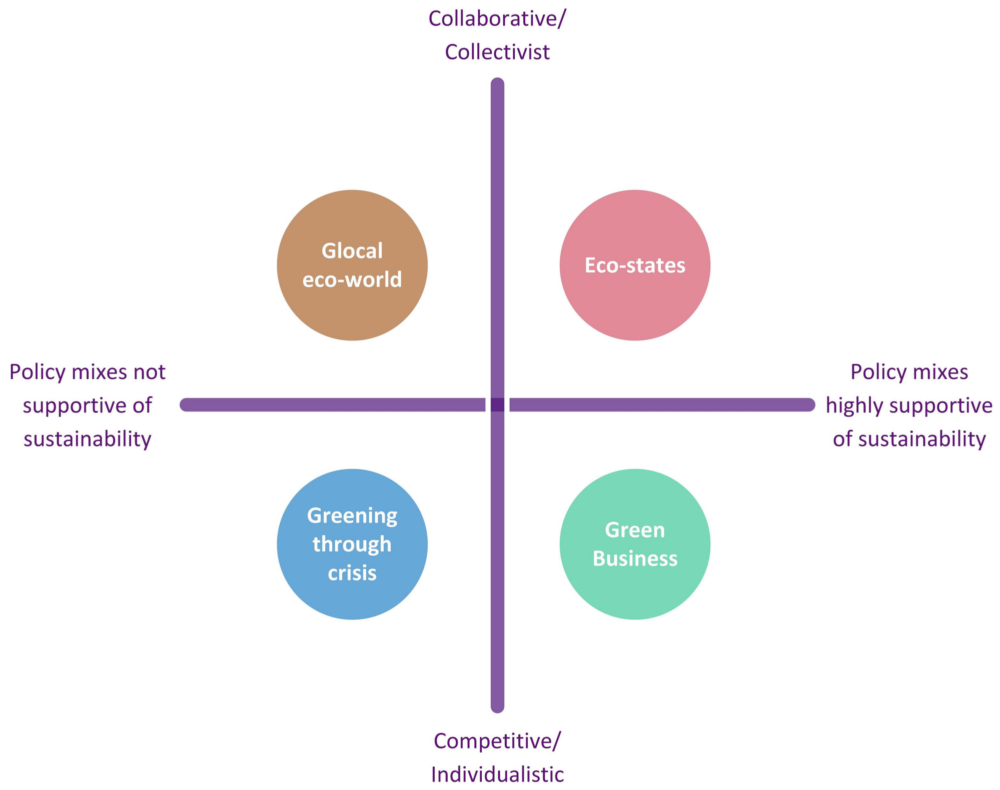


FIGURE 2
Scenario logic for developing the EU 2050 scenarios.

into the future (IFF, 2023). It consists in considering a first, short-term time horizon that enables an observation of established and emergent processes and structures and their drivers. A second time horizon, in a medium-term future allows to consider a transition phase, during which some established patterns from the present progressively fade out and previously emerging processes develop. The third, long-term time horizon looks at the establishment of the new situation resulting from the dynamics considered in the previous horizons. The application of the X-curve in this study helped participants visualize the phase out and build up dynamics taking place over the three horizons separately. The first, phase out, describes the patterns of change for destabilising and phasing out practices that are characteristic of the present. The second, build up, describes the patterns of change in terms of the acceleration, emergence and, finally, scaling of new practices that bear witness to the establishment of the new world (see Figure 3). In the context of this study the build-up pattern of change was renamed scale-up to facilitate the understanding of the concept by a broad set of participants over the foresight process.

A transition pathway was developed for each scenario by describing what specific changes would have to happen at different time steps between today and 2050 (explaining causes and consequences for each contextual factor) to reach the corresponding scenario. This produced a specific pattern of change for each scenario.

During the open participatory process, the co-creation of transition pathways started with the extraction of key topics from the analysis of the scenarios. This helped participants understand what had to change, and, as insights were getting deeper, explore synergies and trade-offs over the transition. This exploration was organized in two steps. The first step focused on identifying the activities and practices of the current system that should stop or be changed (phase-out) and which ones should emerge or develop (scale-up). The second step focused on spotting new actions (or interventions) to support, promote or enable the proposed changes (see Supplementary Table A2).

To facilitate understanding and analysis, the process engaged in a concomitant clustering of elements to obtain clear narratives describing patterns of change as well as a set of key transformative elements such as trade-offs, synergies and systemic relations to facilitate the analysis of transition dynamics.

3.4 Systemic policy mixes and strategic areas for intervention across the pathways

Thanks to the broad scope of the four scenarios and corresponding transition pathways, looking across them made it possible to identify topic areas in which critical change had to happen on the road toward sustainability, even if the specific changes could vary across pathways as part of a broader systemic policy mix. This was instrumental to shed light on what it would take from a policymaking perspective to engage in successful sustainability transitions toward 2050 depending on the selected course toward the future. These areas were first identified collectively during the open participatory process (See Supplementary Table A3).

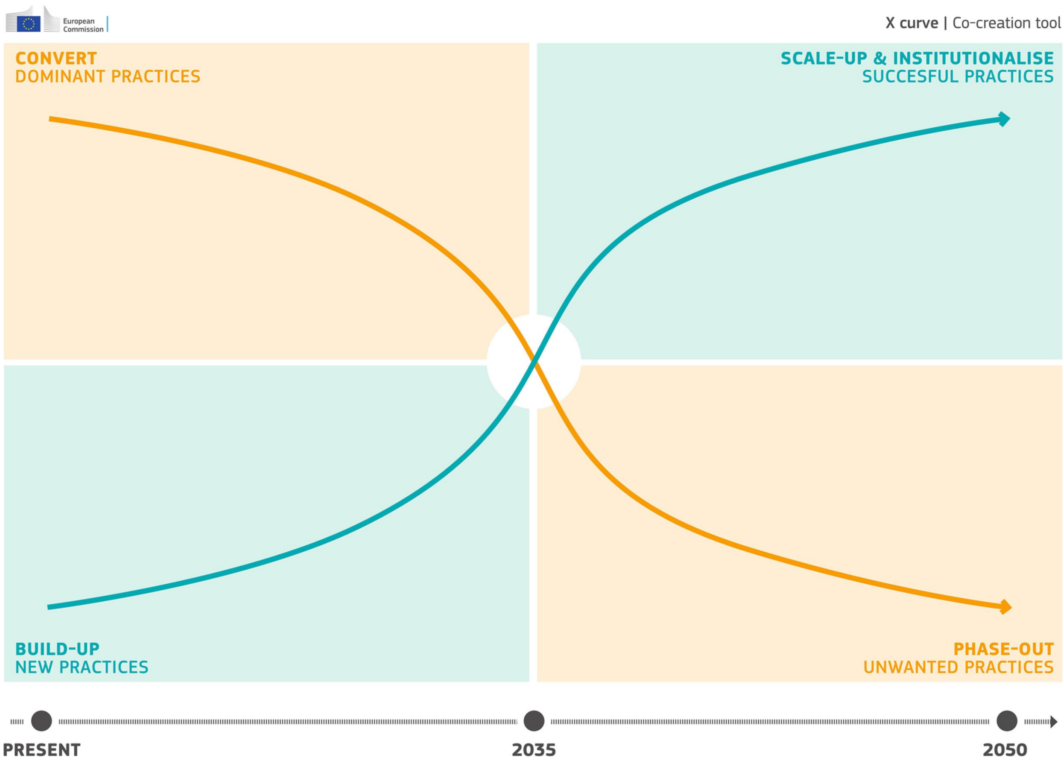


FIGURE 3
The X-curve for co-creating transitions pathways.

First, the transformative elements of each pathway were highlighted so that the experts could analyze and compare them from a systemic point of view. The identified areas were then ranked according to which would be most critical for policy action across all pathways to move sustainability transitions forward. The experts were then asked to address the emerging systemic policy mixes by highlighting synergies, tradeoffs and emerging processes that could activate change and provide direction for the transition.

The experts were then asked to propose interventions in each cross-cutting area that would facilitate sustainability transitions. To make these proposals concrete, they were asked to describe (1) WHAT - Action/verb, (2) WHO - Actor and (3) HOW - Variable/Result. They were guided by a template identifying different aspects[3] of potential interventions. Emphasis was put on understanding the synergies between the actions in terms of the pattern of change (i.e., Scale-up/Phase out).

The different elements describing these strategic areas for intervention were then documented and analyzed using current data and trends. The areas of intervention were then grouped into four systemic clusters to facilitate understanding. This made it possible to discuss the agency of EU actors in managing the changes needed to promote sustainability transitions and, by doing so, improve the understanding of the evolution of the capacity of actors to shape, navigate and orchestrate the change process overtime could determine the scope and scale of the mix of interventions that can be implemented.

4 Key results of the strategic foresight process

As mentioned earlier, an essential goal of the project was to generate actionable knowledge, i.e., information and understanding that would help policymakers concretely in their capacity to develop the systemic policy mixes that are needed to put the EU on a path toward a fair and sustainable future. The foresight process delivered on this objective in two main ways: by shedding light on the nature of changes needed to engage successfully in the transition toward sustainability and by identifying who could or should do what to that end.

4.1 The nature of change in the transition pathways through scaling-up and phasing out practices

Transitioning successfully toward requires speed and scale in a range of critical changes that need to take place in a coordinated fashion. The urgency of climate change, environmental degradation and resource depletion requires rapid activation of systemic change processes, particularly in scaling up sustainable initiatives and phasing out unsustainable practices. This not only requires enhancing existing

3 Different aspects used for exploring potential interventions: (1) Constants, Parameter and numbers, (2) Infrastructures (digital/physical), (3) information flows, (4) Rules, (5) Governance, (6) Goals and (7) Paradigm (Scale-up vs. Phase-out). See Supplementary Table A5.

policies for sustainability, but also rethinking their interactions across different timescales, sectors and levels of government. When comparing the four transition pathways, we can immediately see what different approaches to systemic change lead to, particularly in terms of scaling up and phasing out efforts. These pathways illustrate the implications that different strategies for addressing sustainability transitions have for the agency of various actors and for multi-level governance.

Scaling up sustainable practices is essential. This includes expanding renewable energy sources, promoting frugality in addition to energy and material efficiency and investing in infrastructures for sustainability. Such initiatives need to be supported by coherent policy frameworks that incentivize innovation and collaboration between different stakeholders. The different foresight scenarios illustrate various types of scaling-up and what they lead to. In the pathway toward the 'Eco-states' scenario, for example, the focus is on expanding government intervention, and changing government behavior coupled with investing in green technologies. For the 'Green business boom' scenario, the pathway shows an expansion of market-driven solutions and private sector innovation. In contrast, the 'Glocal Eco-world' pathway scales up grassroots initiatives and local solutions.

However, phasing out unsustainable practices—such as dependence on fossil fuels, wasteful consumption and harmful agricultural practices—is equally important. This requires a systematic dismantling of existing structures that perpetuate environmental degradation, which can only be achieved through the coordinated efforts of governments, businesses and civil society. The efforts to phase out unsustainable agricultural practices, for example, vary in intensity and approaches between the scenarios. The 'Eco-states' pathway shows the most aggressive path toward reform, with governments explicitly discouraging unsustainable practices through regulation and taxation. The 'Greening through crisis' scenario demonstrates a more reactive exit approach driven by external pressures and constraints. The 'Green business boom' pathway relies on market forces to phase out unsustainable practices. The 'Glocal eco-world' pathway can appear on the surface as engaging in a more organic exit, with communities shifting toward sufficiency and local resilience, but in all likelihood, it would be in a post-apocalyptic world in which previous systems would have been profoundly disrupted.

While all pathways show both scale-up and phase-out processes, the emphasis on phase-out efforts is very different. The 'Eco-States' and 'Glocal Eco-World' pathways show the most comprehensive phase-out strategies, albeit through different mechanisms: it results from a visionary and voluntary approach in the former and from a post-trauma survival strategy in the latter. This comparison underscores the richness of considering multiple possibilities for achieving sustainability transitions to be able to reflect on the possible roles of different actors and levels of government in promoting systemic change.

4.2 Exploring the agency of EU actors on sustainability transitions across the strategic areas of interventions

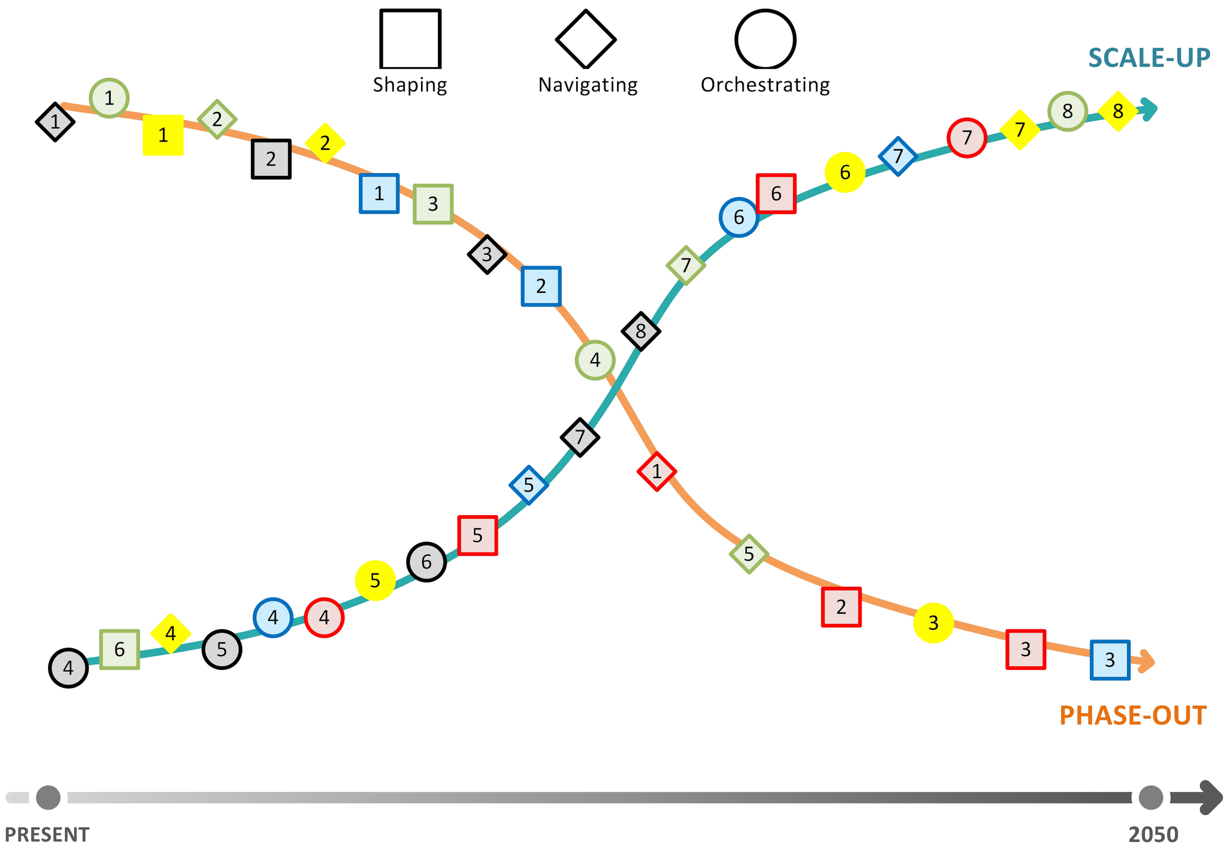
Developing transition pathways for the four scenarios and looking across them led to the identification of critical domains in which the type of change that would happen would have an outsize influence on the transition path. These critical domains were called "strategic areas of intervention" because they should be the focus of policy intervention when actively choosing a specific path toward sustainability. Considering them simultaneously also offers a tool to increase the policy coherence essential to engaging successfully in systemic change. These strategic areas of intervention, e.g., New Social Contract for Sustainability, Governance for Sustainability, People and Economy for Sustainability and Global Perspective on Sustainability, also provide a crucial window on the possible agency of the key actors in sustainability transitions. This concept makes it possible to look at the collective capacity of different actors to drive transformative change.

The roles of the multiple actors that must be mobilized and their interactions are critical to promoting a systemic approach to sustainability that reflects the interconnectedness of social, economic, and environmental systems. In the "Green Business Boom Transition Pathways" (see Figure 4), for example, the different aspects for addressing agency in sustainability transitions (shaping, navigating and orchestrating) take the form of a series of intervention clusters that correspond to a systemic policy mix in which each actor plays a different role to scale-up new practises and phase out unsustainable ones over time. More specifically, the interventions in the area of 'Strong public-private collaboration for a sustainable transition (blue)' show that the role of the government is shifting in terms of the use of public funds and more relevant monitoring activities, with the private sector playing a more important role in financing and providing public services.

In this sense, the government's measures under the 'Bioecenomy takes centre stage (yellow)' area aim to shape the sector by removing market-distorting subsidies, while a shared vision of corporations and SMEs serves as a strategic measure to navigate the changes in the new sector. Finally, the 'New models for enabling social mobility (red)' cluster emphasises shaping and orchestration with new roles for the private sector, philanthropy and civil society organizations in public services, while illustrating a new relationship between companies and employees, who are increasingly becoming shareholders in the company.

From a broader perspective across the different scenarios, Table 2 provides a comparative analysis of the strategic areas of intervention identified in this study, highlighting the diversity of interventions proposed through the three types of interventions in sustainability transitions defined in this paper: (1) Shaping change through Systemic Policy Mixes, (2) Navigating Uncertainty and Complexity and (3) Orchestrating Processes and Relations. Applying this approach across pathways, helps put in evidence the need for a multi-stakeholder approach in each strategic area of intervention. Not only does this type of analysis show that effective change requires the collaboration of different stakeholders, including governments, businesses, civil society and citizens, but it also helps to see that collective agency is essential for shaping change, managing uncertainty, dealing with complexity, and governing processes and relationships.

For example, this work brought to the fore that shaping the change necessary for sustainability transitions requires systemic policy mixes which themselves require a collaborative approach in which governments, civil society and the private sector work together to develop and implement policies that promote sustainable practices. This can ensure that stakeholders develop a good understanding and a sense of ownership of sustainability



Legend. Clusters of Interventions according to agency in sustainaility transitions

Green systemic reconfiguration (green)
1. Resource scarcity pushes global value chain reconfiguration
2. Accelerated exit from fossil fuels
3. New innovative indicators on environmental impacts
4. Critical tech sectors (transport, steel and construction) became GHG-neutral
5. Large corporations abandon resource intensive sectors
6. Adoption of regenerative and remedial practices on environmental services
7. New practices and popular demand for 1,5 degrees lifestyle & eco-consciousness
8. Upscaling circular solutions across value chains

Strong public-private cooperation for a sustainable transition (Blue)
1. New future accountability tax, pricing in all measurable environmental externalities
2. Shift in the role of states on public services and use of public funds
3. Government fully shift to monitoring/ controlling role for public services
4. Multi-actor collaboration supporting new business model
5. Tech neutral regulation + private R&D investment
6. Public-private partnerships + Infrastructure + Green entrepreneurship
7. Finance and corporates - Blended finance instruments

Bioeconomy takes centre stage (yellow)
1. Elimination of subsidies for non-sustainable agriculture
2. Food challenge addressed through agriculture optimization
3. Material and energy efficiency replaced by circular solutions
4. Emergence of agroecology, biotechnologies and urban farming
5. Diffusion of high-tech solutions for bioeconomy sectors
6. Shared vision Corporates & SMES - R&D and Food security
7. Waste is a critical resource
8. Bioeconomy is at the core of the economy

New Business models for reshaping markets (Black)
1. Technological paradigm shift and economies of scale
2. Strong shift to green taxation, standards and market incentives
3. Increased market segmentation, diversification
4. Increasing adoption of high-tech solutions for service sector
5. New business models: high-tech, service and circular economy
6. Consolidation of digital tools and global platforms + service sector
7. Emergence of customer made solutions
8. Consolidation of B2B economy

New models for enabling social mobility (red)
1. Labour force transitions from traditional to dynamic sectors
2. Unskilled non-EU migration is discouraged
3. Elimination of unskilled and repetitive jobs
4. Emergence of private providers of public services
5. Emergence of philanthropy and civil society organizations
6. Educational model shift & Upscaling technologies
7. ↑ Employees as corporate shareholders

FIGURE 4
Green business boom transition pathways - patterns of change according to agency type in sustainability transitions.

goals. Improving the sustainability literacy of citizens and businesses is crucial to enable them to actively participate in change. Moving away from unsustainable production and consumption patterns depends on a coherent mix of regulatory and fiscal measures that not only incentivises sustainable behavior but also removes existing barriers to change. This foresight work shows that this could require the formulation of a new social contract.

Navigating the uncertainty and complexity of the transition to sustainability requires a robust framework for collective action

TABLE 2 Strategic areas of Interventions distributed across the three types of interventions in sustainability transitions.

Strategic areas	A new social contract for sustainability	Governance for sustainability	People and economy for sustainability	Global perspective on sustainability
Shaping change through Systemic policy mixes	- Reformulate the social contract to embed sustainability across all dimensions, ensuring equitable access to resources and opportunities. - Renew democratic engagement through participatory governance, fostering citizen involvement in sustainability initiatives. - Accelerate sustainability competence development through education and training programs. - Develop a coherent mix of regulatory and fiscal policies that reinforce each other, promoting sustainable practices. - Phase out unsustainable production and consumption patterns through targeted policies.	- Foster multi-level governance structures that facilitate collaboration among local, regional, national, and EU levels. - Enhance democratic legitimacy by involving citizens in decision-making processes related to sustainability. - Promote transparency and accountability in governance systems to build trust among stakeholders. - Ensure alignment of policies across sectors and levels to achieve coherent sustainability outcomes.	- Encourage business innovation that aligns with sustainability goals, providing incentives for green technologies and practices. - Support fair labor practices and job creation in sustainable sectors, ensuring equitable economic opportunities. - Promote sustainable consumption patterns through education and awareness campaigns. - Implement social protection measures that address inequalities exacerbated by the transition to sustainability.	- Strengthen international cooperation on sustainability issues through partnerships and agreements that promote shared goals. - Develop strategies to navigate geopolitical uncertainties while maintaining a focus on sustainability objectives. - Foster global trade practices that prioritize sustainability and resilience over short-term gains. - Address global inequalities in resource distribution and access to sustainable technologies.
Navigating uncertainty and complexity	- Develop adaptive policies that can respond to changing social, economic, and environmental contexts. - Build consensus among diverse stakeholders to create a unified approach to sustainability challenges. - Promote research and innovation to anticipate and mitigate potential disruptions.	- Create frameworks for collaborative governance that enable stakeholders to address complex sustainability issues collectively. - Strengthen capacities for crisis management and resilience building in governance systems. - Utilize scenario planning to prepare for various future sustainability challenges.	- Equip individuals and communities with the skills necessary to adapt to changing economic conditions and sustainability challenges. - Foster partnerships between public and private sectors to enhance adaptability and resilience in local economies. - Encourage community-led initiatives that promote sustainable practices and lifestyles.	- Enhance global governance mechanisms to address transnational sustainability challenges effectively. - Build networks of transition-oriented partnerships that facilitate knowledge sharing and resource mobilization. - Promote global initiatives that support sustainable development goals (SDGs) and climate action.
Orchestrating processes and relations	- Facilitate dialog among stakeholders to build consensus on sustainability priorities and actions. - Create platforms for collaboration that connect various actors, including civil society, businesses, and governments. - Promote intergenerational equity in decision-making processes to ensure long-term sustainability.	- Establish clear roles and responsibilities for different governance levels to enhance coordination and effectiveness. - Remove regulatory barriers that hinder innovative business models aligned with sustainability. - Foster collaboration among regions and cities to leverage local knowledge and resources for sustainability initiatives.	- Implement policies that encourage sustainable lifestyles, such as incentives for energy-efficient practices and sustainable transportation. - Support initiatives that promote local economies and reduce reliance on unsustainable global supply chains. - Provide access to resources and support for communities transitioning to sustainable practices.	- Strengthen international partnerships to address global sustainability challenges collaboratively. - Promote synergies between local actions and global sustainability goals, ensuring that local initiatives contribute to broader objectives. - Foster a global culture of sustainability through education and awareness campaigns.

Source: own elaboration.

by different stakeholders. Building new capacities for action through consensus-based partnerships enables stakeholders to manage uncertainty effectively. This collaborative approach fosters resilience and enables communities and organizations to adapt to disruption and align change with long-term sustainability goals. By fostering transition-oriented partnerships, stakeholders can share knowledge and resources, enhancing their ability to respond to emerging challenges. Strategic foresight tools such as scenario planning can help consider a range of potential disruptions and inform decision-making processes. A key element identified in the cross-cutting analysis is the capacity of actors, in particular governments and private sector actors, to navigate uncertainty by maintaining an overall course toward sustainability to the extent that crisis events and shocks can be used to contribute to the reorientation toward sustainability, rather than resorting to unsustainable practices.

Orchestrating processes and relationships is critical to fostering effective multi-level governance models that facilitate the transition to sustainability. The role of different actors—governments, businesses, civil society and local communities — plays a critical role in creating synergies and enhancing collaboration across different levels and sectors. By enabling portfolios of systemic interventions, actors can address the various sustainability challenges in a coherent way. This includes removing barriers to innovative business models and creating an environment conducive to collaboration in which new ideas and practises can flourish. Strengthening the role of regions and cities is crucial, as they are often at the forefront of implementing sustainability initiatives and can utilize local knowledge and resources.

In shaping change, the emphasis on a new social contract underscores the importance of inclusivity and democratic engagement, ensuring that all voices are heard in the sustainability discourse. Navigating uncertainty necessitates adaptive governance that can respond to the complexities of modern challenges, fostering resilience through collective action and innovative partnerships. Orchestrating processes and relations is vital for creating synergies between local and global efforts, reinforcing the notion that sustainability is a shared responsibility. The overall comparative results illustrate that agency for sustainability transitions is not just about individual actions but about the collective capacity to act in concert toward a common goal, requiring a systemic policy mix that transcends traditional silos and fosters holistic approaches to sustainability.

5 Discussion and lessons learned

The foresight process and its use of academic concepts from sustainability transitions studies led to rich discussions on the multiple changes that sustainability transitions would entail and on what it would take to make these changes happen. This generated new knowledge among the participants that could be captured in the study report and inform policymaking.

Figure 5 summarize how the different outputs of the foresight process contributed to generate useful insights on change processes through a sustainability transitions lens. In this context, three important lessons were learned on critical aspects of implementing a foresight process addressing sustainability transitions.

5.1 System perspective on change process

The foresight process facilitated the interplay between futures thinking and sustainability transitions in several ways. First, using the Sustainability Assessment Scenario Framework and its inventory of contextual factors structured through the STEEP model, made it possible to build a future oriented narrative by combining trigger elements, actions and actors with a continuous analysis of systemic relations between the different STEEP categories.

Second, using the X-curve and its 'creation/destruction' duality for developing transition pathways through backcasting facilitated the identification of critical changes, synergies and trade-offs. In both cases, the foresight process facilitated a straightforward operationalization of the discussion on change through simple guiding questions and three instrumental, granular elements that were applied throughout the process: (1) WHAT - Action/verb, (2) WHO - Actor and (3) HOW - Variable/Result. This approach facilitated a systems perspective on possible, future change processes.

5.2 Systemic policy mix

The new insights into how change can happen show how actions taken today determine our ability to act tomorrow. In this sense, the foresight process has strengthened the analysis of the combination of interventions in different policy areas. This helped to illustrate the systemic effects of policy mixes along very different possible pathways, especially, it has enabled a discussion on the scale, complexity and speed of change. This future perspective on dynamic policy coherence shows that systemic consequences are often unpredictable and require regular adjustments. The challenges are large, but the results of this study show that the EU can use the available knowledge and tools, mechanisms and instruments to steer its own course in sustainability transitions.

Moreover, the described strategic foresight framework enabled a detailed discussion on the composition and interrelation of potential interventions through instrumental exercises that contribute to a more operational discussion on change process through simple WHO, WHAT HOW questions, while improving the understanding of how policy mixes generate synergies between actors with different capacity to act. The clustering and analysis contributed to illustrate examples of how policies to enable sustainability transitions should target different levels of society in a coordinated way.

5.3 Agency in sustainability transitions

The Sustainability Transition Framework provided a conceptual grid for considering agency while the foresight process facilitated the necessary discussion on the capacities and resources of different actors (e.g., policy makers at all levels of government, civil society, business leaders, etc.) to engage in transformative change. This interplay between sustainability transitions and foresight has delivered important lessons on the agency of EU actors in sustainability transitions. First, the agency of EU actors can evolve over time. Second, the evolving distribution of agency among EU actors can support society to take new actions in an uncertain situation. Finally, the insights on the strategic areas of intervention

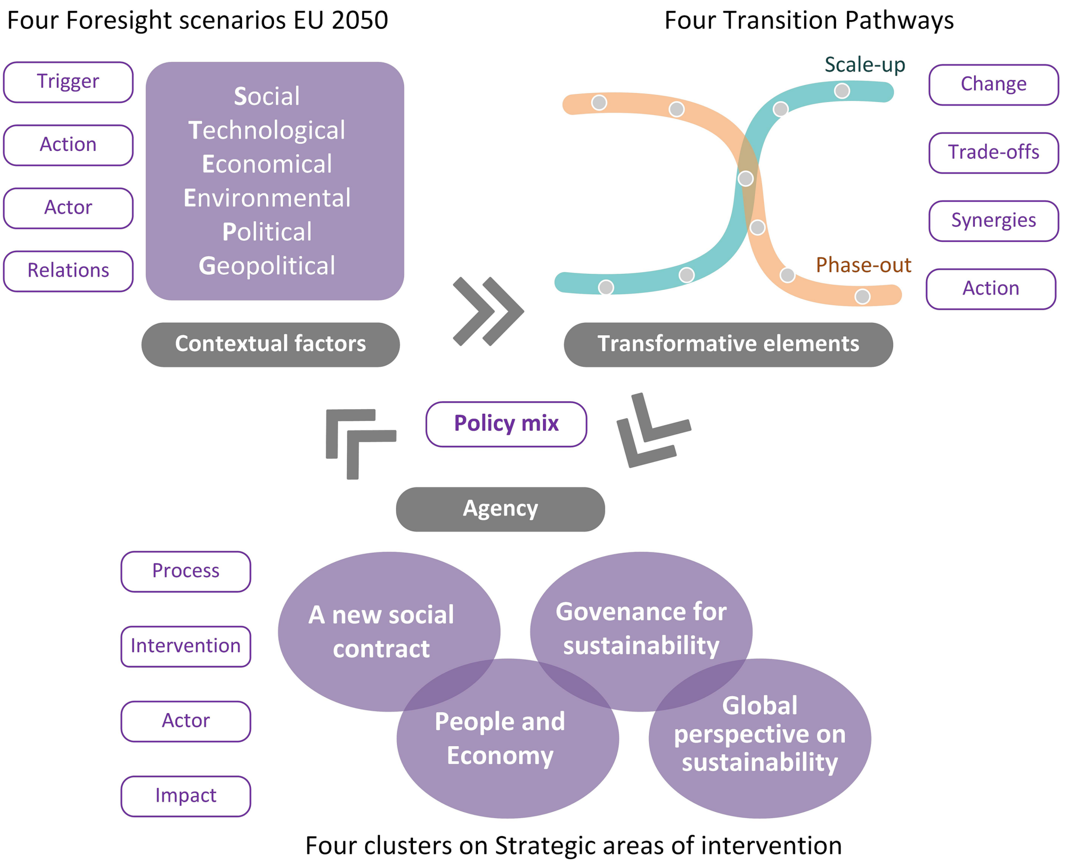


FIGURE 5
Logic flow of the foresight process and key elements on sustainability transitions.

show that this raises the question of which agency the EU wishes to promote, depending on the long-term vision adopted ultimately. In answering this question and shaping the portfolio of systemic interventions, it is crucial to consider that the different types of interventions within Shaping, Navigating and Orchestrating are mutually reinforcing and enable the building of new agency between different actors.

The insights presented in this paper has provided new evidence for the use of foresight to develop new actionable knowledge for policymaking on sustainability transitions. It has shown that combined methods can be used to operationalize concepts at a different level of complexity. The range of concepts that can be used in the foresight process to generate actionable knowledge ranges from the basic notion of systemic relationships and the change process to more sophisticated ideas that require deeper analysis, such as the systemic policy mix and agency of different actors to act in sustainability transitions. In this sense, this paper presented the implementation of an analytical loop that starts with the conceptualization of change through the lens of sustainability transition, which is later operationalized during the foresight process using tools complemented by simple questions such as (1) WHAT - action/verb, (2) WHO - actor and (3) HOW - variable/result to build the narrative for the transition pathways. Ultimately, the clustering and analysis of elements in the different areas of intervention enabled the re-conceptualization of the results in terms of the different agency of actors (i.e., shaping, navigating, orchestrating), which provided new insights for informing policy.

The application of these combined methods can facilitate innovation in the policy-making process to improve understanding of transformative change and, simultaneously, promote the discussion and exploration of strategic areas of intervention. The added value of combining these approaches lies, in particular in strengthening the ability to untangle complex and wide-ranging change processes. Applying foresight methods improved the ability to capture complexity and a wide range of possible changes. Embedding them in change management concepts for sustainability transitions enabled the project to generate systemic knowledge that can be applied strategically for policy (Matti et al., 2023).

5.4 Limitations

The previous sections describe the clear strengths of this strategic foresight framework and Section 6 demonstrates its 'portability' through a brief description and comparative analysis of early applications in three very different contexts. However, in view of the complexity of the issues that this approach addresses, some limitations can be highlighted.

First, to ensure a sufficiently high quality of output, the process must engage with a sufficiently large and broad set of participants with a high level of relevant knowledge, representing all the key stakeholders and with the necessary diversity of perspectives. This is best foreseen (mapped) in the very early stages of project scoping and design. This was achieved in this case thanks to the reach of the European Commission across Europe and to the availability of significant internal expertise.

Second, maximising the use of good quality information and data in the process while maintaining a continuous knowledge management task over the entire process increases the quality of output (Matti et al., 2022). However, this requires time and resources that are not always available. In our case, this was achieved through several weeks of desk research by the various members of the study team with support from experts from the European Commission's Joint Research Centre (JRC). However, no attempt was made to engage in quantitative modeling work as time and resources were not available.

Third, running this process successfully also requires not only clear definitions and explanations of the concepts that are applied but also expertise in running participatory foresight processes to ensure that all participants can fully engage with a solid shared understanding of what is being discussed. The strong conceptual basis for this work both from academic work on sustainability transitions and on the long-established foresight practice ensured a solid basis for the first aspect. Regarding the expertise in running the process, we had the privilege of being able to count on the solid experience of the staff from the EU Policy lab at the JRC.

All these requirements are clearly explained in the foresight process description and the JRC team can provide material and support to people who are interested in running this process elsewhere.

6 Follow up application of the foresight process in different contexts

After the successful completion of the original process, several requests for strategic foresight support were received by the EU Policy Lab. This offered the opportunity to test the concept further and streamline it to apply it to other complex issues through the design of tailored made strategic foresight exercise enabled by co-creation processes (Matti et al., 2022; Matti and Bontoux, 2024). The three examples described below provide a first validation of the relevance and robustness of this novel strategic foresight framework.

6.1 United Nations Environmental Programme (UNEP)

Over the period 2023–2024, UNEP engaged into an in-depth strategic foresight exercise to inform its long-term strategic reflection (UNEP and ISC, 2024). This process included horizon scanning and the development of foresight scenarios on human wellbeing and planetary health with a global perspective. To be able to take into consideration the diversity of situations around the world while preserving a certain coherence of input into the foresight process, the application of SAFS through the co-creation of an inventory of contextual factors addressing multiple sustainability dimension (Arushanyan et al., 2017) from these global scenarios was used to create a common basis for the design and implementation of regional workshops. The regional workshops made it possible to cater for very diverse sociocultural contexts as well as important differences in perception, knowledge acquisition, institutional capacity, motivation and resources around the world.

These workshops were performed with expert participants from the six UNEP world regions: Europe, Africa, North America, West Asia, Latin America and the Caribbean and Asia-Pacific. This was important to put global findings in perspective and uncover dynamics, issues, risks, and opportunities specific to each region.

To adapt to UNEP's needs and constraints, the original process was transformed into a 1.5 day workshop to be repeated across world regions and rolled-out in three main steps:

1. Review, understand and contextualize the four UNEP scenarios. Participants were invited to familiarize themselves with the four scenarios, to validate them, and to translate them into how they would play out in the context of their world region.
2. Determine what sequence of changes could lead us from the present to each of the four global scenarios. The purpose of this exercise was to uncover the potential for disruption to the state of the environment, planetary health and human well-being depending on the trajectory being considered.
3. Identify possible key interventions that would be required to address the main threats to human wellbeing and planetary health identified in each scenario for the region being considered. This step first made use of the strategic reflection of the participants to identify how each of the main changes emerging in the trajectories toward each scenario could affect sustainable development in the region. Then participants were asked to propose specific policy interventions to address the changes perceived as affecting sustainable development negatively.

UNEP rolled out this process across all six world regions and extracted the knowledge thus generated to inform its general assembly.

6.2 The future of the EU single market and industrial policy

Shortly after the completion of the original process, the European Commission's Directorate General for the Internal Market, Industry, Entrepreneurship and SMEs (DG GROW) contacted the EU Policy Lab to reflect on the future of the EU Single Market and industrial policy. The main objectives were to:

1. Identify the most likely and/or most impactful aspects of the possible futures for the work of DG GROW;
2. Discuss future directions for policies that would allow DG GROW to take advantage of the possible evolution of events.

The request came with a tight time-frame for delivery, few resources, and a requirement to engage with the whole management of the organization (over 80 people) at once. The EU Policy Lab decided to transform the SFR23 foresight process into a one-day programme and to use the reference scenarios for the EU Global Standing in 2040 (Vesnic Alujevic et al., 2023) developed previously by the JRC as they were better suited to discussing the chosen topic.

To tailor the workshop to the needs and constraints of DG GROW, the original process was adapted and rolled-out in four steps:

1. Explore and understand the 4 reference foresight scenarios, to grasp their respective implications for the Single Market and industrial policy. For doing so, by following the SAFS approach, the scenarios were unpacked and simplified through an inventory of contextual factors following 8 dimensions agreed with DG GROW.
2. Imagine how the EU Single Market and industrial policy would look like under each scenario, in sufficient detail.
3. Determine the pathways that could lead from the present to each of the alternative scenarios on the EU Single Market and Industrial Policy using the "X-curve."
4. Look across all pathways to identify the key strategic domains of policy intervention, the corresponding drivers of change and the policy leverage points.

All steps were supported by relevant templates.

Over 80 GROW colleagues attended including both DDGs and several directors and contributed very actively to the discussions. This large number required to run the participatory process in two parallel tracks with periodic reconciliation of results. Overall, and despite some initial scepticism, the participants engaged fully and completed all steps successfully. At the end of the day, the objectives of the exercise had been met and the feedback from the participants was overwhelmingly positive. The key domains for policy intervention that were proposed by the participants could be grouped around 8 areas: institutional, financial, sectorial, competition policy, external relations, administrative burden, sustainability, skills, and fairness/cohesion.

While the discussion brought many classic topics of discussion to the fore, it put them into different contexts, put them in a systemic perspective, made trade-offs clear and led to deeper strategic reflections with clear policy and political relevance. It also broadened the reflection to consider coherence with action in other policy areas.

The results of the foresight exercise were then presented to all interested staff of DG who did not take part in the workshop.

6.3 Strategic foresight for sustainable food system transitions

During 2024, the European Topic Centre on Sustainability transitions implemented a project to explore multiple pathways and policy mixes for transforming European food systems. The project demonstrated how strategic foresight can effectively address complex systemic challenges through structured stakeholder engagement. The process combined three complementary methodological approaches to explore future pathways and identify strategic intervention areas for food system transformation (Lorenz et al., in press).

In the first phase, the Future Wheel method was employed during an initial workshop with the EIONET Food Systems Group, EEA officials, and selected experts. The Future Wheel facilitated systematic examination of scenario sustainability and completeness, with particular attention to environmental and social dimensions, including key contextual factors such as justice, equity, food safety, and food security. This brainstorming structured by contextual factors (i.e., SAFS) helped participants explore direct and indirect consequences of potential changes in the food system. The use of the Future Wheel as a visual mapping artefact enabled participants to move beyond linear thinking and identify complex interdependencies within the food system.

The second phase utilized the X-curve framework to analyze transition pathways, explicitly considering the interplay between building up sustainable practices while phasing out unsustainable elements of the current food system. Workshop participants identified key elements requiring change, new activities for scaling up, and existing practices to phase out. The framework highlighted the temporal sequence of policy actions needed across different transition phases - emergence, acceleration, and stabilization. This analysis revealed the importance of developing effective phase-out strategies alongside innovation support, particularly regarding agricultural subsidies and supply chain transformations.

The final phase employed morphological analysis to explore policy combinations systematically across ten key dimensions of food system governance. The analysis framework emerged through a bottom-up approach informed by the X-curve workshop outcomes. Policy options were evaluated through pairwise consistency assessments using a three-point scoring system, leading to the identification of four distinct yet coherent policy pathways: Nature First, High Tech, Top-down, and Mixed Approaches. A second workshop with the EIONET Food Systems Group validated these pathways and assessed policy options for feasibility and desirability.

6.4 Comparative analysis of key aspects of the three applications

The three examples demonstrate the adaptability of the strategic foresight framework to different applications and its transferability to other practitioners while maintaining core methodological elements. The UNEP case emphasized regional adaptation of global scenarios through structured workshops, enabling consideration of diverse sociocultural contexts and institutional capacities as well as to ability of others to lean the process and run it autonomously. The EU Single Market application focused on rapid engagement with large management groups, using reference scenarios to facilitate strategic discussion under time constraints. The application to the food system showcased a more comprehensive approach, combining detailed stakeholder engagement with systematic policy analysis.

Common elements across cases include the use of participatory methods to build shared understanding such as the use of an inventory of contextual factors (i.e., SAFS) to unpack the scenarios, structured frameworks to explore transition pathways, and systematic approaches to identifying strategic interventions. However, they differ largely in scope (global vs. European vs. sectoral), timeframe (from one-day workshops to multiple-month engagements), and depth of policy analysis (from strategic directions to detailed policy mixes). Table 3 provides a comparative analysis of how the strategic foresight framework was adapted to different contexts. While all cases maintain core methodological elements, they demonstrate distinct approaches to scenario development, pathway creation, and strategic intervention identification, reflecting varying institutional settings, timeframes, and stakeholder configurations. The comparison illustrates the framework's flexibility while maintaining methodological rigor.

The three cases demonstrate distinct patterns of agency mobilization in sustainability transitions. In the UNEP case, agency

TABLE 3 Comparative analysis of three applications.

Case	Scenarios sense-making	Transition pathways	Strategic areas of intervention
UNEP global-regional integration	Global scenarios contextualized through contextual factors in regional workshops; adaptation to diverse sociocultural contexts and institutional capacities	X-curve framework applied through regional lens; focus on disruption potential and impacts	Policy interventions identified to address human wellbeing and planetary health threats; region-specific solutions developed through collective intelligence
EU single market	Pre-existing EU Global Standing scenarios adapted to sectoral context with contextual factors; rapid engagement with large management group (80+ participants)	X-curve framework applied to determine pathways between present and alternative policy scenarios	Eight strategic domains identified (institutional, financial, sectoral, etc.); emphasis on policy coherence and cross-domain integration
Food system transformation	Future Wheel method used with EIONET Group for systematic examination of scenarios through contextual factors; focus on environmental and social dimensions	X-curve framework analysis of sustainable practices build-up and unsustainable elements phase-out; temporal sequence across transition phases	Morphological analysis across ten food system governance dimensions; four coherent policy pathways identified through pairwise consistency assessment

was distributed across multiple regional bodies, with international organizations acting as coordinators while empowering regional stakeholders to contextualize global scenarios. This multi-level agency approach enabled adaptation to diverse institutional capacities and cultural contexts.

The EU Single Market case showcased institutional agency at the European level, with DG GROW mobilizing over 80 management-level actors to shape strategic directions. This demonstrated how concentrated institutional agency could be effectively deployed even under tight time constraints, while still maintaining inclusivity in the process.

The food system case revealed a more complex interplay of agency, involving scientific institutions (EEA, EIONET), policy actors, and diverse stakeholders across the food value chain. This distributed agency model enabled a broader perspective on system transformation by engaging actors with different capacities and roles - from primary producers to consumers, and from local to EU-level institutions.

7 Conclusion

The novel foresight framework described in this paper emerged from a study that focused on understanding the key role the social and economic dimensions have in the transition of the EU toward sustainability. Its objective was to make these dimensions salient within the inherently complex, entangled and multi-layered changes that will unavoidably take place in the sustainability transitions. This framework was implemented through a holistic approach that showed the dynamics and interconnectedness of the social, economic and environmental systems as applied to the EU. By revealing how the concurrent scaling up and phasing out of individual phenomena could lead to the radical transformation of the EU toward different forms of sustainability, the application of the foresight framework enabled the study team to generate strategic insights that provided the future-oriented backbone for the preparation of the European Commission's 2023 Annual Strategic Foresight Report.

The application of the original foresight framework delivered actionable knowledge through several outputs: a set of four scenarios for a climate-neutral, sustainable EU in 2050 structured through and inventory of contextual factors following the SAFS approach; a set of four corresponding transitions pathways; and a systemic policy mix conformed by a set of strategic areas of intervention covering a new social contract, governance, people and the economy, and the global perspective. The analysis of the strategic areas of intervention in the perspective of the various scenarios and transition pathways, has enabled the generation of new actionable knowledge to better understand the agency of the various actors in the sustainability transitions.

The step-by-step development of the scenarios and transition pathways, helped by the application of the X-Curve, made it possible to reach the required depth of analysis. This way of separating phase-out and emergence dynamics by combining transition thinking with the 3 Horizons framework often used in foresight helped participants through a difficult reflection exercise. This way of addressing transition dynamics facilitated the analysis of trade-offs, bottlenecks and blind spots along transition pathways, delivering strategic insights for policymaking in a very complex domain. It also demonstrated not only the importance of systemic policy mixes for a successful transition, but also provided tools to generate the required systemic understanding to know what to put into these policy mixes.

The successful implementation of this foresight framework across global and thematic contexts validates its methodological robustness and demonstrates its versatility. The framework has proven effective in helping stakeholders develop systemic understanding and engage in transformative change, promoting both immediate action and long-term resilience. Its successful application across diverse settings - from the EU Single Market to food systems to UNEP's global perspective - demonstrates its adaptability while maintaining methodological integrity. The process has proven particularly valuable in enabling organizations to engage with complex sustainability challenges through structured yet flexible approaches to scenario development and policy recommendation formulation.

The framework reveals specific challenges in mobilizing and coordinating different forms of agency for sustainability transitions. A key challenge is balancing the agency of established institutional actors with emerging stakeholders who may lack formal authority but bring crucial perspectives and capabilities. In view of the difficulty encountered by governments around the world to engage in sustainability transitions, help with in-depth reflection on the issue should be broadly welcome. Indeed, as there is no one-size-fits-all way forward, this type of methods provides both the structure and the flexibility to generate original reflections adapted to any geographical and political context.

The framework also presents unique opportunities to enable systematic incorporation of diverse stakeholder perspectives while maintaining analytical rigor through the interplay of multiple entry points for stakeholder engagement (i.e., scenarios, transition pathways, interventions and policy), desk research and knowledge co-creation to ensure systematic policy development. Furthermore, main aspects of the framework's flexibility such as the use of contextual factors to structure scenarios (i.e., SAFS) and the use of X-Curve for co-creating narratives on pathways from multiple angles allows adaptation to different contexts while maintaining methodological coherence, as demonstrated across the three cases.

In view of the complexity of the issues that this approach addresses, some limitations can be highlighted. First, to ensure a sufficiently high quality of output, the process must engage with enough participants with a high level of relevant knowledge, representing all the key stakeholders and with the necessary diversity of perspectives. This is best foreseen (mapped) in the very early stages of project scoping and design. Second, maximising the use of good quality information and data in the process increases the quality of output. However, this requires time and resources that are not always available. Third, running this process successfully also requires clear definitions and explanations of the concepts that are applied to ensure that all participants can fully engage on the basis of a solid shared understanding of what is being discussed. The study identifies a space for further development of future-oriented co-creation processes by exploring the interplay between foresight methods and the Sustainability Transitions Framework. It also highlights the potential for using transition pathways to inform and structure a discussion over the long-term change needed, the systemic policy mixes required and the agency of different actors on the way toward sustainability. Finally, the methodology's flexibility allows for adaptation to different institutional contexts while maintaining coherence in how agency is mobilized and coordinated. The cases demonstrate how the framework can help overcome traditional limitations in policy planning where different forms of agency can be effectively combined to drive sustainability transitions. This is particularly relevant for EU-level coordination, where success depends on mobilizing complementary forms of agency across governance levels.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Author contributions

CM: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Software, Validation, Visualization, Writing – original draft, Writing – review & editing. LB: Conceptualization, Data curation, Formal analysis, Methodology, Supervision, Validation, Writing – review & editing. KJ: Data curation, Formal analysis, Investigation, Project administration, Writing – review & editing.

Funding

The author(s) declare that no financial support was received for the research, authorship, and/or publication of this article.

Acknowledgments

The authors would like to thank Petra Goran, Alberto Pistocchi and our regretted colleague Maurizio Salvi for their significant contribution in realising the key findings of the European Strategic Foresight Report 2023. We would also like to acknowledge the leadership of Anne-Katrin Bock and Thomas Hemmelgarn, who advised us on the institutional and technical aspects of the process to develop the scientific basis for policy development.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Generative AI statement

The authors declare that no Generative AI was used in the creation of this manuscript.

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Supplementary material

The Supplementary material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/frsus.2025.1507708/full#supplementary-material

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frontiers | Frontiers in Sustainability

TYPE Original Research
PUBLISHED 09 May 2025
DOI 10.3389/frsus.2025.1562615

OPEN ACCESS

EDITED BY
Ahmed Ibrahim Osman,
Queen's University Belfast, United Kingdom

REVIEWED BY
Jessika Luth Richter,
Lund University, Sweden
Mihaela Stefanescu,
Ministry of Environment, Waters and Forests, Romania
Christine Majale,
Kenyatta University, Kenya

*CORRESPONDENCE
Polina Pencheva
p.pencheva@ucl.ac.uk

RECEIVED 17 January 2025
ACCEPTED 11 April 2025
PUBLISHED 09 May 2025

CITATION
Pencheva P, Purkiss D, Hewlett R and Miodownik M (2025) Big Repair Project: using citizen science to better understand the factors affecting household maintenance and repair of home appliances and electronics across the UK. *Front. Sustain.* 6:1562615. doi: 10.3389/frsus.2025.1562615

Big Repair Project: using citizen science to better understand the factors affecting household maintenance and repair of home appliances and electronics across the UK

Polina Pencheva*, Danielle Purkiss, Robert Hewlett and Mark Miodownik

UCL Plastic Waste Innovation Hub, University College London, London, United Kingdom

The world is facing an increasing challenge with the accumulation of Waste Electrical and Electronic Equipment leading to a wide range of negative environmental and social impacts. Supporting higher priority circular economy activities such as repair and extending the lifespan of electrical and electronic equipment (EEE) will help to reduce WEEE's negative impacts, create skilled jobs, and improve supply chain resilience. This requires citizens to be able to identify EEE products as repairable, have basic repair skills, access to repair services (including diagnostics) and motivation to repair. Using a citizen science approach over a 32-month period from January 2022 to September 2024, the Big Repair Project collected 5,958 survey responses and 473 detailed logs of repair activities from people geographically spread across the UK. The data was analyzed to better understand issues that currently exists with household maintenance and repair of home appliances and electronics. Findings reveal a gap between consumer expectations of product lifespan and existing legislation, challenges related to cost and accessibility of repair services, and a desire for improved repair information and spare parts availability. The findings emphasize the need for policy and industry action to diversify local repair economies, extending statutory warranty periods, support diagnostics and repair transparency, and incentivize repair businesses. By fostering a culture of repair, this work aims to inform the development of UK Right to Repair laws and broader circular economy initiatives, contributing to the reduction of electronic waste and the promotion of sustainable consumption practices.

KEYWORDS

repair, economy, WEEE, electronics, electricals, circular economy, citizens

Introduction

The growing accumulation of Waste Electrical and Electronic Equipment (WEEE) poses significant environmental, social, and economic risks globally (Purkiss et al., 2024). With the United Kingdom (UK) generating ~24.5 kg of WEEE per capita (Baldé et al., 2024)—among the highest globally—the consumption and disposal of electrical and electronic equipment (EEE) are on unsustainable trajectories. These trends are leading to exacerbated greenhouse gas emissions, depleted critical materials (NEPC, 2024), and adverse social and health impacts globally (World Health Organization, 2021). The circular economy offers a framework to mitigate these challenges through processes like maintenance, reuse, refurbishment, remanufacture and recycling of electrical and electronic equipment (Ellen MacArthur Foundation, 2025), thereby promoting sustainable production and consumption, and minimizing health risks, in alignment with the UN Sustainable Development Goals (UN, 2015). While recycling remains an important circular economy activity, it cannot keep pace with the growth rate of electronic waste (Forti et al., 2020), requires significant energy use and is a source of emissions (Green Alliance, 2020b). Instead, other circular economy activities such as reduction, reuse, repair and remanufacture are becoming critical priorities (Bakker et al., 2014; Green Alliance, 2018; HM Government, 2022).

Historically, repair was integral to society partly due to the simpler product designs, widespread repair skills and affordable labor (Perzanowski, 2022). However, technological advancements during the digital era, planned obsolescence, and societal shifts have made repairs increasingly complex and cost-prohibitive (Bisschop et al., 2022; European Parliament, 2016). Coupled with the convenience and cost-effectiveness of purchasing new electronics and the influence of fashion and advertising, these factors have diminished repair culture, fueling a throwaway economy (Hernandez et al., 2020). Recognizing these challenges, global policy developments—such as Right to Repair laws—have sought to re-prioritize repair as a cornerstone of circular economy strategies. There is also growing recognition that to support such policy developments and address the challenge of EEE waste, greater awareness, consumer behavior and culture are critical (Baldé et al., 2024). However, the analysis of existing studies discussed in this paper demonstrates that up-to-date data on citizen attitudes, opinions and behaviors toward maintenance and repair of home appliances and electronics in the UK remains limited.

This paper investigates the UK repair system, focusing on citizen attitudes, opinions, and behaviors toward the maintenance and repair of home appliances and electronics. The work explores the Right to Repair and Ecodesign regulations, product health and safety standards and other legislation influencing user behaviors, professional or home repairs in the UK. A review of existing literature on repair user behavior is used to cross reference findings from the Big Repair Project, which uses a citizen-science approach (Haklay et al., 2020) featuring 5,958 survey responses and 473 logged repair activities. The findings reveal a gap between consumer expectations of product lifespan and existing legislation, challenges related to cost, software support and accessibility of repair services, and a desire for improved repair information and spare parts availability. The study emphasizes the need for policy and industry action to diversify local repair services, extend statutory warranty periods, support diagnostics and repair transparency, and incentivize repair businesses. Additionally, fostering repair skills, engaging diverse demographic groups and exploring circular economy business models could help grow a repair economy and reduce WEEE generation.

Repair legislation and standards

Repair is a relatively diverse sphere of activity with different social, contractual, and legal relations depending on the actors involved, whether repair is conducted under consumer law (right to repair or replacement or faulty goods), servicing contracts (e.g., warranties), for personal benefit outside of consumer/contractual protection or for commercial purposes and resale.

The Big Repair Project predominantly focuses on repair activities conducted by private individuals on personal property intended for personal use, or via contracting an independent repair professional to undertake the repair for them, outside of a servicing contract. In each of these scenarios there are laws, regulations and standards specific to the UK that influence repair behavior and thus become important context within which findings should be analyzed. In addition, in the context of UK home repairs there are concerns that repaired products are more likely to develop faults, be sold or passed onto others via second-hand marketplaces, leaving users more vulnerable to health and safety e.g., electrical injuries or liability risks (National Audit Office, 2021; EEESafe, 2025). This section offers a review of relevant legislation and standards that should be considered in the context of the Big Repair Project as they influence, enable or inform repair activities. These include laws, regulations and standards applicable to repair more widely such as (1) Right to Repair and Ecodesign; and (2) product health and safety standards; and also laws, regulations and standards which specifically apply to (3) professional repair services and (4) home repair.

Right to repair and Ecodesign

A measure that has been introduced in the UK and other countries to reduce WEEE waste and reduce greenhouse gas emissions are Ecodesign Regulations, which contain provisions colloquially referred to as “Right to Repair” Regulations (House of Commons Library, 2021; Green Alliance, 2020a). These regulations apply to products introduced onto the market by producers, either directly by manufacturers or by importers—while these do not directly apply to repair activities, they influence and enable them.

UK “Right to Repair” regulations came into force in July 2021 as part of the Ecodesign for Energy-Related Products and Energy Information Regulations 2021 (SI 2021 No. 745) (House of Commons Library, 2021). These Regulations apply to Great Britain, with Northern Ireland subject to EU Ecodesign requirements under the Northern Ireland Protocol (House of Commons Library, 2021). These Regulations aim to increase producer responsibility, reduce energy usage and electrical waste, and enable citizens to identify more energy efficient products (House of Commons Library, 2021). They also increase the responsibilities of electronics manufacturers to provide spare parts and technical repair information and aim to increase consumer product lifespans by up to 10 years by giving professional repairers access to spare parts and technical information from July 2021 (manufacturers have a grace period of up to 2 years to make parts available). The law also requires manufacturers to make specific spare components available to the general public, although these are limited to easy-to-replace parts (e.g. drawers for refrigerators); components requiring more complex installation procedures can be restricted to qualified professionals only.

Currently the UK's "Right to Repair" Regulations do not cover the full range of electrical and electronic equipment (EEE) goods contributing to WEEE waste. They only cover dishwashers, washing machines, washer-dryers, refrigeration appliances as well as televisions and electronic displays. Several organizations are calling for UK Government to include more electronics and appliances within scope, in particular laptops and smartphones (House of Commons Library, 2021) and to better regulate the cost and accessibility of spare parts (House of Commons Library, 2021). The Regulations also do not include a requirement to publish information about the repairability or durability of products based on an agreed repairability and durability assessment framework.

In Europe, Parliament has taken a proactive approach to making repair easier and more accessible to consumers with recent changes to EU Ecodesign Regulations designed to ensure manufacturers repair products for a reasonable price and within a reasonable timeframe, improve access to spare parts, tools and repair information for consumers, introduce incentives such as repair vouchers and funds to opt for repair and propose new forms and platforms to help consumers assess and compare repair services (European Parliament, 2024).

In addition, a wider adoption of a Durability Index is being considered by the European Commission alongside the future European Energy Label which will both include a repairability index. The Durability Index is already mandatory in France and covers products such as smartphones, televisions and washing machines, which were previously covered under the French Repairability Index and policies. The Durability Index incorporates repairability and extends criteria to include trustworthiness, robustness, and upgradeability (France, 2024).

Voluntary ecolabels can also provide citizen information on repairability of specific products. For example, the Germany-based Blue Angel uses individual award criteria for different product types, however repairability is not uniformly covered across products. For example, the DE-UZ 219 criteria for imaging equipment (such as printers) includes requirements for manufacturers to maintain access to spare parts and repair information for at least 7 years and the DE-UZ 78 for computers and keyboards include requirements for repairability and upgradeability (Blue Angel, 2024).

Repair activities globally have been influenced by Intellectual Property (IP) Law. Whilst IP Law is important to ensure a product is not illegally copied, reproduced or sold, however commonly identified manufacturer activities and interpretations of IP Law include limiting the repair of electronic products, restricting access to product manuals, parts numbering, software restrictions and locks, and planned obsolescence (European Commission, 2022; Perzanowski, 2022).

Product health and safety standards

Standards are documents, "established by consensus and approved by a recognized body, that provides, for common and repeated use, rules, guidelines or characteristics for activities or their results, aimed at the achievement of the optimum degree of order in a given context" (International Standards Organisation, 2020). Standards have been developed by the European Committee for Standardization (CEN and CENELEC) and the British Standards Institution (BSI) in response to circular economy and material efficiency initiatives that cover the reuse, repair, and remanufacture of electronic products.

Several standards outline general safety requirements for different categories of electrical products. For example, BS EN 60335-1:2012+A15:2021 covers household and similar electrical appliances, BS EN 60950-1:2006+A2:2013 covers information technology equipment, BS EN 61010-1:2010+A1:2019 covers electrical equipment for measurement, control, and laboratory use, and BS EN 60950-1:2006+A2:2013 sets out different requirements for operators, lay people and for service people to reduce risks of fire, electric shock or injury. These standards provide guidelines to reduce risks such as fire, electric shock, and injury for operators and laypeople. However, they do not specifically address repair activities.

Another relevant standard is The UK Conformity Assessment (CA) Certification, introduced in 2021 to replace the EU Conformité Européene (CE) Certification for products sold in Great Britain (England, Wales and Scotland). In 2023, the UK government announced that the recognition of the CE marking for placing most goods on the market in Great Britain would be extended indefinitely (HM Government, 2023).

These standards exist within the wider Health and Safety legislative framework, which includes the Electrical Equipment (Safety) Regulations. These regulations define "spares" and clarify that products repaired, refurbished, or exchanged without changing their original performance, purpose or type are not considered "new" and do not require recertification or re-marking (HM Government, 2016). This creates a gap in clear, applicable standards for the repair of electrical and electronic equipment.

In response to this gap, standards from grassroot organizations such as EEESafe are gaining momentum. The EEESafe and White Goods Safety Standard alongside the community-focused Training Qualification/Certification are aimed at independent repairers and domestic repairers in the community, setting a higher standard for electrical competency and testing to ensure overall safety of the repair process and the repaired product (LocalitEEE, 2024).

Professional repair services

Professional repair services are covered by the Consumer Rights Act 2015, under "contracts to supply a service", stipulating that such services must be undertaken with reasonable skill and care and that information provided about a service is legally binding, reasonably priced, and carried out within a reasonable time. Under the Consumer Rights Act 2015 Act all products must be of satisfactory quality, fit for purpose and as described. Consumers have the right to refuse, claim repair or replacement of faulty goods under the Act if the product they have purchased fails to meet any one of the above criteria under a 6 year breach of contract period. Rights vary according to when a claim is made from date of purchase (up to 30 days, between 30 days to 6 months, and 6 months to 6 years) (HM Government, 2015). Subsections (14) and

(15) of the Act provide that if the breach e.g., a fault, arises in the first 6 months from delivery it is presumed to have been present at the time of delivery unless the trader proves otherwise, making it easier for consumers to exercise their right to repair or replacement. However, after the 6 month period and up to 6 years after purchase the burden is on the consumer to prove that the fault existed at time of purchase (HM Government, 2015).

Parts used during repair are also covered by the Act, and consumers are entitled to remedies in case of underperformance. During repair, spare parts may come from different sources: new spares manufactured by the original equipment manufacturer (OEM), aftermarket (third-party manufactured) spares made to the same specification, or used spares harvested from end-of-life models—as well as fulfilling expected performance requirements, under the Unfair Trading Regulations 2008, repairers cannot mislead customers over work done, e.g., installing 3rd-party spares after claiming that they are using ones manufactured by the OEM, or installing used spares after claiming to be installing new ones.

During repair, professional repairers must observe the Electricity at Work Regulations 1989 which stipulate that electricity workers have a responsibility to ensure that electrical systems do not give rise to danger either during the work, or after (e.g., ensuring live wires are suitably insulated). Liability for defective products was introduced by the Consumer Protection Act 1987: if a defective product leads to injury, any person injured (not just the person who bought it) may bring a claim against the producer demonstrating proof that the product caused the injury. Additionally, claims in negligence may also be brought against producers. In the case of repaired products under the Act, there is a legal question over whether the repairer would be classified as a "producer"—if a part repaired by a 3rd party is involved in the defect, the original manufacturer will not be liable. In the case of the repair going beyond restoring the product to its original functionality, then the party undertaking the repair would be classified as a producer. If bringing a claim under either the Act or negligence, the injured party would need to clearly demonstrate that the repair process caused the defect which caused injury. Additionally, if the injury is caused by a suitable spare part which was shown to be correctly installed by the repairer, the manufacturer of the spare part would become liable under the Consumer Protection Act.

Home repair (non-professional)

Personal repair activities of products for personal use are not regulated under UK law, and there are no requirements for individuals to meet particular standards.

However, there are requirements in the case of electrical appliances being owned and supplied by landlords to rental properties, which may affect repair of goods by non-accredited persons (e.g., by the landlord or tenant themselves). In the UK, electrical equipment provided by landlords must be safe and fit for purpose and there is an overarching obligation to comply with Health and Safety legislation. In England and Wales, there are no testing requirements for electrical appliances (regulations only apply to fixed electrical installations such as lighting and circuitry)—while in Scotland, the Repairing Standard Housing (Scotland) Act 2006, Chapter 4 requires landlords to carry out regular PAT testing of supplied electrical appliances (Scottish Government, 2024).

In the case of private individuals selling repaired goods in a private sale, the principle of *caveat emptor* (otherwise known as "buyer beware") applies (Catalyst Law, 2021; Britannica, 2024). In this case, it is up to the buyer to carry out due diligence on the item and identify potential problems, although under The Misrepresentation Act, the seller must provide an accurate description of the item (e.g., not declaring a second-hand item to be new). However, if this is the case, the onus is on the buyer to collect and document evidence demonstrating this.

However, if a repaired item is being sold by a trading entity (i.e., not a private sale), consumer protections apply via the Consumer Rights Act 2015 (and the Consumer Contracts Regulations 2013 if purchased from an online retailer). This is particularly relevant where individuals may donate repaired EEE to charities or non-profits for re-sale.

Repair user behavior

Understanding product performance and user behavior is vital to the success of circular economy models of material and product use (Wastling et al., 2018). In the context of the circular economy, repair is defined as the mending or reconditioning of human-made products to restore their form or function (Perzanowski, 2022); activities that extends a product's lifespan (including maintenance) (Hernandez et al., 2020); and part of preparing for re-use activities in the waste hierarchy framework (DEFRA, 2011).

Several studies outside the UK have examined user behaviors toward repair of electrical and electronic products. In the United States (US), several studies have sought to analyse data from users of online platforms such as Amazon Mechanical Turk and most commonly iFixit, an online platform promoting user repair of electronic products (iFixit, 2025). These studies seek to understand economic and technical challenges of repair and user attitudes toward repair (Scott and Weaver, 2014; Raihanian Mashhadi et al., 2016; Sabbaghi and Behdad, 2018; Sabbaghi et al., 2016). Common findings highlight barriers to repair such as high repair costs relative to initial item cost, uncertainty in labor costs, lack of repair manuals, unavailability of spare parts and complicated repair processes. Recommendations to address these barriers including more formal training, better access to spare parts and more accurate cost estimation (Scott and Weaver, 2014; Raihanian Mashhadi et al., 2016; Sabbaghi et al., 2017). Another US based study focuses on user willingness to pay for repair of mobile phones via an online survey of 208 students, calling for manufacturers to improve accessibility and affordability of repair services (Sabbaghi and Behdad, 2018).

In Norway, a smaller scale study, including a survey of 1,196 respondents and 15 interviews with actors in the repair economy, identified several barriers to increasing repair rates. These included the low prices, poor quality and short lifespans of new products, the low profitability of repair businesses and a lack of access to skilled personnel (Laitala et al., 2021).Furthermore, the convenience and affordability of purchasing new electronics, coupled with the influence of fashion and advertising, have contributed to a decline in repair behaviors in favor of consumption (Hernandez et al., 2020). In Ireland, a study involving 208 individuals with pro-environmental inclinations also highlights affordability, access to skills, knowledge and support, and safety concerns as key influencing factors for user repair behaviors (Lefebvre et al., 2018).

UK-based academic studies of repair behavior highlight technical barriers such as accessibility to materials, spare parts and necessary skills, as well as motivators for repair such as emotional attachment, functional and symbolic value (Nazli, 2021). However, these studies generally address a broad range of products or focus on specific repair activities, such as clothing repair, and have not specifically investigated repair behaviors related to electrical and electronic equipment.

Repair behaviors in the UK have been informally observed through initiatives such as the Restart Project's Fixing Factory and Restarters.net platform which run community repair hubs offering repair services and skills training for local residents. These initiatives have reportedly repaired 54,571 devices (Fixing Factory, 2024). Similarly, Tech-Takeback in Brighton and Hove operates a high-street repair shop, provides waste electricals collection, repair and skills training services and has repaired and redistributed 6,500 devices (Tech-Takeback, 2024). Insights from Fixing Factories and Tech Takeback were shared with the Big Repair Project during roundtable discussions in 2023 and 2024. These discussions highlighted additional barriers such as the need for data erasure and cyber security concerns when handling electronic devices, as well as broader benefits such as social inclusion, skills development and wellbeing.

In London, academic studies into enabling repair choices for citizens are ongoing with initial findings highlighting key barriers to repair as perceived time-consumption of repair, cost and justification against initial quality of product (Aurisicchio et al., 2023). In 2023, a smaller study of seven households in London explored consumer behaviors of product life extension in the context of the UK's Cost-of-Living Crisis and highlighted how communication-based interventions can positively influence consumers' attitudes (Reynolds et al., 2024).

Data from YouGov exploring the Right to Repair Regulations, shows men were much more comfortable in undertaking repair than women, with toparticipants feeling most comfortable repairing vacuum cleaners (42%), laptops (30%), kettles (23%), towashing machines (22%), with under a fifth of participants willing to repair a mobileto phone (YouGov, 2021). In a 2020 study of electronic devices, YouGov reported that people are less likely to repair a tablet or a mobile phone device than to buy a new one, with cost of repair, the age of devices and the relative inconvenience of repair being the key reasons for choosing not to repair (YouGov, 2020).

However, more recent consumer data from a nationally representative sample of more than 2,000 UK adults aged 18+, shows changing behaviors where durability (58%) and repairability (37%) are becoming the top two considerations when making a purchase (Deloitte, 2023).

Based on the review of existing user behavior data, to our knowledge the Big Repair Project is the largest citizen science study combining large-scale collection of data on home appliances and electronics repair and behavior across the UK.

Citizen science

We used a citizen science method to collect data on attitudes, opinions and behaviors toward maintenance and repair of home appliances and electronics. Citizen science is a flexible concept which can be adapted and applied within diverse situations and disciplines, however its main aim is to actively involve the general public in the production of scientific knowledge (ECSA, 2015).Following best practice, our study, The Big Repair Project, was designed in accordance with the ten citizen science principles as outlined by the European Citizen Science Association (ECSA, 2015). The ambition for the project was to maximize diverse citizen participation from across the UK. The chosen format for involving the general public builds on previous research (Purkiss et al., 2022) and consists of a publicly accessible website containing a 10-min online survey and an optional home repair logbook facilitated through an online personal login. The logbook asked participants to record details about maintenance and repair activities on home appliances and electronics. The website also allowed citizens to sign up to newsletters and webinars in order to receive progress updates and feedback from the project which are also shared publicly on the website via blog posts, reports and video links. The project was publicized via a media campaign which included features on national radio and news outlets, and social media posts. Significant efforts were made to reach groups from all socio-economic backgrounds. These activities drove recruitment via the project website and were supplemented by word of mouth and direct outreach via professional networks.

Materials and methods

Before participating, citizens are directed to website information relevant to consent: participant information including project aims, data protection, withdrawal rights, image guidelines, use of results, health and safety information and where to direct questions and complaints; and logbook guidelines including additional photography guidelines. Ethics Approval for the study was granted by the UCL Research Ethics Committee (Project ID/Title: 16747/002: Big Repair Project) until 25 November 2024.

Method part 1—survey

The survey began with illustrated definitions of the types of home appliances, followed by questions enquiring about ownership of appliances, influences for purchasing, life expectancy, reasons for replacement, household home repair capability, use of professional repair services, disposal behaviors, Right to Repair Law, motivation for repair (see Figure 1). At the end of the survey, a participant was asked to review their responses and submit by entering their name, email and location. Participants were given the option to sign-up for the Big Repair Project Newsletter at the end of the survey.

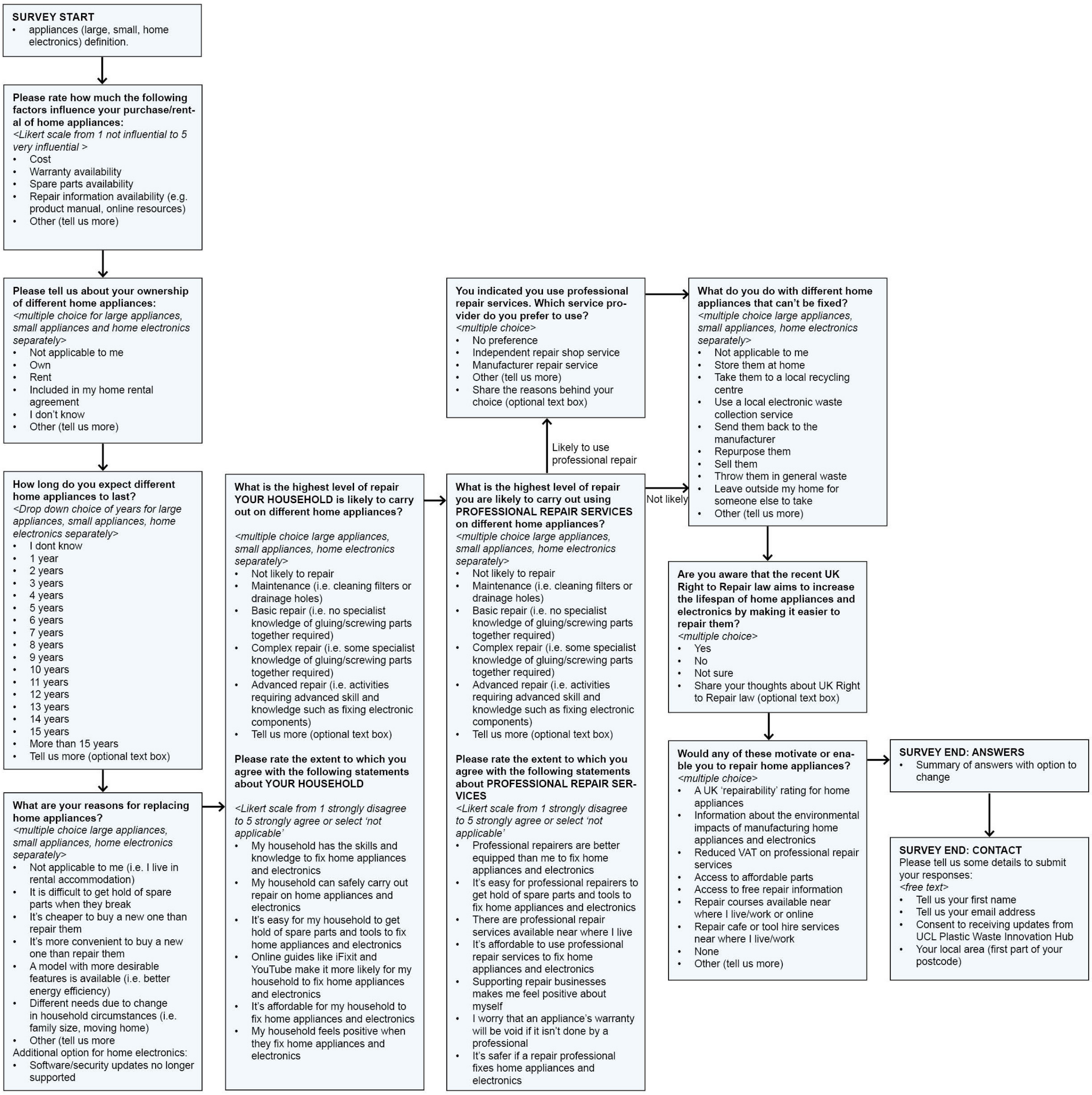

FIGURE 1
Illustration of the Big Repair Project online survey flow.

Method part 2—logbook

Participants were offered the option of recording details about the maintenance and repair activities they have undertaken on home appliances by setting up a user login account (see Figure 2).

The account setup asked for optional personal information such as age range, gender, occupation, home ownership status and local area postcode to better understand repair behavior amongst different groups and geographic locations. It was explained to participants that the local area postcode information would be used to generate a Live UK Repair Map which would also be available on the website (Figure 3).

To log a new repair activity, participants were asked to input information about the item subject to repair. Participants could choose from pre-defined item categories and manufacturers names and were also asked about the item's model or serial number, date of acquiring the item, and who owns the item with an option to submit a photograph of the item pre-repair. Participants were then asked about the repair activity including the date it took place, how the problem was diagnosed, what level of maintenance and repair was required, who carried out the activity, where the resolution information was found, how much it cost, and the result of the activity. Participants were also asked about how they felt about the activity (was it difficult and overall experience) and what happened

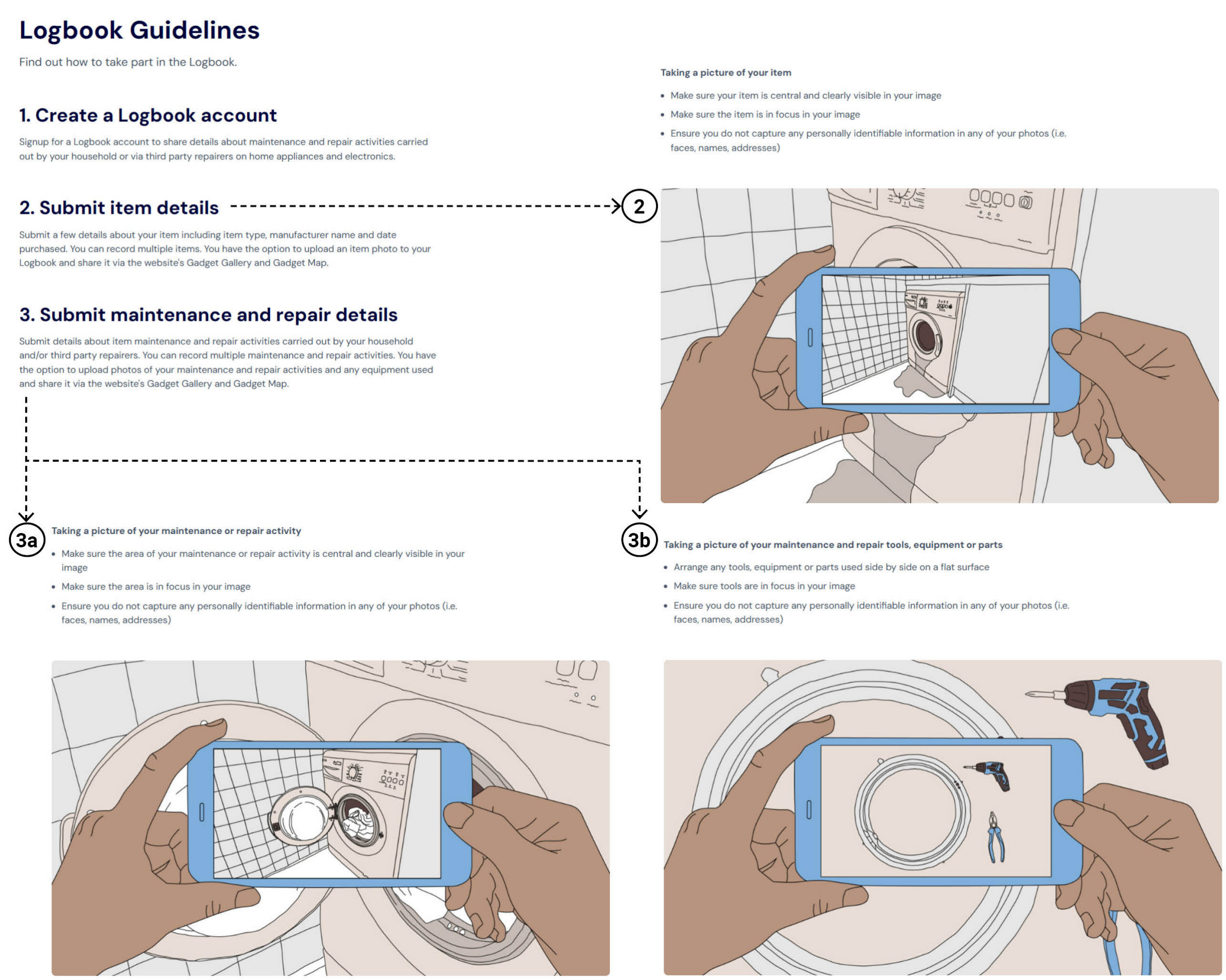

FIGURE 2
Illustration of the Big Repair Project logbook guidelines.

with the item at the end with the option to upload photographs of the repair process and tools. Participants could submit multiple items to their account and add multiple repair activities per each item. The Big Repair Project website automatically logged this information to a database.

Results

The data presented and analyzed were collected over 32 months from 19th January 2022 to 19th September 2024, during that time 5,958 survey responses and 473 logbook repair activity entries were made from across the UK. The difference in responses between the survey and the logbook is attributed to the difference in data collection method and level of engagement required which is also observed in similar previous studies (Purkiss et al., 2022). Whilst the survey takes a few minutes and can be completed without creating an account, the logbook requires additional information from participants including creating an account, uploading details and images of repairs and answering additional questions.

The geographical distribution of the repair activities is shown in Figure 3, demonstrating good coverage across the UK with the highest proportion in Southeast (Greater London) and Northwest (Greater Manchester) of England. This roughly correlates with the distribution of population density in the UK. There are no major regional differences in the findings, highlighting a consistency of dominant barriers and motivations across the UK. Over 50% of Big Repair Project (BRP) respondents reported that their household is likely to carry out basic or complex repair to large and small appliances and home electronics; and from those who recorded detailed repair activities the most common item types were washing machines, cookers/ovens, dishwashers and computers. This contrasts with market research data from 2021 reporting that over 60% of UK adults have not attempted to repair one of these items themselves previously, and would not feel comfortable doing so (YouGov, 2021). However, the recent cost-of-living crisis and increased knowledge of circularity has had an impact on how citizens are adopting more sustainable lifestyles with more recent UK consumer data showing 55% people repaired an item instead of buying a new equivalent (Deloitte,

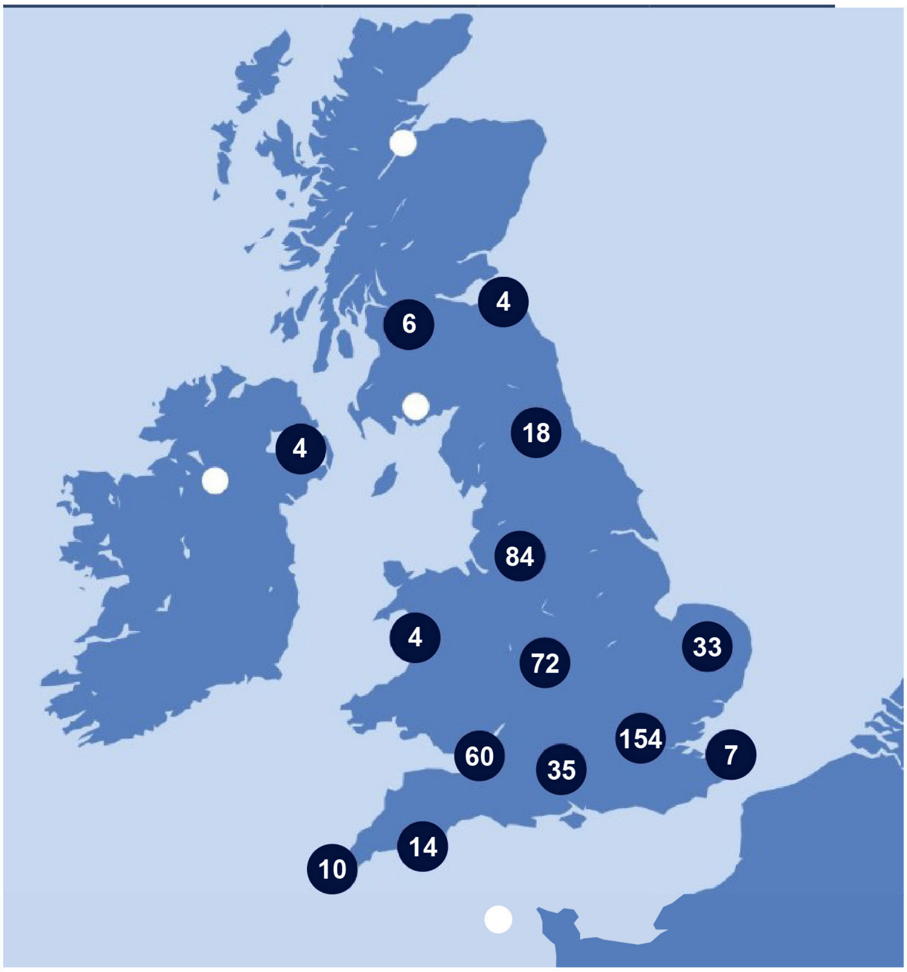

FIGURE 3
Snapshot of the UK Big Repair Project participation map.

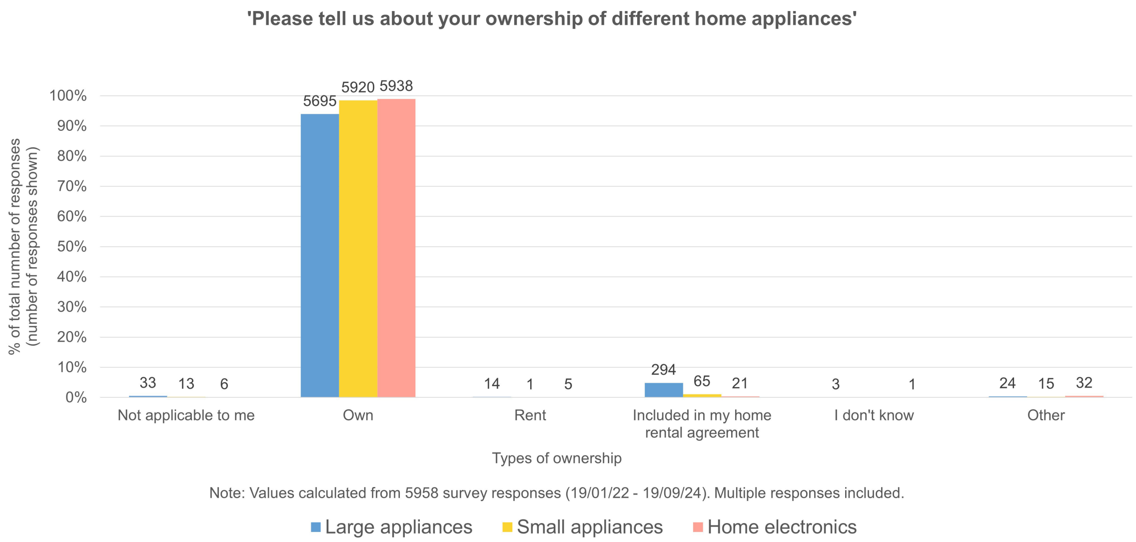

FIGURE 4
Responses to survey question "Please tell us about your ownership of different home appliances".

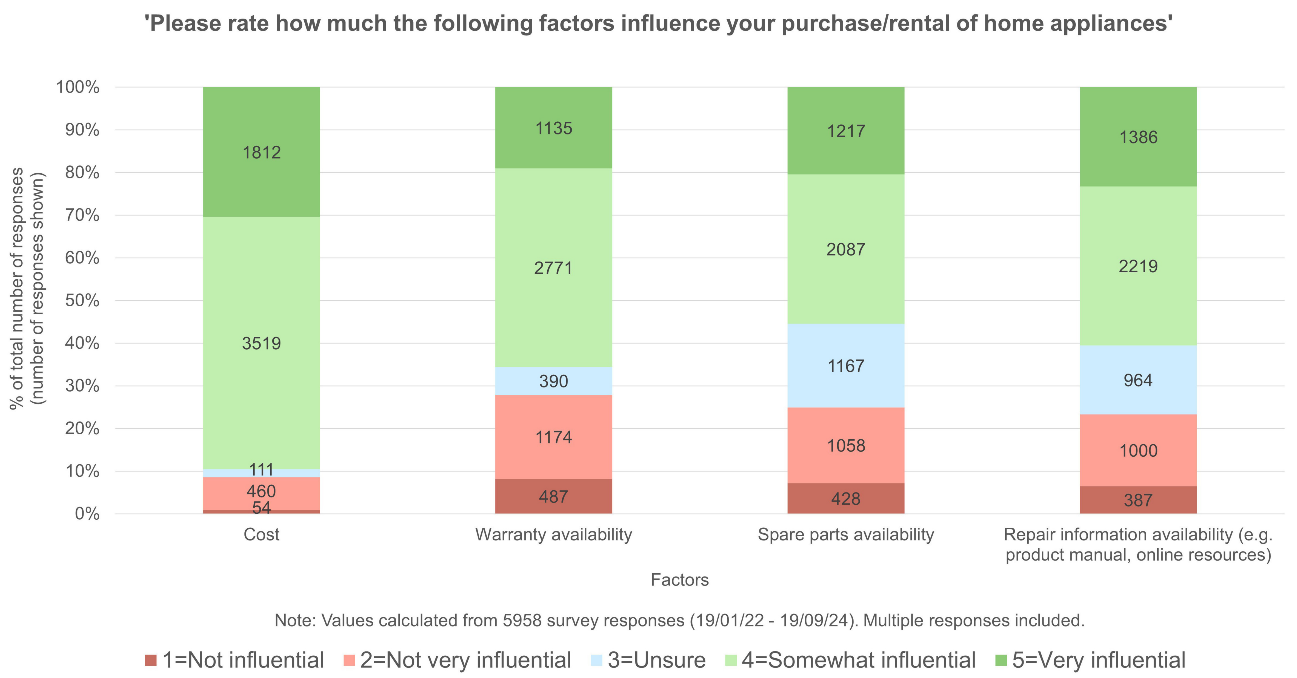

FIGURE 5
Responses to survey question "Please rate how much the following factors influence your purchase/rental of home appliances".

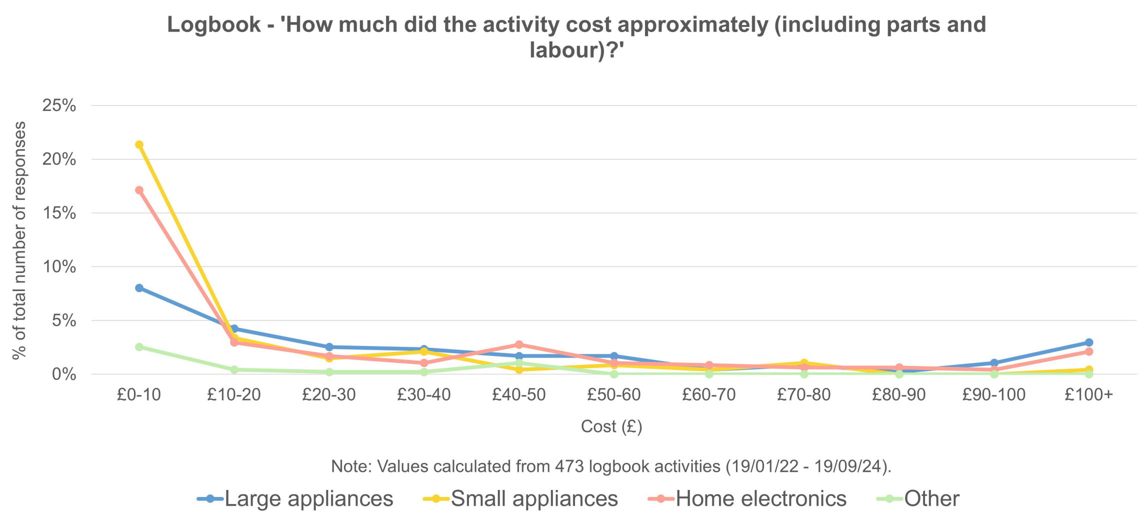

FIGURE 6
Logbook responses to the question "How much did the activity cost approximately (including parts and labor)?".

2023). Additionally, BRP respondents were primarily male (72% compared to 51% national average) and over the age of 55 (66.4% compared to 28.5% national average). This is an indication that the BRP sample is not representative of the general population and that the people attracted to take part in the BRP were those who are already interested in repair. This is also evidenced by the fact that participants in the logbook indicated that they already knew what the problem was rather than relying on online resources or the product manual and that they were carrying out complex or advanced repair.

BRP participants were also asked about whether they owned or rented home appliances to investigate whether this influenced their attitude to repair. A majority of BRP participants own home appliances (94% large appliances, 98% small appliances, 99% home electronics), with only a small number of participants who rent appliances or have them included in their home rental agreement (Figure 4). This is an indication that circular economy business models (pay-per-use, product lease, subscription and shared access) are not scaled-up in the UK's electrical appliances sector in comparison to parts of Europe (Sigüenza et al., 2021).

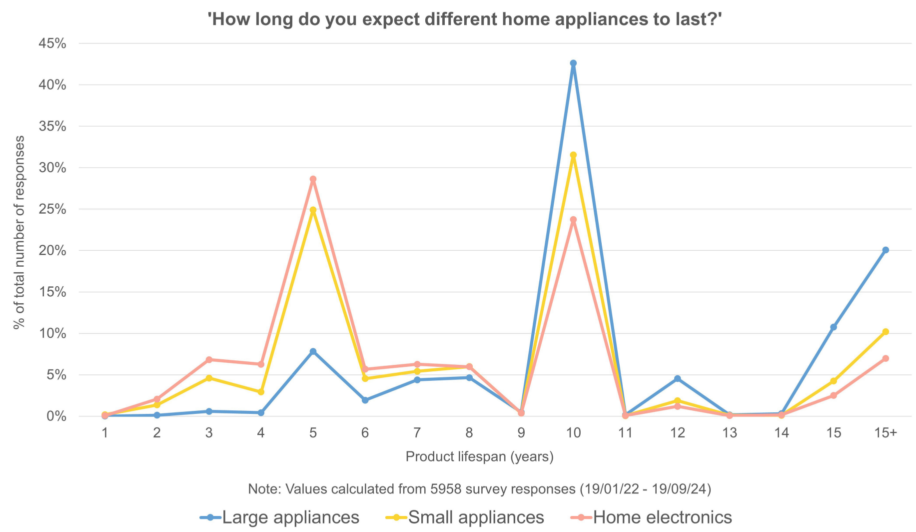

FIGURE 7
Responses to survey question "How long do you expect different home appliances to last?".

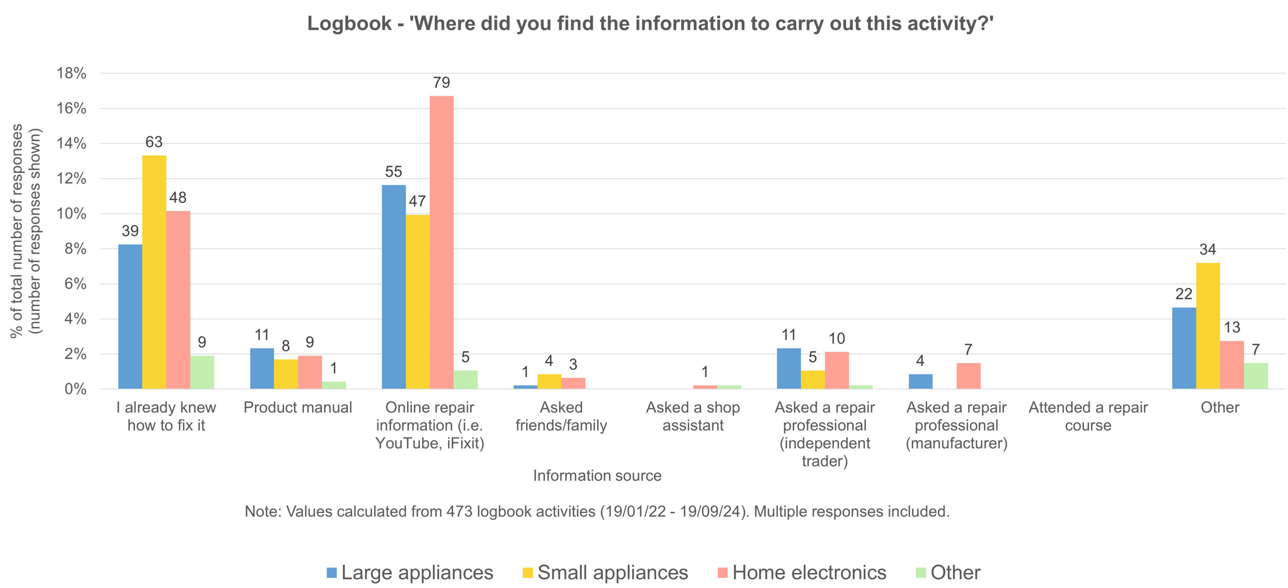

FIGURE 8
Logbook responses to the question "Where did you find the information to carry out this activity?".

The most influential factors when buying (or renting) an appliance were cost (90%), warranty availability (66%) and repair information availability (61%) (Figure 5).

When participants in the logbook activities were asked about the cost of the repair activity (do-it-yourself repair not professional repair), largest number reported £0–10. This may be significant obstacle to repair in the context of small appliances (basic kettle costs in the UK £10–30), but less so in the context of large appliances especially when considering alternatives such as professional repair or replacement (average price of a new washing machine in the UK is £400; Airtasker reporting average cost of professional repair of a washing machine to be between £63–250 or a fridge £78–104 or a dishwasher £150) (Figure 6).

With regards to life expectancy, most respondents are expecting large and small appliances to last 10 years and small appliances to last 5 years (Figure 7). This is in sharp contrast to the current legislative framework in the UK (refer to Repair Legislation and Standards section) which offers effective statutory consumer protection of 6 months for faulty goods (HM Government, 2015).

And with regards to access to repair information, logbook respondents indicated that they are most likely to rely on online repair information (i.e., YouTube, iFixit) for home electronics or that they already had the knowledge for small appliances (Figure 8).

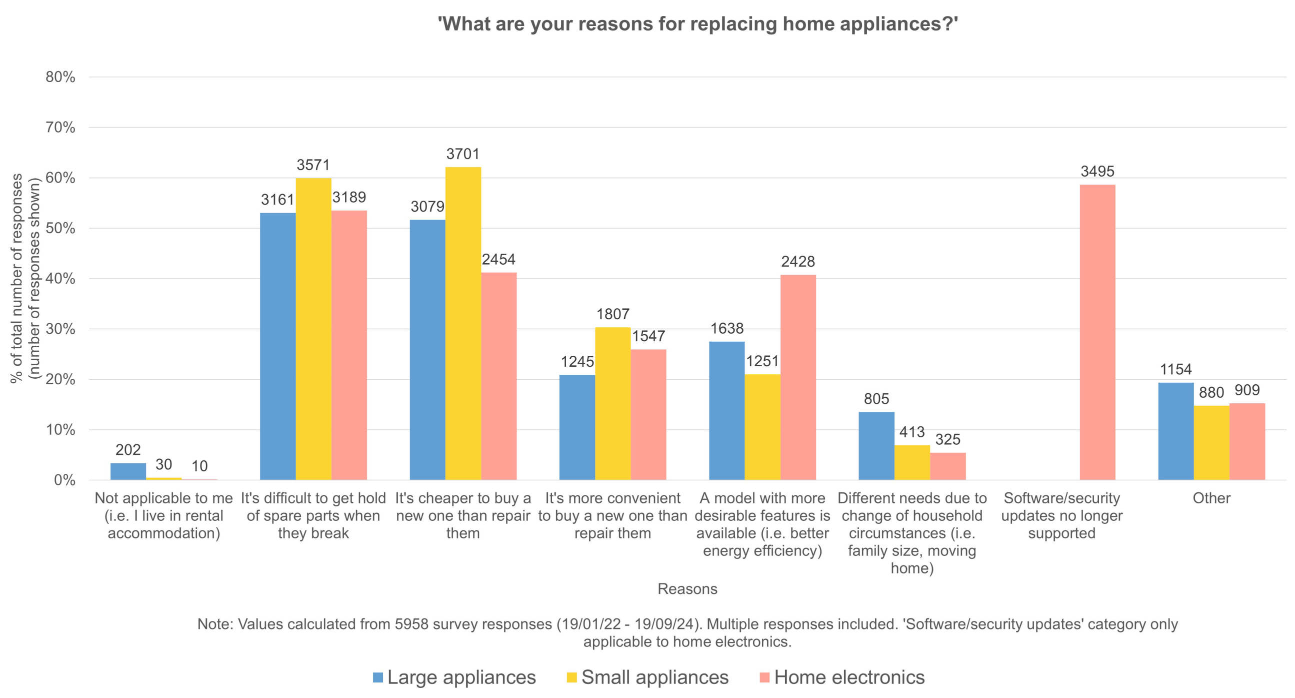

FIGURE 9
Responses to survey question "What are your reasons for replacing home appliances?".

This is highlighting the importance of online resources and general repair skills training.

Reasons to replace home appliances vary depending on the type of product. For large and small appliances, highest number of responses received were for "It's cheaper to buy a new one than to repair" (52% responses for large appliances and 62% responses for small appliances) followed by "It's difficult to get hold of spare parts when they break" (53% responses for large appliances and 60% responses for small appliances). For home electronics the highest number of responses received was for "Software/security updates no longer supported" (59%) followed by "It's difficult to get hold of spare parts when they break" (54%) (Figure 9).

When asked about what would enable and increase their motivation for repair, highest number of responses pointed to access to affordable parts (88%) and free repair information (86%) alongside a UK repairability rating for appliances (82%) (Figure 10).

A majority of participants stated that they would use professional repair services for advanced repairs of large appliances (69%) and for basic to advanced repair of home electronics (32% and 18% respectively) and that when using a professional repairer they would prefer to use an independent repair shop service (59%). Whilst data as to why participants chose that option was not gathered findings on lack of trust in repair services and perceived inconvenience of repairs as key barriers (Lefebvre et al., 2018; Scelfo, 2009; Scott and Weaver, 2014) can be associated with the preference for independent, trusted and convenient local services.

Overwhelmingly 86% of survey respondents stated that they feel positive when they fix appliances, indicating wider co-benefits of the repair economy with regards to wellbeing. Whereas 77% of activity logs in the logbooks led to the items remaining in use after the repair, 5% were recycled and remaining either sold or given away, salvaged/disassembled for spare parts, stored at home or returned to owner, new supplier or manufacturer.

Discussion

The UK consumes circa 1.7 million tons of EEE per year and is the second largest producer of WEEE at circa 24.5 kg per capita (Baldé et al., 2024). The production of new EEE requires vast quantities of Critical Raw Materials, the majority of which are lost if WEEE is exported for dumping, sent to landfill, incinerated or shredded and smelted which is the most common way of recycling (Green Alliance, 2020a). Until advanced recycling technologies are available that can extract all the materials from WEEE and economically put them back into the supply chain the only viable option to reduce waste is to keep products in use for longer through repair and reuse. However, to promote increased repair and reuse, it is necessary to identify the obstacles that prevent repair from being the easiest and cheapest solution for people. Identifying these obstacles in the UK was the aim of our citizen science project. Our results show that there are social, cultural, knowledge and economic obstacles to repair. These influence the repairability of EEE products, their longevity and thus their environmental impact.

Globally, awareness of the environmental impact of WEEE remains low, and there is significant gap between awareness and action (Baldé et al., 2024). Findings from the Big Repair Project confirm that even when awareness exists, and despite the vast amount of online information and the Right to Repair regulations aimed at increasing manufacturer's responsibilities to provide

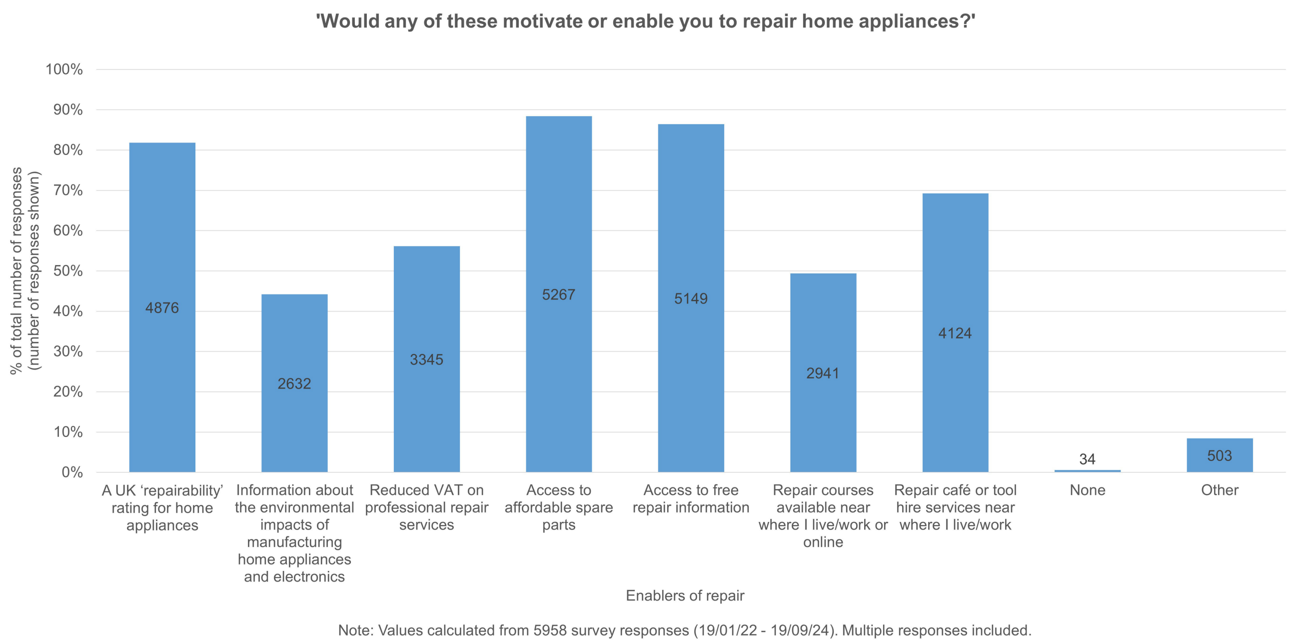

FIGURE 10
Responses to survey question "Would any of these motivate or enable you to repair home appliances?".

information, access to practical repair information remains a key barrier to action.

Currently in the UK, at the point of purchase there is limited information about the product's durability and/or repairability which can lead to overall lack of awareness and transparency about product's lifespan, maintenance, repair and disposal. Our results show there is significant appetite for this information (86% would like repair information, 82% would like a UK repairability rating for appliances, Figure 5). Our participants were not fully representative of the whole UK population but nevertheless, other indicators such as the popularity of the French repairability index (HOP, 2022) give credence to this result.

In addition, more transparency is required when it comes to legal guarantees and warranties, as people may confuse rights under the Consumer Rights Act with warranties and many people do not realize that there is no statutory warranty in the UK. Our data further revealed that participants care about warranty availability and expect products to last longer than standard warranties offered by manufacturers (see Figures 1, 2). A Government review of statutory warranties and legal guarantees could grow the repair economy and decrease WEEE. But more data and analysis would be needed to do a full analysis this policy opportunity and identify the impact on the manufacturing and retail sectors. This would need an approach different from our citizen science study, it would need to gather data systematically form the whole population with representation from all socio-economic sectors, not just from those who voluntarily take part.

Furthermore, at the point of product fault there is limited information about diagnostics, repair options and costs. The barrier to diagnostics is a significant limiting factor as it also contributes to perceived "inconvenience" of repair as well as to the costs of repair (Scott and Weaver, 2014; Raihanian Mashhadi et al., 2016). This is also linked with the barriers associated with accessing warranties. This is a process which can be both obscure and time consuming depending on the product, seller and particular situation. For instance, manufacturers sometimes outsource warranty services making it unclear who is responsible for which aspects of the repair (Scelfo, 2009). More should be done to democratize diagnostics so that citizens can make informed decisions and are able to assess repair options and costs. These challenges are currently being targeted by the European Parliament in the latest updates do the Ecodesign Regulations (European Parliament, 2024) but are yet to be translated by the UK legislators e.g., a UK Durability index. We acknowledge the complications to manufacturers of making product information, assembly and repair more accessible, and recommend that further research and trials are needed in different national and cultural contexts to inform next steps (Purkiss et al., 2024). Nevertheless, there is a market for this as our data shows.

When asked about diagnostics, majority of participants in the Big Repair Project logbook activities noted that they "already knew what the fault was" rather than relying on online resources or product manuals. This might be evidence that perceived barriers to cost, and convenience can be overcome through improving practical repair education and skills training through the formal education system or through more community-centered initiatives such as the repair events run by the Restart Project (The Restart Project, 2024).

The data presented within this paper also highlights that people who are already interested, experienced and engaged in repair tend to be predominantly male and from older age groups 55+. In addition, whilst participants indicated that they take part in a variety of different levels of repair complexity and engage with some repair themselves, when using a professional repairer participants prefer to use an independent repair service. This indicates that to grow the UK repair economy in the long-term (up to and beyond 2050), engagement and inclusion of more diverse groups of people (age, gender and abilities) will be required alongside providing support and incentives to diversify independent repair services and local access to professional repairers. There is a considerable skills gap to enable these sectors to grow (NEPC, 2024), furthermore there are electrical safety and regulatory issues that must be addressed (Purkiss et al., 2024).

Most participants in the Big Repair Project stated that they owned electronic and electrical equipment (94% large appliances, 98% small appliances, 99% home electronics) rather than renting or leasing it, which cross references with the age profile of the participants being 55+ and the latest English Housing Survey showing that older citizens are more likely to own their property (DLUHC, 2023). However, government data shows that a high proportion of the population (above 30%) rent from the social and private rented sector and that young people aged 16–34 predominantly rent. In rental properties where household goods are supplied by the landlord it will be their responsibility to repair them. This demonstrated the importance of engaging landlord groups alongside researching what circular economy business models can be deployed and scaled up to effectively support this group for example these may include pay-per-use, product lease, subscription and shared-access model which embed repair services as part of the model.

The research highlights that cost is a factor of purchasing but also a key barrier to repair. Participants in the Big Repair Project noted average costs of repair to be £0–10 which may preclude the involvement of professional repair in the context of small appliances (basic kettle costs in the UK £10–30). This re-emphasizes the need for upskilling to enable more people to undertake simple repairs on small home appliances themselves as well as more EEE products to be designed for repair and longevity. To reduce the costs of repair of small and large appliances and home electronics without putting undue pressure on capital costs for customers several different measures can be considered including VAT adjustments on parts and labor, subsidies repair vouchers as explored in Austria and parts of UK (Bundesministerium für Klimaschutz, 2023; Groupon, 2024) as well as business rate adjustments.

Beyond policy measures such as a Durability Index, extended warranties, and VAT reductions on repair, a broader macroeconomic shift is necessary to promote repair and reduce waste and pollution. Currently, disposability drives economic growth more effectively than a repair-based economy, which is why consumerism has been instrumental in increasing per capita income. This dynamic also explains why WEEE generation is highest in affluent countries. A repair economy can only compete with consumerism when the environmental costs of waste and pollution are factored into the price of goods. Mechanisms such as carbon taxes and extended producer responsibility (EPR) policies could help achieve this goal. However, such measures must also address unregulated loopholes, such as online marketplaces that allow the importation of cheap, often unsafe electrical goods into the UK (CTSI, 2024). These goods undermine both the repair economy and efforts to reduce global waste and pollution. While these policies may be environmentally necessary, they are likely to face resistance from customers, who perceive these marketplaces as providing affordable EEE products.

Product safety is another important consideration for a growing repair economy. Brands have legitimate concerns about the safety of repaired appliances where the repairs have not been carried out by skilled professionals. This is one of the stated reasons why the supply of spare parts for 10 years, as specified by Right to Repair regulations in the UK, only makes them available to professional repairers. Whether or not this is the best way to ensure safety of repaired products it disputed by the Right to Repair movement (The Restart Project, 2024). However, it is clear from the long list of product safety regulations that we reviewed in the Introduction that this is a complex area for anyone to understand, whether they be a local professional repair person or a skilled product owner who chooses to home repair. The use of product passports, which give the owner information about the repair history of a product, may be a way forward for the sector. Others are advocate for professional accreditation for engineers in the repair sector to deal with safety concerns (LocalitEEE, 2024).

More research focused on national economic impact modeling and analysis is required in this field to support decision-making with regards to specific economic interventions. This includes macroeconomic modeling to understand the size and growth potential of the repair sector; social value modeling to establish repair benefits beyond direct monetary value e.g., jobs creation; and mental health and wellbeing improvements and environmental benefit (Purkiss et al., 2024).

Although participants in our survey expressed a clear preference for repair and more durable EEE goods, caution is needed when generalizing these findings to the broader population. As noted, the demographics of the Big Repair Project participants do not fully reflect society as a whole. Market evidence also reveals that highly repairable products—such as FairPhone—exist but hold a small market share (FairPhone, 2023), likely because consumers are guided by marketing trends and desire for acquiring the latest model. The joy and social status derived from acquiring new items are deeply rooted human motivations, which have underpinned the success of consumerism as an economic model. In contrast, environmental protection is less intrinsically linked to the human reward system. Shifting societal values will be essential for making repair as appealing as buying new products and further behavioral science research can support progress in this area (Purkiss et al., 2024).

There is, however, some cause for optimism. Our data shows that 86% of participants enjoy repair and report feelings of wellbeing associated with it. If these positive emotions can be leveraged to counteract the desire for constant consumption, manufacturers of durable and repairable products may gain a competitive edge. Such a cultural shift could lead to a reduction in per capita WEEE production and a more sustainable economic model.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

Ethics approval for the study was granted by the UCL Research Ethics Committee (Project ID/Title: 16747/002: Big Repair Project). The studies were conducted in accordance with the local legislation and institutional requirements. The participants provided their written informed consent to participate in this study.

Author contributions

PP: Data curation, Formal analysis, Project administration, Writing – original draft, Writing – review & editing. DP: Conceptualization, Data curation, Funding acquisition, Investigation, Methodology, Project administration, Supervision, Visualization, Writing – review & editing. RH: Writing – original draft. MM: Conceptualization, Funding acquisition, Methodology, Resources, Supervision, Validation, Writing – review & editing.

Funding

The author(s) declare that financial support was received for the research and/or publication of this article. This research was funded by UKRI EPSRC under grant EP/V011804/1.

Acknowledgments

We would like to thank all members of the UCL Plastic Waste Innovation Hub, past and present, for their help developing the Big Repair Project and contributing to this research.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Generative AI statement

The author(s) declare that no Gen AI was used in the creation of this manuscript.

Publisher's note

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frontiers | Frontiers in Sustainability

TYPE Systematic Review
PUBLISHED 06 June 2025
DOI 10.3389/frsus.2025.1556835

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OPEN ACCESS

EDITED BY
Elisabeth Süßbauer,
Technical University of Berlin, Germany

REVIEWED BY
Eri Amasawa,
The University of Tokyo, Japan
Tahira Javed,
China Three Gorges University, China

*CORRESPONDENCE
Annuska Toebast-Wensink
✉ annuska.toebast@hu.nl

RECEIVED 10 January 2025
ACCEPTED 19 May 2025
PUBLISHED 06 June 2025

CITATION
Toebast-Wensink A, van den Broek KL, Timmerman T and Hekkert MP (2025) Experience matters: a systematic review and research agenda on predictors to buy sustainable fashion. *Front. Sustain.* 6:1556835. doi: 10.3389/frsus.2025.1556835

Experience matters: a systematic review and research agenda on predictors to buy sustainable fashion

Annuska Toebast-Wensink[1,2]*, Karlijn L. van den Broek[2,3], Tijs Timmerman[1] and Marko P. Hekkert[2]

[1]Research Group Marketing & Customer Experience, Utrecht University of Applied Sciences, Utrecht, Netherlands, [2]Copernicus Institute of Sustainable Development, Utrecht University, Utrecht, Netherlands, [3]Research Centre for Environmental Economics, Heidelberg University, Heidelberg, Germany

Introduction: While consumers have become increasingly aware of the need for sustainability in fashion, many do not translate their intention to purchase sustainable fashion into actual behavior. Insights can be gained from those who have successfully transitioned from intention to behavior (i.e., experienced sustainable fashion consumers). Despite a substantial body of literature exploring predictors of sustainable fashion purchasing, a comprehensive view on how predictors of sustainable fashion purchasing vary between consumers with and without sustainable fashion experience is lacking.

Methods: This paper reports a systematic literature review, analyzing 100 empirical articles on predictors of sustainable fashion purchasing among consumer samples with and without purchasing experience, identified from the Web of Science and Scopus databases.

Results: The review revealed that (I) environmental cognition, such as environmental awareness, knowledge, and perceived consumer effectiveness, occurs most frequently as significant predictors for both groups; (II) subjective norms occur more frequently as significant predictors for general consumers than for experienced consumers; (III) habits occur more frequently as significant predictors for experienced consumers compared to general consumers; and (IV) experience can shift barriers into motivators.

Discussion: This review highlights experience as a transformative factor for sustainable fashion purchasing, showing that as consumers gain experience, their attitudes evolve and influence decisions. It also emphasizes the potential of goal framing, suggesting that effective goal frames can encourage initial sustainable fashion purchases among general consumers. From a practical perspective, this review suggests that marketers and retailers should employ distinct tactics for first-time and experienced sustainable fashion consumers to effectively engage each group and enhance purchasing.

KEYWORDS

consumer behavior change, sustainable fashion consumption, intention-behavior gap, prior experience, systematic literature review

1 Introduction

From 2000 to 2015, annual clothing sales doubled from 100 to 200 billion units, while the average number of times an item was worn decreased by 36% (Lai, 2021). The surge in consumption has resulted in an alarming increase in clothing-related waste, totaling 92 million tons each year (Lai, 2021). In response, the United Nations Sustainable Development Goal (SDG) #12, part of the Agenda 2030, prioritizes a more sustainable approach to fashion production and consumption (UNEP, 2023). Achieving SDG 12 requires a fundamental change in consumption patterns and a consumer shift toward prioritizing sustainable fashion (SF) over fast fashion (Coscieme et al., 2022; UNEP, 2023).

To motivate a shift in consumption patterns toward SF, it is crucial to understand the social-psychological predictors that influence consumer behavior (Busalim et al., 2022). Social-psychological predictors, such as attitudes and norms, play a key role in shaping behavior and offer insights for strategies aimed at increasing SF adoption (Lundblad and Davies, 2016). While numerous studies have explored these predictors and their influence on consumers' intentions to buy SF (Dabas and Whang, 2022), intentions do not always result in actual purchasing behavior—a phenomenon known as the intention-behavior gap (Dabas and Whang, 2022; McKeown and Shearer, 2019).

The transition from mere intention to actual purchasing behavior is marked by experience with SF, such as making a purchase from an SF brand or renting an outfit. It appears that experience with SF positively shifts consumer perceptions of these products and increases the likelihood of future purchases. A lack of firsthand experience often results in negative perceptions of SF (Silva et al., 2021), while experienced consumers tend to have positive perceptions, associating sustainability with style, quality, and wellbeing (Bly et al., 2015). Furthermore, experienced SF consumers are more likely to consider the entire life cycle of their purchases, while general consumers typically focus only on the initial acquisition (Lundblad and Davies, 2016). Understanding how predictors of SF purchasing differ between consumers with and without experience is essential for designing tailored strategies that effectively promote SF adoption across both groups.

Although only one empirical study has directly compared SF purchasing between general and experienced SF consumers, it shows that experienced consumers exhibit greater fashion consciousness, environmental concern, perceived consumer effectiveness, and stronger subjective norms than general consumers (Riesgo et al., 2023). Existing reviews on SF purchasing have primarily focused on specific types of SF such as collaborative consumption (Arrigo, 2021) or specific predictors like the influence of social media on SF consumption (Vladimirova et al., 2024). Notably, no review has yet examined the predictors of SF purchasing in a comparative manner between consumers with and without SF experience. Addressing this gap will deepen our understanding of SF behavior and better understand how to bridge the intention-behavior gap of SF purchasing.

This study addresses the need for a comprehensive view on predictors influencing SF purchasing, specifically distinguishing between consumers who have converted their intentions into actual purchases and those who have not. Through a systematic literature review, this study aims to answer the research question *"How do the predictors of SF purchasing vary between consumers with and without experience with SF?"* Utilizing descriptive and thematic analyses, this study synthesizes existing literature to enhance our understanding of these predictors, compare the two consumer groups, and propose future research directions. By identifying key predictors for both consumer groups, this study provides theoretical insights into the transformative factors encouraging SF purchasing behavior. It highlights relevant avenues for future research and provides practical recommendations for practitioners to develop targeted marketing strategies to encourage consumers to translate their intentions into actual purchases, ultimately contributing to achieving SDG 12.

2 Scope of the review and definitions

As sustainability in the fashion industry continues to evolve, exact definitions of SF remain fluid and subject to change (Vladimirova et al., 2024). Terms such as slow fashion, eco-friendly fashion, ethical fashion, and green fashion are often used interchangeably with SF, despite nuanced differences in practice (Henninger et al., 2016; Mukendi et al., 2019). Moreover, SF encompasses various consumption practices (Vladimirova et al., 2024), such as Rental (e.g., renting clothes from Rent the Runway), Resale (e.g., purchasing second-hand fashion on Vinted), and Recycling (e.g., purchasing Stella McCartney clothing made from recycled water bottles). Resale and Rental are also referred to as Collaborative consumption (Iran and Schrader, 2017), and Recycled fashion is sometimes referred to as Circular fashion (Vehmas et al., 2018).

For the purpose of this review, purchasing SF is defined as the acquisition of sustainable fashion, slow fashion, eco-friendly fashion, ethical fashion, green apparel, rented fashion, second-hand fashion, recycled fashion, collaborative consumption, circular fashion, or related concepts with similar objectives. For definitions of SF terminology in literature, see Table 1. Strategies that do not involve purchasing SF, such as Refuse or Repair, are not within the scope of this study.

3 Methods

A systematic literature review was conducted to investigate the predictors of SF purchasing for consumers with and without experience. This review adheres to Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) guidelines (Moher et al., 2009). This rigorous approach is structured into stages of identification, screening and inclusion, as depicted in Figure 1.

The lead researcher's professional background in the fashion industry may have influenced initial interpretations of the data. To minimize potential bias during identification, screening, and data synthesis, several strategies were implemented. First, the research team collaboratively discussed and refined inclusion and exclusion criteria (detailed below). Next, predictors were coded using a data-driven iterative approach to reduce interpretive bias. Ambiguous cases (e.g., predictors that fit multiple codes) were resolved through

TABLE 1 Sustainable fashion terminology and definitions.

Term	Definition
Sustainable fashion	Clothing which incorporates one or more aspects of social or environmental sustainability, such as fair-trade manufacturing or fabric containing organically grown raw material (Henninger et al., 2016).
Slow fashion	Slow fashion is a philosophical ideal that centers on sustainability values, such as good working conditions and reducing environmental destruction (Henninger et al., 2016).
Eco- fashion	Clothing that is designed for long lifetime use; is produced in an ethical production system, perhaps even locally; causes little or no environmental impact and makes use of eco-labeled or recycled materials (Niinimäki, 2010).
Ethical fashion	Clothing that seeks to minimize its negative impact on the environment, employees and animals via processes that include, but are not limited to, slow fashion (Reimers et al., 2016).
Green apparel	Green apparel aims to exclude environmental issues at every stage of the fabric's life cycle, from early purchase to post-purchase, including storage, use, maintenance, preservation, and disposal (Rutelione and Bhutto, 2024).
Rental	Rental may refer to borrowing clothing from fashion libraries, and/or rental services (Mukendi et al., 2019).
Resale	Resale refers to the procurement of still-valuable second-hand clothing and the redistribution of under-utilized garments to new owner (Armstrong and Park, 2020).
Recycle	Recycling is the conversion of waste into reusable material by down-grading it into raw inputs and then using these raw factors in a new industrial process (Adigüzel and Donato, 2021).
Collaborative consumption	Collaborative consumption refers to individuals sharing and collaborating to meet a specific need (Arrigo, 2021).
Circular fashion	Circular fashion is based on closed loops through which reuse and recycling of garments into new fibers can significantly be increased (Vehmas et al., 2018).

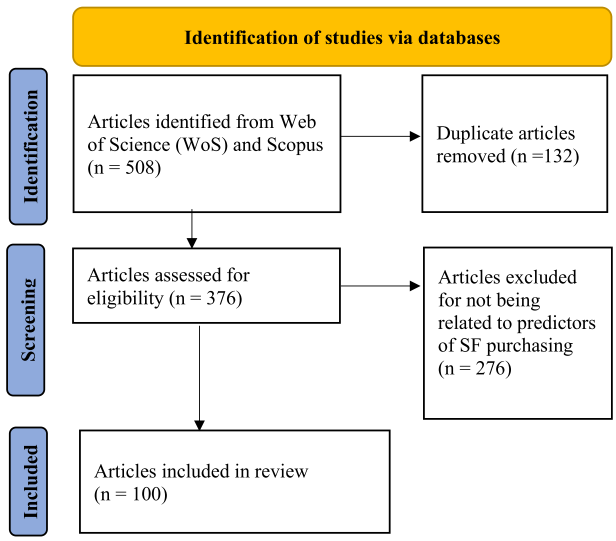

FIGURE 1
PRISMA flowchart for this review (adapted from Moher et al., 2009).

team discussions, ensuring alignment with evidence rather than individual perspectives.

3.1 Identification

Based on the research question, a search string was developed, focusing on key words related to predictors to purchase SF: ("consumer") AND ("predictor*" OR "antecedent*" OR "buy*" OR "purchase*" OR "behavior" OR "behavior") AND ("fashion" OR "apparel" OR "cloth*") AND ("sustain*" OR "slow" OR "eco-friendly" OR "ethical" OR "green" OR "rent*" OR "resale" OR "second-hand" OR "collaborative consumption" OR "recycled" OR "circular"). Keywords such as "motivators" or "barriers" were excluded to prevent narrowing the search scope. Additionally, we did not include "experience" as a keyword in the search string, as we aimed to categorize the research samples in the reviewed articles by experience. This approach allowed us to capture a broader and potentially richer set of articles, covering predictors to purchase SF influenced by experience without limiting the focus to experience as a central concept.

The search was conducted in January 2024 using Web of Science (WoS) and Scopus, two bibliographic databases well-suited for scientific research that include high-impact peer-reviewed journals (Gusenbauer and Haddaway, 2020). Since 2018, SF research has expanded rapidly, with a notable shift beginning in 2019 toward understanding purchasing behaviors and exploring the intention-behavior gap (Arrigo, 2021; Busalim et al., 2022). Around this time, mainstream brands began offering sustainable alternatives that increased consumer awareness, while technological advancements and the expansion of SF options—particularly in the Resale sector—made SF more accessible (Busalim et al., 2022). Given the rapid changes in SF, it is important to recognize that predictors of SF behavior measured in earlier studies may no longer accurately reflect current trends and motivations. To provide an up-to-date analysis of predictors influencing current SF purchasing behavior, this review focuses on articles published between 2019 and 2023.

An advanced search was conducted in WoS categories Business, Environmental Sciences, Environmental Studies, Communication, Psychology, Psychology multidisciplinary, and Psychology applied. In the Scopus database a search was performed in the title, keywords, or abstracts within the categories Environmental Sciences and Psychology. These categories were selected as they encompass a wide range of disciplines that investigate social-psychological predictors. In both databases, review articles and conference papers were excluded, allowing the focus to remain solely on empirical, peer-reviewed journal articles to ensure the quality of the selected works. Quantitative research articles were included for their insights into tested effects, while qualitative research articles were incorporated for their broader and deeper perspectives on SF purchasing. This search strategy resulted in the identification of 508 articles: 223 from WoS and 285 from Scopus. After removing duplicates, 376 unique articles remained.

3.2 Screening

Inclusion and exclusion criteria were developed to ensure the selection of articles was relevant to this review. As this review focuses on social-psychological predictors to purchase SF, the main inclusion criterion was that the study tests one or more social-psychological predictors of SF purchasing. All 376 articles were carefully reviewed, resulting in the exclusion of 276 articles that were not related to the predictors of SF purchasing. These excluded articles focused on topics such as selling second-hand luxury (Turunen et al., 2020), predictors of purchasing fast fashion (Cayaban et al., 2023), how fashion brands move toward circularity (Brydges, 2021), or how to promote repair (Laitala et al., 2021). In addition, non-empirical articles were excluded (see Figure 1). Ultimately, 100 articles were included in the final review sample.

3.3 Data synthesis

The full text of each article was read and relevant information was extracted through charting, a technique for organizing data by sifting and sorting material according to key descriptors and themes (Arksey and O'Malley, 2005). From the included articles, the following information was coded: the specific SF terminology used (e.g., SF or Rental), geographical context (where the study was conducted), the research method (e.g., quantitative or qualitative), and the dependent variable (e.g., intention or behavior). This helped us identify dominant research areas in the field and contextualize the output. Some articles did not clearly describe all these aspects, resulting in missing codes for those entries.

Next, references to experience with SF consumption were examined in the sample descriptions of the dataset to code the sample type. Articles that focused explicitly on experienced consumers were coded as such. Examples include articles on customers of second-hand clothing stores (de Groot, 2021; Lichy et al., 2023), Facebook groups for second-hand clothes (Corboş et al., 2023), or apparel consumers who participated in the study only after confirming they had purchased green apparel at least once in the previous 6 months (Tandon et al., 2023). Articles coded into the general consumer category were articles that did not explicitly define or measure prior experience with SF. These articles typically focused on the general population or specific consumer segments, for example Generation Z (Pradeep and Pradeep, 2023), without considering their history of SF purchasing. Therefore, the general consumer group likely included a mix of individuals with varying levels of SF experience, ranging from inexperienced consumers to those with some experience, although this experience was not a measured variable. It is important to note that no articles explicitly investigated inexperienced consumers as a distinct group. Articles focusing on generic, general, average, or unspecified consumers were classified as general consumer samples. For example, one study explicitly stated to target a general sample by stating "the population of interest are consumers in general, without age, sex, or specific behavior restrictions, whether they frequent second-hand stores or not" (Amaral and Spers, 2022). However, the majority focused on consumer segments without referring to experience with SF, such as potential luxury consumers (Adigüzel and Donato, 2021). Finally, three articles comparing general and experienced consumers (for e.g., Riesgo et al., 2023) included separate studies for both groups. This resulted in 103 coded studies from 100 articles. Here, "articles" denote individual publications, while "studies" represent distinct research comparisons within them. Supplementary material provides a comprehensive overview of the references for all articles included in the review, detailing the research methods employed and the characteristics of the research samples.

Subsequently, the social-psychological predictors from each article were coded. Inductive coding, a data-driven approach suitable for identifying emerging concepts (Braun and Clarke, 2013), was used. In quantitative articles, significant predictors were coded; in qualitative research articles, predictors that the authors of those articles deemed relevant or meaningful to SF purchasing, even if not statistically measured, were coded. Additionally, the evidence identified was coded as either a motivator or barrier to purchasing SF. For example, treasure hunting was coded as a motivator when mentioned as a reason for purchasing SF in the article.

Next, an iterative approach was taken to group the predictors into higher-order themes through thematic analysis (Braun and Clarke, 2013), allowing themes to emerge and evolve throughout the process. Codes with similar semantic meanings were grouped, ensuring that the themes were mutually exclusive and reflected the predictors identified in the articles under review. For example, "price" and "willingness to pay" were categorized under the higher-order theme "economic motivations," while "environmental awareness" and "knowledge" fell under the theme "environmental cognition." Importantly, these themes emerged from iterative grouping based on meaning rather than solely relying on previously established classifications from the literature, even though some themes have been recognized in prior research (e.g., Ferraro et al., 2016). Three concepts were coded only once and could not be logically grouped into higher-order themes; for example, mindfulness. Therefore, they were excluded from the analysis.

Finally, the number of codes per theme of predictors was counted for both consumer groups. These counts reflect the prevalence of significant or relevant predictors in the current literature. This study interprets these counts in relative terms; a higher count for a particular theme of predictors indicates greater prevalence of significance within the context of this review.

4 Results

This section presents the results of the descriptive analysis of the articles (4.1), followed by the results of the thematic analysis (4.2).

4.1 Descriptive results

Of the articles in the review sample, ($n = 81$) articles focused on general consumers, while ($n = 16$) articles focused on experienced consumers. The difference in the number of articles created an imbalance in the amount of evidence for the two sample groups, which should be considered when interpreting the review

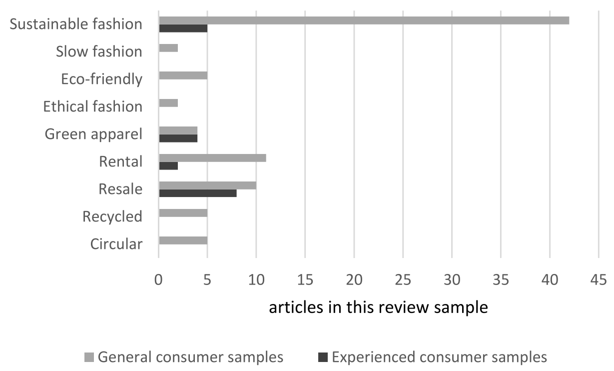

FIGURE 2
Overview of the SF concepts referenced in the dataset.

results. Three articles in the sample contained both general and experienced consumers.

Figure 2 illustrates the SF terminology used in the articles within the review sample. Most articles involving general consumers referred to SF ($n = 41$), while Resale was focused on most by articles involving experienced consumers ($n = 8$). Two articles initially coded as Collaborative consumption were recategorized as Rental upon review, based on their research focus (Chi et al., 2023). One article reported on Rental, Recycled, and Resale (Lin et al., 2023), and these were attributed to all three SF concepts. Notably, there were no articles on experienced consumers that investigated purchasing Slow fashion, Eco-friendly fashion, Ethical fashion, Recycled fashion, or Circular fashion.

Figure 3 displays the geographical distribution of the 100 research articles included in the review across 34 countries. While it shows an acceptable distribution across most continents, research from the African continent is notably absent. The majority of articles on general consumers were conducted in the USA ($n = 17$), China ($n = 14$), Germany ($n = 6$), Brazil ($n = 4$), the UK ($n = 4$), and Italy ($n = 4$). Articles on experienced consumers were primarily conducted in the USA ($n = 4$), China ($n = 4$), and Japan ($n = 2$). Most articles on general consumers focused on a single country, with a smaller number conducted in two or three countries ($n = 6$). All articles on experienced consumers were based in a single country.

Figure 4 illustrates the distribution of research methods identified in the articles in the review sample. For both sample groups, the majority of articles employed quantitative research methods: ($n = 74$) articles for general consumers and ($n = 10$) articles for experienced consumers. Among these, surveys were frequently used, for example, to test predictors to buy on Resale platforms (Styvén and Mariani, 2020). Qualitative articles predominantly adopted interviews to explore SF purchasing behaviors, for example investigating ethical consumption among Generation Z (Djafarova and Foots, 2022). Only seven of the 100 articles employed mixed methods, for example, combining approaches such as participant observation and interviews (Waight, 2019).

Finally, in 69% of the articles on general consumers, the intention to purchase SF was investigated. For example, Abrar et al. (2021) used the Theory of Planned Behavior to study the purchase intentions among Generation Y and Z. In contrast, 63% of the articles on experienced consumers focused on SF purchasing behavior. For instance, how mothers with Resale experience buy and sell second-hand children's clothing (Waight, 2019). Additionally, five articles on general samples addressed both intention and behavior, such as qualitative research on converting purchase intention into behavior (Djafarova and Foots, 2022), and these were categorized under both intention and behavior.

4.2 Results of the thematic analysis

In this section, we present the results from the thematic analysis. Across the 100 articles in the review sample, we identified eight themes of social-psychological predictors of SF consumption: Subjective norms, Fashion consciousness, Economic motivations, Environmental cognition, Habits, Perceived behavioral control (PBC), Hedonism, and Risk and trust. Figure 5 illustrates the key findings: (I) environmental cognition, such as environmental awareness, knowledge, and perceived consumer effectiveness, occurs most frequently as significant predictor for both groups; (II) subjective norms occur more frequently as significant predictors for general consumers than for experienced consumers; (III) habits occur more frequently as significant predictors for experienced consumers compared to general consumers; and (IV) experience can shift barriers into motivators.

Table 2 provides a summary of the key social-psychological predictors for each theme, additionally indicating whether the evidence identified served as a motivator (indicated by "+") or barrier (indicated by "–") to purchasing SF. The predominance of motivators in the findings may reflect the literature's focus on motivators.

The following sections will define each theme and explain the significant or relevant predictors of purchasing SF among general and experienced consumers.

4.3 Subjective norms

Subjective norms, also referred to as social norms, refer to the perceived social influence or pressure from relevant others to engage in specific behaviors (La Rosa and Johnson Jorgensen, 2021). For both sample groups, subjective norms were found to influence purchasing SF (Leclercq-Machado et al., 2022; Slaton and Pookulangara, 2022). Two types of subjective norms can be distinguished: descriptive norms, which refer to what others do, and injunctive norms, which pertain to behaviors that are commonly expected (i.e., approved or disapproved) (Ahn et al., 2020). Across both sample groups, the majority of the subjective norms codes focused on descriptive norms, such as how consumers are influenced by family and friends (La Rosa and Johnson Jorgensen, 2021; Zahid et al., 2021). Only articles focused on general consumers addressed the influence of social media influencers. These articles showed that influencers could significantly impact attitudes toward purchasing SF, especially

FIGURE 3
Geographical focus of the articles in the dataset (covering 106 countries in 100 articles).

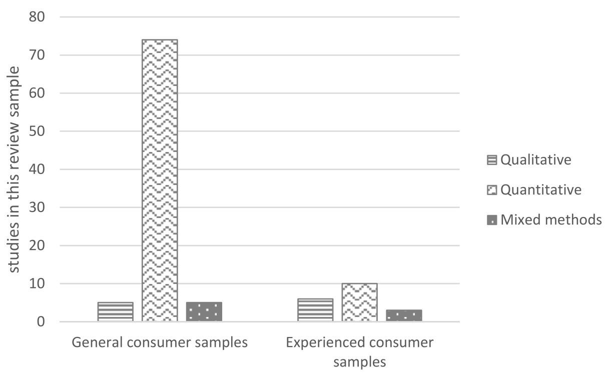

FIGURE 4
Applied research methods of studies in the dataset.

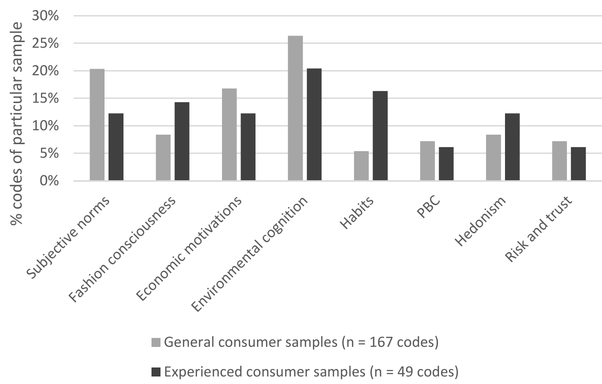

FIGURE 5
Overview of themes of predictors identified in this review, showing the distribution of codes for general and experienced consumer samples across these predictors. Percentages indicate the proportion of codes assigned to each theme relative to the total number of codes generated.

when they are perceived as knowledgeable about SF (Johnstone and Lindh, 2022).

In both sample groups, articles were found referring to conspicuous consumption, which involves purchasing and displaying products to show wealth, status, or social position (Apaolaza et al., 2023; Waight, 2019). Conspicuous consumption was coded as subjective norms, as it reflects the influence of societal expectations and the desire to align with social standards. For instance, individuals may choose SF products to create and maintain a desirable public image (Lou et al., 2022) or to impress

TABLE 2 Summary of key predictors for general and experienced consumers.

Theme	General consumers	Experienced consumers
Subjective norms	+ Family and friends + Conspicuous consumption + (Knowledgeable) influencers	+ Family and friends + Conspicuous consumption
Fashion consciousness	+ Fashionable or unique looks + Trendiness of Resale	+ Fashionable or unique looks + Uniqueness of Rental
Economic motivations	– Perceptions of price + WTP for high perceived value + Value-led shopping style	- Perceptions of price + Accessibility of affordable luxury (Rental) + WTP for sell-back value + Investment-led shopping style
Environmental cognition	+ Awareness is prerequisite for sustainable behavior + Knowledge + PCE motivates purchasing SF + Brand is a credible source of information	+ Awareness is prerequisite for sustainable behavior + Knowledge + PCE motivates purchasing SF + Actively seek knowledge from various sources
Habits	+ Perceived ease of use + Past environmental behavior + Positive experience leads to repeated purchases	+ Positive first-time experience with SF + Preferred shopping channel
Perceived behavioral control	+ Availability of online services and digital platforms	+ PBC to purchase
Hedonism	+ Pleasure of treasure hunting + Reduction of guilt	+ Pleasure of treasure hunting + Obtaining SF provides social connections
Risk and trust	– Risk of hygiene issues or counterfeits	+ Trust in provider mitigates worries of hygiene & liability + Trust in authentic SF brands

A "+" indicates a motivator and a "–" indicates a barrier to purchasing SF.

others by renting an outfit for a special event to demonstrate social status (Pantano and Stylos, 2020).

4.4 Fashion consciousness

Fashion consciousness refers to an individual's interest in, and awareness of, the latest trends and new styles in fashion (Lee et al., 2020b). Both sample groups are interested in purchasing SF products if these items are fashionable or provide unique looks, even if consumers do not prioritize sustainability in their choice for SF (Lee et al., 2020b; Riesgo et al., 2023; Yang et al., 2023). For example, fashion consciousness has driven general consumers to embrace Resale since it was perceived as a fashion trend (Amaral and Spers, 2022), and experienced consumers to embrace Rental due to the opportunity to enhance variety and uniqueness in their looks and the chance to never wear the same dress twice (Ruan et al., 2022; Slaton and Pookulangara, 2022). In a comparison between experienced consumers and general consumers, it was found that experienced consumers demonstrate greater fashion consciousness than general consumers (Riesgo et al., 2023).

4.5 Economic motivations

In this review, economic motivations encompass price and willingness to pay (WTP). Price is a critical factor for both sample groups (Djafarova and Foots, 2022; Stolz, 2022). While both sample groups perceive SF as expensive (Lin et al., 2023; Tandon et al., 2023), they are both attracted to Resale due to the lower prices, which enable them to acquire clothing from prestigious brands at reduced costs and to increase their shopping volume (Rodrigues et al., 2023; Slaton and Pookulangara, 2022). Research on general consumers has shown that price is considered more important than sustainability when purchasing SF (Helinski and Schewe, 2022; Pradeep and Pradeep, 2023).

WTP assesses the price a consumer is willing to pay relative to the perceived value of a product (Dangelico et al., 2022). Perceived value is the consumer's assessment of the benefits of a product or service, including environmental, monetary, and psychological advantages (Choi and Ahn, 2023; Pandey et al., 2020). Research on general consumers shows that they are willing to pay more for products perceived as novel (Chen et al., 2021) or scarce (Seo et al., 2023). Such WTP reflects the value, emotional appeal, and status associated with these items, suggesting a value-led shopping style. Conversely, research on experienced consumers indicated higher WTP for branded products, as these items retain their value and can be resold through online resale channels after use (Waight, 2019), indicating an investment-led shopping style.

4.6 Environmental cognition

In this review, the term Environmental cognition refers to key drivers rooted in environmental and ecological awareness, along with a commitment to critical and ethical consumption practices. It encompasses environmental awareness, knowledge, and perceived consumer effectiveness.

Firstly, environmental awareness involves understanding the social and environmental impacts of mass production and consumption (Kleinhückelkotten and Neitzke, 2019; Lee et al., 2020a). Environmental awareness is also referred to as environmental concern (Ceylan, 2019; Rodrigues et al., 2023) or environmental consciousness (Lou et al., 2022; Yoo et al., 2021). While awareness alone may be insufficient, it is often considered a prerequisite for sustainable behavior for both sample groups (Pang et al., 2022). For example, more environmentally aware consumers tend to buy less brand-new fashion, preferring alternatives such as Resale and Rental (Riesgo et al., 2023).

Secondly, knowledge encompasses a comprehensive understanding of SF. In the review sample, references were made to consumer knowledge (Lionço et al., 2019), product knowledge (Lang et al., 2019), and environmental knowledge, significantly influencing attitudes and leading to SF purchasing for both sample groups (Abrar et al., 2021; Slaton and Pookulangara, 2022). For example, knowledge about which materials can be upcycled in fashion impacts the intention to purchase upcycled fashion products (Yoo et al., 2021). However, the sample groups differ in how they acquire information: general consumers may view brands as credible sources of information (Day et al., 2020), while experienced consumers actively seek sustainability knowledge from various sources (Zhang et al., 2023).

Thirdly, perceived consumer effectiveness (PCE) describes the likelihood of individuals purchasing SF when they believe their purchasing decisions can make a tangible difference (La Rosa and Johnson Jorgensen, 2021; Lionço et al., 2019). Experienced consumers were found to have higher PCE than general consumers (Riesgo et al., 2023). Moreover, experienced consumers' strong environmental concerns lead them to act positively toward sustainable purchases without needing to consider their capability to make a difference (Tandon et al., 2023).

4.7 Habits

Habits are cognitive structures that automatically guide future behavior by linking specific situational cues to behavioral patterns (Klockner and Verplanken, 2019). In this review, habits encompass past sustainable behavior and ease of purchasing. Habitual behavior requires minimal attention. However, changing habitual consumption patterns and switching to purchasing SF necessitates attention and a strong willingness to change (La Rosa and Johnson Jorgensen, 2021).

Research on general consumers showed that ease of use facilitates online SF shopping (Park et al., 2022; Shrivastava et al., 2021). While past sustainable behavior may influence the initial intention to buy SF (Chi et al., 2023), a positive SF experience often leads to repeated purchases in the future (Stolz, 2022; Styvén and Mariani, 2020). Moreover, articles on experienced consumers indicate that the first-time experience with SF is critical for customer retention (Liu et al., 2023) and establishing a new shopping routine (Dhir et al., 2021). While some experienced consumers prefer shopping second-hand in physical stores (Zhang et al., 2023), others favor shopping online, whether occasionally or frequently (Corboş et al., 2023; Slaton and Pookulangara, 2022). In either case, when consumers start to engage in second-hand purchases, they often begin promoting the exchange of used clothing in others too (Machado et al., 2019).

4.8 Perceived behavioral control

Perceived behavioral control (PBC) is a concept within the Theory of Planned Behavior and refers to an individual's perception of their ability to successfully perform a particular behavior (La Rosa and Johnson Jorgensen, 2021; Lionço et al., 2019). PBC in the context of purchasing SF can be understood through factors such as availability (i.e., the availability of SF products), ability (i.e., knowing where to go), and opportunity (i.e., situational factors that enable or facilitate the purchase of SF, such as time, attention, and the absence of distractions) (Hasbullah et al., 2022).

PBC was coded as a motivator for experienced consumers, who are well-informed about SF and make informed conscious purchasing decisions (Slaton and Pookulangara, 2022). They are not deterred by the usual time and cost associated with sustainable consumption. The effort they invest in researching fabrics, brands, and limited availability of natural materials, is outweighed by benefits such as unique designs, timeless cuts, higher quality, and longer-lasting textiles.

4.9 Hedonism

Hedonism reflects a care for comfort and the enjoyment of life. In the context of purchasing SF, hedonistic values manifest as self-gratification through the pleasure of shopping, fulfilling fashion desires, and exploring new clothing styles (Wang et al., 2021).

For both sample groups, hedonic value was found to positively influence purchasing SF (Lou et al., 2022; Pantano and Stylos, 2020). For example, SF shopping satisfies a recreational desire in the form of treasure hunting or, more specifically, bargain hunting or vintage shopping. Bargain hunting offers hedonic pleasure by providing opportunities to purchase rare outfits at reduced prices, while vintage shopping is associated with nostalgic pleasure and an appreciation for the history of previous owners (Styvén and Mariani, 2020).

For experienced consumers, hedonic motivations sometimes outweigh environmental benefits (Liu et al., 2023). For instance, the low price of Resale can lead to desire-driven rather than need-driven consumption (Waight, 2019). Additionally, the social value of engaging in SF, such as attending SF events, repair cafes, or swap sessions, fosters connections with like-minded people, enhancing pleasure and enjoyment of life (Machado et al., 2019).

Conversely, articles on general consumers report lower hedonic value for luxury SF products. For example, the sustainable features of luxury products may diminish consumers' pleasure, as they feel less guilt after purchasing sustainable luxury but do not necessarily experience increased pleasure (Alghanim and Ndubisi, 2022). Additionally, luxury consumers tend to be more critical about the type of SF; for instance, luxury consumers might attribute stronger feelings of pride and greater novelty to upcycled goods compared to recycled goods (Adigüzel and Donato, 2021).

4.10 Risk and trust

When purchasing SF, risk refers to the concern that the purchase may not meet expectations (Yoo et al., 2021), while trust involves believing in the other party's credibility, benevolence, or environmental responsibility (Apaolaza et al., 2023).

Research on risks primarily focused on general consumers and showed that risk perception has a negative impact on SF purchasing (Lin and Chen, 2022). Examples of perceived risks include hygiene concerns (Xu et al., 2022) and the fear of purchasing counterfeits in Resale markets (Stolz, 2022). In articles originating from the

USA, risk did not affect consumers' purchasing second-hand luxury products, possibly indicating that its second-hand luxury market is well-established and that consumers can easily access and compare information to evaluate product authenticity and quality (Lou et al., 2022).

For both sample groups, trust in the SF brand or provider is a significant factor shaping SF consumption (Pang et al., 2022; Riesgo et al., 2023). Trust reduces skepticism about greenwashing practices (Apaolaza et al., 2023) and alleviates concerns about wearing used clothing and financial liability for product damage in rental scenarios (Day et al., 2020). For general consumers, the influence of sustainable aspects on purchasing decisions is minimal when trust in the brand is already high (Riesgo et al., 2023). In contrast, experienced consumers trust brands that engage in sustainability out of genuine commitment rather than for profit or other self-interested motives, valuing authenticity (Riesgo et al., 2023).

5 Discussion and proposed future research directions

This systematic literature review aimed to investigate how the predictors of SF purchasing differ between consumers with and without SF experience. A total of 100 articles were analyzed, beginning with a descriptive analysis to provide context for the dataset. This initial analysis revealed a predominant focus on general consumers over experienced ones, and a greater emphasis on purchase intention rather than actual purchasing behavior. Next, through a thematic analysis eight themes of social-psychological predictors of SF purchasing were synthesized, allowing for a comparative examination of these predictors across the two consumer groups. This revealed that (I) environmental cognition, such as environmental awareness, knowledge, and perceived consumer effectiveness, occurs most frequently as significant predictor for both groups; (II) subjective norms occur more frequently as significant predictors for general consumers than for experienced consumers; (III) habits occur more frequently as significant predictors for experienced consumers compared to general consumers; and (IV) experience can shift barriers into motivators. These findings are discussed in greater detail below, along with proposed directions for future research, and are summarized in Table 3.

(I) Environmental cognition: The findings indicate that environmental cognition—including environmental awareness, knowledge, and perceived consumer effectiveness — occurs most as significant driver of SF purchasing among both general and experienced consumers in this review. While these motivations serve as a rational starting point for sustainable choices, it is essential to acknowledge that fashion consumption often deviates from purely rational processes. Emotional and contextual factors play a substantial role in influencing consumer choices (Busalim et al., 2022; Niinimäki, 2010). Although environmental cognition is valuable for initiating discussions around SF consumption, evidence suggests that interventions focusing solely on these aspects often overlook the complex interplay of emotional and social influences that more effectively drive actual purchasing behavior (Albarracín et al., 2024). This complexity is underscored by the diverse themes of predictors identified in this review, each supported by significant research findings. Therefore, appealing exclusively to environmental cognition may not bridge the gap between intention and actual behavior (Busalim et al., 2022). Future research should explore how other predictors operate alongside environmental cognition. Investigating various predictors simultaneously could yield a more holistic understanding of SF purchasing behavior, highlighting the relative influence of each predictor.

TABLE 3 Summary of proposed future research directions based on this review.

Finding	Proposed directions for future research
(I) Environmental cognition occurs most as significant predictor for both groups	- How do various predictors interact with each other to affect SF purchasing? - How does the relative importance of various predictors of SF purchasing change with experience?
(II) Subjective norms occur more as significant predictor for general consumers than experienced consumers	- How does experience with SF influence subjective norms in the context of SF? - What processes contribute to the internalization of subjective norms, and how do these processes vary by level of experience?
(III) Habits occur more as significant predictor for experienced consumers than general consumers	- How does experience with SF influence various goal frames to purchase SF? - What are effective goal frames to purchase SF for inexperienced consumers?
(IV) Experience can shift perception of barriers into motivators	- How does experience with SF influence self-perception? - What are key moments that facilitate the transformation of barriers into motivators as consumers gain experience with purchasing SF?

(II) Subjective norms: The comparison of general and experienced samples reveals that there is more significant evidence that general consumers are influenced by subjective norms, such as the perceived expectations of friends and family, than experienced consumers (Leclercq-Machado et al., 2022; Slaton and Pookulangara, 2022). This finding aligns with the sole study comparing general and experienced consumers, which showed that while experienced consumers feel pressure to act sustainably, it stems more from internal moral obligations than from external social influences (Riesgo et al., 2023). This suggests that subjective norms create external pressure on inexperienced consumers to adopt SF practices, such as purchasing SF for social approval. With experience, some of these norms may be internalized, shaping individuals' beliefs and motivations. For instance, an experienced consumer may choose to buy SF because it resonates with their personal values, rather than out of concern for social disapproval (Legros and Cislaghi, 2020). This highlights the need for research that distinguishes between general and experienced consumers regarding the internalization of subjective norms into moral obligations. Future research should consider comparing predictors across these consumer groups and may employ experimental

methods to explore how subjective norms operate at different levels of experience with SF.

(III) Habits: The comparison of the two consumer groups indicates that there is more significant evidence that experienced consumers are influenced through their habits — for example, their previous engagement in environmental behavior (Stolz, 2022) and the ease of purchasing SF—than general consumers. While retaining SF consumers is essential for promoting ongoing sustainable consumption (Liu et al., 2023), it appears that after making an initial purchase, these consumers tend to develop a more positive perception of SF (Silva et al., 2021). This suggests that experience shapes how consumers frame their sustainable choices, potentially leading to different purchasing goals. Goal framing theory posits that the way goals are presented can significantly influence consumer behavior and decision-making (Lindenberg and Steg, 2007). For instance, experienced consumers who have developed habits around sustainable practices are more likely to engage in sustainable consumption as their goals to purchase SF are framed positively or as moral imperatives (Van Der Weiden et al., 2020). In contrast, inexperienced consumers may struggle to form these habits without clear and compelling goal framing, highlighting the potential of effective goal framing in promoting sustainable consumption. Therefore, future research should investigate effective goal framing strategies for inexperienced consumers to facilitate SF purchasing.

(IV) From barriers to motivators: This review revealed that certain predictors, which initially serve as barriers for general consumers, can become motivators for experienced consumers. This shift aligns with prior research (Silva et al., 2021). For example, in the context of the theme hedonism, general consumers do not expect to derive additional pleasure from purchasing SF; instead, they primarily expect to feel less guilt (Alghanim and Ndubisi, 2022). In contrast, experienced consumers report deriving greater pleasure in SF purchasing, such as through social connections formed while purchasing and trading SF (Machado et al., 2019). These findings align with self-perception theory (Bem, 1972), which posits that individuals develop attitudes and beliefs by observing their behaviors within specific contexts. As consumers engage more deeply with SF, their experiences may prompt them to reinterpret their motivations and identities, underscoring the dynamic nature of self-perception. Future research should further investigate this dynamic, focusing on the cognitive and emotional changes that occur as consumers gain experience with SF. A longitudinal study design could be particularly valuable in exploring how barriers evolve into motivators by tracking changes in self-perception over time with repeated purchases or deeper engagement with SF.

5.1 Contribution to theory and practice

This systematic literature review provides a significant theoretical contribution by elucidating what is known about the differences in predictors of SF purchasing between general consumers and those with prior experience. The key theoretical contribution is the identification of experience as a transformative factor in SF purchasing behavior. Experience acts as a tipping point in the shift from external influences to internalized motivations. As consumers gain experience, their self-perception evolves, directly impacting their purchasing behavior. This dynamic challenges the traditional Theory of Planned Behavior, which posits that attitudes influence behavior. In the context of SF purchasing, however, it is behavior that shapes attitudes. This aligns with research demonstrating that consumers' purchasing behaviors actively contribute to the formation of new attitudes, reinforcing the notion that behavior can precede and modify intent (Sommer, 2011). Furthermore, this review highlights the potential of goal framing within the context of SF. Experienced consumers develop effective goal frames that facilitate ongoing SF purchasing habits, while general consumers often lack these. Consequently, this review contributes by recommending further investigation into effective goal frames that can motivate consumers to make their initial SF purchase.

From a practical perspective, this review offers recommendations for SF marketers, communicators, and retailers. As consumer perceptions of SF change with experience, the findings suggest that distinct marketing and communication strategies should be used for first-time consumers and experienced consumers. Environmental cognition serves as key predictor for both consumer groups; however, they require different approaches to engage each consumer group. First-time consumers require clear, brand-driven education to build trust. Patagonia's Worn Wear program exemplifies this through accessible repair guides and transparent product lifecycle information, directly addressing newcomers' need for foundational knowledge (www.wornwear.patagonia.com). To standardize such efforts, EU Green Claims Directive compliance becomes essential—mandating verified sustainability labels to prevent greenwashing and enable informed comparisons. Governments could incentivize this through tax breaks for brands adopting standardized labeling aligned with Directive requirements. Experienced consumers demand depth and authenticity. Partnerships with documentary filmmakers (e.g., The True Cost screenings) can engage this group's preference for systemic analysis while fostering community. Brands could integrate Directive-compliant substantiation into these efforts, for instance, pairing film discussions with granular data on supply chain emissions reduction, verified through third-party audits.

6 Limitations

While this literature review has provided valuable insights, the study does have some limitations. The first limitation is that most articles relied on quantitative methods, particularly surveys, to examine predictors of consumer behavior. While these methods align with consumer behavior research traditions (Arrigo, 2021; Busalim et al., 2022), survey scales often employ vague frequency measures that may overstate links between motivations and behaviors (Nielsen et al., 2023). Additionally, self-reported questionnaires are susceptible to biases such as social desirability and recall issues, which can lead respondents to overstate intentions or inaccurately recall behavior (Nielsen et al., 2023). Consequently, conclusions drawn from quantitative data may not accurately reflect true intentions or behaviors. Qualitative approaches are better suited to uncover deeper social and psychological predictors, providing richer, culturally sensitive insights into the complexities and underlying motivations of SF purchasing (Lloyd and Gifford, 2024). To address this limitation, this review included both qualitative and quantitative articles on SF purchasing to provide context that surveys alone might miss. Future research should prioritize qualitative approaches, such as interviews and focus groups, to engage consumers directly and uncover the motivations and barriers shaping actual SF purchasing behavior.

A second limitation is the imbalance between articles that focus on experienced consumers and those that do not, particularly regarding how behavior is measured. For general consumers, SF purchasing is often assessed through intention, while articles on experienced consumers typically measure actual purchasing behavior, reflecting the ease of observing purchases among actively engaged consumers. This difference may confound the identified predictors for each group and skew the understanding of the true drivers behind SF purchasing, as certain predictors may be over- or underreported. To address this limitation, we propose future research that examines purchasing behavior across consumer groups using the same measures. For example, experimental research design would enable direct comparisons and allow for statistical testing of the effect of experience on SF purchasing.

A third limitation of this review is that it focused on statistically significant results. Predictors like environmental cognition are easier to measure on a large scale and thus more frequently studied and published, potentially leading to an overrepresentation of their influence in the counts. As a result, these predictors may appear more impactful, while others, like risk and trust, may be underrepresented due to less research. This could indicate publication bias stemming from the reliance on published articles (Berinsky et al., 2021). Consequently, the data presented in Figure 5 emphasize the prevalence of significance within the context of this review rather than the most essential predictors, reflecting research trends or methodological constraints instead of robust theoretical foundations. To address this limitation, we referred to predictors that "occur most as significant" rather than labeling them as the "most important." Future research should explore a broader array of predictors simultaneously to foster a deeper understanding of the predictors genuinely driving consumer behavior in SF. Additionally, future studies could integrate insights from gray literature, such as industry reports on rental platforms, to capture up-to-date behavioral patterns of experienced consumers.

Finally, this review aimed to provide a broad view of the SF market; however, it became clear that different SF approaches (such as slow fashion, resale, and rental) exhibit distinct characteristics. For example, while new SF products are often priced higher, second-hand items typically offer lower-cost options, affecting the predictors for each purchasing decision. The resale market, in particular, is rapidly evolving, with online platforms propelling its growth and placing it in competition with ultra-fast fashion (Arrigo, 2021). To address this, we have highlighted specific SF approaches where predictors differ. Future research should focus on distinguishing strategies like resale and rental from other SF approaches, such as slow fashion, by exploring the unique consumer predictors in each. A targeted approach could help refine effective tactics for promoting SF consumption across diverse consumer segments.

7 Conclusion

In recent decades, SF consumption has garnered significant attention from researchers, leading to an increase in articles on SF consumer behavior. However, a notable research gap remains regarding the predictors influencing individuals who have not yet converted their intentions into actual purchases (i.e., general consumers) compared to those who have (i.e., experienced consumers). A total of 100 articles were investigated on predictors for purchasing SF and synthesized in eight themes of social psychological predictors that affect and hinder SF purchasing, comparing general and experienced consumers. The review revealed four pivotal insights that deepen our understanding of SF purchasing behavior. First, environmental cognition including environmental awareness, knowledge, and perceived consumer effectiveness, emerges as the most extensively researched predictors for both consumer groups. Second, compelling evidence indicates that subjective norms influence the choices of general consumers, suggesting that perceived social pressures play a crucial role in their decision-making. Third, for experienced consumers, habits are a vital factor, highlighting the importance of established behaviors in guiding their sustainable choices. Finally, experience can transform barriers into motivators. This review highlights the role of experience as a transformative factor in SF purchasing behavior, demonstrating that as consumers gain experience, their self-perception evolves and influences their purchasing decisions. Additionally, it emphasizes the potential of goal framing, suggesting that effective goal frames can encourage initial SF purchases among general consumers, who often lack these motivational frameworks. Practitioners can leverage these insights to develop tailored strategies for both first-time and experienced consumers, ultimately transforming fashion consumption patterns and supporting the fashion industry's contribution to SDG 12.

Data availability statement

The original contributions presented in the study are included in the article/Supplementary material, further inquiries can be directed to the corresponding author.

Author contributions

AT-W: Conceptualization, Data curation, Formal analysis, Methodology, Writing – original draft, Writing – review & editing. KB: Conceptualization, Supervision, Writing – review & editing. TT: Conceptualization, Supervision, Writing – review & editing. MH: Writing – review & editing.

Funding

The author(s) declare that financial support was received for the research and/or publication of this article. This open access publication was funded by HU University of Applied Sciences Utrecht through its Open Access Fund, which supports researchers in making their work freely accessible.

Acknowledgments

The authors would like to thank the editor and reviewers.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Generative AI statement

The author(s) declare that no Gen AI was used in the creation of this manuscript.

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Supplementary material

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/frsus.2025.1556835/full#supplementary-material

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frontiers | Frontiers in Sustainability

TYPE Original Research
PUBLISHED 14 July 2025
DOI 10.3389/frsus.2025.1540113

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OPEN ACCESS

EDITED BY
Elisabeth Süßbauer,
Technical University of Berlin, Germany

REVIEWED BY
Alice Dal Gobbo,
University of Trento, Italy
Marlyne Sahakian,
University of Geneva, Switzerland

*CORRESPONDENCE
Sara Karimzadeh
sara.karimzadeh@oru.se

RECEIVED 05 December 2024
ACCEPTED 24 June 2025
PUBLISHED 14 July 2025

CITATION
Karimzadeh S (2025) Consuming with care: insights into ethical consumption in Iran. *Front. Sustain.* 6:1540113.
doi: 10.3389/frsus.2025.1540113

Consuming with care: insights into ethical consumption in Iran

Sara Karimzadeh *

School of Humanities, Education and Social Sciences, Department of Sociology, Örebro University, Örebro, Sweden

This study examines the meanings and practices of ethical consumption in Iran, enriching dominant narratives that link ethical consumption primarily to institutional frameworks or environmental discourses. It argues that ethical considerations are instead embedded in local cultural, spiritual, and social norms. The research draws on 19 in-depth qualitative interviews with urban residents in the midsized city of Urmia. A thematic analysis was employed to understand participants' practices across three stages of consumption: pre-consumption, consumption, and post-consumption. In the pre-consumption stage, structural constraints—such as limited access to reliable information and economic precarity—define the boundaries of ethical choices. The consumption stage is primarily influenced by sufficiency-oriented ethic through the avoidance of *heyf-o-meyl* (wastefulness and unnecessary consumption), reflecting values rooted in traditional and cultural teachings. In the post-consumption stage, the practice of ehsan kardan (acts of care and generosity) emerged as a key form of ethical divestment that minimizes waste and supports others in need. The study reveals that participants conceptualize ethical consumption through human-centered values—such as care, responsibility, and generosity—rather than through environmentalism or formal regulation. The results contribute to the literature on sustainable consumption by highlighting culturally embedded, locally meaningful forms of ethical engagement that constitute a moral micro-economy.

KEYWORDS

care, mindful consumption, Iran, local moralities, everyday ethics

1 Introduction

Ethical consumption refers to everyday practices aimed at minimizing harm and promoting care for people, resources, society, and the environment (Yang and Cayla, 2025; Ariztia et al., 2018; Summers, 2016). It is a complex and multifaceted subject. For instance, consumption is dependent on infrastructures of provision (Shove, 2003) and is deeply embedded in social relations, norms, and institutional structures (Princen, 1999; Boström, 2023); and the "ethical" is inherently relative, taking on diverse forms across different contexts and often motivated by varying moral, cultural, political and institutional stimuli (Garlet et al., 2024; Trnka and Trundle, 2014). As societies evolve, so too do the meanings and practices associated with ethical consumption, making it increasingly challenging to determine what it means to consume ethically and how to do so in practice (Newholm et al., 2015). These challenges highlight the need to understand ethical consumption within specific contexts and to explore how it is practically interpreted and enacted in everyday life.

The phenomenon has gained significant visibility in the Global North, where both its conceptual foundations and practical expressions are deeply rooted in historical trajectories of modernity, liberal market institutions, and individualistic moral frameworks. Within these contexts, ethical consumption often intersects with other emerging forms of consumption, such as conscious consumption (Carfagna et al., 2014; Foti and Devine, 2019), sustainable consumption (Geiger et al., 2018), green consumption (Connolly and Prothero, 2008), and voluntary simplicity (Rebouças and Soares, 2021). These recently developed consumption practices are supported by a combination of civil society engagement, policy innovation, and consumer movements, all of which are grounded in values of individual autonomy and market liberalism. Consumers in these settings are regularly exposed to a wide and evolving array of information encouraging lifestyle change, typically framed in terms of market-based choices. As a result, ethical consumption is often expressed through institutionalized forms of consumer activism: buying Fairtrade or eco-labeled products, supporting ethical fashion, or participating in targeted boycotts. Across these practices, personal responsibility is emphasized as the primary mechanism for achieving social and environmental change (see Ariztia et al., 2018; Connolly and Prothero, 2008; Carfagna et al., 2014; Foti and Devine, 2019; Lekakis, 2012).[1]

However, framing ethical consumption primarily through market-based mechanisms risks overlooking alternative forms of ethical engagement that are embedded in social relations, communal obligations, and cultural-religious norms (Karimzadeh and Boström, 2024; Ariztia et al., 2018; Carrier and Wilk, 2012). Importantly, the notion of "the market" is not universally applicable: markets can take various forms, including globalized supply chains, informal community exchanges, barter networks, or state-regulated economies. When ethical consumption is narrowly defined through practices such as Fairtrade certification or consumer boycotts—markers rooted in Northern consumer cultures—it promotes a deficit narrative. This narrative mistakenly portrays communities outside these frameworks as disengaged from ethical concerns (Ariztia et al., 2015).

This narrative also contributes what decolonial scholars describe as epistemic privilege: the tendency to universalize Northern, white, and affluent understandings of "ethical" behavior while marginalizing or erasing alternative subjectivities and practices (see Escobar, 2018). Ethical frameworks rooted in colonial histories and liberal moral philosophies often fail to account for how people in the Global South, or in economically marginalized regions more generally, navigate ethical decisions within contexts of structural constraint and material precarity. In this sense, the concept of ethics itself is not ideologically neutral; rather, it is historically and culturally produced and often aligned with Eurocentric narratives of progress, transition and sustainability (cf. Hickel, 2020).

This calls for a rethinking of ethical consumption—one that recognizes how it is narrated and enacted differently across cultural, material, and historical contexts. It also raises several critical questions: How does ethical consumption take shape in communities with varying forms of market or civil society infrastructure? What values—spiritual, relational, or cultural—guide consumption choices in these settings? And how are ethical concerns articulated when conventional sustainability mechanisms are absent or inaccessible?

2 Context and contribution

Ethical consumption is widely recognized as a phenomenon shaped by specific cultural, institutional, and socio-economic environments (Karimzadeh and Boström, 2023; Boström et al., 2018; Shaw et al., 2016; Newholm et al., 2015). Despite this recognition, the literature has predominantly focused on Global North contexts and market-based possibilities such as Fairtrade, eco-labeling, and consumer boycotts (Connolly and Prothero, 2008; Ghali, 2021). These frameworks tend to assume the presence of liberalized market economies, strong civil society institutions, consumer sovereignty, and regulatory infrastructures—conditions that are not universally applicable. In contexts like Iran, where prolonged economic sanctions and political isolation have significantly shaped the economy, such assumptions do not hold. Limited access to certified ethical goods, coupled with constrained institutional support and consumer advocacy, poses a distinct set of challenges for practicing ethical consumption (Kahalzadeh, 2023). While some recent work has begun to address ethical consumption in non-Western and marginalized contexts (Kutaula et al., 2024; Karimzadeh and Boström, 2024; Ariztia et al., 2018), much remains unexplored. This study contributes to this growing body of literature by examining ethical consumption in Urmia, a mid-sized city in northwestern Iran, where individuals negotiate ethical concerns in ways that reflect local constraints, cultural norms, and everyday lived realities.

Urmia, a city marked by ethnic and linguistic diversity, accommodating a variety of cultural traditions and social networks that shape everyday life, including consumption. Despite its growing urbanization, it retains many features of a tightly knit community where family and friendship networks, cultural customs, and informal exchange relationships play a strong role in daily life. Such social ties often influence where people shop, who they trust, and how they interpret responsibility and care in everyday consumption. However, these local dynamics must be situated within the broader national context. Its production system operates within a complex framework shaped by prolonged economic sanctions and political isolation, leading to partial integration with global supply chains. While Iran maintains trade relations with selected countries, particularly within Asia and the Global South, it remains largely excluded from global ethical production circuits commonly associated with certifications like Fairtrade, organic labeling, or international labor standards. As a result, Iranian consumers have limited access to globally recognized ethically certified goods. The country lacks strong consumer advocacy groups, independent labor unions, and functioning civil society organizations that might otherwise support ethical or sustainable consumption. Civil society actors operate under tight regulatory oversight (Bayat, 2013), and there are no nationally recognized ethical labeling schemes or certification mechanisms like Fairtrade.

Consumer agency in markets depends on the availability of [ethical] alternatives (Casais and Faria, 2022)—yet in Iran, such options are often absent, particularly for products like organic foods or ethically sourced textiles. Consequently, even consumers with

1 To further understand to what extent the neoliberal market can provide possibilities to consume "ethically", see "Critical Perspectives on Ethical Consumption" written by Carrington and Chatzidakis (2018).

strong ethical intentions may find it difficult to act on their values, leading to a cycle of frustration and disengagement. Nevertheless, informal economies including street vendors, small-scale traders, and traditional bazaars (Pourjafar et al., 2014; Moosavi, 2005) continue to play a vital role in integrating different forms of ethical values in everyday practices. Recent research highlights diverse and often contradictory consumption patterns emerging in Iran, reflecting the country's complex socio-political context. For example, Rahmanian (2023) examines how consumers resist the authoritarian regime through deliberate consumption choices, while Karimzadeh (2022) explores unsustainable consumption practices driven by widespread social discontent. On the other hand, Iran and Müller (2020) emphasize the potential of grassroots initiatives in Tehran to foster sustainable consumption, though they note the critical need for institutional support to amplify their impact. Karimzadeh and Boström (2024) discuss that in the absence of institutional support and despite economic hardship, tradition and cultural values continue to motivate ethical consumption among Iranians. Accordingly, ethical consumption in Iran is most likely shaped by cultural norms, religious duty, and personal interpretations of care, philanthropy, and sufficiency, rather than by formal certifications or structured consumer movements.

This study contributes to redefining ethical consumption as a pluralistic concept, advocating for more inclusive understandings of consumption beyond Global North contexts. Focusing on the city of Urmia, it offers nuanced insights into how ethical consumption is understood, negotiated, and practiced within a landscape shaped by material constraints, moral frameworks, and cultural traditions. By centering local voices and everyday practices the research challenges universalizing accounts of ethical consumption. Drawing on empirical data, the study shows that ethical action in this context is rarely institutionalized or driven solely by individual choice; rather, it is frequently improvised, relational, and collective. These situated practices reveal ethical consumption as a lived, contextually embedded phenomenon shaped by structural limitations and cultural specificities.

3 Integerating ethics in consumption

Consumption cultures and social contexts have long influenced one another, shaping practices and norms over time. Ethical considerations in consumption, although prominently discussed from the latter half of the twentieth century onwards, have deeper historical roots illustrating the intrinsic relationship between societal upheavals and changes in consumption practices (Smith and Johns, 2020). Events such as the Richmond Bread Riots in 1863, the British boycott of slave-produced sugar in the late 18th century, boycotts against South African products during the apartheid era, and the 1890 Tobacco Protest in Qajar-era Iran, illustrate how social movements have significantly impacted consumption practices locally and internationally (Carrier, 2012; Newholm et al., 2015; Shaw et al., 2016; Boström et al., 2018). Historically, working-class participation was central to these movements, driven by varied motivations, including both ethical concerns and self-interest (Newholm et al., 2015; Stolle and Micheletti, 2005).

According to the literature, ethical consumption encompasses three dimensions: political, social, and environmental which manifest either through consumption refinement (e.g., buying ethically certified products) or consumption reduction (e.g., minimalism, voluntary simplicity) or a combination of both (Isenhour, 2012). Consumption refinement involves deliberate choices to avoid products deemed unethical due to their social or environmental impact, while consumption reduction implies decreasing overall consumption motivated by ethical, social, or ecological concerns (Li et al., 2020). However, the effective realization of these ethical dimensions depends on diverse factors such as supportive policies, infrastructural availability, and cultural and social contexts. Consequently, ethical consumption is inherently multidimensional and context-dependent, making clear distinctions challenging yet necessary for understanding varied societal contexts (Newholm and Shaw, 2007; Orlando, 2012; Summers, 2016).

Despite its perceived promise, its actual impact on environmental and social protection often remains limited or unfulfilled. For example, research indicates materialistically oriented consumers frequently purchase ethical products for self-benefit rather than altruistic motivations (Ryoo et al., 2020). Additionally, ethical consumption is often accessible predominantly to economically privileged individuals (Carrington and Chatzidakis, 2018; Chatzidakis et al., 2016). Also, it is frequently framed in political and market-driven terms, emphasizing consumer choices as a mechanism for expressing political agency through actions such as boycotting and buycotting (Beck and Ladwig, 2021; Davies et al., 2012; Hassan et al., 2023; Jung et al., 2016; O'Connor et al., 2017). Such framings carry three limitations: they confine ethical consumption studies to predetermined manifestations (e.g., boycotts, Fairtrade); geographically limit them to contexts with liberal market infrastructures; and imply that ethical consumption is exclusively a modern phenomenon, overlooking historical evidence of pre-modern ethical consumption practices (Berlan, 2012; Carrier, 2012) as well as its different manifestations. Accordingly, the market-mediated understanding of ethical consumption has faced significant criticism (Ariztia et al., 2018; Pellandini-Simányi, 2014), prompting a broader conceptualization that integrates notions of care and sufficiency (Godin et al., 2025; Callmer and Boström, 2024; Karimzadeh and Boström, 2023; Godin and Langlois, 2021).

Another critical challenge in integrating ethical consumption to everyday life is determining what constitutes a genuinely "ethical" practice, as seemingly ethical actions often entail unintended unethical consequences. For instance, purchasing products labeled Fairtrade is frequently identified as ethical consumption due to its emphasis on improving conditions for producers in developing countries. Yet, the same action can inadvertently create negative impacts, such as the environmental harm caused by long-distance transportation and packaging, or economic disadvantages for local producers unable to compete with imported Fairtrade goods (Berlan, 2012; Lyon, 2006). Moreover, practices labeled as ethical consumption, embedded within existing market logics, often serve dual purposes of promoting social responsibility and securing market profitability (Goodman, 2010; Fridell, 2007). Ethical labeling and certification schemes may reinforce consumerism rather than challenging the systemic issues that underpin inequality and environmental degradation (Barnett et al., 2011). These contradictions prompt consideration of alternative frameworks that might be more comprehensively understood through the lens of localized, seasonal, and informal market practices, where relationships between consumers and producers are direct and community oriented.

4 Method and materials

To explore the meanings and practices of ethical consumption, I adopted an exploratory qualitative design and conducted nineteen semi-structured, audio-recorded interviews with economically independent adults (aged 18 and over) residing in Urmia, Iran, between May and September 2022. Interviews lasted 17–75 min, were audio-recorded, transcribed verbatim, and data collection ceased once thematic saturation was evident in the nineteenth transcript. Participants were recruited initially through purposive outreach to my community network, a strategy intended to build rapport and create a secure environment for open dialogue on topics (ethical consumption in this case) that may include sensitive issues (Kvale and Brinkmann, 2015; Atkinson and Flint, 2001). It was combined by snowball sampling to access participants beyond my immediate circles. Both sampling strategies carry inherent risks; recruiting from known networks, while facilitating trust and richer disclosures, may limit the diversity of perspectives captured. Similarly, snowball sampling can reinforce existing social similarities, potentially constraining the range of experiences discussed. Nevertheless, these recruitment strategies were supplemented by deliberate efforts to ensure demographic heterogeneity: the final sample included ten women and nine men, aged between 22 and 62 years, with education levels ranging from secondary school ($n = 1$) and diploma ($n = 3$) to associate degree ($n = 1$), bachelor's degree ($n = 6$), master's degree ($n = 5$), and doctoral degree ($n = 3$). While the study does not claim statistical generalizability, the purposive pursuit of information-rich cases, the attainment of thematic saturation, and the provision of thick descriptive data support the study's credibility and facilitate analytic transferability to other underexplored settings in the ethical consumption literature.

Participants were asked questions structured around three stages of consumption: pre-consumption (decision-making and selection of goods), consumption (purchasing and actual usage), and post-consumption (disposal, reuse, or reflection). At each stage, follow-up probes explored ethical considerations indirectly to avoid bias; the explicit term ethical consumption was not mentioned. Instead, ethical dimensions were elicited by prompting participants to reflect on how "other-oriented" factors—such as concern for family, community, future generations, or environmental impacts—shaped their everyday consumption practices. In the pre-consumption stage, participants discussed conditions and considerations influencing their routine decisions, such as purchasing food, clothing, and other consumer goods. Specific probes included their thoughts on the production processes behind products they regularly consume, the potential impacts of their shopping decisions on broader society, and whether concerns about product origin, materials, or the quantity purchased influenced their choices. They were further asked how contextual factors (such as cultural norms, regulatory frameworks, available infrastructure, technological opportunities, and social expectations) enable or constrain their integration of ethical considerations. At the consumption stage, questions explored participants' opinions on the volume consumed, especially within private or social contexts (e.g., family gatherings), and whether they actively tried to reduce their consumption, including reasons and strategies for doing so. Finally, during the post-consumption stage, participants described their practices related to disposal, recycling, reuse, and redistribution (e.g., via second-hand stores, sharing, or gifting), explaining the motivations and processes underlying these practices.

The data analysis followed a two-stage thematic process. It began with initial (open) coding, in which broad patterns and categories were identified, followed by focused coding to refine these into more specific subthemes (Mason, 2017; Braun and Clarke, 2006). The analysis adopted a combined deductive and inductive reasoning which allowed for a dynamic interplay between theory and empirical observation (Timmermans and Tavory, 2012). The deductive phase involved examining pre-existing conceptual categories commonly associated with ethical consumption such as boycotting and fair trade, though with sensitivity toward their varied interpretations and manifestations within the studied context. Simultaneously, the inductive dimension facilitated the identification of emergent themes, particularly those capturing how ethical consumption is shaped by local, cultural, and social factors. The iterative movement between theory and data allowed for both the recognition of globally circulated categories and the discovery of locally meaningful expressions of care, restraint, and responsibility in everyday consumption.

5 Results

The findings are structured across a three-phase consumption spectrum: pre-consumption, consumption, and post-consumption (Figure 1). Each phase highlights distinct dynamics, challenges, and practices related to ethical consumption, reflecting individuals' subjective understandings of ethics, their practical enactments, and the barriers or opportunities they encounter given the available resources.

In the pre-consumption stage, three critical factors influencing ethical purchasing decisions are identified: difficulty accessing reliable information, economic adversity, and considerations of fair trade. In the consumption stage, I analyze a culturally embedded belief and enact: the notion that caring for one's belongings is a personal and moral responsibility. This cultural logic reframes ethical consumption as the act of maintaining and preserving possessions rather than prioritizing the ethical sourcing of goods. Finally, the post-consumption stage explores an Iranian tradition that, while not originally motivated by environmental concerns, inadvertently promotes sustainable practices such as sharing and donating.

By interpreting ethical consumption through the lens of local culture and tradition, this analysis shows how context-specific norms can support broader environmental objectives and extend the scope of sustainable practices accordingly. Together, these stages reveal a multifaceted portrait of ethical consumption, where cultural values, individual agency, and structural constraints intersect—sometimes harmoniously, sometimes in tension.

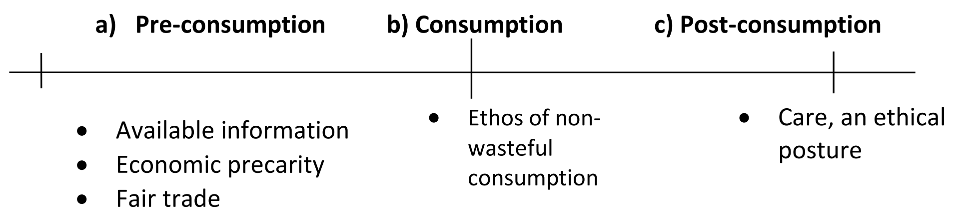

FIGURE 1
Ethical considerations on a consumption spectrum.

5.1 Pre-consumption stage

5.1.1 Difficulty accessing reliable information

A lack of credible and clear information is one of the most consistent barriers to ethical consumption (Casais and Faria, 2022; Ghali, 2021; Wiederhold and Martinez, 2018). The missing data span the entire value chain—from the origin of raw materials to wages, working hours and workplace safety—leaving consumers unable to judge whether a product accords with their values. According to Osburg et al. (2017), information must be credible (they trust the source), meaningful (it relates directly to their concerns) and easy to understand if it is to trigger ethical purchasing. This study shows that all three criteria are largely unmet in the studied context. Participants specifically mentioned difficulties reaching trustworthy information on working conditions, wages or the origin of raw materials. As Mahi (47, female) put it:

> *"I personally know many workers who are working in horrible situations. Can you study them?... there is no organized information about it."*

Several interviewees doubted the truthfulness of official statements. Behnam (42, male) explained:

> *"We don't have time to hunt for evidence, and I don't trust formal reports. Factories here pay minimum wages, use short contracts and keep everything hidden. I only see the final product, never the process."*

A Retailer raised similar doubts:

> *"Responsible consumer is linked to a responsible producer. You cannot be a responsible consumer unless the producer is also responsible. Environmental issues or labour conditions are not at all a concern for producers."* (Emad, 62, male)

Despite a widespread belief among participants that many goods are produced under unfair conditions, no one mentioned ceasing to buy specific products on this basis.

> *"I don't remember I have done something like boycotting. The market is the same everywhere. There is no alternative. I recently bought a car which I know damages the environment, has low quality but I still buy it. There is no other choice for us or if there is they are very expensive."* (Ali, 29, male)

From his point of view, those living in such a situation feel confined by external forces that significantly limit their freedom of choice and impose unwanted circumstances upon them. He ended his response by saying that "... *we can't do what we want to do*". Instead of boycotting a particular product they are favoring local and seasonal farm markets. Given the context, these settings are perceived as more transparent, closer to the consumer, and more trustworthy. While occasional objectionable actions may surface among individual consumers (Rahmanian, 2023), these behaviors are typically transient and fail to yield the desired impact as they are provisional. However, this mirrors evidence that, when formal certification is weak, consumers fall back on relational cues to infer ethical production (Johnstone and Tan, 2015).

Interestingly, a clear divergence emerged when participants discussed services such as insurance companies compared to physical goods like food or clothing. In contrast to product purchases, respondents were far more willing to boycott service providers.

> *"...I look for fair services... for example, I boycotted some insurance companies because of the damage that they cause to the environment. When I was in their offices, I learned they use a lot of paper for their paperwork, I saw it... and it really bothers me."* (Mehrdad, 31, male)

This discrepancy reflects key differences between services and material goods. Services are delivered in real time and often involve face-to-face interaction. This proximity gives consumers more direct exposure to the provider's behavior and values, making ethical judgments more immediate and tangible. As Princen (1997, 1999) argues, modern consumption is often shaped by processes of distancing—where the social and environmental consequences of consumption are physically and psychologically removed from the consumer—and shading, in which ethically relevant information is obscured or selectively presented. These mechanisms tend to reduce the visibility of harm or exploitation, particularly in globalized supply chains. Service transactions in this case minimize both distancing and shading. Because interactions occur in person, consumers observe and assess the provider's actions directly, without relying on third-party narratives or certifications. As a result, ethical decisions are more often grounded in immediate experiences. In such cases, the primary factor influencing whether individuals choose to boycott or disengage from a service provider is how that provider treats its customers. When companies are also perceived to be affiliated with the state—a common suspicion in Iran—these individual refusals can escalate into collective acts of consumer resistance (Rahmanian, 2023).

In the context studied, boycotting is not a widely accepted or practiced mode of (material) market communication. This aligns with Katz's (1996) assertion that when outcomes are uncertain or unlikely, people often find it more acceptable to endure the consequences of inaction than to risk the potential fallout of taking ineffective action. In contrast, taking an ethical stand—such as boycotting products—entails financial, emotional, and social costs that many participants are unwilling or unable to bear without a clear sense of impact. This rationalization reflects cognitive strategies identified in the literature on consumer ethics. Concepts such as "willful ignorance" (Ehrich and Irwin, 2005) and "intentional ignorance" (Mackendrick and Stevens, 2016) describe situations in which individuals deliberately avoid seeking additional information about the ethical implications of their consumption choices. They do so not because they are indifferent, but because they anticipate that such knowledge would create a moral obligation to act; an obligation they feel structurally unable to meet. However, when conditions of visibility, support, and responsiveness are present, they are more likely to mobilize even if only selectively (through acts like service boycotts).

5.1.2 Dealing with economic precarity

Economic precarity is a significant barrier to ethical consumption, and it consistently appears in literature as a determinant of limited or compromised consumer agency (Huddart Kennedy et al., 2019; Isenhour, 2010; Orlando, 2012). In contexts of economic instability, individuals often prioritize survival over values-based purchasing, not because they are indifferent to ethical concerns, but because the costs—both material and symbolic—are too high to bear. This tension emerged clearly in the data. Participants frequently described how high inflation, insecure employment, and limited purchasing power forced them to deviate from their ideals.

> "*The main concern is how to make money. Your job might completely damage the environment, but what you think about is how to feed your family. Our priority is surviving.*" (Arman, 29, male)

This remark illustrates how survival needs displace environmental and ethical considerations. For many, the ethics of consumption are not dismissed outright, they are simply subordinated to more immediate and pressing concerns. Dana (40, male), a factory worker, echoed this sentiment:

> "*I am a worker. Everything that I buy, I think about workers' conditions. But there is something here. I am still struggling to meet my basic needs, then I cannot do anything. I cannot even express it [my environmental concerns] to my wife or my kids. It looks very nonsense to them.*" (Dana, 40, male)

In such contexts, ethical consumption is perceived as a form of privilege, a luxury afforded only to those with a buffer from economic hardship. Many participants described boycotts and ethical purchasing not as irrelevant, but as actions that require a threshold of material security. This finding supports results in other global studies (Shaw et al., 2005), particularly where ethical acts are tied to more expensive alternatives or information-intensive decision-making. Amin (35, male) commented on this disparity:

> "*… these ideas work better in EU countries and so on which have access to brands and then they have more options.*" (Amin, 35, male)

This notion of "having options" was central. Without affordable and accessible alternatives, making ethical choices becomes not only difficult but emotionally burdensome. Ethical ideals may even provoke guilt or frustration in those who cannot act on them:

> "*… People shouldn't be blamed for their wrong behaviour if they aren't given better options. When they are soaked with many other problems in their daily life, taking care of the environment goes to the end of their [to-do] list. They are not the right people to think about the future generation. Don't forget social dissatisfaction on top of it as well. I am sure it is not just about Iranian citizens. If Russia keeps continuing this war and people in Europe lack gas, what do they do? If you stuck in a war situation, which one do you prefer? To stay in the cold or to cut the trees to keep your room warm… we struggle to keep ourselves alive, their [people in welfare societies] stomach is full, and their money is in their pockets… Of course, we all are responsible for the future, but we should be able to live first.*" (Arman, 29, male)

This framing moves beyond simple economic logic to a more existential rationale: when basic needs are unmet, ethical consumption becomes morally deferred rather than rejected. Ethical behavior, in this view, requires structural support: access to options, consumer protection, economic stability, and trust in institutions. This dynamic reflects *ethical elasticity*, a strategy that individuals adjust their ethical behaviors in relation to perceived necessity and available resources (Barnett et al., 2011). Under conditions of hardship, the ethical horizon narrows, and long-term concerns (e.g., environmental protection, intergenerational justice) are displaced by short-term needs. In such cases, ethical action is not absent, but reframed around immediate responsibility—for family, survival, and daily functionality. Maintaining existing consumption patterns, especially when they are more financially viable and socially normalized, offers a form of psychological comfort and economic pragmatism. Participants in this study frequently expressed this dual consciousness: as citizens, they are deeply worried about environmental degradation and social injustice; as consumers, they feel largely powerless to respond through the collective choices. Therefore, ethical inaction in this context might be interpreted not as complacency, but as a form of constrained agency. People are not ignoring the problem; they are navigating it with limited tool and limited hope that their individual choices can contribute to small-scale changes.

5.1.3 Fair trade in Iran

Fair trade—whether defined as a formal certification system (Fairtrade) or as a broader commitment to socially just and equitable trading practices—has long been viewed as a cornerstone of ethical consumption (Carrier, 2012; Brinkmann and Peattie, 2008). Varul (2009) argues that the realization of global Fairtrade schemes depends on three preconditions: a functioning global market, a consumer culture based on individual choice, and a moral ideology that fosters recognition of distant others (p. 184). Yet, these assumptions do not easily map onto every context.

Findings from this study suggest that localized forms of fair trade exist in Iran, shaped not by certification or formal systems, but by informal, value-driven economic relationships rooted in cultural and social obligations. Notably, none of the participants were familiar with the term *Fairtrade* as a global brand or certification. However, many are engaged in practices that align with the ethical logics of fair trade—particularly by choosing to buy from local vendors, farmers, peddlers, and independent artisans.

> *"… I try to find old sellers [in terms of age] and far-away shops. I know they need money, and I see it as a responsibility to support them."* (Nasim, 36, female)
>
> *"…I try to buy some time from local shops, retailers, child workers*[2] *and so on to help them [to earn money for food]."* (Nazanin, 22, female)

Buying from these sellers primarily revolves around monetary transactions between the buyer and seller, with little intention of fulfilling needs rather more benevolence. A similar content but in a different form:

> *"… I try to buy from local shops… especially from those who are new in the area and have younger sellers. I like to support them. I also introduce them to others and encourage other people to support them."* (62, female)

These actions reflect a relational, care-oriented approach to consumption, motivated less by material necessity than by a sense of attentiveness to others. In this context, purchasing becomes a means of expressing solidarity, addressing social inequalities, and supporting economic survival within the community. As Selma (41, female) noted:

> *"… think about how these big supermarkets have ruined, the local economy and individual sellers' lives. But chain markets by doing deceptive advertising trick people. It is a sort of unethical business. As much as I can, I try to buy from local retailers and independent sellers. Sometimes I don't even need what I buy, but that is the only thing they sell."* (Selma, 41, female)

The other one with some concerns about the economic growth in the country mentioned:

> *"Local businesses are very important to me because I think they have the main role in our economy in this situation. We don't have a growth plan like other countries. So, I value them a lot. I support them in my living neighbourhood."* (Arman, 29, male)

One particularly notable practice involves direct trade, where middlemen are bypassed, and ethical value is derived from personal connection and community benefit:

> *"…my mother lives in a village. She helps link farmers to city people so they can trade directly. She also helps people to exchange home furniture."* (Dana, 42, male)

This echoes what Lekakis (2012) describes as decommodification where market exchanges are reframed as social relationships rather than impersonal transactions. Similarly, Carrier (2012) emphasizes how direct trade reduces the anonymity of market objects, enhancing the ethical value of consumption by restoring a connection between buyer and producer.

Participants in this study demonstrate that socially embedded forms of trade ethics can flourish through informal, culturally resonant practices. These local strategies prioritize proximity, trust, and care, even if they sacrifice product variety or convenience. This localized ethical practice aligns with research suggesting that consumer morality is often shaped by immediate social experiences, rather than abstract global narratives (Orlando, 2012; Hassan et al., 2016). Rather than viewing fairtrade as a matter of individual choice within affluent markets, the Iranian case illustrates how people adapt moral economies to survive economic pressure while maintaining social values. Here, fair trade is not about labels but about sustaining community, and care in the face of economic adversity.

5.2 Consumption stage: ethos of non-wasteful consumption

In the consumption stage my focus is on how ethical considerations can influence consumption act in terms of form or volume. Data showcase that the participants' ethical concerns are manifested in a form of conscientious consumption drawing on an Iranian culture avoiding *heyf-o-meyl* (حیف و میل). Literally, *heyf* (حیف) means "a pity (a shame or loss)" and *meyl* (میل) can imply "to consume or appropriate for oneself." In Persian usage, the compound phrase *heyf-o-meyl kardan* حیف و میل کردن means to squander or misappropriate something of value, whether through neglect or selfish misuse. The term carries ethical and even spiritual weight. Wasting food, money, or any blessing is seen not just as imprudent but as morally wrong—a point reinforced by religious teachings that condemn wastefulness. Thus, *heyf-o-meyl* signifies more than just "waste" in a technical sense; it invokes a value-laden stance that one should not carelessly and unnecessarily let useful things go to waste or misuse what one has. This concept is deeply ingrained in Iranian popular ethics and forms a key part of what is considered proper, responsible consumption in everyday life. One could say it is ingrained cultural ethic.

It is utilized in many different contexts to indicate that something which might be material such as natural resources, food, goods and commodities, or non-material such as time, feeling, emotions, youth and so on, is not being used or treated appropriately. This insight is rooted in the belief that belongings

2 Child labour, as referred to in this context, pertains to children engaged in street peddling.

inherit value, as they encompass resources such as human ideas and labor, natural resources, and divine blessings, as well as economic investment and monetary worth. In essence, every object holds significance, hence recognizing and cherishing this value is a demonstration of being responsible and considerable human, citizen and consumer. When you are doing *heyf-o-meyl*, you use things carelessly and irresponsibly, you neglect proper care and squander them. The closest term in the English vocabulary might be mindful consumption however, it exclusively focuses on material aspects of consumption and therefore is not as comprehensive as the Iranian version. When participants were asked about their consumption patterns, they mainly referred to this concept: "*I have learned not to heyf-o-meyl.*" Arman, a 29-year-old man continued:

> "*…I take care of my stuff as much as possible. Materials are valuable to me… when something is not consumable anymore, I give it to people who make money from them. When you consume carefully, it is not just taking benefit from that stuff, you save your time as well because you don't spend time looking for new ones, you can put that time into other activities, and you can even make money from this saved time. Time, energy, money, and everything should be considered in the consumption process.*" (Arman, 29, male)

The other participant mentioned:

> "*…I wear clothes as long as possible. Electronic devices as well. I don't change them just to have a new one. No!*" (Behnam, 42, male)

For older participants, especially more religious ones, *heyf-o-meyl* is associated with a kind of "sin" and violating your responsibility in relation to "God". They believe that everything bears the face of the creator, in their case, God, therefore, human beings should act extremely careful not to distort this face with wrong consumption forms. One can believe *heyf*-ing is not ethically acceptable because:

> "*Many people are injured in the production process. Every single grain of rice has a huge effort behind it. Have you ever seen those women who are working on rice farms? So, it brings responsibility to us. I try not to throw things away easily. I believe by making even a small [unnecessary] piece of waste we throw away the efforts that labours have put into the goods. I believe our consumption put this pressure on them.*" (Mahi, 47, female)

Obviously, the concept involves various motivations related to reducing consumption volume, but it doesn't necessarily originate from modern environmental concerns aiming to minimize consumers' negative impacts on the environment and mitigate climate change. Rather, it adheres to the idea that human beings are an integral part of nature and should live in harmony with it. This way of thinking is transmitted from one generation to another through everyday life habits, norms, and informal education, and can therefore be considered as their habitus, in Bourdieusian term (Bourdieu, 1977). Inheriting the culture, an Iranian consumer may avoid waste almost automatically due to habitual values, rather than through the self-conscious reflection implied by mindfulness. Moreover, *heyf-o-meyl* carries a collective and spiritual connotation—it is tied to communal norms and religious teachings about not wasting divine blessings. The fundamental significance embedded in this concept revolves around its impact on minimizing consumption. Practicing restraint—not-"*heyf-o-meyl*-"ing—used to be considered as a positive character, and is still practiced, clearly not due to environmental concerns, but because it is a moral duty to consume responsibly, within limits that safeguard both human life and the environment as a God creature. One participant described the transition like this:

> "*…I have treated my kids in a way that they take good care of their stuff. I don't need to be worried about this anymore. Now they know the value of things.*" (Saba, 34, female)
>
> "*… I think my parents had a big impact on the creation of my view in relation to consumption. My father used to tell us buying is very easy, but good taking care of things is important. So I have learnt it.*" (Mahi, 47, female)

The sufficiency-oriented nature of this culture does not suggest that it is primarily common among low-income groups as a strategy for managing daily expenses, which Korsnes and Solbu (2024) refer to as 'sufficiency as a necessity. In the Iranian case, individuals are socialized to this practice regardless of their economic status. This culture has extended its influence into realms beyond mere individual lifestyle choices. Until recently, a well-known phrase, particularly within the clothing market, was "Beshoor-o-Bepoosh" signifying "wash and wear" [as much as you want], highlighting the durability of products that could serve you for an extended period. In this ethos, the value of long-lasting items was recognized, and consumers were incentivized to invest their money in acquiring such goods. While this motto may not hold the same prominence in today's market, its legacy persists among the majority of elderly people.

5.3 Post-consumption stage: care as an ethical posture

The post-consumption stage generally includes practices such as divestment, waste sorting, recycling, sharing, handing things over to other people, or to antique shops (second-hand shops are not common in the studied context) (Karimzadeh and Boström, 2023). Among these, the practice of sharing or shared usage (e.g., borrowing tools, appliances, or clothing) is relatively uncommon in everyday Iranian life, except in situations of necessity. For many participants, sharing recalls earlier periods of hardship—particularly the Iran–Iraq war (1980–88)—when families were compelled to share resources due to scarcity. While some older participants associate sharing with care and solidarity, others viewed it as a sign of material instability rather than ethical preference.

> "*… if you live a decent life, why sharing? It is okay to donate your stuff but not accept donation.*" (Behnam, 42, male)

This perspective reflects a status-based discomfort with reciprocal sharing, where giving is seen as generous, but receiving is stigmatized. Sharing, in this case, does not reflect ethical mutuality, but a class-coded act tied to need.

Despite the growing global emphasis on household waste sorting out as a hallmark of sustainable post-consumption, in Iran this practice remains limited due to infrastructural and institutional shortcomings. Recent data show that over 80% of household waste is sent to landfills, with <6% recycled and fewer than 20% of households engaged in sorting waste (Mir Mohamad Tabar et al., 2024). As a result, participants often perceived household waste segregation as ineffective from an environmental standpoint. However, rather than abandoning the practice entirely, some individuals engaged in it for alternative ethical reasons—specifically, to assist economically vulnerable individuals who collect recyclables for resale (Karimzadeh and Boström, 2024). This shift in motivation—from environmental protection to humanitarian support—reveals an important link to the broader moral economy evident in post-consumption practices in Iran. Waste sorting can become an act of compassion, performed not for planetary gain, but for the direct benefit of others. Although sorting out lacks systemic support, the ethical impulse to care for others remains a unifying thread across post-consumption behaviors, even when those actions diverge from formal sustainability frameworks.

The most prominent ethical practice in the post-consumption stage is a cultural tradition called *ehsan kardan* (احسان کردن), which loosely translates as "acts of generosity" or benevolent giving. *Ehsan kardan* involves giving goods, often clothing, food, household items, or money to those in need, not out of transactional obligation but as a caring and spiritual gesture. In many cases, the donor is motivated by both compassion and religious belief.

> *"…I give many of my clothes and stuff to people who need them. Years ago, I was a teacher in a school in a very deprived district. I still contact some of my former students and let them know I have packages for them."* (Shoja, 36, female)

Ehsan can also be performed on behalf of deceased loved ones. In lieu of buying flowers or holding elaborate grave ceremonies, families may donate useful items to others in memory of the deceased. This not only benefits recipients but also imbues the act with spiritual significance.

> *"…I used to live with my mother-in-law. After she passed away, I donated her home stuff, while I could use them myself, to many of those families who needed those things. Instead of buying flowers for her grave, which fades quickly, I give that money to help others. That feels more meaningful."* (Mahi, 47, female)

Considering these quotes, ethical consumption can be translated into an action that helps other people meet their basic needs and brings blessings to the donor and the family. In this form of consumption-related activities, the emphasis is on the positive emotions experienced by the individual engaging in such actions. *Ehsan* also strengthens one's symbolic capital since generosity is a virtue deeply embedded in both traditional teachings and everyday cultural norms.

6 Conclusion

The objective of this study was to understand the interplay of local and cultural factors, and ethical consumption. It draws on a small, non-representative sample encompassing Iranian consumers to offers in-depth insight into how a diverse group of urban residents in an understudied context make sense of and enact ethical consumption. Despite the structural conditions, and the challenges discussed in different stages on consumption process, ethical considerations in the studied context still play a role in fulfilling various drivers. The findings suggest that ethical consumption in this setting is shaped less by institutional structures and more by informal, traditional, and culturally embedded practices. These include values passed on sustaining communities through care (local fair trade), deeply rooted moral frameworks related to caring (*ehsan kardan*) and anti-wastefulness (*heyf-o-meyl*). Such motivations reflect ethical concerns that are integrated into daily life, even in the absence of systemic incentives or organized civil society efforts. Combination of mindful consumption, compassion, generosity, and care reflect the essence of ethical consumption among participants. On one hand, when you avoid *heyf-o-meyl* you manage your resources thoughtfully (avoiding excess consumption), while through *ehsan kardan*, you assist to those who are underconsumption to meet their needs, at least for a short period of time. Living an everyday life like this, ethical consumption flows in all pillars of life.

Indeed, one of the core global challenges today is the coexistence of overconsumption by some and underconsumption by others, which highlights enduring inequalities and ecological injustice. Being an ethical takes place by controlling overconsumption through non-wasteful and reducing underconsumption through wisely allocating available resources within the planetary boundaries and consumption corridors (Fuchs et al., 2021). While this remains a significant global ambition, the practices observed in this study, though local, informal, and often unrecognized, align in spirit with these principles. Recognizing and reinforcing these ethical traditions—through scholarship, policy, and community engagement—may offer not only a corrective to global imbalances but a culturally resonant pathway toward more just and sustainable forms of consumption.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

The studies involving humans were approved by Ethical approval from Swedish Ethical Review Authority was obtained for the project on April 14, 2022 (Dnr 2022-01430-01). To be able to obtain our ethical approval from Swedish Ethical Review Authority, by providing the requested forms and information we committed to protecting personal information based on Swedish Ethical Review Act and Örebro University regulations. The studies were conducted in accordance with the local legislation and institutional requirements. The participants provided their written informed consent to participate in this study. Written informed consent was obtained from the individual(s) for the publication of any potentially identifiable images or data included in this article.

Author contributions

SK: Conceptualization, Data curation, Formal analysis, Funding acquisition, Investigation, Methodology, Project administration, Resources, Software, Supervision, Validation, Visualization, Writing – original draft, Writing – review & editing.

Funding

The author(s) declare that financial support was received for the research and/or publication of this article. This work was supported by the European Union's Horizon 2020 research and innovation programme under the Marie Skłodowska-Curie grant agreement No. 101022789 titled "Social (im)possibilities of the formation of ethical consumption: A comparative study of Sweden and Iran." The funder has no role in study design, data collection and analysis, decision to publish, or preparation of the manuscript.

Acknowledgments

I would like to express my sincere gratitude to all the individuals who assisted me during the interview process, with special appreciation to the participants who generously dedicated their time and shared their insights. I am also deeply grateful to Professor Magnus Boström, whose guidance throughout the broader research project of which this paper is a part has been invaluable.

Conflict of interest

The author declares that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Generative AI statement

The author(s) declare that Gen AI was used in the creation of this manuscript. Generative AI was used for language editing.

Publisher's note

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frontiers | Frontiers in Sustainability

TYPE Original Research
PUBLISHED 24 October 2025
DOI 10.3389/frsus.2025.1681357

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OPEN ACCESS

EDITED BY
Maria Alzira Pimenta Dinis,
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REVIEWED BY
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Federal University of Santa Catarina, Brazil
Nelson Duarte,
School of Health of the Polytechnic Institute of Porto, Portugal

*CORRESPONDENCE
Brikene Dionizi
✉ brikene.dionizi@unishk.edu.al

RECEIVED 07 August 2025
ACCEPTED 07 October 2025
PUBLISHED 24 October 2025

CITATION
Dionizi B, Kalaj EH and Avdullahi A (2025) Behavioral readiness for circular economy in Albania: a consumer perspective.
Front. Sustain. 6:1681357.
doi: 10.3389/frsus.2025.1681357

Behavioral readiness for circular economy in Albania: a consumer perspective

Brikene Dionizi[1]*, Ermira H. Kalaj[1] and Ajtene Avdullahi[2]

[1]University of Shkoder "Luigj Gurakuqi", Economic Faculty, Shkoder, Albania, [2]University "Isa Buletini" Mitrovica, Kosovo, Mitrovice, Albania

Background: The transition to a circular economy is critical in achieving sustainable consumption, particularly in emerging economies such as Albania. While circular economy strategies have gained attention in policy and academic discourse, their success heavily depends on consumer engagement. Albania presents a unique context as a post-socialist, EU-inspiring country with evolving infrastructure and limited consumer exposure to circular economy practices.
Objective: This study investigates the readiness of Albanian consumers to engage with circular and sustainable practices, examining behavioral drivers, perceived barriers, and the influence of socio-demographic variables.
Methods: A cross-sectional survey was conducted among respondents in North Albania, employing a structured questionnaire based on behavioral theories. Statistical analysis including regression models and structural equation modeling (SEM) is realized to assess relationships among latent variables.
Results: Employment status, income and education significantly predicted circular economy knowledge and behavior. Key practices like sufficiency-driven consumption and donation of goods were associated with socio-economic variables, while motivational drivers such as environmental concern and practicality were more universally distributed. SEM results confirmed significant impacts of knowledge, behavior and practices on circular economy readiness, while preferences and influences had weaker predictive power. The findings inform context-specific policy and business interventions to support circular economy adoption in emerging economies.
Conclusion: Behavioral engagement in circular economy in Albania is shaped by both structural constraints and evolving socio-cultural values. Policy and business strategies must consider contextual realities and co-create circular solutions with customers to ensure adoption. The findings contribute to the behavioral understanding of circular economy readiness in emerging economies and provide a basis for targeted interventions in similar contexts.

KEYWORDS

circular economy, sustainable consumption, consumer behavior, emerging economies, Albania, behavioral science

1 Introduction

The circular economy (CE) has emerged as a transformative paradigm that shifts the focus from linear modes of production and consumption to regenerative and resource-efficient systems. It integrates environmental sustainability with economic innovation, aiming to close material loops, minimize waste, and foster long-term resilience. Achieving circular economy objectives like waste reduction and resource conservation requires both recycling and purchasing circular products (Stangherlin et al., 2023). The transition to a circular economy requires a shift not only in technological and systemic infrastructures but also in individual and collective behaviors. Behavioral science provides a framework for understanding the psychological, social, and cultural dimensions that influence the adoption and success of circular practices.

Circular ecosystems thrive on the active participation of individuals, communities, and organizations. Behavioral science highlights the interplay between individual decisions and collective actions in driving sustainability (Aarikka-Stenroos et al., 2021; Singh and Giacosa, 2018). Individual actions, such as recycling, composting, and purchasing refurbished goods, are foundational to CE (Kirchherr et al., 2018). However, these behaviors are often hindered by barriers like lack of awareness, perceived inconvenience, and cultural resistance (Koistila, 2020). Addressing these barriers through education, incentives, and accessible infrastructure is essential for fostering widespread participation. Collective behaviors on the other hand emerge when groups coordinate efforts to achieve shared goals (Aarikka-Stenroos et al., 2021). In circular ecosystems, collective actions include community-led recycling initiatives, business partnerships for resource sharing, and government policies and incentives to promote sustainability (Avdullahi and Shala, 2023; Singh and Giacosa, 2018). Collaborative efforts amplify the impact of individual behaviors and create a supportive environment for circular practices. The integration of sustainable consumption with circular practices requires robust policy incentives and consumer education to build trust and ensure behavioral shifts (Snezana et al., 2025).

While the CE concept has gained substantial momentum in European policy agendas, especially under the European Green Deal, its implementation in emerging economies faces significant contextual challenges. One of the least explored dimensions of this transformation is the behavioral readiness of consumers, particularly in societies undergoing post-socialist transitions, such as Western Balkans countries (Albania included), which are currently in the process of aligning their institutional and environmental governance frameworks with European Union (EU) standards, making this a salient case for examining the intersection of policy ambition and consumer realities in EU-aspiring countries.

This study addresses a critical question: To what extent are consumers in emerging countries such as Albania ready to engage with circular and sustainable business offerings? It aims to explore the behavioral readiness of Albanian consumers to engage with CE and sustainable consumption practices, considering demographic, attitudinal and motivational factors. The objectives of the study are:

- To assess the level of consumer awareness and engagement with CE practices
- To identify demographic and socio-economic predictors of sustainable behaviors, and
- To evaluate key motivational influences and perceived barriers to CE adoption in an emerging context.

By integrating behavioral science with empirical data from a transitioning economy, the paper contributes to the literature on sustainable consumption and business model innovation. In doing so, the study also builds on key behavioral theories to explore the psychological, social, and cultural dimensions that shape consumer decisions in circular ecosystems. These theoretical insights inform both the design of the research instrument and the interpretation of findings.

Based on prior literature, regional and international (De et al., 2025; Bhar, 2023; João et al., 2025; Rexhepi Mahmutaj et al., 2025; Avdullahi and Shala, 2023; Snezana et al., 2025), we propose the following hypothesis:

- H1: Full-time employment and higher education levels are positively associated with knowledge and engagement in CE practices.
- H2: Gender differences influence motivations and perceived barriers to adopting CE behaviors.
- H3: Economic incentives and awareness campaigns significantly impact willingness to adopt sufficiently driven practices.
- H4: Demographic variables have limited predictive power for certain CE behaviors, suggesting contextual or structural limitations.

The remainder of the paper is structured as follows: *Section 2* outlines the theoretical background and local context, moving on *Section 3* is the methodology, including the theoretical underpinnings of the survey design; *Section 4* presents the empirical results and critical discussions; and *Section 5* provides the conclusions for the study including implications, limitations and prospects.

2 Theoretical background and local context

Behavioral science offers a range of theories that explain how individuals and groups make decisions about sustainability. A significant blind spot in traditional CE business models in the passive framing of consumers. Chevrollier et al. (2025) advocate for business model innovation that involves the consumers from the outset, including in the co-creation of value and service design. This is echoed by De et al. (2025) who argue for deeper consumer-business alignment through participatory design approaches. In Albania, this means embedding consumer values into business models from the ideation phase rather than merely offering "green" alternatives. Nielsen (2023) and Pearce (2023) also discuss how regulatory uncertainty in emerging markets can be leveraged for innovation, including flexible models that adapt to consumer co-creation. Ajzen (1991) in his *Theory of Planned Behavior* (TPB) posits that behavior is driven by three key factors: attitudes, subjective norms, and perceived behavioral control, being this the most referenced model explaining consumer intention and making a widespread use in sustainability contexts (Naskar and Lindahl, 2025). In the context of CE, TPB has been used to explain why individuals engage in recycling, reuse, and waste management practices (Koistila, 2020). For instance, individuals with positive attitudes toward recycling, influenced by societal norms and confidence in their ability to perform recycling tasks, are more likely to engage in such behaviors. Valencia-Arias et al. (2025) demonstrate that integrating environmental values, subjective norms and perceived policy support significantly improves predictive power in emerging economies, demonstrating this as an extension of TPB. The *Value-Belief-Norm Theory (VBN)* (Stern et al., 1999) connects values (e.g., environmental concern) with pro-environmental behaviors through personal norms and a sense of moral obligation. This theory has been instrumental in examining behaviors such as waste reduction and product reuse, where individuals' ethical responsibility often drives action (Kirchherr et al., 2018). *Social Practice Theory* shifts the focus from individual actions to the broader social practices that shape behavior (Hargreaves, 2011). Practices like recycling or sharing-economy activities are embedded in routines, cultural norms, and material contexts (Gobbo, 2022). Adopting circular practices often requires reshaping these practices at the societal level (Singh and Giacosa, 2018). *Cognitive dissonance theory* (Festinger, 1957; Bosone et al., 2022) suggests that individuals experience discomfort when their actions contradict their beliefs or values. This discomfort can motivate behavior change, such as adopting circular practices to align actions with environmental concerns (Koistila, 2020).

Taking Albania into consideration, it represents a relatively young market economy, having undergone a radical transformation in the early 1990s after more than five decades of centralized economic governance. Prior to 1990, Albania operated under an autarchic system, largely self-regulated and disconnected from international trade flows. Consumer goods were domestically produced, reused, and circulated within national borders, and household waste was predominantly organic or biodegradable in nature. Notably, plastic was largely absent from the local market due to total isolation of the country. On the other hand, there were great environmental issues caused by the heavy industry, but they were not even considered at that time (Xhafa and Kosovrasti, 2016). Decades of centralized economic planning prior to the 1990s shaped consumption patterns that emphasized reuse and scarcity-driven sufficiency. However, the rapid liberalization of markets in the post-1990s introduced a proliferation of imported goods, especially plastics, significantly altering consumer behavior. The rapid market liberalization, coupled with limited public awareness and infrastructure for waste segregation or recycling, exacerbated the environmental pressures associated with plastic waste. The transition altered substantially the composition and volume of municipal waste, with plastic becoming a growing component of urban waste streams. Understanding this historical trajectory is essential to assessing consumers' preparedness and behavioral orientation toward circular and sustainable consumption practices nowadays. Albania grapples with underdeveloped recycling infrastructure, weak enforcement of environmental regulations, and fragmented public awareness campaigns. These structural limitations are compounded by cultural and economic factors that hinder widespread engagement in CE-aligned practices. Bhar (2023) conceptualizes the notion of sustainable consumption as requiring contextual frameworks that move beyond universal models. Similarly, Saravanan (2024) shows how property and cultural practice shape consumption patterns, suggesting that behavioral nudges must be tailored to socio-economic realities. Recent studies emphasize the intention-behavior gap, a persistent challenge where pro-environmental attitudes do not translate into action (De et al., 2025). Moreover, Akomea-Frimpong et al. (2024) identify macro-level regulatory and operational barriers, including limited stakeholder engagement, fragmented waste management systems, and insufficient enforcement of legal frameworks in emerging economies. Similar insights are echoed by Trigkas et al. (2025), who examine Greek consumers' readiness and find low levels of awareness and behavioral engagement despite stated environmental concern. Mindful consumption prioritizes awareness of the environmental footprint and promotes intentional consumption choices (De et al., 2025; Snezana et al., 2025). However, its application in emerging economies remains underexplored, revealing a research gap this paper addresses. Furthermore, as CE transitions require consumer alignment with new business models, scholars underscore the importance of co-creation and value-alignment between firms and consumers (João et al., 2025). Empirical evidence from business-level perception in the Western Balkans highlights systematic barriers to circular economy adoption, including added costs, the perception of customer demand, and a prevailing of knowledge and technical capacity within the business, conditions that collectively undermine the operationalization of circular strategies in the private sector (Rexhepi Mahmutaj et al., 2025).

Infrastructure limitations, informal economies, and low regulatory enforcement shape the everyday realities of consumption (Akomea-Frimpong et al., 2024). For CE to be effective, circular offerings must align with local value systems (Dawkins et al., 2023; Axelsson et al., 2023) and affordability thresholds. As João et al. (2025) argue, without tailoring models to cultural and institutional contexts, CE efforts risk non-participation. In Albania and other Western Balkan countries this is intensified by systematic and infrastructural deficits, as well as weak market readiness for CE-oriented business models. Business models that merely integrate circular principles operationally, without involving consumers in the design or delivery of sustainable services, risk misalignment and rejection. This is especially salient in Albania, where CE adoption is in nascent stages and lack a history of participatory policymaking, even if by promoting resource efficiency, reducing waste, and enhancing local engagement, the sector of agritourism in Albania embodies the call for sustainability in production processes and consumers patterns (Dionizi and Kercini, 2025). There is also a growing consensus around integrating social marketing approaches into circular interventions, especially in culturally diverse and economically transitioning societies. These approaches leverage behavioral insights and local values to reshape consumption norms and improve CE adoption (Trigkas et al., 2025; Mont et al., 2022). For Albania this could mean embedding circular practices into social identity and community-based frameworks, increasing legitimacy and uptake. This point to a persistent "intention-behavior" gap (De et al., 2025), also identified in Albania, where individuals may express willingness for sustainable behavior but lack the infrastructural and economic means to act accordingly. However there are cases where traditional knowledge aligned with sustainability objective, can foster food security, biodiversity preservation and local ownership (Dionizi et al., 2025), critical dimensions for circular models. Empirical evidence in emerging markets highlights perceived barriers such as affordability, lack of awareness, and absence of local circular options, as constraints even for environmentally aware individuals (De et al., 2025). They propose models of mindful, responsible consumption where intentional awareness (rather than automaticity) drives behavior. This is especially relevant in the contexts like Albania, where consumer behavior is deeply embedded in cultural and historical consumption norms. In transitioning societies, societal belonging and status can significantly influence behavioral conformity to green norms. In terms of theoretical innovation, models such as mindful consumption, rooted in individual reflection and values, have emerged as useful complements to TPB. Drawing on the TPB and extended sufficiency frameworks, this study hypothesizes that intention to engage in CE-related practices is influenced by attitudes (e.g., care for environment), subjective norms (e.g., social responsibility), and perceived behavioral control (e.g., affordability, infrastructure). These theoretical constructs inform our hypothesis (H1-H4), which connect consumer attitudes, socio-demographic characteristics, and behavioral drivers within the specific context in Albania.

3 Materials and methods

3.1 Research design and data collection

The research process went through some key stages from conceptual development to empirical analysis. Figure 1 represents the logical sequence and methodological rigor of the study.

The study employed a cross-sectional quantitative design using a structured questionnaire to explore customer readiness for CE practices in Albania. The survey used Google Forms and was administered online and in person to ensure inclusivity across digital divides. A total of 250 valid responses were collected from residents of North Albania area between January and June 2025. Respondents were reached through a combination of email outreach, WhatsApp/Viber groups, social media distribution, and face-to-face interviews. Ethical standards, including informed consent for inclusion in the study and data anonymization, were rigorously followed. The collected data underwent additional processing to ensure confidentiality and to comply with data ethical guidelines.

3.2 Hypotheses development

Transitioning to a CE in emerging contexts such as Albania demands more than policy change or business innovation, it requires alignment with consumer awareness, motivation and behavior (Snezana et al., 2025). However, as noted by Bhar (2023); Saravanan (2024), generic behavioral models may fail to account for the socio-cultural and infrastructural constraints that shape decision-making. Building on this contextual insight, this study formulates four hypotheses grounded in literature that explores the interplay between demographic traits, CE-related behaviors and motivational drivers. Prior research has established that awareness of CE principles tends to correlate with socioeconomic status. João et al. (2025); De et al. (2025) emphasize that individuals with higher education and formal labor participation often have greater access to sustainability narratives and institutional touchpoints that foster environmental literacy. In the Albanian context, where CE knowledge is still emerging, such links may be even more pronounces. Thus, we hypothesize

- (H1) Full-time employment and higher education levels are positively associated with knowledge and engagement in CE practices.

Gender may influence how individuals conceptualize CE practices. As noted by Dionizi and Kercini (2025), generational exposure to environmental discourse shapes whether recycling, waste reduction, or product durability are seen as central to sustainability. Similarly, Akomea-Frimpong et al. (2024) found significant gendered differences in CE engagement in resource-limited contexts. This leads to the second hypothesis:

- (H2) Gender differences influence motivations and perceived barriers to adopting CE behaviors.

The concept of sufficiency has gained attention in CE literature (Megha, 2024; Bocken et al., 2022; Gossen et al., 2023). However, evidence suggests that sufficiency practices are unevenly adopted, particularly in emerging economies where economic precarity constrains choice (De et al., 2025; Snezana et al., 2025). Building on this, we test the hypothesis:

- (H3) Economic incentives and awareness campaigns significantly impact willingness to adopt sufficiently driven practices.

Certain CE behaviors may be strongly influenced by structural, infrastructural, or contextual barriers rather than by individual socio-demographic traits. Existing literature suggest that in emerging economies, where infrastructural systems for waste management, repair culture, or product lifecycle support are underdeveloped, behavioral participation may be constrained regardless of consumer readiness or awareness (Akomea-Frimpong et al., 2024; Saravanan, 2024; Trigkas et al., 2025; Mont et al., 2022). Hence, we hypothesize:

- (H4) Demographic variables have limited predictive power for certain CE behaviors, suggesting contextual or structural limitations.

3.3 Questionnaire design

The questionnaire was divided into two sections. The first section included demographic questions (age, gender, education, income, employment). While for the second part, the questionnaire was designed based on the key behavioral theories: (a) Theory of Planned Behavior (TPB): provided constructs on attitudes, subjective norms, and perceived behavioral control (Ajzen, 1991; Naskar and Lindahl, 2025); (b) Value-belief-norm

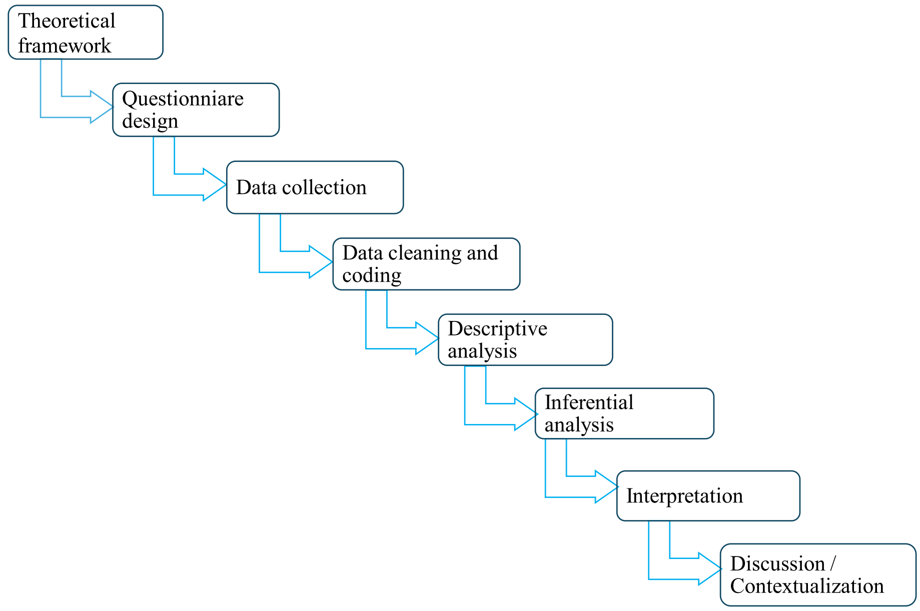

FIGURE 1
Methodological flowchart.

(VPN) Theory: introduced ethical and normative drivers of behavior (Stern et al., 1999; Kirchherr et al., 2018); (c) Social practice Theory: helped frame routine behaviors as socially and materially embedded (Hargreaves, 2011; Singh and Giacosa, 2018); (d) Sufficiency principle: guided questions on consumption moderation and mindful use (Bocken et al., 2022; Kropfeld and Reichel, 2019).Variables were grouped into five latent constructs:

- Knowledge (KN)—2 items
- Behavior (BH)—5 items
- Influences (IN)—5 items
- Practices (PC)—3 items
- Preferences (PF)—2 items

Each construct was measured using a 5-point Likert scale (Strongly disagree = 1; Disagree = 2; No comment = 3; Agree = 4; Strongly agree = 5). We have also constructed a latent variable labeled CE (Circular Economy) as shown in Figure 2. The sample size of 250 respondents meets the requirements of the SEM model (Hair, 2011; Hair et al., 2021). The figure is obtained by using Stata SEM builder.

The SEM analysis provides strong empirical support for the theoretical assumptions underpinning the study. Specifically, knowledge (KN), behavior (BH), and practices (PC) emerged as statistically significant predictors of circular economy (CE) readiness, with knowledge and practices exerting the strongest effects. This confirms that consumers' cognitive understanding of CE concepts and their concrete sufficiency-driven practices are the primary determinants of readiness. The significant role of knowledge suggests that awareness campaigns and educational interventions can directly strengthen CE readiness, underscoring the importance of informational tools and communication strategies in emerging economies. Behavioral engagement, though weaker in effect compared to knowledge and practices, still highlights the role of everyday actions—such as recycling and donating goods—as enablers of CE participation. Practices, particularly sufficiency-oriented consumption (buying only what is needed, valuing necessity over desire), proved to be highly influential, showing that moderation in consumption is not just an ethical stance but a measurable behavioral driver of readiness.

Interestingly, influences (IN) and preferences (PF) did not significantly predict CE readiness in the SEM results, despite their theoretical relevance. This gap indicates that stated motivations (e.g., environmental concern, social responsibility) and expressed preferences for incentives may not translate into measurable readiness unless supported by enabling infrastructure and socio-economic conditions. This finding aligns with the "intention-behavior gap" documented in sustainability research (De et al., 2025) and reinforces the idea that values and preferences alone are insufficient in contexts where structural and cultural barriers persist.

Taken together, the SEM results highlight a hierarchy of readiness determinants, where concrete knowledge and practiced behaviors outweigh abstract preferences or influences. This has important implications for CE policy and business interventions in Albania: strategies should prioritize strengthening consumer knowledge and enabling sufficiency-oriented practices, while recognizing that motivational appeals alone may not yield significant behavioral change.

3.4 Statistical methods

We used regression analysis to explore the impact of socio-demographic characteristics on key behaviors and attitudes.

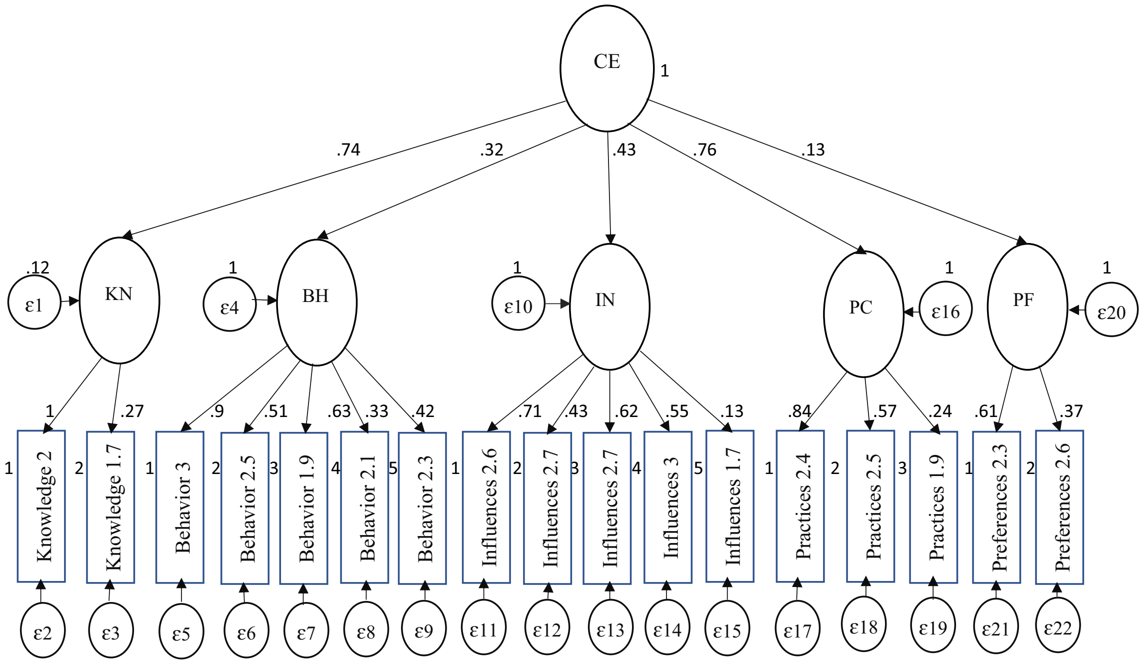

FIGURE 2
SEM model results.

All analysis was conducted in Stata. The structural equation model (SEM) is used as the statistical framework for this study, which utilizes the survey investigation method of a questionnaire. Multidimensional relationships among a large number of variables in the model have been investigated using structural linear models (SEM). SEM illustrates the relationships among latent variables. SEM integrates various methods, including factor analysis, multivariable regression, and correlation analysis (between network diagram segments), which allows us to examine the complex relationships within the model. To implement the SEM model, we conducted data cleaning, scale testing and exploratory factor analysis (EFA). And SEM was employed in this study because it enables the analysis of complex and multidimensional relationships that cannot be fully captured by traditional techniques. Many of the central constructs in the research (knowledge, behavior, influences, practices, and preferences) are latent in nature. This means that they are not directly observable but are inferred from multiple questionnaire items. SEM is particularly suited for this purpose, as it incorporates measurement error and thereby produces more reliable estimates than single-item indicators. Another advantage of SEM is its ability to estimate several dependent and independent relationships simultaneously. This is essential in the context of consumer readiness for the circular economy, which is shaped my a network of interrelated factors rather than by isolated linear effects (Lacej and Kalaj, 2015). Furthermore, the method aligns well with the theoretical foundations of the study. Behavioral frameworks such as TPB (Ajzen, 1991; Naskar and Lindahl, 2025) and VBN theory (Stern et al., 1999; Kirchherr et al., 2018) emphasize interconnections between attitudes, norms, values, and behaviors. SEM makes it possible to test these theoretical pathways directly to verify whether the data supports the proposed relationships. Equally important is the capacity of SEM to distinguish between direct and indirect effects. So, the model allows us to examine whether knowledge exerts a direct influence on readiness for the CE, as well as to identify more complex pathways, such as the role of socio-demographic characteristics operating through knowledge and behavior before shaping readiness outcomes. This holistic perspective provides a nuanced understanding of consumer decision-making in sustainability contexts.

To ensure the robustness of the findings, the measurement model was evaluated through indices such as composite reliability, average variance extracted (AVE), and overall model fit statistics. These tests confirmed that the constructs were adequately represented and that the hypothesized relationships were supported by the data, thereby strengthening the credibility of the analysis. Finally, the sample of 250 respondents satisfied established guidelines for SEM (Hair, 2011; Hair et al., 2021), providing sufficient statistical power to estimate multiple constructs and pathways with confidence.

3.5 Sample profile

The sample was predominantly composed of students and young adults, with balanced gender representation and a wide range of income and education levels. Table 1 presents the full breakdown.

TABLE 1 Research sample characteristics.

Variable	Categories	Percentage(%)
Gender	Male	14.2
	Female	83.3
	Prefer not to respond	2.5
Age	Below 18	5
	18–24	67.5
	25–34	10
	35–44	9.2
	45–54 Over	5
	55	3.3
Education	8–9 years	1.7
	High school	51.6
	Bachelor's degree	21.7
	Master's degree	19.2
	Doctorate degree	5.8
Occupation	Full-time	30
	Part-time	6.7
	Unemployed	3.3
	Student	57.5
	Retired	2.5
Income level	Below 40,000 ALL	21.7
	40,001–80,000 ALL	29.2
	80,001–1,20,000 ALL	31.6
	1,20,001–1,60,000 ALL	10
	Above 1,60,000 ALL	7.5

4 Results and discussions

The regression analysis (Table 2) revealed important socio-demographic patterns shaping consumer knowledge and behavior regarding the CE. Employment status emerged as a strong predictor of awareness: individuals working full-time consistently reported higher familiarity with CE concepts, suggesting that active participation in the labor market provides exposure to sustainability discourses.

Age and gender also played a role. Older respondents tended to associate CE more with recycling, whereas younger individuals emphasized resource minimization, reflecting generational differences in environmental framing. Women more frequently linked CE to recycling compared to men, a finding that aligns with eco-gender gaps observed in resource-limited contexts (Akomea-Frimpong et al., 2024). Behavioral outcomes (Table 3) reflected similar socio-demographic stratification. Donation practices (BH3) were more common among men and those in full-time employment, while sufficiency-oriented consumption (BH4) was positively associated with both higher education and employment.

By contrast, recycling and waste sorting behaviors (BH1, BH2, and BH5) showed no significant demographic associations, indicating that systematic and infrastructural barriers, rather than individual traits, may constrain these practices (Akomea-Frimpong et al., 2024; Rexhepi Mahmutaj et al., 2025; Trigkas et al., 2025). This illustrates how certain pro-environmental intentions remain unrealized when enabling structures are absent, reinforcing the persistence of an intention-behavior gap. Motivational drivers (Table 4) of CE engagement provided further nuance. Respondents employed full-time were more likely to report environmental care (IN1) as a motivating factor, while men, highly educated participants, and those in employment emphasized economic savings (IN2) as central to their decision-making. Employment status also correlated with perceptions of CE as a civic duty (IN3), suggesting that formal labor participation enhances normative commitments to sustainability (De et al., 2025; João et al., 2025).

Practicality (IN4) was valued particularly by men and employees, highlighting the importance of convenience for behavioral adoption. Barriers (IN5) differed along educational lines: respondents with higher education cited infrastructural deficiencies, while those with lower education more often emphasized financial constraints. This divergence underscores how knowledge can sharpen expectations for enabling environments, while economic precarity continues to hinder behavioral change. Further insights were provided by the analysis of sufficiency-oriented practices. Both valuing necessity over desire (PC1) and prioritizing sufficiency (PC2) were significantly associated with higher income and employment, suggesting that socio-economic security enables individuals to embrace consumption moderation as a normative orientation (Bhar, 2023). Preferences for sufficiency incentives (PC3) did not vary significantly by demographic traits, indicating motivational levers may cut across social groups but require contextual adaption to translate into practice (De et al., 2025). Intervention-related preferences revealed that full-time employees were more supportive of awareness campaigns (PF1), highlighting the latent demand for informational tools, while no demographic group dominated in terms of preferred incentives (PF2), where opinions were spread across financial discounts, reward points, and recognition. These findings reinforce the role of occupational and income structures not only in shaping current CE behaviors, but also in determining receptivity to future interventions.

Before estimating the SEM, the measurement model was validated (Table 5). All constructs reached acceptable levels of composite reliability (CR > 0.7) and satisfied discriminant validity criteria (Peterson, 1994; Peterson and Kim, 2013).

The SEM results (Table 6) confirmed that knowledge, behavior, and practices significantly predicted CE readiness, though with varying magnitudes. Knowledge and sufficiency-oriented practices exerted the strongest effects, while influences and preferences did not reach statistical significance. This hierarchy of effects demonstrates that concrete cognitive and behavioral engagement is more decisive than stated values or preferences, echoing earlier findings on the intention-behavioral gap in sustainability contexts (Bosone et al., 2022).

All the results mentioned above provide empirical support for the study's hypotheses, while also offering deeper insights. H1 is supported: educational and employment enhance CE awareness and practice, functioning as proxies for exposure to sustainability narratives. H2 receives partial support: while women emphasize

TABLE 2 Knowledge (KN) on CE practices.

	How well are you acquainted with the concept of CE (KN 1)		Which of the practices do you connect mostly with CE (KN 2)	
Variables	coefficient	*p*-value	coefficient	*p*-value
Age	0.054	0.475	0.473	0.004***
Gender	−0.169	0.225	0.606	0.043**
Education	−0.111	0.208	−0.307	0.102
Occupation	0.101	0.019**	0.155	0.088*
Income	0.008	0.858	0.131	0.188
Constant	1.984	0***	0.437	0.521

****p* < 0.01, ***p* < 0.05, **p* < 0.1.*

TABLE 3 Engagement behavior (BH) on CE activities.

	Recycling of household waste (BH 1)		Repairing instead of replacing (BH 2)		Donating what is no longer needed (BH 3)		Buy what's just needed (consume reduction) (BH 4)		The organic waste is put on: recycling bins at home, recycling community centers, don't recycle (BH 5)	
Variables	coeff	*p*-value	coeff	*p*-value	coeff	*p*-value	coeff	*p*-value	coeff	*p*-value
Age	−0.139	0.336	0.044	0.723	0.026	0.85	−0.126	0.315	−0.127	0.305
Gender	−0.527	0.051*	−0.436	0.063*	−0.712	0.007***	−0.442	0.059*	−0.285	0.217
Education	0.19	0.261	0.124	0.399	0.21	0.2	0.367	0.013**	0.262	0.072*
Occupation	0.137	0.096*	0.076	0.286	0.275	0.001***	0.282	0***	0.081	0.25
Income	0.013	0.887	−0.004	0.963	−0.044	0.613	0.149	0.057*	−0.019	0.804
Constant	2.895	0***	1.978	0***	1.311	0.029**	0.537	0.315	1.678	0.002***

****p* < 0.01, ***p* < 0.05, **p* < 0.1.*

TABLE 4 Influences (IN) mostly to be involved in CE practices.

	Care for the environment (IN1)		Economic savings (IN2)		Social responsibility (IN3)		Practicality (IN4)		The obstacles to adopt CE practices (lack of infrastructure, lack of awareness, cultural impediments, time limitation, economic limitation)(IN5)	
Variables	Coef.	*p*-value	Coef.	*p*-value	Coef.	*p*-value	Coef.	*p*-value	Coef.	*p*-value
Age	0.078	0.223	−0.049	0.503	0.076	0.314	0.054	0.468	−0.37	0.063*
Gender	−0.218	0.068*	−0.4	0.004***	−0.198	0.16	−0.408	0.004***	−0.234	0.523
Education	0.128	0.088*	0.225	0.009***	−0.024	0.783	0.115	0.187	0.488	0.036**
Occupation	0.09	0.014**	0.085	0.043**	0.085	0.048**	0.095	0.026***	0.21	0.063*
Income	0.001	0.972	0.037	0.415	0.047	0.313	0.055	0.233	−0.063	0.609
Constant	0.653	0.018**	1.008	0.002***	1.16	0***	1.191	0***	1.734	0.041**

****p* < 0.01, ***p* < 0.05, **p* < 0.1.*

environmental motives and men highlight economic or practical ones, behavioral outcomes were often similar, suggesting gendered differences in motivation more than in action. H3 is only partly confirmed: incentives and campaigns are perceived as important but not strongly stratified by demographics, pointing to their universal appeal as policy levers. H4 is strongly supported: recycling and waste sorting behaviors show no demographic differentiation, underlining how structural barriers overshadow individual readiness (Rexhepi Mahmutaj et al., 2025).

Beyond the hypotheses, the findings highlight broader patterns of consumer readiness in Albania. Sufficiency-oriented behaviors, while aligned with cultural traditions of reuse, appear to be easier to adopt when supported by socio-economic stability. This resonates with social practice theory, which emphasizes the embedding

TABLE 5 Results of testing composite reliability.

	CR (composite reliability)	AVE(average variance extracted)	MSV (maximum shared variance)
Knowledge (KN)	0.848	0.543	0.481
Behavior (BH)	0.829	0.572	0.401
Influences (IN)	0.705	0.464	0.553
Practices (PC)	0.773	0.501	0.361
Preferences (PF)	0.709	0.462	0.481

TABLE 6 Results of impact assessment of relationships.

Circular economy	Estimates	*p*-Values	Results
Knowledge (KN)	0.74	0.001	Not rejected
Behavior (BH)	0.32	0.000	Not rejected
Influences (IN)	0.43	0.762	Rejected
Practices (PC)	0.76	0.002	Not rejected
Preferences (PF)	0.13	0.258	Rejected

of practices in cultural and material contexts (Hargreaves, 2011; Gobbo, 2022). The dual legacy of Albania's post socialist transition, shifting from scarcity-driven sufficiency to liberalized consumerism, creates opportunities to revitalize older practices through intergenerational learning (Dionizi et al., 2025). The results also confirm the importance of differential communication. While green-motivated consumers may respond to identity and value-based messages, benefit- motivated consumers require economic and practical incentives (Gossen et al., 2023; Eg et al., 2025).

Finally, the study underscores the role of local governance and context-sensitive interventions (Dawkins et al., 2023; Axelsson et al., 2023). Municipal actors and NGOs already active in awareness campaigns, can leverage the preference for informational tools to build legitimacy and increase uptake. Businesses too, must move beyond offering "green" products toward participatory models such as repair services, leasing, or take-back schemes, aligning consumer constraints and values (Chevrollier et al., 2025; João et al., 2025). Aligning such practices with global sustainability frameworks, particularly the SDGs, may enhance credibility and open opportunities for internationalization. The integration of statistical results with theoretical discussion demonstrates that fostering CE readiness in Albania requires attention to both structural barriers and socio-demographic stratification. Employment and education provide important entry points, but lasting change will depend on enabling infrastructures, sufficiency-oriented norms, and participatory models that co-create value with consumers.

5 Conclusion

The findings of this study underline the significance of the CE in the Albanian and broader Western Balkan context, where historical legacies, infrastructural constraints, and the aspiration for EU integration converge. Albania's post socialist transition has generated both opportunities and challenges. While traditional practices of reuse and sufficiency resonate with the principles of circularity, fragmented infrastructure and limited policy enforcement continue to hinder their systematic adoption. Against this backdrop, understanding consumer readiness becomes crucial for shaping effective interventions and policies. Methodologically, the study combined a structured survey with 250 respondents in North Albania and advanced statistical techniques, including regression analysis and SEM. This approach allowed for the assessment of complex relationships between socio-demographic traits, behavioral constructs, and readiness for circular practices. The integration of behavioral theories provided a robust framework for interpreting results, confirming that consumer behavior in sustainability contexts cannot be fully understood through linear models alone.

The results point to knowledge and sufficiency-oriented practices as the most decisive drivers for readiness. Respondents who reported higher awareness of CE concepts and those who prioritized moderation in consumption were more likely to engage in circular practices. Employment status, education, and income further reinforced these outcomes, suggesting that socio-economic positioning enhances both the resources and the awareness necessary to participate. At the same time, the absence of significant effects for motivational influences and preferences illustrates a persistent intention-behavior gap, where values and stated aspirations do not translate into measurable engagement. This gap reflects the broader structural barriers in Albania, including weak recycling infrastructure and limited institutional support, which remain stronger determinant of action than individual readiness alone. These findings have important implications for policymakers, businesses, and educators. Policymakers must address structural barriers by investing in enabling infrastructures and designing interventions that make sufficiency practices feasible across socio-economic groups. Businesses can move beyond offering green alternatives by engaging consumers as co-creators through service-based models such as repair, leasing, and tack-back schemes. Educators and awareness campaigns should prioritize CE literacy, recognizing that knowledge is not merely a background factor but a primary driver of readiness. By combining infrastructural investments with behavioral interventions, actors across quadruple helix can accelerate Albania's transition toward a more sustainable economy.

The analysis, however, must be read with caution. The sample is geographically concentrated in the North and overrepresents younger respondents, which may limit representativeness across Albania. Self-reported survey data carry risks of social desirability bias, and the cross-sectional design prevents conclusions about causality. These limitations do not diminish the value of the findings but point to the need for more diversified and longitudinal research to strengthen the evidence base. Looking ahead, future research would benefit from longitudinal designs that trace changes in behavior over time, particularly as Albania advances its EU integration and sustainability agendas. Expanding to other regions of Albania and the wider Western Balkans would enable comparative perspectives, while qualitative methods could capture the cultural and social dynamics that underpin customer decisions. By broadening the methodological lens, future research will be able to offer even more nuanced guidance for interventions. The study demonstrates that Behavioral readiness for the CE in Albania is determined not only by individual knowledge and practices but also by the broader structural environment. Advancing CE adoption will require a dual approach through building enabling infrastructures and institutions and simultaneously fostering sufficiency-oriented behaviors and knowledge. Only through this integration can Albania and the Western Balkans achieve meaningful progress toward sustainability.

Data availability statement

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author/s.

Ethics statement

Ethical review and approval was not required for the study on human participants in accordance with the local legislation and institutional requirements. The participants provided their written informed consent to participate in this study.

Author contributions

BD: Conceptualization, Funding acquisition, Investigation, Methodology, Project administration, Writing – original draft. EK: Formal analysis, Methodology, Resources, Software, Writing – original draft. AA: Validation, Visualization, Writing – review & editing.

Funding

The author(s) declare that no financial support was received for the research and/or publication of this article.

Acknowledgments

The authors gratefully acknowledge the support of University of Shkoder “Luigj Gurakuqi” in enabling the publication of this article. Sincere thanks are also extended to the reviewers for their constructive feedback and valuable suggestions, which significantly improved the quality of the final manuscript.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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TYPE Original Research
PUBLISHED 21 November 2025
DOI 10.3389/frsus.2025.1666622

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OPEN ACCESS

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Maria Alzira Pimenta Dinis,
University Fernando Pessoa, UFP, Portugal

REVIEWED BY
Jawad Asif,
University of Gujrat, Pakistan
Serap Kalfaoğlu,
Selçuk University, Türkiye
Manuel Do Carmo,
Academia Militar - Campus da Amadora, Portugal

*CORRESPONDENCE
Yvonne van der Meer
yvonne.vandermeer@maastrichtuniversity.nl

RECEIVED 15 July 2025
ACCEPTED 17 October 2025
PUBLISHED 21 November 2025

CITATION
Bettker Vasconcelos C, Sanchez-Zeziaga A, Henning K and van der Meer Y (2025) Evolving (dis)engagement: analyzing employees' responses to sustainability initiatives through causal loop diagrams.
Front. Sustain. 6:1666622.
doi: 10.3389/frsus.2025.1666622

Evolving (dis)engagement: analyzing employees' responses to sustainability initiatives through causal loop diagrams

Carolina Bettker Vasconcelos[1], Ane Sanchez-Zeziaga[2], Klaus Henning[3] and Yvonne van der Meer[1]*

[1]Aachen-Maastricht Institute for Biobased Materials (AMIBM), Maastricht University, Geleen, Netherlands, [2]Faculty of Engineering, Mondragón Unibertsitatea, Arrasate, Mondragón, Spain, [3]Henning4future, Aachen, Germany

Introduction: This study employed a systems thinking approach to explore the complex and dynamic interactions between sustainability initiatives, and employees' subsequent perceptions, attitudes, and behaviors. It aims to address limitations in existing literature, arising from methodological approaches that fail to capture the nuances in employees' responses, and a lack of knowledge integration.

Methods: Insights from neo-institutional theory, sensemaking, and attribution theory were integrated with findings from 46 previous studies and 50 empirical qualitative data points though Causal Loop Diagrams (CLDs) to reveal feedback mechanisms and temporal dynamics that potentially shape employees' responses to sustainability initiatives.

Results and discussion: Two main reinforcing feedback loops were identified: one supporting continued engagement and implementation of sustainability initiatives, and another hindering initiatives through negative perceptions. A balancing loop revealed how increasing employee knowledge, experience and scrutiny can lead to more critical perceptions over time. The analysis suggests that more symbolic sustainability initiatives can foster initial employee engagement and support for future sustainability implementation in the early stages of a sustainability journey. However, this initial positive momentum can be fragile and transition into a "vulnerability period", where initial enthusiasm may transition to frustration if perceived impacts do not meet employees' growing expectations. This potential progression follows a "Fixes that Fail" systems archetype.

Conclusion: In this study, the use of CLDs provides a more temporally-bound and integrated understanding of employees' responses to sustainability initiatives. Therefore, this study challenges the simplistic dichotomy of positive versus negative effects of sustainability initiatives, revealing a more nuanced interplay between individual differences and organizational factors in shaping progressive employee (dis)engagement. Ultimately, the findings suggest that symbolic initiatives are not inherently bad, but sustaining employee engagement requires organizations to "walk their talk" by implementing consistent initiatives whose perceived impact can withstand increasing employee scrutiny.

KEYWORDS

sustainability initiatives, corporate social responsibility (CSR), stakeholder engagement, sustainability implementation, micro-CSR, causal loop diagrams, systems thinking, employees' perception

1 Introduction

Employees play a vital role in advancing an organization's commitment to the environment and society. They not only help to implement and advocate for sustainability initiatives but also encourage future efforts. Frequently, they also experience the impacts and changes these initiatives bring or the consequences of the their absence (Süßbauer et al., 2019; Onkila and Sarna, 2022). This dual role of employees as both drivers and recipients of sustainability efforts highlights their significance as key internal stakeholders in driving change toward sustainability and fostering a culture of environmental and social responsibility within the workplace. The growing recognition of the importance of employees in an organization's sustainability journey has led to increasing research focused on exploring how employees affect and are affected by sustainability initiatives (Onkila and Sarna, 2022; Aguinis et al., 2024).

A growing body of research focuses on understanding the effects of corporate social responsibility (CSR) initiatives on employees' outcomes (Donia et al., 2017; De Roeck and Maon, 2018; Glavas and Kelley, 2014). Current studies have investigated an impressive number of variables, broadly categorized into employees' perceptions, attitudes, and behaviors toward CSR, which are influenced by individual, organizational, and system-level factors (Aguinis et al., 2024; De Roeck and Maon, 2018). Two recent review papers provide a detailed overview of the topic, including the limitations of this body of research (Yassin and Beckmann, 2024; Aguinis et al., 2024).

Despite the acknowledged complexity of employees' responses to sustainability initiatives, limitations in methodology and knowledge integration continue to exist (Rupp et al., 2024). Most studies in the field of micro-CSR have investigated this topic using a linear approach, mainly quantitatively and through a cross-sectional design (Akhouri and Chaudhary, 2019; Onkila and Sarna, 2022). According to a recent literature review, approximately 80% of the studies in the field were based on quantitative or mixed methods in 2023 (Yassin and Beckmann, 2024). Additionally, studies that employ such a research approach tend to investigate relationships between variables that represent either positive or negative employees' responses toward CSR, with a predominant focus on variables that represent positive, or highly valued, attitudes and behaviors. This poses important challenges to academic understanding for two reasons. First, although cross-sectional studies often generate repetitive and comparative findings, the results provide a one-time snapshot of the moment of measurement, thus failing to capture the nuances and changes in employees' perceptions (Akhouri and Chaudhary, 2019; Yassin and Beckmann, 2024; Onkila and Sarna, 2022). Second, the literature often overlooks negative outcomes, with most previous studies investigating and interpreting employees' responses to sustainability initiatives as either positive or negative (Aguinis et al., 2024). This approach fails to recognize the complexity and potential nuances involved in the process, resulting in a limited and unrealistic understanding about the impacts of sustainability-oriented initiatives on employees' perceptions and outcomes (Babu et al., 2020; Yassin and Beckmann, 2024).

To address these gaps associated with methodology and knowledge integration, this study employs systems thinking lenses and tools to integrate insights and capture the dynamic complexity of the relationships between employees and sustainability initiatives. By doing so, this study provides a more temporally bound, nuanced, and integrated understanding of the topic. Based on 50 empirical data points obtained through semi-structured interviews and qualitative survey (QS) responses, and supported by 46 previously published research papers, this study answers the following research question: how can employees' perceptions, attitudes and behaviors regarding sustainability-oriented initiatives evolve over time?

This paper is structured as follows: subsection 1.1 outlines the theoretical framework of the study. Section 2 details the research methods employed, while section 3 presents the results. Section 4 offers a discussion and situates the findings within the context of existing research, providing insights to practitioners. Finally, Section 5 concludes this paper with an overview of the results, their main contributions, limitations and suggestions for future research. It is important to note that while existing literature predominantly explores employees' perceptions of CSR (i.e., micro-CSR), this research adopts a broader lens by considering any sustainability initiative that aimed at improving a company's environmental or social outcomes (hereafter also referred to as "sustainability initiatives" or "sustainability practices"). This focus applies regardless of their implementation approach (top-down or bottom-up), alignment with organizational goals, or level of complexity.

1.1 Theoretical foundation

The theoretical framework of this study, illustrated in Figure 1, presents an overview of the interplay between external pressures, organizational responses and employees' outcomes through a systems thinking approach. Therefore, in this section, the rationale that guided the development of the theoretical framework will be outlined. First, basic concepts, tools and notations related to systems thinking are explained, thereby justifying the use of such approach in this research. Then, to guide the readers through the theoretical framework depicted in Figure 1, key insights from neo-institutional theory, attribution theory and micro-CSR literature are gradually elucidated and cross-referenced in both Figure 1 and Table 1.

1.1.1 Systems thinking as the integrative framework

Despite the intricate dynamics between sustainability initiatives, and employees' perceptions, attitudes and behaviors, this phenomenon has not yet been explored through more integrative, methodological approaches, such as systems thinking. Systems thinking is an interdisciplinary approach that offers insights into how various elements of a system interact with each other over time, instead of focusing on the analysis of individual and isolated elements (Kim, 2000; Richardson, 1995). Consequently, systems thinking approaches are increasingly employed by practitioners and researchers in diverse fields of knowledge to tackle "wicked problems", such as those related to sustainable development, where trade-offs between economic, environmental and social aspects need to be managed (Williams et al., 2017; Grewatsch et al., 2021). In organizational contexts, systems thinking enables companies to guide organizational transformations in complex environments and anticipate unintended consequences (Bansal and Birkinshaw, 2025; Grewatsch et al., 2021). In research, his approach allows the integration of findings derived from different theories and levels of analysis, accounts for temporal aspects, and illustrates potential behavioral changes over time in the system or problem under investigation. Given these advantages systems thinking serves as a valuable framework to better comprehend interconnected factors influencing employees' perceptions, attitudes and behaviors triggered by sustainability initiatives in the workplace.

Rooted in systems thinking, causal loop diagrams (CLDs) are dynamic thinking tools that visually communicate the dynamic complexity of a problem or system (Kim, 2000; Sterman, 2000). CLDs consist of variables (i.e., dynamic elements) connected by links that represent hypothetical causal connections between variables, which often stem from the mental model of various stakeholders (e.g., employees, managers, and domain experts) and are supported by different degrees of scientific evidence (Sterman, 2000; Uleman et al., 2024). Each causal link is represented by arrows, indicating the direction of the effect, while the link polarity shows how two variables change in relation to each other: a positive ("+") polarity means that the variables change in the same direction, while a negative ("−") polarity indicates the opposite. Other important notations in CLDs are delays (||), which represent the relevant time lags in specific links. Additionally, feedback loops are a crucial feature of CLDs, describing sequences of cause-effect relations that begin and end with the same variable, resulting in either reinforcing ("R") or balancing ("B") patterns of behavior. Therefore, feedback loops are basic building blocks of dynamic systems (Sterman, 2000; Kim, 2000; Uleman et al., 2024). In this study, CLDs enable the integration of insights from

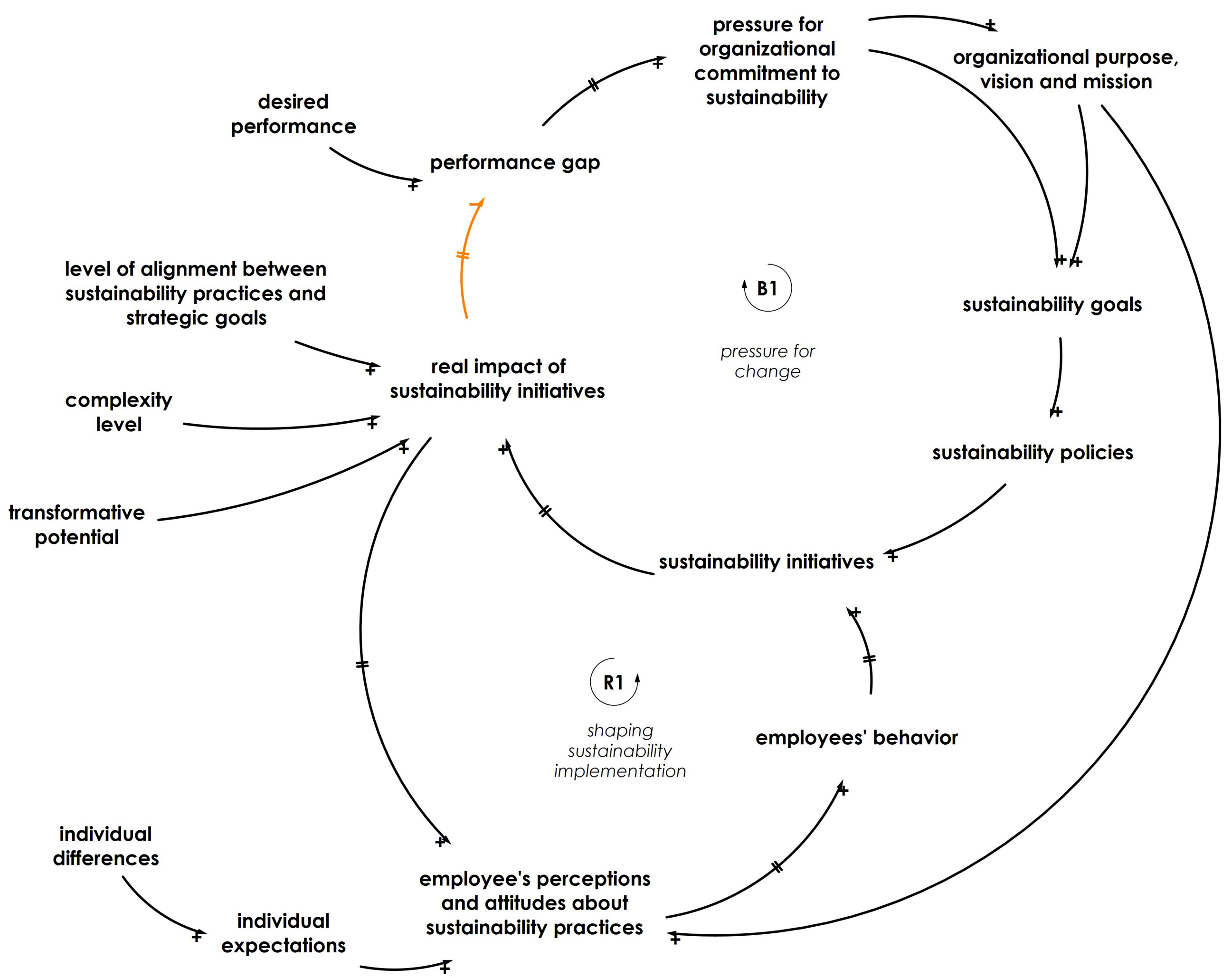

FIGURE 1
Theoretical framework of this study. The link polarity indicates how two variables change in relation to each other, i.e., a positive ("+") polarity means that the variables change in the same direction, while a negative ("−") polarity denotes the opposite. Red arrows highlight negative polarity. Double lines perpendicular to the arrows indicate a substantial time delay in that causal relationship.

neo-institutional, sensemaking and attribution theories into a unified framework.

Having established the basic concepts of systems thinking and CLD notations, the relevant theories and concepts integrated into the theoretical framework of this study (Figure 1) are presented. First, the nature of sustainability initiatives in organizations is presented, based on insights from neo-institutional theory. Subsequently, the focus shifts to the individual level of analysis, highlighting sensemaking and individual processes, such as motive attributions, that occur when employees are affected by sustainability initiatives.

1.1.2 Balancing external pressure through sustainability initiatives

The current environmental, economic and societal challenges intensify pressures on organizations to commit to principles that embrace not only economic prosperity, but also environmental and social responsibility (Helmig et al., 2016; Lubin and Esty, 2010). According to insights from neo-institutional theory, such pressures stem from coercive, mimetic or normative forces (Di Maggio and Powell, 1983; Bhuiyan et al., 2025). Coercive forces refer to regulations or laws imposed by powerful institutions that force firms to conform to certain standards. Mimetic pressures are related to the firms' inclination to imitate practices of legitimate and successful competitors (e.g., creating sustainability departments). Normative pressures are related to professionalization, and the broadly expected standards, such as international practices or norms on environmental behavior (Di Maggio and Powell, 1983).

To navigate such pressures and maintain legitimacy, companies can adapt their corporate purpose, vision, mission, goals, policies and practices with sustainability principles. However, the character of such actions can range from symbolic to substantive (Meyer and Rowan, 1977; Ashforth and Gibbs, 1990; Bromley and Powell, 2012). More symbolic actions are legitimacy-seeking. They primarily offer ceremonial signs of corporate engagement with sustainability in short term and are decoupled from strategic goals; therefore, they fail to promote the deep organizational change needed to address pressing sustainability challenges (Truong et al., 2021; Schons and Steinmeier, 2016). Oppositely, more substantive efforts are highly aligned with strategic goals, requiring significant investments of time, resources and organizational commitment. Driven by efficiency and adaptation purposes, such efforts aim to drive meaningful changes in organizational practices. Given the higher level of complexity, the impacts of more substantial actions are delivered in the longer term, gradually decreasing the pressure for corporate engagement with sustainability (Hyatt and Berente, 2017; Ashforth and Gibbs, 1990; Schons and Steinmeier, 2016). The specific characteristics of sustainability initiatives depend on the time horizon over which their impacts are realized, their transformative potential and their degree of strategic alignment.

In the theoretical framework that guided this study, neo-institutional theory informs about the generic external pressures that drive organizations to invest in sustainability initiatives. The organizational responses to increasing pressures are captured in the balancing feedback *B1 (pressure for change)*, as shown in Figure 1 and summarized in Table 1. Starting with the variable "pressure for organizational commitment with sustainability," Figure 1 illustrates that, as the pressure for change increases, the organization ideally aligns its purpose, vision and mission more closely with sustainability principles. This drives the establishment of sustainability goals and policies which, in turn, lead to the

TABLE 1 Description of feedback loops comprising the theoretical framework of this study.

Feedback loop	Description	Causal relationships	References
B1 (pressure for change)	Pressure for corporate engagement in sustainability (normative, coercive or mimetic) pushes the organization toward the establishment of sustainability goals and policies, which are then implemented through sustainability practices. Although there is a delay, these practices eventually reveal their real impact, which in turn negatively affects the performance gap and ultimately influences the pressure for corporate commitment to sustainability. Importantly, the time frame and real impact of sustainability practices depend on the degree to which they are symbolic or substantive, according to their complexity, transformative potential and alignment with strategic goals.	pressure for organizational commitment to sustainability >(+) sustainability goals >(+) sustainability policies >(+) sustainability initiatives >(‖)(+) real impact of sustainability practices>(‖)(−) performance gap>(‖)(+) pressure for corporate commitment to sustainability	Neo-institutional theory (Ashforth and Gibbs, 1990; Meyer and Rowan, 1977), decoupling (Bromley and Powell, 2012)
R1 (shaping sustainability implementation)	Sustainability initiatives are implemented, but there is a lag before their real impact becomes visible and perceived. Employees engage in sensemaking and attribution processes, which inform their perceptions and attitudes about such initiatives, shaping their behavior. Finally, employees' behavior influences the level of support for the implementation of future sustainability practices.	sustainability initiatives >(‖)(+) real impact of sustainability initiatives >(‖)(+) employees' perceptions and attitudes >(‖)(+) employees' behavior >(+) sustainability initiatives	Sensemaking theory, attribution theory and micro-CSR research (Aguinis et al., 2024; De Roeck and Maon, 2018; Weick, 1995; Kelley and Michela, 1980; Aguinis and Glavas, 2019)

implementation of sustainability initiatives. The real impact of such initiatives depends on the nature of the sustainability initiatives themselves: the higher the complexity and alignment with strategic goals, the greater their impact. Importantly, while more substantial initiatives are more complex and lead to higher impact, their outcomes take longer to be manifested. In contrast, the symbolic initiatives provide quick wins, but are usually less impactful. This is represented in Figure 1 as a delay (||) between the variables "sustainability initiatives" and "real impact of sustainability initiatives," and by the variable "transformative potential." As the impact of sustainability initiatives manifests, the performance gap begins to narrow. In turn, this gradually decreases the pressure for organizational commitment to sustainability, bringing the system to a state of reduced pressure. Ultimately, based on insights from neo-institutional theory, this process demonstrates how organizations respond to pressures and alleviate demands through the implementation of sustainability actions.

1.1.3 Employees' perceptions shape and are shaped by sustainability initiatives

Regardless of the degree of alignment with strategic goals, the successful implementation of sustainability initiatives relies on the active support of individual employees (Süßbauer et al., 2019). Employees—even those whose roles are not explicitly linked to sustainability topics—are increasingly recognized as key internal stakeholders for sustainability implementation, since they can act as implementers, ambassadors or recipients of corporate sustainability practices (Süßbauer et al., 2019). However, the way employees respond to sustainability initiatives depends not only on the practices themselves, but on how employees perceive and interpret them, including the motives attributed to their implementation (Aguinis et al., 2024; Akremi et al., 2018; Vlachos et al., 2017). To express these dynamics, we draw on sensemaking and attribution theories, since both provide interconnected insights and highlight the importance of perception and interpretation in shaping behaviors and decisions (Babu et al., 2020; Kelley and Michela, 1980; Weick, 1995).

Due to the intrinsic complexity and unavoidable tradeoffs associated with sustainability-related topics, sustainability initiatives often trigger sensemaking processes (Aguinis and Glavas, 2019; Hahn et al., 2010; Babu et al., 2020). According to sensemaking theory, when individuals are confronted with complex or ambiguous situations, they engage in sensemaking to understand such events and decrease uncertainty (Weick, 1995). This process happens collectively and individually, in an iterative and retroactive fashion, when employees actively interpret cues from their environment and draw on their previous experiences, social interactions and organizational context to create a coherent comprehension of what happened (Glavas, 2016; Weick, 1995). Informed by such sensemaking process and its consequent narratives, individuals make attributions about the motives behind organizational policies and practices, distinguishing between genuine (i.e., substantial, internally motivated, cause-serving) and self-serving (i.e., symbolic, externally motivated, self-serving) motives (Babu et al., 2020; Kelley and Michela, 1980).

The resulting attributions, narratives and perceptions (hereafter referred to as perceptions) influence employees' attitudes, which refer to negative or positive emotions and beliefs triggered by sustainability initiatives. In turn, the resulting employees' perceptions and attitudes lead to specific behaviors toward sustainability initiatives, including engagement, participation and proactivity (Aguinis et al., 2024). For instance, a time-lagged empirical study demonstrated that positive outcomes for employees occur only when they perceive CSR actions in their organizations as being driven by genuine motives (Donia et al., 2019). Importantly, a myriad of external and individual factors, along with information provided by the organizational context (such as its purpose, vision and mission), influence employees' perceptions of sustainability initiatives. This explains why, inside the same company, employees display varying opinions about such initiatives, which may change over time as new information becomes available or the context changes (Aguinis and Glavas, 2019; Gond et al., 2017).

In summary, employees' perceptions, attitudes and behaviors shape and are shaped by sustainability efforts that take place in their work environment (Aguinis et al., 2024). This interplay between organizational factors and employees' responses is depicted in Figure 1 and summarized in Table 1. Beginning with the variable "real impact of sustainability practices," the reinforcing feedback loop *R1 (shaping sustainability implementation)* demonstrates how the real impact of sustainability practices influences employees' perceptions and attitudes toward such practices, thereby shaping their behavior and ultimately impacting the implementation of future sustainability initiatives. Specifically, when the impact of sustainability initiatives is positively perceived, employees' attitudes and behaviors become more supportive, fostering a virtuous cycle that encourages further implementation of sustainability initiatives. Oppositely, negative perceptions lead to attitudes and behaviors that hinder sustainability implementation, creating a vicious cycle that reduces impact and increases pressure for change. Therefore, the feedback loop *R1 (shaping sustainability implementation)* depicts the self-amplifying role of employees in shaping the success or failure of an organizations' sustainability journey.

2 Methods

This research builds on observations from an in-depth single case study conducted by some of the authors of this paper (CBV, KH, YVM). Designed according to best practices available in literature (Yin, 2018), this case study primarily explored barriers to the implementation of sustainability-oriented projects within a multinational corporation (MNC) involved in the life sciences industry, focusing on the perspectives of employees from enabling functions. Detailed information about the company, sample and context are available in Supplementary material, Section S1, and in Bettker Vasconcelos et al. (2025). The methods employed in this study are presented in the following subsections.

2.1 Primary data collection and description

The collection of primary data involved a multimethod qualitative approach, including semi-structured interviews alongside a qualitative survey (QS) (Das et al., 2022; Mik-Meyer, 2020). This strategy facilitates the exploration of a specific phenomenon from multiple perspectives, minimizing the risk of over-representing the views of a few participants. It also allows researchers to confront and complement the findings from semi-structured interviews. The initial data collection phase, which included semi-structured interviews and a qualitative survey, took place from October to December 2022. Additional semi-structured interviews were conducted between August 2023 and November 2024 to validate and expand findings. This approach enabled the researchers to confirm, expand, and evaluate the temporal consistency of their preliminary findings. The semi-structured interview plans and QS details are available in Supplementary material, Section 1.

The empirical dataset comprised 50 data points, including 9 exploratory semi-structured interviews, 33 valid survey responses and 8 validation interviews. The sample was diverse regarding the participants' roles within the company, their areas of expertise, and years of experience within the organization. Detailed information regarding participants' details is available in Supplementary Table S1. To ensure anonymity, participants' current positions were not revealed. This rich empirical dataset has also supported the development of a separate study (Bettker Vasconcelos et al., 2025). Importantly, research questions, theoretical lenses, and methodologies of these studies are entirely distinct, thereby ensuring the originality and unique contribution of their findings. Additionally, while both studies share part of the empirical dataset, this study also builds on secondary data, as described in the following subsection.

2.2 Secondary data collection and description

A systematic literature review was conducted to validate and complement the primary data. Secondary data was obtained based on the following search string on Scopus: TITLE-ABS-KEY (employee* AND perception OR attribution OR sensemaking OR meaning OR interpretation AND "corporate sustainability" OR "corporate social responsibility" OR "csr" OR "esg" OR "environmental performance" OR "sustainability initiatives" AND symbolic OR substantial OR genuine OR self-serving OR intrinsic OR extrinsic OR greenwashing). The initial search generated a total of 70 results. The exclusion criteria eliminated studies focused on stakeholders other than employees, specific sectors (hotels, public sector and educational institutions), external communication (e.g., reporting), green HR practices, non-empirical research, and those not examining employee perceptions or interpretations of sustainability initiatives. After applying exclusion criteria and reviewing titles, keywords, and abstracts, 37 papers were selected. Additional papers were included through snowball sampling, resulting in a total of 46 studies. An overview of the selected papers is available in Supplementary material, Section 2.1.

2.3 Data analysis

This section describes the gathering and analysis of both primary and secondary data. Figure 2 illustrates the main steps of this process.

2.3.1 Primary data

Data gathering, analysis and validation were performed iteratively, as demonstrated in Figure 2. First, primary data obtained through semi-structured interviews and QS responses was analyzed through an inductive approach inspired by Kim and Andersen (2012). Each participants' sentences that suggested causal relationships were inductively coded in the software MAXQDA 2022 (VERBI Software, 2021). Based on the coded textual data, variables representing hypothetical causes and effects were identified, and the polarity of such relationships was also documented. Then, the identified causal links were added to the theoretical framework of this study (Figure 1). This process was performed using the software Vensim® PLE 10.2.1. The resulting Preliminary CLD was refined and iteratively validated throughout 8 validation interviews, as mentioned in Section 2.1. Additionally, such preliminary versions were presented in four distinct scientific events, namely: International Conference on New Business Models (July 2024, Donostia/San Sebastian, Spain); International System Dynamics Conference 2024 (August 2024, Bergen, Norway); 4th Maastricht Observatory on Responsible, Resilient and Sustainable Societies, Economies and Enterprises (MORSE) Academic Conference 2024 (October 2024, Maastricht, Netherlands); 3rd Learning and Innovation for Resilience and Sustainability Symposium (November 2024, Heerlen, Netherlands). Feedback from experts across various disciplines contributed to the validation and the conceptual significance of this study, while experts in SD provided substantial methodological support.

2.3.2 Secondary data

While iteratively refining and validating the preliminary versions of the CLD, the analysis of the 46 selected scientific papers was conducted, with a focus on identifying variables and their relationships. To ensure representativeness and avoid redundancy in literature-derived data, only variables supported by at least two distinct references or associated with at least three other variables were selected for the following data analysis step. In addition, variables expressing similar concepts were merged into a single variable. This process led to the selection of 18 variables and their hypothetical relationships, which were subsequently integrated into the validated version of the Preliminary CLD. This process not only expanded the results of this research but also provided additional validation for some empirically identified causal links, leading to the generation of an Integrated CLD, as mentioned in Figure 2. At this stage, each causal link was associated with its respective source reference, following recommendations available in the literature (Jalali and Beaulieu, 2024).

2.3.3 CLD simplification and interpretation

The Integrated CLD was analyzed with the aid of the software Vensim® PLE 10.2.1, and feedback loops were identified. Each feedback loop was analyzed using an approach inspired by Tomoaia-Cotisel et al. (2021). During this process, the researchers gathered supporting quotes and previous studies that assisted

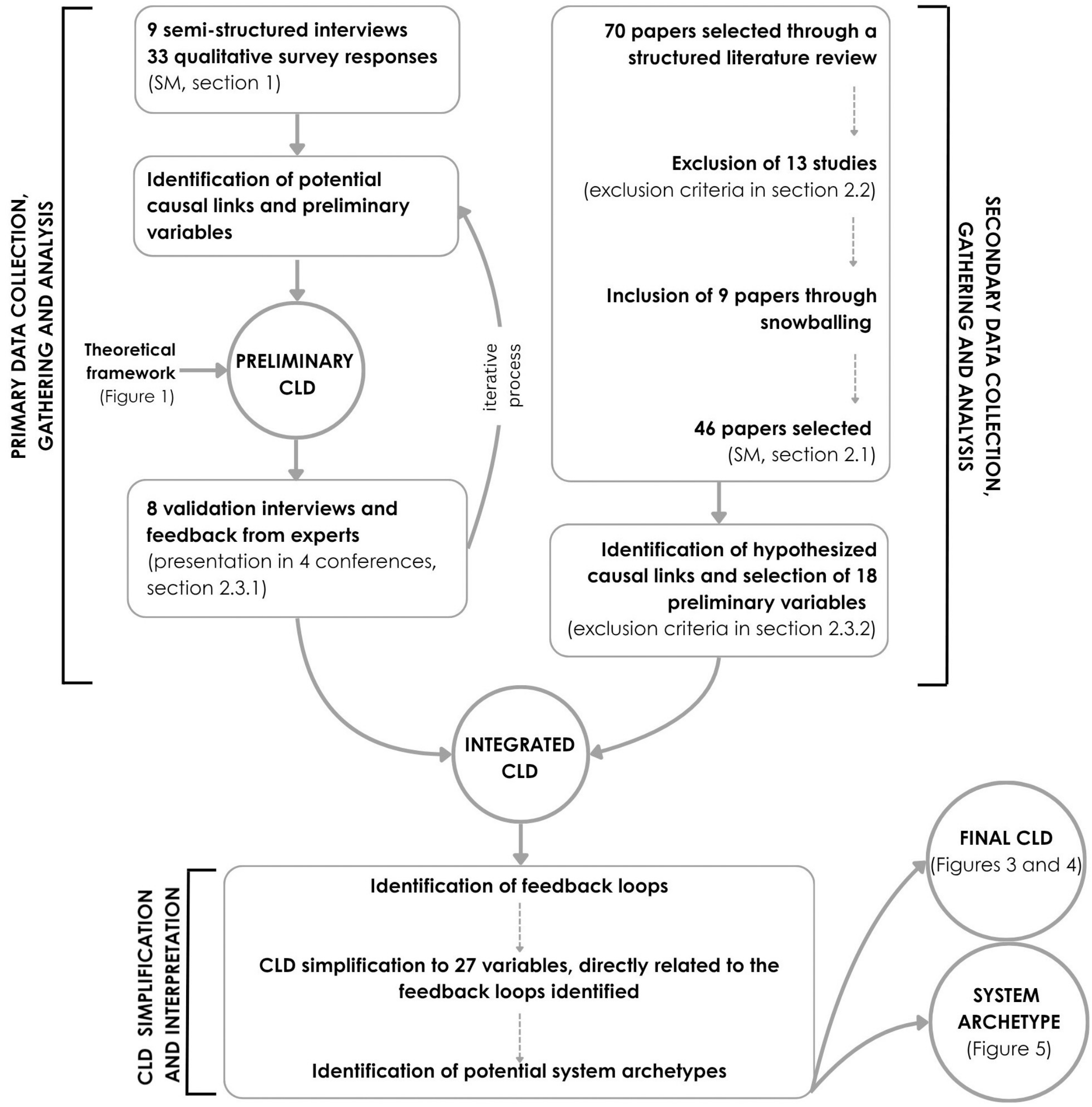

FIGURE 2
Diagram representing iterative data analysis and validation process. CLD, Causal loop diagram; SM, Supplementary material.

the comprehension of each feedback loop identified, while also indicating relevant temporal aspects. The researchers' reasoning and interpretation were systematically documented to increase the credibility and reproducibility of causal links and feedback loops, thus ensuring a transparent interpretative process. Following the identification and interpretation of feedback loops, variables not associated with these loops were removed from the final diagram to facilitate readability and focus on the main dynamics of the phenomenon under investigation. This process generated the final CLD presented in this study (Figures 3, 4), which was assessed for the identification of system archetypes, i.e., recurring structures responsible for patterns of behavior over time, especially counterintuitive behaviors (Kim, 2000; Wolstenholme, 2003).

3 Results

This section presents the main findings of this study, which result from the integration of insights obtained through semi-structured interviews, QS and systematic literature review into the theoretical framework of this study (Section 1.1, Figure 1). Table 2 lists key variables presented in Figures 3, 4. A detailed description of each variable presented in this paper is available in Supplementary material, Section 3, Supplementary Table S2. Additionally, a summary of each feedback loop is provided in Table 3, containing exemplary quotes and supporting studies.

The analysis of the CLD, derived from the integration of empirical data and prior research findings, reveals the existence of two main reinforcing feedback loops. As depicted

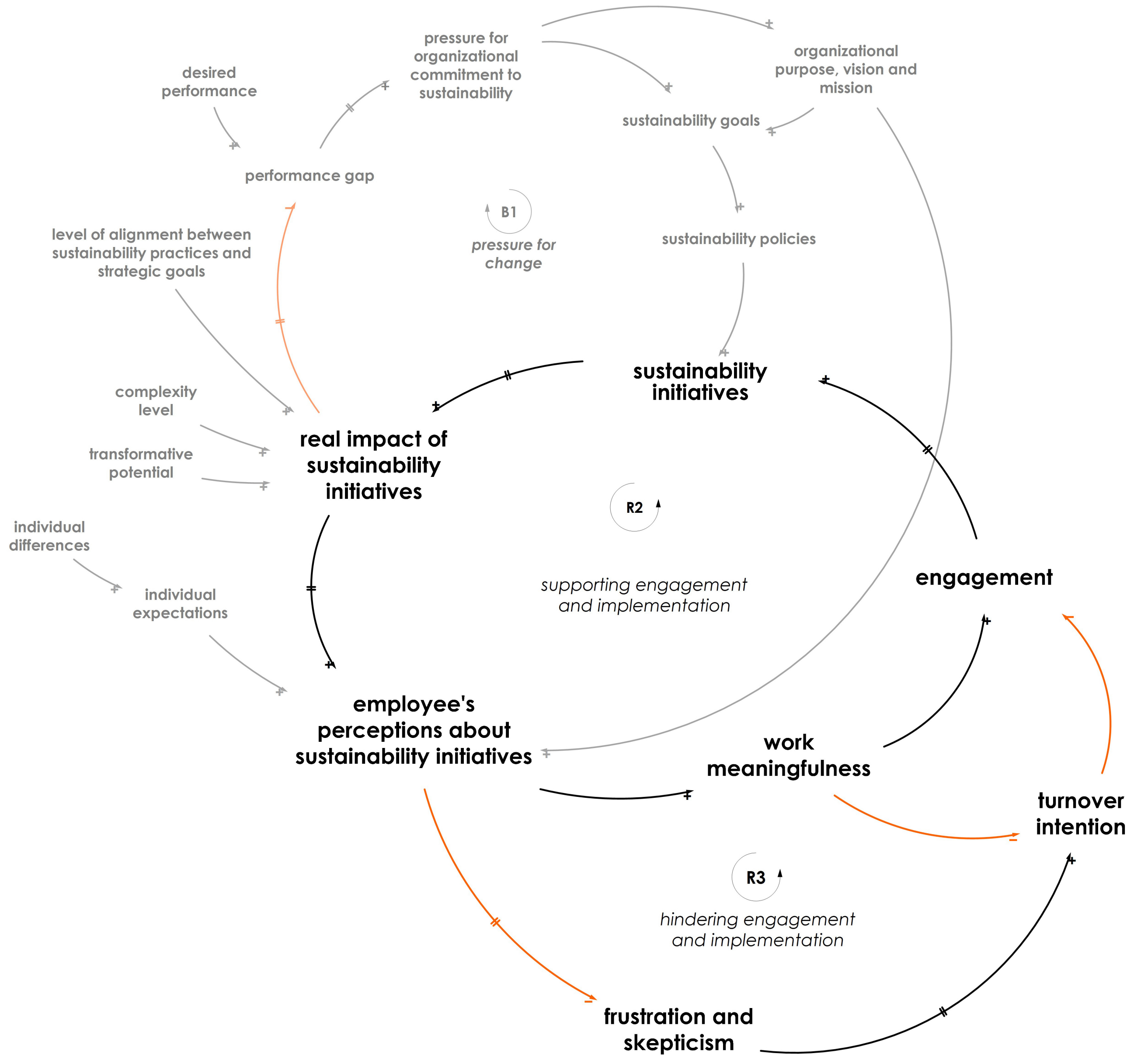

FIGURE 3
Sustainability initiatives shape and are shaped by employees' perceptions, attitudes, and behaviors, generating feedback loops that either support (R2) or hinder (R3) further sustainability implementation. The link polarity indicates how two variables change in relation to each other. Orange arrows highlight negative polarity. Gray text and arrows refer to the theoretical framework of this study. Double lines perpendicular to the arrows (||) indicate a substantial time delay in that causal relationship.

in Figure 3, the feedback loop *R2 (supporting engagement and implementation)* shows that when employees display more positive perceptions about sustainability initiatives their sense of work meaningfulness and engagement increase. This, in turn, increases the implementation of future sustainability practices within the organization and increasing their chances of success. Oppositely, the reinforcing feedback loop *R3 (hindering initiatives through negative perceptions)* shows that negative perceptions about sustainability initiatives potentially reduce sustainability implementation. The findings indicate that there is an increase in frustration and skepticism when employees perceive sustainability practices more negatively (i.e., initiatives are perceived as symbolic, hypocritical, or having low impact). According to empirical data, this process occurs gradually, as indicated by a delay sign between the variables "employees' perceptions about sustainability initiatives" and "frustration and skepticism" (Figure 3). The data also show, these negative attitudes lead to higher turnover intention and lower employee engagement. Decreased employee engagement, in turn, reduces the implementation of sustainability practices, reinforcing negative perceptions and completing the reinforcing loop. The perspective of a participant illustrates this dynamic:

FIGURE 4
Deeper knowledge in sustainability-related topics increases scrutiny and leads to more critical perceptions of sustainability efforts (feedback loops B2 and R4). The link polarity indicates how two variables change in relation to each other. Orange arrows highlight negative polarity. Gray text and arrows refer to the theoretical framework of this study. Double lines perpendicular to the arrows (||) indicate a substantial time delay in that causal relationship.

> "Lack of focus on topics where they can create significant and sustained impact, in line with company priorities, tends to proliferate actions, reduce impact and hence create frustration and hinder longer term employee engagement." (Survey #6)

The analysis of the resulting CLD also reveals variables that influence the dynamics of feedback loops *R2 (supporting engagement and implementation)* and *R3 (hindering initiatives through negative perceptions)*, such as knowledge level regarding sustainability. The data show that, over time, employees increase their expertise about sustainability through training opportunities, direct engagement with sustainability initiatives or role-related involvement. This increase in knowledge and experience levels lead to higher scrutiny of sustainability initiatives, thereby reducing the perceived impact of these initiatives. As a result of the diminishing levels of perceived impact, employees' perceptions gradually become more negative. Therefore, unless employees perceive the impacts of sustainability initiatives as significant or satisfactory, negative perceptions will rise, fostering negative attitudes and behaviors associated with feedback loop *R3 (hindering initiatives through negative perceptions)* in a reinforcing manner. This overall dynamic is represented in Figure 4, specifically in the balancing loop *B2 (aiming for excellence*) and *R4 (increasing criticism)* (Table 3). The viewpoint of a participant in this study illustrates this finding:

> "When it comes to sustainability, you sometimes have the impression we are now trying to incorporate sustainability in every aspect of the company and are coming up with initiatives even if their impact is close to zero. We need to be careful that we are not doing sustainability initiatives for the sake of doing it (....). If you are not making any impact with your initiatives, you might not do it and focus energy and resources on your role." (Survey > #15)

To summarize these dynamics, Figure 5 depicts the interaction pattern between the feedback loops *B2 (aiming for excellence)* and *R2 (supporting engagement and implementation)*. It shows that the implementation of sustainability initiatives increases employees' engagement (short-term effect), while simultaneously increasing employees' knowledge and experience in sustainability topics. However, higher knowledge and experience levels increase scrutiny regarding the impact of sustainability initiatives, which can unintentionally decrease employees' engagement when the impact of sustainability initiatives is not considered satisfactory (long-term effect).

TABLE 2 Definition of important variables, according to this study's context.

Variable	Definition	References
Engagement	Enthusiastic and proactive behavior toward sustainability efforts, which allows employees to bring their physical, cognitive and emotional potential to sustainability initiatives. In empirical data, this behavior was identified through expressions of energy, effort, emotional involvement or mental focus regarding the organizational journey toward sustainability or sustainability initiatives themselves.	(Chaudhary, 2020; Kahn, 1990)
Skepticism and frustration	Sense of doubt and distrust toward the authenticity or effectiveness of organizational claims or actions. In empirical data, this behavior was identified through expressions of doubt, irony, detachment or disappointment toward the organizational journey toward sustainability or sustainability initiatives themselves, especially when initiatives are perceived as futile or expectations are unmet.	Author's elaboration
Work meaningfulness	Feeling that one's work is significant, purposeful, and makes a positive difference. This attitude was identified in empirical data through expressions of fulfillment or satisfaction regarding one's personal growth, positive impact on others or on the broader contexts (organization, society, environment).	(Chaudhary, 2020; Aguinis and Glavas, 2019)
Turnover intention	Conscious and deliberate thought of leaving one's current job or organization. This attitude was identified in empirical data through statements that explicitly demonstrate participants' intention to leave their company, department or role.	(Wandycz-Mejias et al., 2025)
Scrutiny	Critical evaluation of organizational practices, stemming from increased awareness or a desire for transparency and accountability. In empirical data, scrutiny was identified in sentences where participants demonstrate to reflect or question the rationale behind organizational decisions and practices related to sustainability, or critically evaluate their impact in the organization or broader context (environment and society).	Author's elaboration
Knowledge level	Level of one's understanding, information and expertise regarding sustainability topics. This variable was not directly measured for each participant, but it was included in the CLD based on sentences demonstrating that one's understanding about sustainability evolves over time, affecting how they perceive sustainability efforts in the organization.	Author's elaboration

4 Discussion

Based on the interdisciplinary and integrative perspective of systems thinking, this study relies on the development of CLDs to explore the complex and dynamic relationships between sustainability initiatives and employees' perceptions, attitudes and behavior. To develop the theoretical framework of this study, a CLD was developed to integrate insights from neo-institutional theory, attribution theory and micro-CSR research. The theoretical framework, illustrated in Figure 1, provided a dynamic perspective into the topic and depicted the interplay between external pressures, organizational responses and individual reactions. To address the research question of this study, insights obtained from semi-structured interviews, QS responses, and prior studies were integrated into the theoretical framework (Figure 1), generating the CLD depicted in Figures 3, 4.

The results presented in Figures 3, 4 reveal complex interconnections among the variables and feedback loops associated with employees' responses to sustainability efforts in the workplace (Table 3). The feedback loop *R2 (supporting engagement and implementation*) represents the virtuous cycle of continued support for sustainability implementation, where employees with positive perceptions about sustainability initiatives support continuous sustainability implementation within the organization, potentially generating more impact and positive perceptions (Figure 3). Oppositely, *R3 (hindering initiatives through negative perceptions)* demonstrates a vicious cycle of continuous negative perceptions and decreased engagement in sustainability implementation (Figure 3). Additionally, in Figure 4, the feedback loop *B2 (aiming for excellence)* illustrates how the gradual accumulation of key variables, such as knowledge and experience levels, influences the dynamic interactions between feedback loops *R2, R3*, and *B1*.

The interdependencies among these feedback structures, as shown in Figures 3, 4, suggest the existence of a coupled feedback system, where the loops are structurally connected through shared variables, mutually influencing their activation and dominance patterns. Therefore, the system behavior over time depends on which of the feedback loops is more dominant (Richardson, 1995; Sterman, 2000). When examining these findings through the integrated perspective of neo-institutional, sensemaking and attribution theories, it can be suggested that the feedback loop *R2 (supporting engagement and implementation)* is dominant in the early stages of an organization or individual's sustainability journey. According to neo-institutional theory, more symbolic sustainability initiatives are typically simpler to execute and manifest their effects quickly, allowing companies to manage their legitimacy at short term (Di Maggio and Powell, 1983; Schons and Steinmeier, 2016). At this stage, the implementation of simpler sustainability initiatives, along with limited employee expertise, creates a straightforward environment, in which fewer contradictions and trade-offs are noticed. This can create a temporary sense of achievement among employees, especially those whose roles offer limited involvement with sustainability practices (Sancak, 2023; Stouten et al., 2018). In this context, more uncritical narratives about sustainability initiatives are generated, providing a favorable context for individual attribution processes (e.g., employees are more likely to attribute genuine motives to sustainability initiatives) (Babu et al., 2020). This leads to more positive perceptions, increasing employee engagement, and enhancing their support toward additional sustainability initiatives.

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TABLE 3 Evidence and description of feedback loops and key relationships identified in this study.

<table>
<tr><th>Feedback loop</th><th>Causal links</th><th>Interpretative notes and justification of the relationships between variables</th></tr>
<tr><td>R2 (supporting engagement and implementation)</td><td>Sustainability initiatives >(||)(+) real impact of sustainability initiatives >(||) (+) employees' perceptions about sustainability initiatives > (+) work meaningfulness >(+) engagement >(+) sustainability initiatives.

Sustainability initiatives >(||)(+) real impact of sustainability initiatives >(||) (+) employees' perceptions about sustainability initiatives > (+) work meaningfulness >(−) turnover intention >(−) engagement</td><td>The more positive the initiative is perceived, the more positive employees' attitudes are (e.g., meaningfulness at work). Such positive attitude leads to increased engagement. In turn, a high engagement level, facilitates the implementation of future sustainability initiatives, thereby creating more positive impact and reinforcing positive perceptions.

Employees' perceptions about sustainability initiatives > (+) engagement: previous studies suggest that positive perceptions about CSR (or sustainability initiatives) lead to increased employee engagement (Al-Madadha et al., 2023; Oh et al., 2023; Dong and Zhong, 2022; Hur et al., 2018; Babu et al., 2020; Ahmad et al., 2019; Chaudhary and Akhouri, 2018). This is also demonstrated by participants' perspectives such as: "[regarding initiative of digital files hygiene to save energy] They were only 20, 30 people, and they've reduced [energy use] significantly! They calculated the amount of carbon that they saved. It was pretty significant. (...) [Colleagues are] recalculating that to the broader group, and making those bigger initiatives. I think that can be quite motivating! (...) My personal footprint is significantly lower." (Val_Interview #18)

Employees' perceptions about sustainability initiatives > (+) work meaningfulness: previous studies also demonstrate a positive influence of employees' perceptions of sustainability initiatives on work meaningfulness (Chaudhary, 2020; Nejati and Shafaei, 2023). This is also suggested by participants. For instance: "For me, it feels really satisfying if I do something, because just ignoring the problems also doesn't help, right? And if many people do the same things, maybe it helps." (Interviews >#39)

Work meaningfulness >(+) engagement: The relationship between work meaningfulness and employee engagement is also in line with previous studies. According to Kahn (1990), employees vary their engagement levels based on several psychological factors, including the meaningfulness perceived of a certain activity. This is also demonstrated by participants of this study: "People that are interested, really also love to discuss and also love to bring ideas how [the case company] can become more sustainable with small things. Also not related to production processes or things, but also to offices, to reduce for example, garbage." (Interviews >#39)

Work meaningfulness >(−) turnover intention: the negative relationship between work meaningfulness and turnover intention has also been explored in previous studies (Wandycz-Mejias et al., 2025; Sánchez-Cardona et al., 2021). Sentences like the following also suggest that more negative perceptions about sustainability initiatives and lower levels of work meaningfulness may lead to higher intention to quit over time: "Honestly, I will leave the [department X]. (...). I cannot spend my time with superficial [projects]. Then I prefer to be in a function where I can make a difference than just being in the function that sells it nicely. (Val_Interviews > #38)</td></tr>
<tr><td>R3 (hindering engagement and implementation)</td><td>Sustainability initiatives >(||)(+) real impact of sustainability initiatives >(||) (+) employees' perceptions about sustainability initiatives >(||)(−) frustration and skepticism >(+) turnover intention >(−) engagement >(+) sustainability initiatives</td><td>When employees perceive sustainability initiatives as having little impact, their positive perceptions are decreased. Consequently, frustration and skepticism gradually grow. This leads to higher turnover intention and decreased engagement over time, hindering the implementation of future sustainability efforts and reinforcing negative perceptions. There is growing evidence that symbolic attributions and negative perceptions of sustainability initiatives lead to employees' negative outcomes, including higher turnover intention and decreased engagement (Shahzadi et al., 2024; Robertson et al., 2023; Chen et al., 2023). Besides exemplary quotes presented in Section 3, the following perspective also exemplifies the temporal aspects associated with frustration and turnover intention in the feedback loop R3: "In the first year, I was very excited in [department X] (...) It's starting to increase frustration. Honestly, I will leave the [department X] (...) I cannot spend my time with superficial [projects]. Then I prefer to be in a function where I can make a difference than just being in the function that sells it nicely." (Val_Interviews > #38).</td></tr>
<tr><td>B2 (aiming for excellence)</td><td>When perceived impact does not outweigh employees' scrutiny level: sustainability initiatives >(||)(+) knowledge level >(||)(+) scrutiny level >(−) perceived impact of sustainability initiatives >(+) employees' perceptions about sustainability initiatives >(||)(−) frustration and skepticism >(+) turnover intention >(−) engagement >(+) sustainability initiatives
When perceived impact does outweigh employees' scrutiny level: sustainability initiatives >(||)(+) knowledge level >(||)(+) scrutiny level >(−) perceived impact of sustainability initiatives >(+) employees' perceptions about sustainability initiatives (+) work meaningfulness >(+) organizational commitment >(+) engagement >(+) sustainability initiatives</td><td>Accumulated knowledge over time increases employees' ability to critically evaluate the impact of sustainability initiatives. If the impact perceived is not considered sufficient, negative perceptions, attitudes and behaviors are triggered. Oppositely, if the impact of sustainability initiatives is considered sufficient, positive perceptions, attitudes and behaviors are triggered.
This feedback loop is supported by participants of this study and by previous studies (Asante Boadi et al., 2020; Robertson et al., 2023).
"The closer people are to the true concept of impact, managing for impact and understanding handprint, footprint topics and what the company actually can achieve and is achieving or doing and also how we are doing it, the more they look at these type of what you call symbolic initiatives as like "What? You're joking". Yeah, I heard that. I mean, even from some people, like, "yeah, when we run, we run for water. Yeah, that's gonna save the planet". (...). So it becomes even sarcastic." (Val_Interview #41)</td></tr>
</table>

(Continued)

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TABLE 3 (Continued)

Feedback loop	Causal links	Interpretative notes and justification of the relationships between variables
R4 (increasing criticism)	Scrutiny level > (−)perceived impact of sustainability initiatives >(−) scrutiny level	The higher the scrutiny level, the lower is the perceived impact of sustainability initiatives. Conversely, when the perceived impact of sustainability initiatives is high, the lower is the scrutiny level. *"When it comes to the sustainability you sometimes have the impression we are now trying to incorporate sustainability in every aspect of the company and are coming up with initiatives even if their impact is close to zero. We need to be careful that we are not doing sustainability initiatives for the sake of doing it (. . .) but to make a real impact. If you are not making any impact with your initiatives, you might as well not do it and focus energy and resources on your role". (Survey #15)*

However, the findings suggest that this initial positive momentum is fragile and can transition into a "vulnerability period" (Figure 6). The "vulnerability period" represents a challenging phase, when initial enthusiasm and engagement may decrease while pressure for change increases., In other words, it can be suggested that the dominance of the feedback loop *R2 (supporting engagement and implementation)* decreases, while there is an increase in the dominance of *B1 (pressure for change)* (Figure 6). According to this study's findings, the gradual accumulation of employees' knowledge and experience in sustainability efforts is crucial in triggering a transition toward the "vulnerability period." The "vulnerability period" marks a phase where employees gradually become aware of the potential disconnect between their organization's policies or ceremonial actions ("talk") and the daily practices that promote substantial progress toward sustainability ("walk") (Schons and Steinmeier, 2016). As shown in the balancing feedback loop *B2 (aiming for excellence)* (Figures 4, 5), as employees gradually accumulate knowledge and experience in sustainability-related areas, they tend to perceive the impact of sustainability initiatives with greater scrutiny, being able to identify potential inconsistencies and shortcomings. If there is a perception of disconnection, or if the impacts of more substantial sustainability changes are not yet apparent, employees may engage in collective sensemaking processes to make sense of such a discrepancy. This heightened scrutiny potentially increases ceremonial or external attributions toward sustainability efforts (Lauriano et al., 2022; Babu et al., 2020). Consequently, negative perceptions arise, gradually increasing the dominance of the feedback loop *R3* (*hindering initiatives through negative perceptions)* and leading to a decline in employee engagement. Ultimately, this decline in engagement hinders the overall implementation of sustainability initiatives and reinforces the pressure for organizational commitment with sustainability (*B1, pressure for change*), as depicted in Figure 6.

This dynamic can also be comprehended through the system archetype "Fixes that Fail" (Figure 5), which illustrates that while certain solutions may be effective in the short term, they can lead to unintended long-term consequences (Senge, 2006; Kim, 2000). In this scenario, the long-term negative effects of more symbolic sustainability initiatives can exacerbate pressure for organizational commitment to sustainability. The outcome of this period can influence the sustainability implementation trajectory, leading to either significant improvements in the quality and impact of sustainability initiatives or cycles of diminishing returns and increasing scrutiny (Wolstenholme, 2003).

Interestingly, the "vulnerability period" can also reflect the complexity of implementing more substantial sustainability initiatives. As organizations transition from simpler and short-term solutions to more substantial sustainability changes, employees confront the inherent difficulties associated with the implementation of substantial sustainability changes. This critical period has been acknowledged in the change management literature. Since a sustainability transformation in organizations is a long-term process, previous studies claim that focusing on short-term wins is fundamental for obtaining employees' initial support (Sancak, 2023; Kotter, 2007). However, it is easy to get stuck in this initial stage, since the relative ease and low cost of more symbolic efforts may be prioritized over deeper and more complex ones (Riemer et al., 2025). Consequently, overreliance on short-term wins can lead to misunderstandings that undermine change initiatives (Stouten et al., 2018). Therefore, as the severity and length of this period are context-dependent, it is critical to raise awareness about the differences between short-term wins and long-term expectations to avoid getting trapped into a "Fixes that Fail" dynamics (Sancak, 2023; Senge, 2006). Clear and transparent internal communication is key for maintaining engagement, readjusting trust and aligning expectations among employees (Robertson et al., 2023).

Overall, the findings of this study align with previous research that demonstrates the importance of perceived impact and authenticity of sustainability-focused actions in shaping employees' attitudes and behaviors (Donia et al., 2017). For instance, this study's results resonate with previous work demonstrating that genuine, substantial attributions of CSR are associated with employee engagement, whereas ceremonial attributions trigger negative outcomes, such as cynicism (Shahzadi et al., 2024). However, this research expands on this understanding by suggesting that employees' perceptions may gradually change over time. In this study, the findings indicate that such changes result from the accumulation of knowledge, experience, and subsequent heightened scrutiny levels. This demonstrates the importance of considering temporal aspects, individual and contextual changes when investigating employees' responses to sustainability initiatives.

Additionally, the findings also contribute to the literature by challenging the traditional dichotomy between the positive and negative effects of sustainability initiatives on employees. Instead, this study uncovers a more nuanced interplay between individual processes and organizational factors in shaping progressive (dis)engagement in sustainability. This finding is in line with

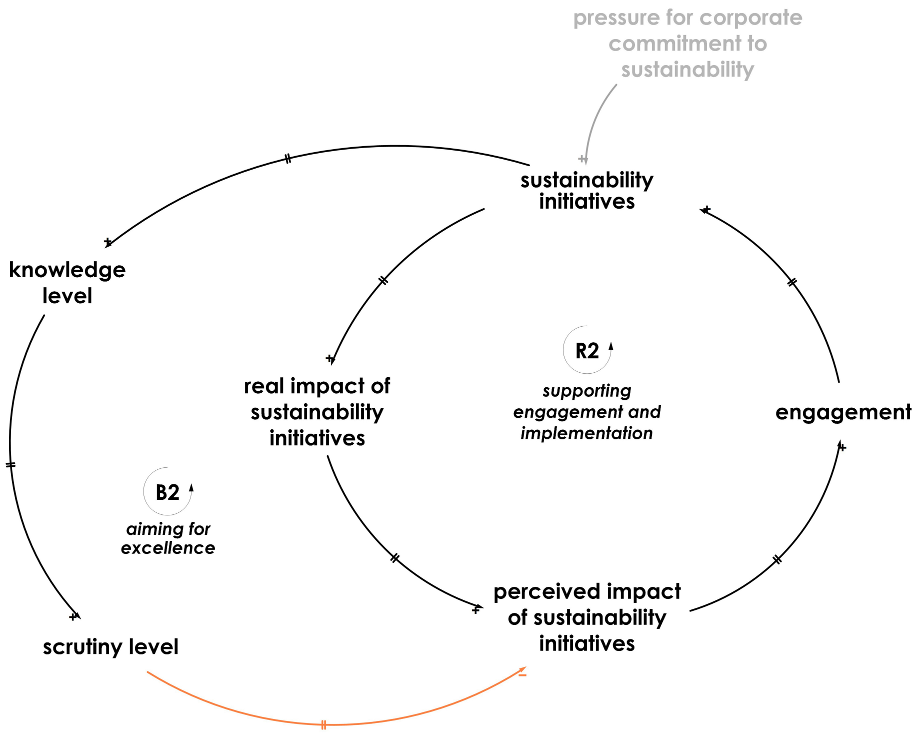

FIGURE 5
Fixes that fail: Although more symbolic sustainability initiatives initially boost employee engagement (R2), increasing knowledge and skepticism (B2) can unintentionally decrease engagement if the perceived impact of these initiatives does not outweigh the growing scrutiny. Orange arrows highlight negative polarity.

Hejjas et al. (2019), who suggest employee engagement in CSR as a spectrum rather than a binary state. Similar to their findings, this research acknowledges the individual differences among employees, highlighting that, in certain contexts or at early stages, initiatives perceived as "symbolic" or "ceremonial" by some employees may still generate positive outcomes for others, especially those who are still developing their understanding of sustainability topics or cannot directly work in sustainability through their formal roles. Importantly, this study also highlights the importance of knowledge and experience accumulation in changing employees' perceptions about sustainability initiatives. This finding corroborates previous results of Robertson et al. (2023), who demonstrated the important role of environmental education in mediating turnover intentions resulting from perceived greenwashing. Finally, this study's methodological approach is novel. By integrating insights from neo-institutional, sensemaking and attribution theories into CLDs, this study provides a multilevel perspective on the dynamics of sustainability implementation, therefore providing the foundation for future interdisciplinary and integrative research.

This study also has valuable implications for practitioners, since its findings depict the complexity of implementing sustainability initiatives in organizational contexts while managing stakeholders' expectations and responses. First, practitioners must acknowledge the dual nature of short-term wins, or symbolic sustainability initiatives. This study's findings reveal that while such efforts might be relevant to employees who are not formally involved in sustainability topics through their roles, they potentially hinder the engagement of more critical and more experienced employees. Therefore, consistent, impactful and authentic efforts are necessary to maintain employees' engagement and support in the longer term (Sancak, 2023). Additionally, understanding the dynamic nature of employees' perceptions is key to effective sustainability implementation. The shift in engagement during the "vulnerability period" is a critical phase for management. To navigate this phase, transparent and consistent communication is crucial for realigning expectations and reinforcing trust (Robertson et al., 2023; Sancak, 2023). Finally, the findings of this study also suggest that employees' vigilance and scrutiny are not only a challenge for sustainability implementation, but also an asset to the organization. Creating formal channels for feedback and participation can assist managers in better understanding employees' perspectives. This can serve as valuable input for continuous improvement, and potentially encouraging more plural perspectives about corporate sustainability in organizations (Hahn and Aragón-Correa, 2015).

5 Conclusions

This study provides valuable insights into the complex dynamics between sustainability initiatives and employees' perceptions, attitudes and behaviors in organizational settings. By applying systems thinking lenses and tools, this research reveals a critical "Fixes that Fail" archetype that can undermine sustainability changes in organizational settings. The findings

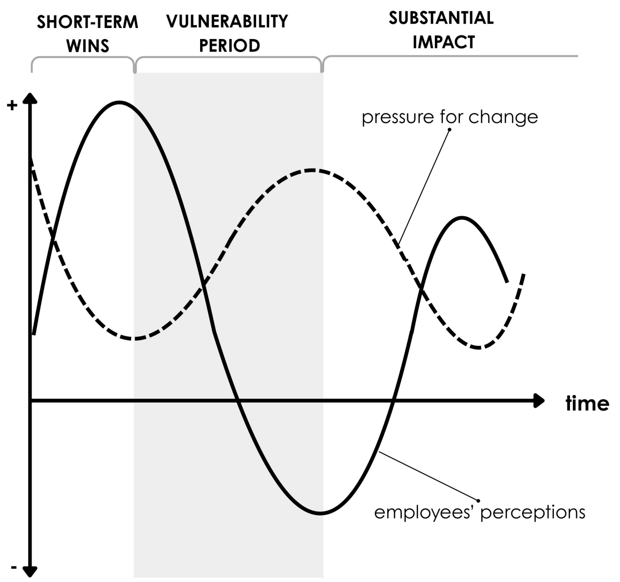

FIGURE 6
Potential dynamic behavior over time. The shaded gray background represents the "vulnerability" period, a critical phase where employees' perceptions, attitudes and behavior regarding sustainability initiatives are prone to shifting toward more negative states. This is a conceptual figure.

demonstrate that while simple sustainability initiatives, or short-term wins can boost employee engagement and support for future sustainability implementation, this initial enthusiasm can turn into frustration and skepticism as employees become more knowledgeable and critical over time. This creates a "vulnerability period," where maintaining employees' engagement and support becomes challenging if the perceived impact of sustainability initiatives does not consistently outweigh their growing scrutiny. These dynamics demonstrate that employees' vigilance is a powerful force for pushing an organization toward excellence in its sustainability efforts.

Additionally, this study's findings also provide a more nuanced perspective on more symbolic sustainability initiatives. Results suggest that these symbolic initiatives are not inherently bad. At early stages, initiatives perceived as "symbolic" or "ceremonial" by some employees may still generate positive outcomes for others, especially those seeking meaningful work and engagement in sustainability, but who cannot achieve this directly through their roles. However, to sustain long-term engagement and avoid falling into the "Fixes that Fail" archetype, organizations must deliver consistent, impactful and authentic efforts whose perceived impact withstand increasing employees' scrutiny. Ultimately, if companies fail to deliver substantial sustainability impact, which is in line with their long-term sustainability strategy and goals, initial employee engagement may give way to skepticism and disengagement. This could not only hinder specific sustainability initiatives but also undermine employee trust in the company's commitment to sustainability, potentially leading to systemic failure in achieving broader sustainability objectives. Therefore, this study also corroborates the importance of companies "walking" their "talk." In summary, it contributes to academia and practice by demonstrating possibly unexpected consequences of sustainability initiatives, challenging traditional dichotomies and providing a more nuanced understanding of progressive employee (dis)engagement. It also addresses literature gaps by adopting a multi-level and integrative systems perspective, taking into account temporal aspects, interconnections and feedback loops.

This research also has limitations, mainly regarding the generalizability of the findings and methodological constraints. While the sample of 42 participants and previous 46 studies is adequate for qualitative analysis, the results obtained cannot be generalized to organizations, regardless of their size and sector. Additionally, the exclusion criteria applied for the selection of secondary data has left important variables out of the CLD presented in Figure 4. Moreover, the CLDs presented in this study did not account for the external context in which the case organization or individuals are situated. Such simplification limits the interpretation of this study's findings. Finally, given the diverse definitions of sustainability initiatives and CSR, participants might have interpreted such terms differently.

Despite these limitations, this study offers prospects for future interdisciplinary research. Future studies could build on the CLD presented in Figure 4 and integrate other theoretical perspectives, additional empirical data and macro-level variables. Analyzing how variables at macro level influence employees' perceptions could substantially expand the current academic understanding of the topic. Additionally, future research could explore how the implementation approach (top-down or bottom-up) influences employees' perceptions, attitudes and behaviors. Finally, researchers are invited to formulate and test simulation models based on the dynamic hypothesis (CLDs) presented in this paper (Sterman, 2000). This would allow for a more rigorous and predictive analysis of feedback loops dominance and behavior over time.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

The studies involving humans were approved by Maastricht University Data Protection Officer (DPO). The studies were conducted in accordance with the local legislation and institutional requirements. The participants provided their written informed consent to participate in this study.

Author contributions

CB: Conceptualization, Formal analysis, Investigation, Methodology, Validation, Writing – original draft, Writing – review & editing. AS-Z: Formal analysis, Methodology, Supervision, Validation, Writing – review & editing. KH: Conceptualization, Methodology, Supervision, Validation, Writing – review & editing. YM: Conceptualization, Funding acquisition, Project administration, Supervision, Writing – review & editing.

Funding

The author(s) declare that financial support was received for the research and/or publication of this article. This project has received funding from the European Union's Horizon 2020 research and innovation program under Marie Skolodowska-Curie grant agreement ID: 956621.

Acknowledgments

We would like to express our gratitude to the participants who generously allocated their time to this research and shared their insights. We also thank all experts who provided feedback and assistance during the research design phase, data analysis and interpretation of results, especially Dr. Daniel Guzzo and those engaged with the Systems Dynamics Society.

Conflict of interest

KH was employed by Henning4future.

The remaining authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Supplementary material

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/frsus.2025.1666622/full#supplementary-material

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