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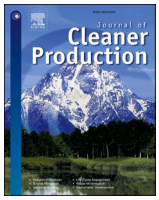

Navigating sustainability challenges in design: Bridging theory and practice with tactical sustainability cards

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ABSTRACT

This research investigates how professional designers engage with sustainability in their practices, focusing on the early ideation phase. A comprehensive literature review identified gaps in existing tools and methods, highlighting a lack of practical guidance for addressing sustainability within organisational and societal contexts. Semi-structured interviews with design practitioners provided insights into the challenges designers face, including conflicting stakeholder priorities, greenwashing, and the need for alignment across diverse perspectives. A co-creation session further refined these insights, leading to the development of the Tactical Sustainability Cards—a tool designed to inspire sustainable thinking, guide decision-making, and foster collaboration. The Tactical Sustainability Cards were validated through expert feedback and iterative refinement, emphasising their utility in overcoming limitations of existing Design for Sustainability (DfS) tools, such as complexity and narrow focus. By providing actionable prompts and a shared language, the cards empower designers to navigate sustainability challenges, align stakeholders, and justify sustainable initiatives effectively. This research contributes to bridging the gap between sustainability theory and practice by offering a practical tool that integrates sustainability into design processes. The findings lay a foundation for future work exploring the broader applicability of the cards and elaborate on the potential for design to harmonise innovation and sustainability, addressing the environmental and societal challenges.

1. Introduction

Sustainability has emerged as a complex duality across industries, shaped by global challenges such as climate change, resource depletion, and social inequities (Aschehoug and Boks, 2011). The design profession, with its influence on shaping products, services, and systems, plays a key role in addressing these challenges. For example, strategic design is uniquely positioned to integrate sustainable innovation into business practices, aligning organisational objectives with environmental and societal goals (Baldassarre et al., 2020a,b). Moreover, designers are particularly well-suited to facilitate sustainable development by embedding environmental responsibility and human centricity into their processes (Thatcher, 2012). However, there exists a significant gap in understanding how designers and innovation team engage with sustainability within their professional practices, particularly during the early stages of the design process "i.e. the ideation phase".

Existing literature offers valuable insights into strategies such as Design for Sustainability (DfS), eco-design (Bhamra and Lofthouse, 2016), and product-service systems (PSSs) (Tukker, 2015) that integrate sustainability into design processes (Ceschin and Gaziulusoy, 2016). Despite these advances, a gap exists between theoretical frameworks and their translation into design practices. Designers often prioritise aspects like functionality, human centricity and aesthetics, as they have been educated and trained in these domains (Bocken et al., 2014; Ceschin and Gaziulusoy, 2016). Although they are concerned about sustainability and environmental impact, they lack the tools and skills to integrate these considerations into their design processes. Additionally, while designers possess the capability to influence user behaviour and drive sustainable change (Niedderer et al., 2016), they face limitations in sustainability-focused skills, education, and workplace policies, which hinder their ability to drive effective environmental and social outcomes.

A more critical research gap lies in the lack of understanding of how designers define and perceive sustainability and how they collaborate with stakeholders to address sustainability challenges (Maher et al., 2018). Existing studies predominantly focus on evaluating

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methodologies rather than exploring the subjective experiences and practical challenges faced by designers (Lewis and Sauro, 2021; Schneider and Buser, 2018). This necessitates the need for a holistic approach that integrates theoretical foundations with practical actions, empowering designers to contribute effectively to sustainability goals.

The objective of this research is to assess how professional designers engage with sustainability during the early stages of the design process, particularly the ideation phase. This research focuses on designers in business-to-consumer (B2C) companies in the Netherlands and Belgium, aiming to explore how they conceptualise sustainability, assess their readiness to tackle sustainability challenges, and evaluate their ability to collaborate with innovation teams. Based on these insights, this research seeks to develop practical tools that support designers in embedding sustainability into their design practices, facilitating sustainable decision-making and fostering collaboration within innovation teams. To achieve this, the following research question has been formulated to guide the research.

The aim is to develop practical tools and approaches, grounded in the personal experiences of designers, to enhance the integration of sustainability into design practices. To achieve this, the following research question has been formulated to guide the research.

RQ: How can design tools support design professionals in integrating sustainability into the early stages of the design process?

To address this question, the research begins with an extensive literature review and desk research to establish a foundational understanding of the topic and identify key areas for further exploration. Building on these insights, we use a design science research approach (Peffers et al., 2007) to iteratively and rigorously derive a tool that support design practitioners in integrating sustainability during the early stages of the innovation process. We start from a series of semi-structured interviews to gather in-depth qualitative data on diverse designers' practices and perspectives. Subsequently, we use co-creation sessions to collaboratively explore innovative solutions and tools, refining emerging concepts. Finally, concept validation phases are carried out to evaluate the desirability, feasibility, and relevance of the emerging tool. The outcome of the process is a deck of *Tactical Sustainability Cards*, an inspirational tool designed to activate the ideation process and foster deeper engagement with sustainability among designers within the innovation teams.

By amplifying the voices of designers and providing actionable guidance, this research bridges the gap between sustainability theory and practice. Through threefold contributions, (i) it offers a deeper understanding of how professional designers in B2C companies conceptualise and engage with sustainability, uncovering the challenges they face in integrating sustainability into their practices. Moreover, (ii) this research identifies gaps in existing tools and frameworks, revealing how intuitive decision-making and organisational constraints impact sustainability outcomes (Barness and Mejía, 2018). Furthermore, (iii) it provides practical guidelines for embedding sustainability into early design processes, aligning with the United Nations Sustainable Development Goals (SDGs) (Bhamra and Hernandez, 2021; UN, 2015). Overall, the findings enhance the design process by fostering the creation of meaningful and sustainable products and services, empowering designers as agents of sustainable change, and advancing the role of design in addressing global sustainability challenges.

2. Literature review

The 1987 United Nations Brundtland Report (UN, 1987) laid the groundwork for companies' sustainability efforts, emphasising the need to balance present needs with those of future generations (Frecè and Harder, 2018). Moreover, in 2015, the international community adopted the 2030 agenda for Sustainable Development, containing 17 Sustainable Development Goals (SDGs), amongst which are "climate action, clean water and sanitation, and sustainable cities and communities" categorised under topics such as "biodiversity and ecosystems, chemicals and waste, and climate action and synergies" (UN, 2015).

Mahajan et al. (2024) argue that economic and environmental viability, along with social acceptance, are essential for a company to operate sustainably. The SDGs provide a comprehensive framework for companies to plan their sustainability strategies (Fleming et al., 2017). The SDGs emphasise the integration of economic viability, social and environmental responsibility, guiding companies in aligning their goals and actions for sustainable business operations.[1] These foundational documents present sustainable development as a framework that balances present needs with the preservation of resources for future generations, emphasising key goals and priorities within the global sustainability agenda.

Weiland et al. (2021) argue that today we hold an agenda with clearly defined goals and targets for the next decade, serving as a guiding framework for the transition toward sustainable development. Achieving these goals requires collective action: individuals adopting more sustainable lifestyles, companies leveraging their innovations and creative skills to address sustainability challenges, and governments implementing policies that promote long-term environmental and social wellbeing (UN, 2015). Although existing models have limited effectiveness in driving significant behavioural change, governments play a vital role in promoting sustainable behaviour through targeted interventions (Gonzalez-Arcos et al., 2021; Whitmarsh et al., 2021). Similarly, companies face challenges in maximising their positive impact on society and the environment (van Zanten and van Tulder, 2021). Despite calls for individuals, governments, and companies to align their efforts with the UN's agenda, substantial barriers and challenges persist, impeding progress toward meaningful change.

2.1. The role of Human-Centred Design in promoting sustainability

The inherently human- and meaning-centred discipline of design (Karpen et al., 2017) holds significant potential to influence decision-making processes. As humanity edges closer to irreversible climate damage, it is essential that these decisions are made with greater care and consideration (Kulsbjerg Løgager et al., 2021). Designers, with their deep understanding of human behaviour are uniquely positioned to drive individual behaviour change, particularly in the realm of sustainability (Emans and Murdoch-Kitt, 2018). By leveraging their expertise, designers can facilitate shifts toward more sustainable behaviours, contributing meaningfully to the fight against environmental degradation.

Researchers have explored the relationship between Human-Centred Design (HCD), rooted in Human Factors and Ergonomics (HFE), and sustainability. HCD has been proposed as a valuable tool to help designers create eco-friendly and inclusive designs that benefit customers, society, and all stakeholders involved (Rossi and Attaianese, 2023). Additionally, it has been recognised as a powerful tool for addressing the often-overlooked "people" dimension of sustainability (Lubis et al., 2022) and to integrate sustainable considerations into design practices (Bhamra and Lofthouse, 2008, 2016). By focusing on understanding the user, HCD enables designers to educate individuals on sustainability issues and nudge them toward more sustainable consumption, facilitating behaviour change and potential sociocultural transformation (Efkolidis et al., 2019). This interplay between HCD and sustainability has the potential to drive individual change while contributing to broader systemic transformations in society culture.

2.2. Challenges of current approaches to Design for Sustainability

With design often positioned as a contributor to ecological and

[1] https://sdgs.un.org/goals?utm_source=chatgpt.com.

environmental harm (Jung and Mejía, 2023), a wide range of conceptual approaches and practical applications has emerged. Since the 1990s, these approaches have enriched design discourse and can be broadly categorised under the term DfS, encompassing product-focused concepts like eco-design as well as systems-oriented approaches such as Design for System Innovations and Transitions (Ceschin and Gaziulusoy, 2016). Over time, the field of DfS has shifted its focus from product-level innovation to system-level transformations (Tukker, 2015). This evolution can be mapped as a progression from product innovation to socio-technical system design, with intermediate stages including product-service systems and spatio-social innovations (Ceschin and Gaziulusoy, 2016). As the scope of design expands at each level, a similar progression can be observed in the approaches used, ranging from tools targeting the design process, to tactical mid-level evaluation methods, and finally to high-level strategic frameworks (Rocha et al., 2019). While this trend reflects a broader shift from discrete product design to strategic systems design, there remains much to explore at the product and service levels.

This research focuses primarily on the product and product-service systems innovation levels, as these levels directly challenge key aspects such as customer behaviour, organisational structure, and regulatory frameworks (Ceschin and Gaziulusoy, 2016). Designers operating at this level often encounter latent needs and barriers in addressing sustainability, including adopting a systemic approach (Dewberry et al., 2013) and overcoming difficulties in testing and implementation (Vezzoli et al., 2015). Investigating the interaction between design and sustainability at this level offers valuable insights that could inform and benefit other levels of DfS as well.

Seminal work in this regard includes transition design (Irwin, 2015) and design for social innovation (Manzini, 2014), both striving to use design methods to address social issues and activate societal transitions. Furthermore, in their book "Design for Sustainability: A Practical Approach," Bhamra and Lofthouse (2016, 2008), listed a selection of methods and tools for DfS and group them under the following headings: Environmental Assessment, Strategic Design, Idea Generation, User Centred Design, and Information Provision. Special attention can be given to the heading UCD, which comprises participant observation, user trials, product-in-use, and others. The reasoning behind including UCD techniques is that if designers get a better understanding of how users (mis)use a product, they can lower the negative impacts of said product.

More recent works focus on DfS approaches that target the systemic and societal levels of innovation. While these approaches have been developed to facilitate the efforts of the designer, they have also brought some criticism along. Despite being titled sustainable, some approaches turned out to not comprise the critical characteristics of the sustainability concept (Lubis et al., 2022). For example, Lifecycle Design Strategies (LiDS), which offers eight strategies for eco-design, falls short in addressing both the people and financial aspects of sustainability. Furthermore, while designers are familiar with sustainable approaches, they often perceive them as complex and time-consuming, with limited impact on their performance metrics (Aschehoug and Boks, 2011; Bhamra and Hernandez, 2021; Raja Ghazilla et al., 2015). Therefore, due to its perceived complexity, time-consuming quality, and trace level impact on performance metrics, designers face barriers in implementation of sustainable practices. Moreover, some so-called sustainable approaches face criticism for failing to address significant aspects of sustainability, with critiques highlighting the lack of a comprehensive approach in certain sustainable design methods (Vandevyvere and Heynen, 2014). For example, some green buildings focus narrowly on energy efficiency while neglecting broader environmental and social impacts, leading to solutions that are less sustainable than claimed.

2.3. Limitations of existing sustainability design tools

In this section, the state-of-the-art literature on sustainability-focused design methodologies has been reviewed, highlighting key gaps in existing approaches (see Table 1). As sustainability has become one of the primary concerns in design, it demands new approaches that balance environmental, economic, and social considerations. While the advancement of DfS has provided various practical methods and frameworks, still significant challenges remain in translating theoretical knowledge into practical tools for designers (Ceschin and Gaziulusoy, 2016). Moreover, despite these advancements, designers continue to face difficulties in practical implementation, as existing tools often fail to effectively support decision-making in the early ideation phase (Mejía et al., 2022). Table 1, provides a comparative analysis of key sustainable design methodologies, highlighting their focus areas and limitations.

As shown in Table 1, current sustainability-focused design tools face multiple challenges:

Lack of Practical Guidance: many frameworks provide theoretical principles but lack clear, practical steps for implementation (Mejía et al., 2022; Peters et al., 2021).

Complexity and Accessibility Issues: tools such as Lifecycle Design Strategies (LiDS) rely on technical assessments, making them challenging for non-experts to apply effectively (Lubis et al., 2022).

Limited Stakeholder Integration: many tools prioritise environmental impact metrics but often lack to address social and business considerations (Bocken et al., 2014).

Gap Between Research and Practice: design practitioners often depend on intuition over structured frameworks, as many tools remain relevant to academic discussions with limited industry adoption (De Rooij et al., 2021).

Given these challenges, this research proposes Tactical Sustainability Cards as a practical, accessible, and actionable tool to bridge the gap between sustainability theory and design practice.

2.4. Design thinking and sustainability

Design thinking, as a distinct approach separate from other DfS methodologies, has emerged as a valuable tool that, when integrated with other frameworks, can significantly contribute to sustainable development. Shapira et al. (2017) point out that design thinking is recognised as an approach to help develop socio-ecological design solutions and support strategic sustainable development. Similarly, Geissdoerfer et al. (2016) present a value mapping process that targets how sustainable business modelling could be enhanced by design thinking. Furthermore, Baldassarre et al. (2017), explore the integration of sustainable business model innovation with user-driven innovation to address sustainable development challenges by designing value propositions that merge economic and environmental goals.

However, a common criticism of these approaches is that their tools and methods often fail to transition effectively from theory to practice. While the literature emphasises the development of methods and tools, their implementation in design activities is frequently challenging, as academic research often falls short in accurately reflect on how designers engage with sustainability (Mejía et al., 2022). Consequently,

Table 1
A comparative analysis of key sustainable design methodologies.

Approach	Strengths	Limitations
Eco-Design (Bhamra and Lofthouse, 2008)	Addresses environmental impact	Lacks systemic considerations
Lifecycle Thinking (Vezzoli et al., 2018a, 2018b)	Promotes circular economy	Difficult to apply in early design phases
Product-Service Systems (Tukker, 2015)	Reduces material consumption	Requires business model adaptation
Sustainable Business Models (Bocken et al., 2014)	Aligns business and sustainability	Focuses more on strategy than design tools
Design for Social Innovation (Manzini, 2014)	Encourages participatory design	Implementation complexity

many tools remain confined to research and do not make the leap into practical application (Peters et al., 2021). Moreover, designers are known to act intuitively rather than strictly adhering to theoretical frameworks or evidence, leading to criticism that design researchers perpetuate knowledge that remains untranslated into practice (Barness and Mejía, 2018). This reliance on intuition rather than structured guidelines further highlights the persistent disconnect between theory and practice in design (De Rooij et al., 2021).

Designers may feel apprehensive about sustainable design tools because many fail to provide actionable guidance or relevant information to effectively support the design process (Bhamra and Lofthouse, 2003). Additionally, this highlights the need for a more comprehensive tool that can be integrated into each step of the design process, enabling designers to evaluate the sustainability rating of their work more effectively (Lubis et al., 2022). Some researchers emphasise the need for sustainable design approaches and highlight key focus areas for designers. For example, they argue that the responsibility for sustainability should be shared among individuals, companies, and governments (Luchs et al., 2015). Similarly, the designer should be careful not to blame the individual when trying to achieve a behaviour change (Evans, 2011).

Additionally, with the introduction of or replacement with a new sustainable design product, the change in the quality of life should be considered (Steg and Vlek, 2009). One aspect that is often overlooked is the implications for marginalised communities and the designer should consider these unwanted effects. Plastic bags: for instance, have dire consequences for disabled people who need single-use plastic products in their daily lives (Jenks and Obringer, 2020). Also, the ethical implications of sustainable design are significant, with some researchers agreeing on an influence on the individual if their autonomy is not compromised (Lilley and Wilson, 2013). Mejía et al. (2022) point out that the tools are significant for assisting designers in convincing or collaborating with management and policymakers. Furthermore, they argue that there is still a gap in sustainable design that overlooks the behavioural, ethical, social, and critical visions of sustainable design, and not just technological and economic ones. Similarly, the tools should go beyond targeting product configuration and micro-level improvements and reach macro-level issues such as ethics and politics of design.

Lastly, two concrete examples of improving approaches to sustainable design include (i) providing designers with tools or training to enhance their understanding of sustainability (Aschehoug and Boks, 2011; Bhamra and Lofthouse, 2003; Grosse-Hering et al., 2013; Reyes et al., 2020) and (ii) developing specific product design processes that involve users, extend product lifecycles, and promote repairability (Aschehoug and Boks, 2011; Lowley and Gulden, 2016; Sumter et al., 2018). Therefore, it can be argued that to address the wide range of challenges and considerations in the field, there is a need for more inclusive and multifaceted sustainable design tools.

2.5. Priorities, roles, and responsibilities around sustainability

Contrary to the study of Papanek (1985), contemporary researchers express their belief in the potential of design and designers as enablers of sustainable development (e.g. Thatcher, 2012). However, this does not necessarily mean that sustainability is primary on the designer's agenda. Mejía et al. (2022) refer to this by stating that designers may consider sustainability in their practice as a second priority or not even one at all, even though they understand its vital value.

Similarly, research on the designers of a multinational engineering and technology company shows that while sustainability is acknowledged as a strategic aspect, the emphasis is on the desirability, feasibility, and profitability of the operational process (Grobelnik et al., 2022). Despite conflicting views on design in the context of sustainability, one common finding in the literature is that designers often prioritise other factors over sustainability, which may slow the advancement in sustainable development.

In their viewpoint, Jung and Mejía (2023) highlighted the positioning of designers, specifically service designers, to respond in their practice to sustainability and contribute to climate action. They mentioned that designers not only work on products but also services and systems to address sustainability. They argue that in an economy that is dominated by services, the influence of these designs can reach higher levels of innovation including socio-technical systems. Service designers are recognised for their ability to employ foresight exploration methods to address complex sustainability challenges. By integrating foresight techniques, such as trend analysis and scenario building into their practice, they can transform intricate sustainability issues into actionable strategies for sustainable future (Kulsbjerg Løgager et al., 2021).

Moreover, designers possess capabilities that can significantly advance sustainable development. Their skills in HCD, systems thinking, and innovation enable them to create solutions that align with sustainability goals. By focusing on user experiences and preferences, designers can drive growth and uncover new business opportunities, helping companies innovate for future user needs (Baldassarre et al., 2024). This can potentially lead to better adoption of design practices that overall lead to more sustainable outcomes. It is also externally desired that a designer, even if their employer favours short-term monetary benefits over long-term sustainability benefits, conceives and enforces a sustainability direction (Coutts et al., 2017).

2.6. Challenges for designers

Designers possess the qualities and capabilities to help progress with sustainable development, yet, they also have certain shortcomings (Lee, 2021). The shortcomings may stem from an inadequate level of skills and education, but also from external factors such as the workplace conditions and policies. Lee (2021) examines the challenges of current design thinking practices within organisations and argues that despite claims of evolving beyond mere artifact creation, current theories continue to be deeply rooted in the creation-focused paradigm. Therefore, the focus on production-centric models, such as intervention design and enterprise design thinking, often overlooks the complexities of social systems and the importance of symbolic capital (Lee, 2021).

Moreover, designers often encounter significant challenges when integrating environmental sustainability into their work, primarily due to constraints imposed by organisational priorities and policies. Mejía et al. (2022) highlight that designers' efforts to address sustainability are frequently limited by management decisions and policy frameworks that prioritise other objectives. Similarly, Gaziulusoy (2015) emphasises that while designers possess the potential to drive sustainable innovation, their influence is often neglected by existing organisational structures and decision-making processes that do not prioritise sustainability. This misalignment between designers' capabilities and organisational priorities hinders the effective incorporation of sustainable practices into design processes. Furthermore, Irwin (2015), and Irwin et al. (2022) discuss the concept of "*transition design*", which advocates for a holistic approach to design that addresses complex societal challenges, including sustainability. The author argued that designers aiming to implement such approaches often face obstacles due to entrenched organisational cultures and policies that resist change, thereby limiting their ability to effect meaningful sustainability transitions.

These studies collectively highlight the systemic challenges and barriers that designers encounter when striving to integrate environmental sustainability into their work, emphasising the need for organisational and policy reforms to empower designers in contributing effectively to sustainable development.

2.7. Conceptual model development

The literature highlights conflicting perspectives on the role of

design in the context of sustainability but converges on a critical insight: designers often prioritise other factors over sustainability, impeding progress toward sustainable development (Baldassarre et al., 2024). Nevertheless, designers hold a unique capacity to drive individual behaviour change. This potential change arises from the interplay between HCD and sustainability, which could serve as a catalyst for systemic societal transformations. Additionally, design methods and designers' capabilities are regarded as instrumental in addressing sustainability challenges by translating complex issues into actionable strategies for sustainable futures, even when managerial pressures favour short-term wins. However, the literature also underscores certain challenges faced by designers, such as gaps in skills and education, as well as external barriers like workplace conditions and policy constraints.

The review of DfS approaches highlights the benefits and limitations, along with criticisms about their effectiveness and impact. A significant gap between theory and practice persists, as designers tend to rely on intuition rather than applying theoretical frameworks, making it difficult for sustainable design methods to transition into actionable practice. Moreover, there is a need for tools that not only support designers at the micro-level but also address broader systemic and societal issues, emphasising actionable, user-friendly solutions.

Building on these insights, this research draws from the foundational "Brundtland Report" (UN, 1987), framing sustainability as a dynamic and fluid concept. It explores how sustainability can be better integrated into design practices, emphasising its critical role in guiding practitioners through product and service development. Building on the existing literature and addressing the gap between theory and practice, this research proposes the framework illustrated in Fig. 1. The framework aims to provide a deeper understanding of how design practices can be transformed to effectively advance sustainability goals.

The proposed framework places the **designer** at its centre, emphasising its role in integrating various dimensions of sustainability into design practices. It highlights the importance of **clearly defining sustainability principles** to ensure a shared understanding that guides consistent and aligned efforts. **Practical applications of sustainability** focus on enabling designers with tools and methods to translate theoretical concepts into tangible design strategies. The framework emphasises the **roles, rights, and responsibilities** of designers as mediators between stakeholders, encouraging sustainable practices to address societal impacts and marginalised communities. The **HCD** in the framework recognises designers' ability to influence individual behaviour and foster systemic transformation through empathy-driven, and inclusive solutions. **Ethics, values, and morals** are also integral, advocating designers to embed fairness, responsibility, and long-term thinking into their practices while balancing economic, environmental, and social factors. Together, these components empower designers to address the complexities of sustainability and translate goals into impactful and practical strategies.

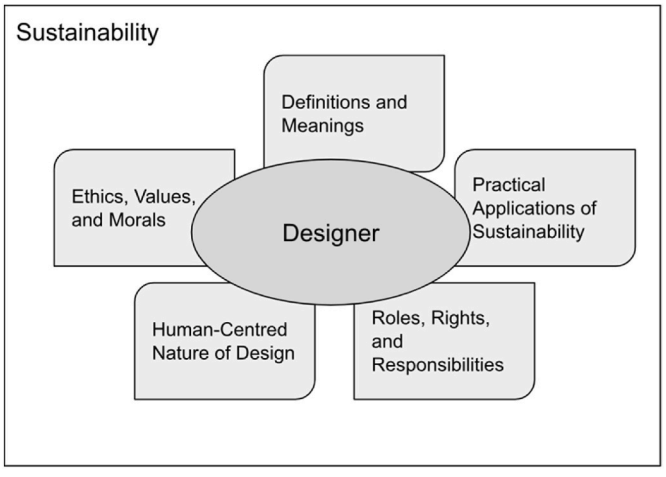


Fig. 1. Proposed conceptual framework for improving designers' sustainability practices (authors' own work).

3. Methodology

This study follows a design science research (DSR) approach, a methodology aimed at generating scientific knowledge by creating, iterating, and evaluating an artifact in response to a research question (Peffers et al., 2007). DSR integrates theoretical reflection with empirical investigation and provides an overarching and yet structured process in which multiple research methods can be applied. This approach is particularly useful for the scientific development of innovations or tools (e.g., Annarelli et al., 2018; Baldassarre et al., 2020a,b), making it well-suited to the goals of this study. To specifically address the participatory design aspect and ensure a strong connection to design methodology, we structured the research into the following iterative phases:

- Theoretical investigation (literature review): this phase aimed to identify challenges designers face when integrating sustainability into the early ideation phase of their processes. Through this first theoretical step, we created a more nuanced problem definition to further investigate through the empirical work (see Fig. 1 with the proposed conceptual framework).
- Participatory qualitative research (interviews and co-design activities): semi-structured interviews were conducted with design practitioners to explore how they perceive and experience these challenges in practice. Rather than relying solely on passive data collection, co-design elements were integrated, allowing participants to reflect on their own design processes and contribute to defining key areas for tool development. The five areas of improvement identified in the literature review were further refined through interactive discussions with practitioners, ensuring the insights directly shaped the tool's requirements.
- Tool development through participatory design: the tool was not just conceptually developed but emerged through an iterative co-design process using creative techniques such as participatory workshops. These activities helped to create designer-driven tool, meaning that practitioners actively contributed to shaping the format, usability, and content of the cards.
- Validation through iterative testing and theoretical refinement: the tool underwent an evaluation phase where it was iteratively tested and improved through structured feedback loops from designers and domain experts. This ensured that both theoretical and practical applicability were considered in refining the final version of the cards.

By incorporating participatory design throughout the research process, this study ensures that the Tactical Sustainability Cards are not only theoretically grounded but also co-developed with designers, making them highly relevant to real-world design challenges. These phases are described in detail in the following sections.

3.1. Qualitative interviews: approach and insights

Based on the proposed conceptual framework, an interview protocol was developed, and 10 semi-structured interviews were conducted to gain additional insights from experts and professionals in design and innovation teams from various companies (see Table 2). The interview protocol included questions related to how informants understand sustainability and how they incorporate related considerations in their work. For example, we asked "*How do you feel when you put the two notions (design and sustainability) together?*". Furthermore, informants were asked to describe the tools that they current use to integrate

Table 2
Interview participant profiles.

Participant Title	Participant Industry
Lead Engineer R&D	Household Durables
Last-mile Product Designer	Consumer Staples Distribution and Retail
Sr. Strategic Design Researcher	Household Durables
Concept Designer	Textiles, Apparel and Luxury Goodss
Global Design Manager Cooking and Refrigeration	Household Durables
Product Engineer	Marine Transportation
Manager Innovation and Sustainability	Household Durables
Senior Service Designer	Banks
Design Director - Home Care Innovation	Consumer Staples Distribution and Retail
R&D Manager	Leisure Products

sustainability goals in the design process, their suitability and gaps. For example, we asked "*What strategies or tools do you or would you use to ensure that sustainability is prioritised in your decision-making process?*". Finally, they were asked "*How can designers contribute to sustainable development?*", to reflect on the effectiveness of design tools and design practices to sensitise other stakeholders on the centrality of sustainability issues. Interviews were conducted with design practitioners from the Netherlands and Belgium. Participants were selected to fit the description of "*design practitioners working in-house for companies*" and were reached out directly or using a snowballing approach. In-house designers were preferred as they tend to have a more extended understanding of manufacturing and marketing at a given company compared to consultants (Bohemia, 2004), enabling for a more holistic investigation of the organisational contexts. Interviews were conducted online or in person. The informants first received an explanation of the goals of the study and of the following data analysis. We then shared with them an informed consent form clarifying the anonymity and voluntary nature of their participation and offering them the possibility to withdraw their participation at any moment and omit questions. Interview data were transcribed, and thematic analysis was performed. Next, through a series of inductive coding, a code structure was established. Besides the thematic analysis, key quotes from the transcripts were selected.

Quotes that have the potential to guide towards design directions were prioritised. Next, the quotes were clustered under statements; actionable and provocative characteristics were prioritised for this clustering. The main purpose behind the selection of quotes, clustering, and statement forming was to create insight cards. These cards comprise a provocative statement, a brief explanation, and supporting quotes. The cards were established as a medium to conceptualise the insights from the interviews and make them concrete to be used in the following steps of the research.

Several key insights were revealed through the interviews. For example, it was revealed that designers are not in positions of decision-making. This phenomenon is twofold, on the hierarchical axis, management has the final saying when making decisions. On the other side, customers have the purchasing power which can guide the decisions by making the companies offer products that customers would be more willing to purchase. Here, designers do have some power of nudging the customers to perform certain behaviours yet still the qualities of the product itself determine its sustainability status. It was reported that user-centricity is prioritised over sustainability when making product design decisions and that sustainability is not holistically integrated into the process, although it was noted that ultimately, both would co-exist in a product. One of the interviewees mentioned that "*We will never leave away human-centred thinking, and then it is more a matter of maybe balancing it with environmental concerns*".

Furthermore, the importance of physical artefacts was mentioned, arguing that it is one of the significant skills and crucial contributions of the designer. One of the interviewees mentioned that "*But I think what a designer can bring is actually tie in those long-term goals that a company has persistent ability with human insight and contextual information for that matter. So, it is sort of bringing a bit of storytelling into the whole sustainability agenda, so making it much more relatable*".

Moreover, designers need to have a basic understanding of business concepts which is especially helpful when having conversations with other stakeholders who may have different priorities. One of the interviewees mentioned that "*I think you make a much stronger case when you align with other departments, so it should be an entire strategy and not just 'design is saying this'. So, talk to the business, talk the language of business and come with good proposals, then you can move things*". The analysis revealed that designers need to ask the right questions to the right people at the right time to trigger sustainability transformations. Designers also need to treat good sustainability examples as such, simply examples that they should strive to go beyond. One of the interviewees mentioned that "*So, what I would always think that design can do is push the boundaries of what exists already and sort of go a little bit beyond*".

Lastly, it was revealed that sustainability is a complex issue involving multiple stakeholders, many of whom may not share the same level of enthusiasm for sustainability. As one mentioned that "*So, I am a bit in between; I am optimistic and positive about what a sustainability-related project can do. But on the other side, I know that there are always implications when you do a sustainable project and that is where you start thinking of the connection with all the different aspects, so it becomes a system, right?*" These insights suggest that sustainability is currently a contested issue with a variety of viewpoints. Overall, it was highlighted that different stakeholders have different perspectives, and the designer should be properly equipped with tools and skills to navigate towards impactful change.

3.2. Tool development phase

In the next phase of the research, a co-creation session and a brainwriting session were conducted to generate design directions and gain further insights into the problem formulation. These sessions built on the pain points and opportunities identified through the literature review and the insights gained from the interview analysis. The participants, master's-level design students, engaged in group discussions held in person. To enrich perspectives and simulate a broader stakeholder environment, participants were assigned personas representing a designer, policymaker, customer, or management. This approach aimed to explore diverse viewpoints and compensate for the challenge of recruiting actual stakeholders (designers). The sessions aimed to refine and validate the framework developed in the earlier research phase, and the proposed framework was acknowledged and explored in depth during these discussions (see Fig. 2). This process provided valuable input for designing an intervention to enhance the integration of sustainability into design practices. Following the group discussions, a design problem statement was formulated, and brainwriting was employed as the primary ideation technique for concept generation. Although traditionally a group activity, brainwriting was adapted for individual execution in this research due to resource and time constraints.

The knowledge gained from these sessions revealed that designers' roles extend beyond traditional responsibilities to include advocacy for sustainability, navigating conflicting stakeholder priorities, and aligning user and company values. Key challenges included balancing sustainable lifestyle changes with user quality of life, addressing siloed stakeholders with conflicting goals, combating greenwashing, and justifying sustainability efforts to management. The knowledge gained directly informed the design of the first prototype of the *Tactical Sustainability Cards*, marking a key step toward developing tools to support sustainability integration in design practices. Tactical Sustainability Cards are an inspirational tool designed to support designers and innovation teams in incorporating sustainability into the early stages of the design and innovation process (Ræbild and Hasling, 2018). They provide actionable prompts, strategies, and ideas to tackle sustainability challenges,

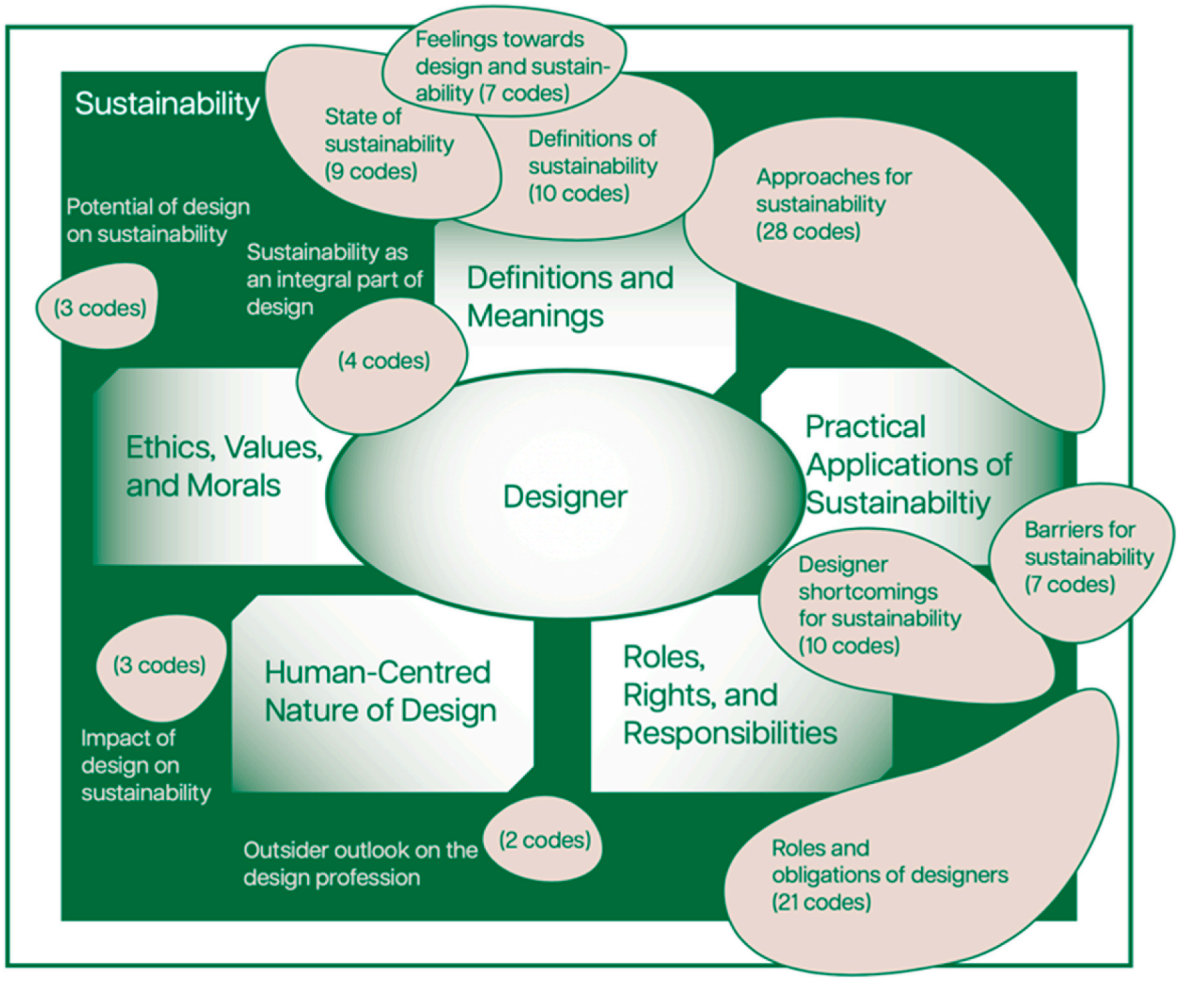


Fig. 2. Proposed model after the interviews (authors' own work).

fostering creativity and encouraging engagement with sustainable practices. By simplifying complex sustainability concepts into practical, manageable insights, the cards help practitioners integrate sustainability into their decision-making processes (Roy and Warren, 2019), contributing to systemic transformations toward sustainable development. For higher-level contexts, the All-Cards Mapping could be used, and depending on how Tactical, Strategic, Focused, or Systemic an intervention is desired to be, a corresponding card could be chosen directly, see Fig. 3.

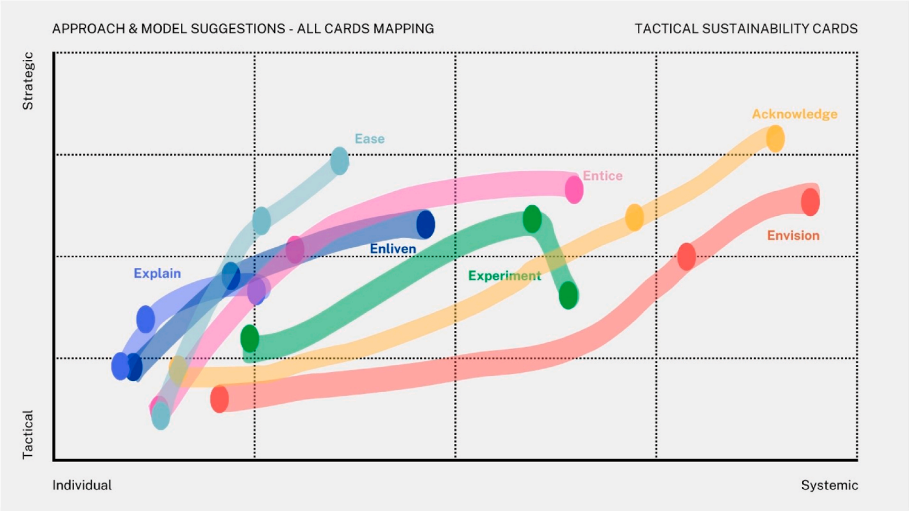


Fig. 3. All cards mapping (authors' own work).

3.3. Validation phase

In the next phase and in order to validate and improve the concept, we conducted two different sessions. A first session to obtain expert feedback involved six practicing professionals. These experts were invited via email to evaluate the feasibility, desirability, and viability of the *Tactical Sustainability Cards*. The expert feedback was instrumental in refining the cards, ensuring they effectively address sustainability challenges and provide value to designers in their practice. The following questions were included in the email to guide their feedback:

- *How effectively do the cards address the challenges and needs you mentioned in your interview?* This question sought insights into the feasibility and viability of the cards by asking participants to reflect on the challenges and needs discussed during their interviews.
- *Do you see value in using these cards in your practice? If yes, how?* This question aimed to assess the desirability of the cards by exploring their practical relevance and application.
- *Do you have any other feedback you would like to share for further improvement?* This open-ended question encouraged participants to provide additional perspectives and suggestions for enhancing the cards.

The feedback from the validation session revealed a range of insights about the Tactical Sustainability Cards. Experts appreciated their ability to raise awareness by providing a structured overview of strategic directions and their potential to inspire creativity during the early stages of the design process. The cards were also recognised for their possible role in evaluation mechanisms and their value as an academic resource, although concerns were raised about their accessibility for non-academic users. Additionally, experts appreciated their relevance in communication and storytelling, particularly in aligning stakeholders during ideation sessions and facilitating collaboration across departments. The cards were seen as useful for highlighting the complexity of sustainability challenges and encouraging meaningful conversations. However, some experts indicated limitations of the cards such as lacking actionable prompts and focusing more on implementation than on the underlying reasons for sustainability. Suggestions included offering a more flexible format, such as a digital version, to remain relevant over time and providing additional guidance or workshops to enhance usability. Experts also pointed out that the cards alone were insufficient to generate innovative ideas, emphasising the need for complementary tools or insights, such as market knowledge and user-business data, to address diverse sustainability impacts effectively.

A second validation session was conducted to assess the effectiveness of the cards in targeting the early ideation phase and enhancing sustainability engagement. The session aimed to further refine the design concept and explore potential use cases, aligning with the research objective of supporting designers in integrating sustainability into their practices. The session was held with a group of design researchers at PhD level from the Industrial Design Engineering Faculty. The main activity, "*Cards in Action*", was designed to test the cards' practical application in a real-world context. Participants were tasked with redesigning a product or service using the cards. As a case study, the reusable coffee cup-token system used at the university campus was selected. This example was chosen due to participants' familiarity with the system and ongoing discussions about its potential improvements. Participants began by selecting one or two cards, reviewing their content, and asking clarifying questions. They were then instructed to ideate and develop redesign concepts based on the guidance provided by the selected cards. Finally, participants shared their concepts and explained their design processes, offering valuable insights into the cards' functionality and impact during the ideation phase. Based on the insight of this session, we crafted final version of the seven *Tactical Sustainability Cards* as a practical tool for empowering designers (see Appendix). The following section describes the main characteristics of the Cards as well as how their use is envisioned.

4. Results

4.1. Creation of tactical sustainability cards

A concept that combines the desired qualities of multiple concepts was selected as the main design intervention of this phase of the research. This section shows the discarded concepts and briefly motivates the reasoning.

4.2. Seamless sustainability

As a method for redesigning existing products and services, seamless sustainability offers a compartmental way of approaching the design process. The method divides an existing user experience into steps and guides the designer to ideate on each step by improving the sustainability and user-centeredness. For each step, a numerical value is assigned to allow for comparisons between the old and redesigned concepts. This concept was discarded as it forces the designer to quantify aspects of the designed experience, which may not be as straightforward. Furthermore, a redesign may not always be so linear that allows for comparisons between two distinct concepts. Additionally, it only operates on a narrow perspective on sustainability and user-centeredness with not much regard to other factors.

4.2.1. Metaphorical Designer Hats

A response to the question "How might we leverage the many roles of the designer?" Metaphorical Designer Hats are based on the roles such as the educator, devil's advocate, etc. The designer is expected to approach the problem via one of the hats and shift their perspective accordingly. This concept was discarded, while may be beneficial in other contexts, it does not have a sustainability focus. Thus, this concept does not answer the problem statement nor the research goal.

4.2.2. "Making sustainability attractive" campaign

This concept aims to foster an engaging sustainability culture within a given company through creative initiatives, awareness campaigns, and ongoing employee involvement and education. This concept was discarded because a campaign might be company-specific and needs certain insights relevant to the given company. Thus, a universal campaign would not work for this concept.

4.2.3. Set of inspiring sustainability project examples

Answering the question "How might we engage employees in sustainability?" This set of project examples aims to curate a collection of innovative sustainability initiatives from around the globe, showcasing actionable solutions for a greener future. As much as it might be an inspiring tool, the scope is quite narrow. This alone would not be a full-fledged concept, but perhaps a component of a bigger design intervention.

4.3. Co-creation session and brainwriting: first prototype

As mentioned, *Tactical Sustainability Cards* is a strategic approach that provides an innovative approach on sustainability in the design process. The cards comprise a tactic, a description of the tactic, an inspiring example, and relevant literature. The cards could be acquired by management to be used by multiple teams. For the design team, for instance, they can help create concepts that are aligned with literature, innovative, and sustainable. The cards manage to do this by giving inspiring examples, interesting prompts, and promoting creativity. For co-creation sessions where non-designers are present, the cards can help with aligning them and providing a common agenda. They can do so by providing a shared and common language as a reference point. Furthermore, for innovation teams, the cards can promote creative

thinking. By encouraging experimentation and making sustainability coexist with innovation, the innovation teams can make use of these cards. Lastly, for sustainability teams, they can have them go beyond traditional sustainability approaches such as total bans, complete reductions, etc. Useful across various teams, *Tactical Sustainability Cards* offer a versatile tool that integrates sustainability seamlessly into the design process. They help design teams create sustainable concepts, align non-designers in co-creation sessions, and promote innovation beyond traditional methods.

4.4. Expert feedback and validation session: final prototype

All in all, the session provided critical and valuable feedback on the cards' ability to inspire actionable ideas, engage users in sustainability challenges, and foster creativity during the early stages of design. These insights were in used in the final iteration of the *Tactical Sustainability Cards*, ensuring they align more closely with the research goal of equipping designers with practical, effective tools to integrate sustainability into their work. Key updates included modifications to both the content and structure of the cards (see Fig. 4a and b):

Front Side Improvements: A dictionary definition was added to enhance clarity, and an inspiring prompt question was included to make the cards more actionable. The text was also revised for better balance between brevity and depth.

Back Side Adjustments: The axes were renamed, changing from "focused-systemic" to "individual-systemic" for improved alignment with the cards' purpose and usability.

Workshop Context Updates: The workshop now begins with a clearly defined goal, such as the scope of the design, affected stakeholders, or a strategic purpose, to provide clearer direction and focus during the session. These changes were implemented to improve the cards' usability, relevance, and effectiveness in guiding designers toward integrating sustainability into their design processes.

4.5. How to use the tactical sustainability cards

The Tactical Sustainability Cards are designed as a flexible and interactive tool to help designers embed sustainability considerations into the early stages of the design process. They can be used individually or in group settings and are adaptable to different design contexts, including corporate teams, and innovation-driven projects. By providing structured yet open-ended prompts, the cards support designers in navigating sustainability challenges. The process includes five key steps:

1. **Identify the Design Challenge:** define the sustainability issue or objective within the design process.
2. **Select Relevant Cards:** choose one or more cards based on the challenge, using them as prompts for discussion and exploration.
3. **Apply to Ideation Sessions:** use the cards to inspire creative solutions and guide team discussions during brainstorming or co-creation workshops.
4. **Evaluate and Align**: leverage the cards to justify design decisions by aligning them with sustainability principles, business goals, and user needs.
5. **Refine and Implement:** iterate on the ideas developed, integrating sustainability insights into concept development and prototyping.

5. Discussions

This research investigates how professional designers can better engage with sustainability during the early stages of the design process, specifically focusing on the ideation phase. The research addresses the gaps identified in the literature, such as the lack of actionable, user-friendly tools that effectively bridge the gap between sustainability theory and practice (Bhamra and Hernandez, 2021; Lubis et al., 2022). Designers often face challenges in aligning sustainability with organisational priorities, stakeholder interests, and the practicalities of product and service design. Existing tools and methods for DfS have been criticised for being theoretical, complex, with narrow focus (Vandevyvere and Heynen, 2014; Mejía et al., 2022). This research addresses these limitations by creating a practical intervention that equips designers with the resources they need to integrate sustainability meaningfully into their practices.

The *Tactical Sustainability Cards* emerged as the main findings have been developed through a structured processes that combined insights from a comprehensive literature review, semi-structured interviews with design professionals, and co-creation sessions. These cards have been designed to address key challenges highlighted in the literature. First, they provide designers with structured guidance and inspiration, supporting their ability to address sustainability challenges during the ideation phase (Ræbild and Hasling, 2018).

By presenting actionable prompts, examples, and relevant literature, the cards simplify complex sustainability concepts, enabling designers to incorporate these principles into their decision-making processes (Roy and Warren, 2019). The literature emphasises the importance of tools that not only inspire creativity but also foster collaboration and alignment among diverse stakeholders (Ceschin and Gaziulusoy, 2016). This research contributes to this concern by showing how the *Tactical*

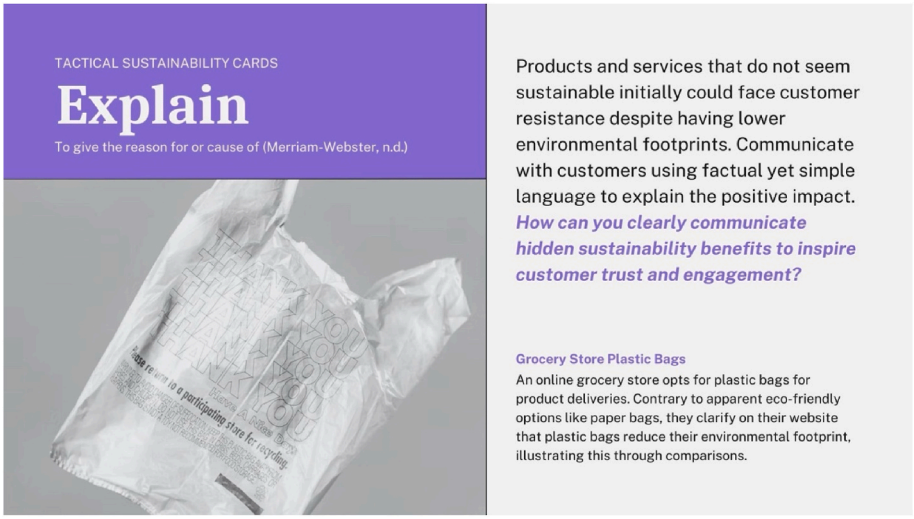


Fig. 4a. Final version of the Tactical Sustainability Cards (front side), Source: https://picnic.app/nl/tasjes/.

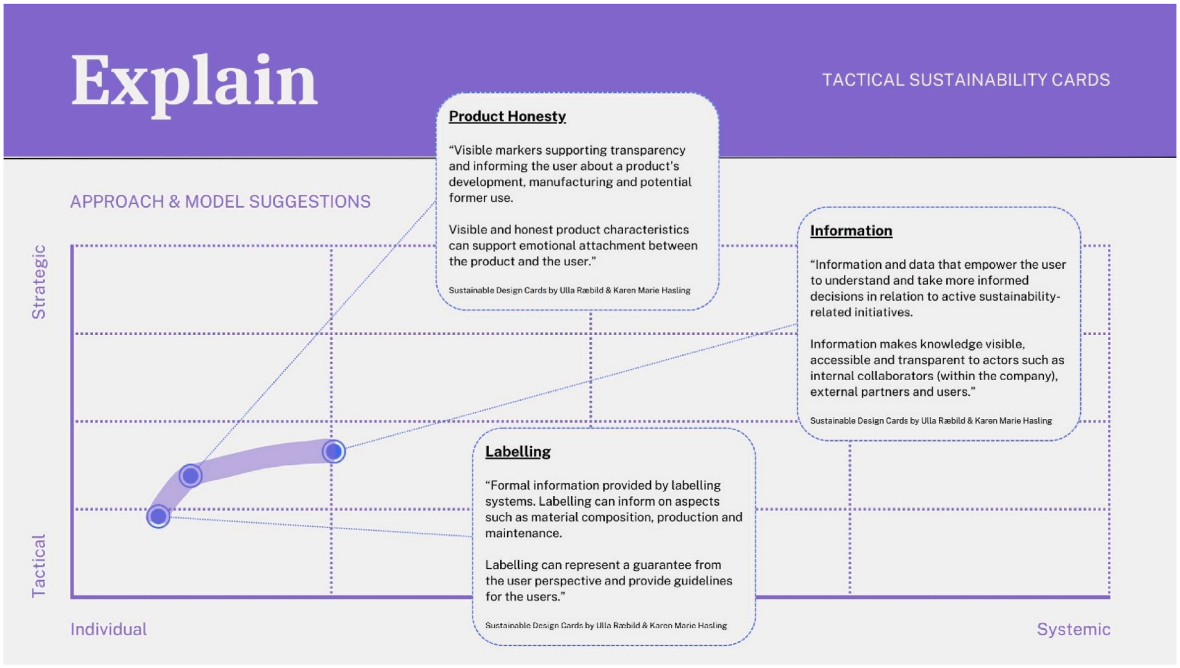


Fig. 4b. Final version of the Tactical Sustainability Cards (authors' own work).

Sustainability Cards can serve as a shared language for designers, managers, and other stakeholders. During validation sessions, participants acknowledged the cards' ability to align teams and stimulate ideation while addressing systemic and organisational sustainability challenges. This aligns with findings by Baldassarre et al. (2024), who argue for the need to integrate tools that can align organisational goals with broader environmental and social objectives.

Furthermore, the cards were validated and refined based on expert feedback, addressing limitations highlighted in previous DfS methodologies. For instance, while many tools focus on environmental metrics, the *Tactical Sustainability Cards* take a holistic approach by incorporating social, economic, and environmental dimensions. This is consistent with the integrated perspective of the United Nations Sustainable Development Goals (UN, 2015) and works of Maher et al. (2018) and Schneider and Buser (2018).

However, despite their potential, the cards also received some limitations, such as the need for a more flexible format and the inclusion of actionable prompts. These limitations reflect ongoing challenges in translating sustainability into actionable design practices (Mejía et al., 2022; Peters et al., 2021). To address these concerns, the final prototype incorporated improvements, including enhanced clarity, restructured axes to better align with design objectives, and updated workshop guidelines to support practical application. This aligns with calls for tools that go beyond theoretical frameworks to provide actionable and scalable solutions (Bhamra and Lofthouse, 2008; Bhamra and Hernandez, 2021).

6. Conclusion

6.1. Contributions and implications

This research bridges the gaps in existing DfS tools by developing and validating the Tactical Sustainability Cards, a novel, flexible, and accessible tool designed to enhance practicality in sustainable design. By facilitating sustainable thinking and empowering designers during the early ideation phase, the cards provide an actionable approach to integrating sustainability into design processes. Unlike traditional methods that often impose rigid frameworks or narrow perspectives, the *Tactical Sustainability Cards* encourage a holistic, adaptable approach to sustainability. By offering actionable prompts, strategic guidance, and inspiring examples, the cards simplify the integration of sustainability principles into design practices while fostering creativity and innovation.

This research bridges the gap between theory and practice by providing insights that move from sustainability literature into a practical, user-friendly tool, supporting designers to deal with complex interplay between environmental responsibilities and organisational pressures. Designers, who often face the dual burden of fostering innovation while addressing sustainability challenges, can use these cards to align stakeholder priorities, justify sustainable actions to management, and tackle systemic sustainability issues with confidence. This research highlights the critical role of designers as agents of change and driving sustainable development through informed decision-making and collaborative efforts. The *Tactical Sustainability Cards* contribute theoretically by highlighting the importance of tools that not only inspire creativity but also address systemic and organisational sustainability challenges. The findings emphasise the importance of providing designers with tools that enable them to balance human-centric design with environmental considerations.

6.2. Practical implications

This research has significant implications for designers, managers, and policymakers, emphasising the need for structured yet adaptable approaches to sustainability in organisational contexts. *The Tactical Sustainability Cards* serve as a practical resource for design and innovation teams, enabling them to generate actionable and innovative solutions while aligning with broader organisational and societal goals. Managers and decision-makers can integrate the cards into practices to promote sustainable ideation, enhance collaboration across departments, and create a culture of accountability in sustainability initiatives. Practically, the cards provide a structured yet flexible approach to sustainability, empowering designers to operationalise sustainability goals in diverse contexts.

At the policy level, the insights from this research can inform frameworks that incentivise the adoption of tools like the *Tactical Sustainability Cards*. Policymakers can encourage industries to integrate such tools into their practices, ensuring alignment with sustainability

objectives and fostering multi-stakeholder collaborations. By facilitating a shared language and decision-making framework, the cards can enhance cross-disciplinary dialogues and support the development of policies that reflect diverse perspectives and priorities.

Furthermore, this research highlights the importance of empowering designers with tools that not only address immediate sustainability challenges but also contribute to long-term systemic change. By providing designers with actionable insights and fostering collaboration among stakeholders, the developed cards can be used to bridge the gap between sustainability principles and practical outcomes. This approach supports the creation of an environmentally, socially, and economically sustainable future. Finally, the cards can be used to harmonise innovation and sustainability, enabling practitioners to navigate the complexities of sustainability in a structured and collaborative way.

6.3. *Limitations and future directions*

While this research provides valuable insights, it has certain limitations as well. The interview study, though detailed, involved participants with varying levels of work experience and organisational roles, which may have influenced the findings. Future research could focus on a more targeted participant group to gain a clearer perspective on the relationship between sustainability and design. Additionally, all participants were based in the Netherlands and Belgium, limiting the geographic scope. Expanding the participant pool to include professionals from other countries would provide a broader understanding of the challenges and opportunities in integrating sustainability into design practices. As with any qualitative study, participant bias is a limitation. However, this subjectivity was leveraged as a strength to inform the design intervention. Increasing the sample size in future studies could yield more diverse and comprehensive insights.

The design intervention, *Tactical Sustainability Cards*, was validated through feedback from experts and professionals but has not yet been tested in real-world scenarios. Future research could involve collaborations with organisations to pilot the concept in practice, providing critical insights into its feasibility, desirability, and viability. Real-life trials would not only enhance the validity of the findings but also offer practical guidance for refining and scaling the tool.

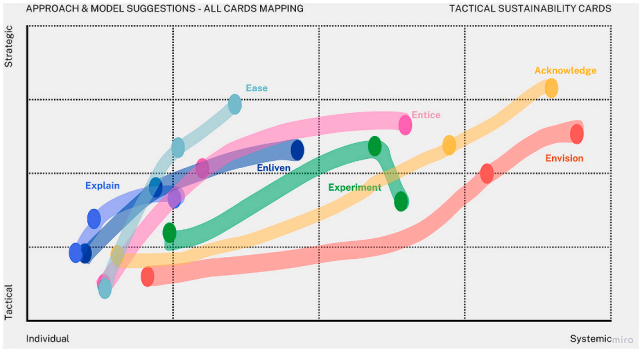
CRediT authorship contribution statement

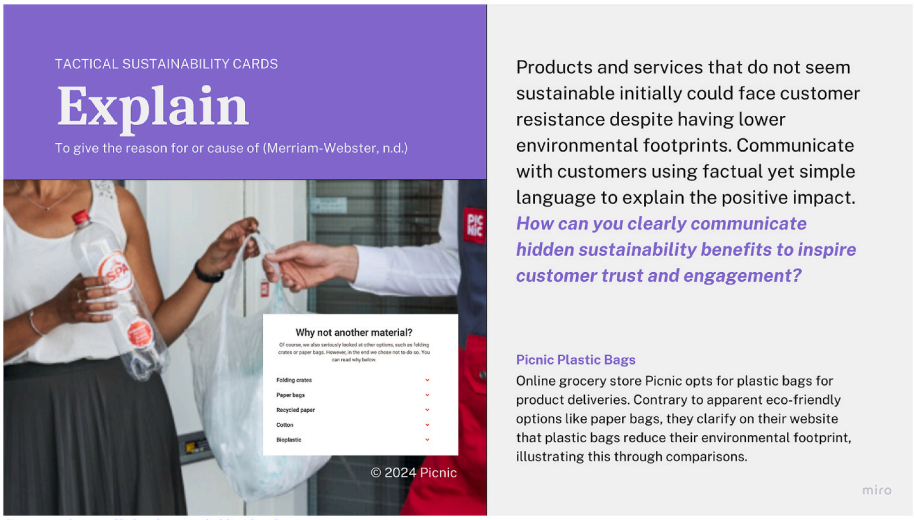
Giulia Calabretta: Writing – review & editing, Writing – original draft, Supervision, Methodology, Conceptualization. **Ömer Döver:** Writing – review & editing, Writing – original draft, Validation, Methodology, Investigation, Formal analysis. **Shahrokh Nikou:** Writing – review & editing, Writing – original draft, Validation, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix. Tactical Sustainability Cards





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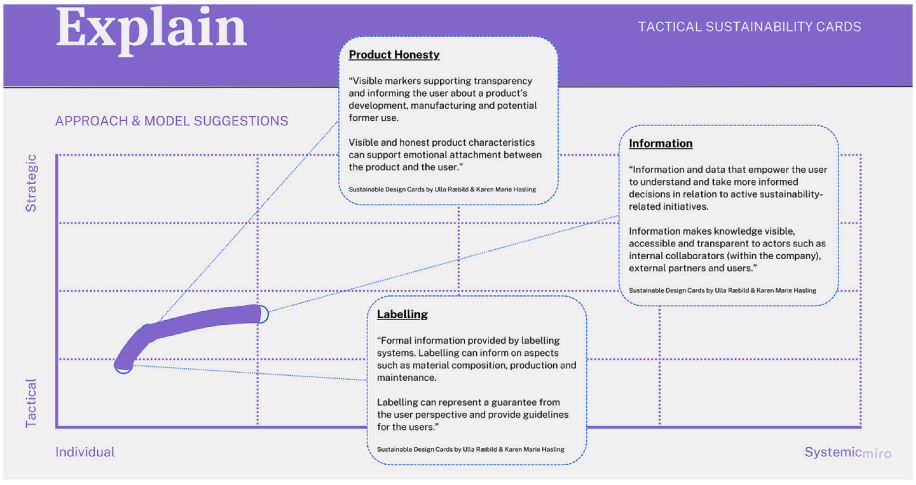

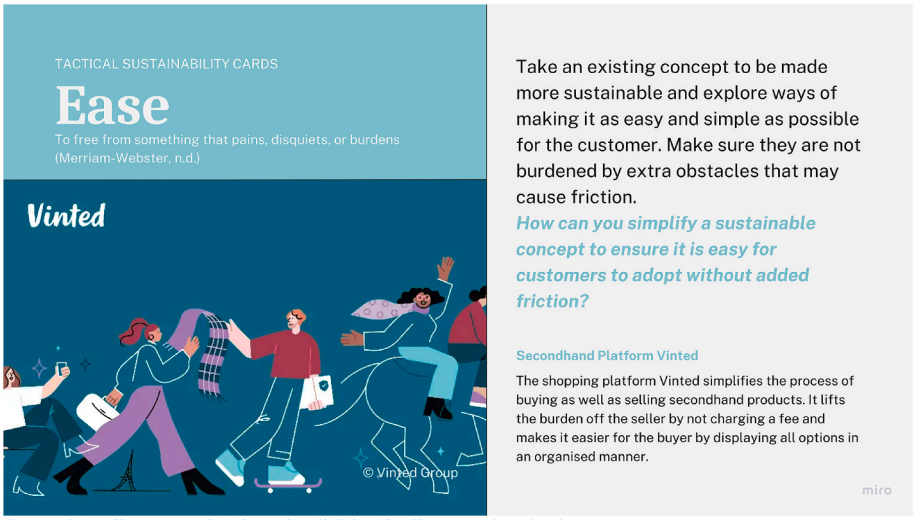

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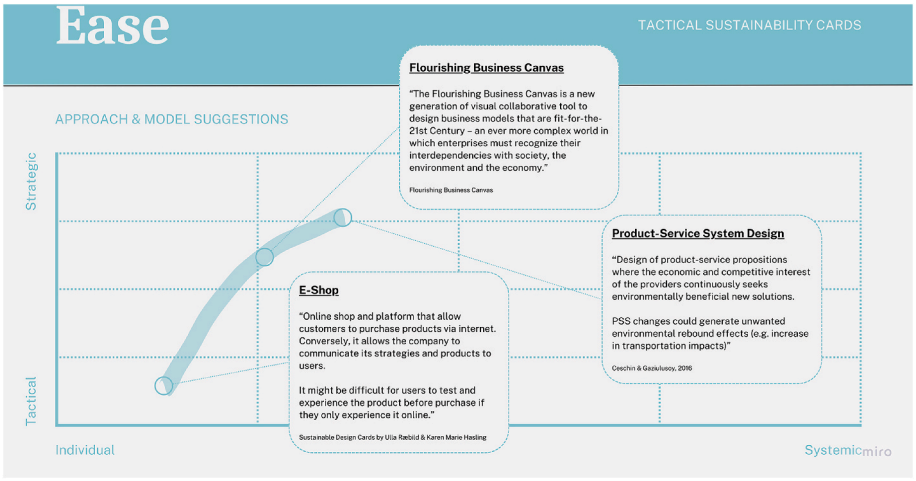

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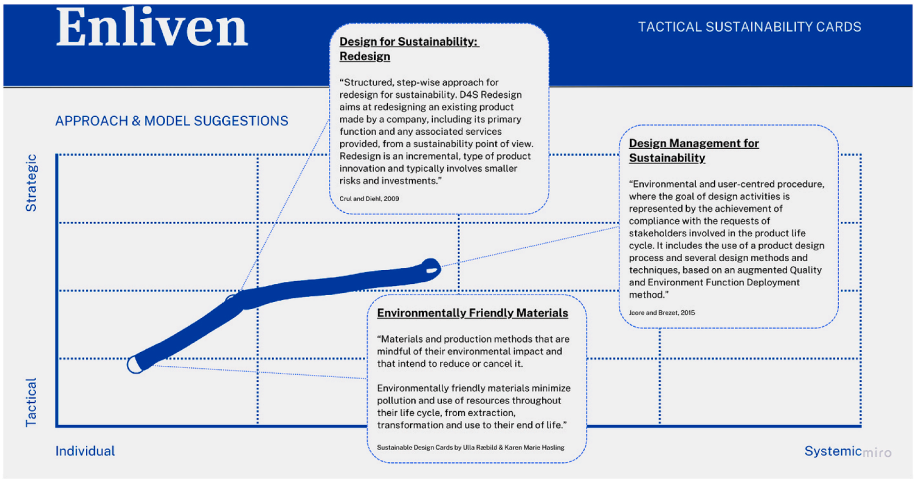

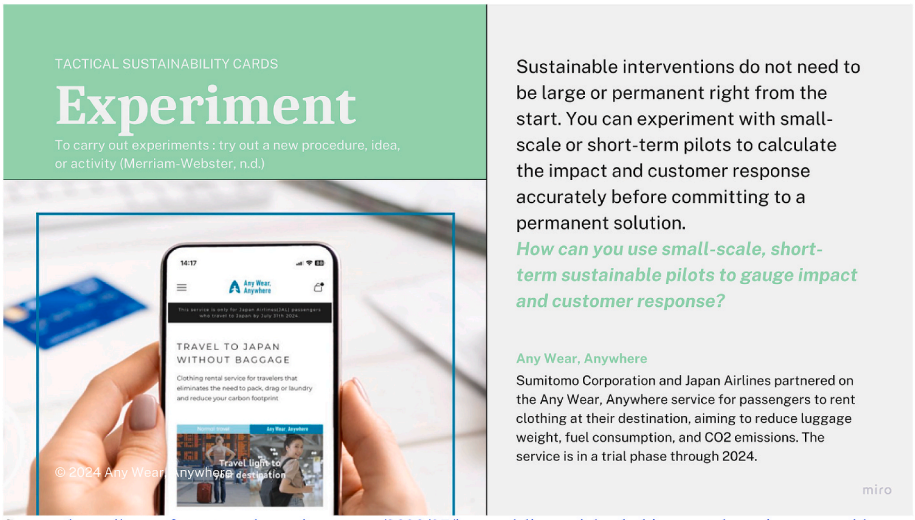

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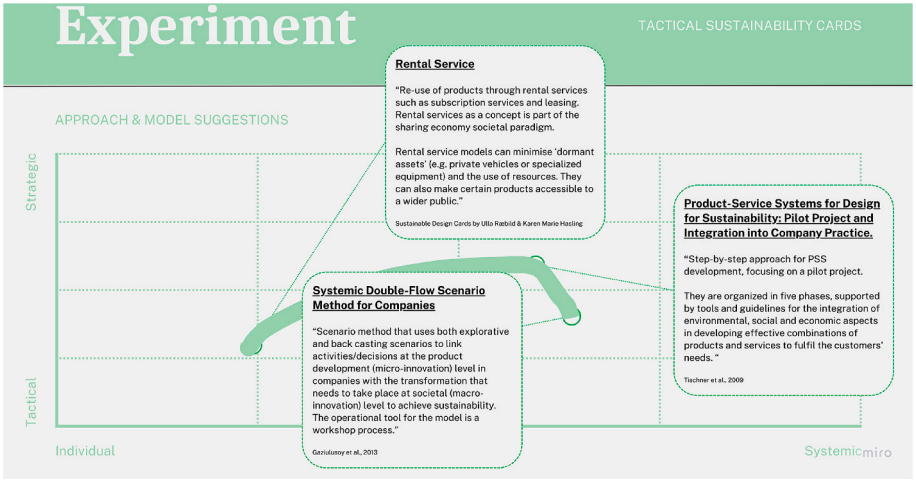

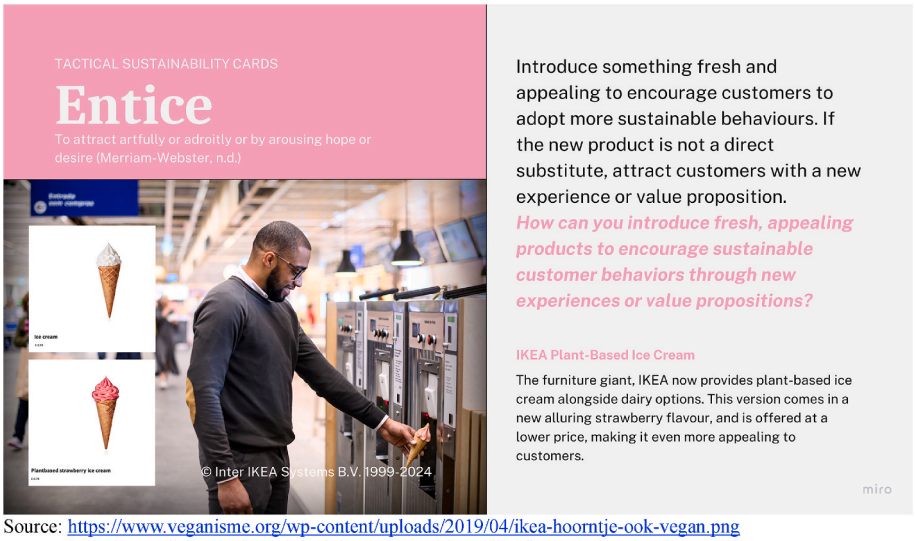

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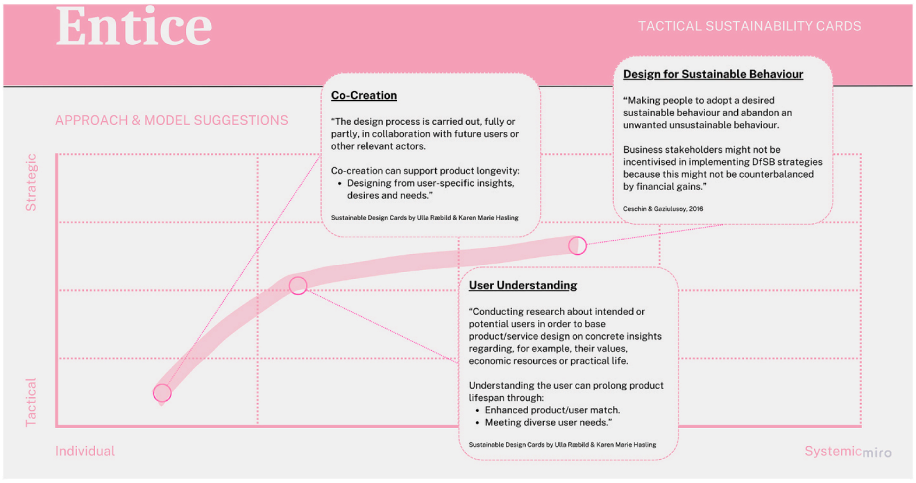

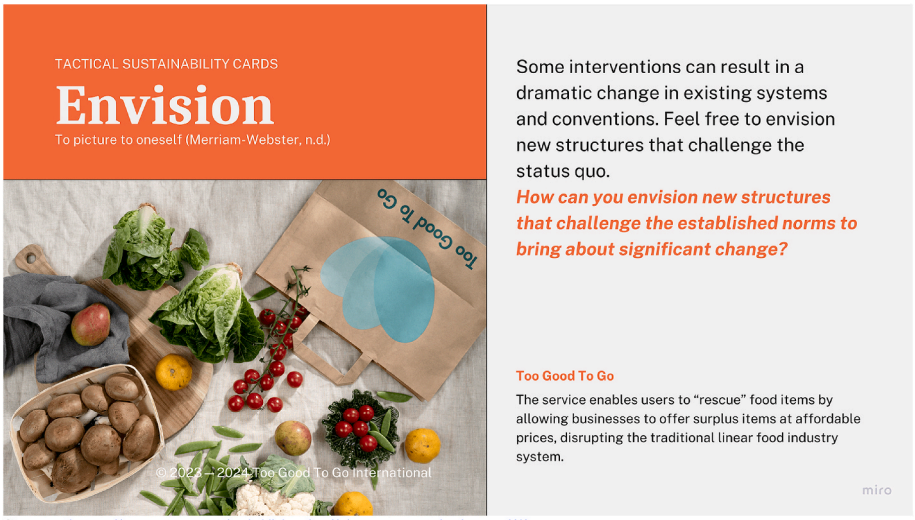

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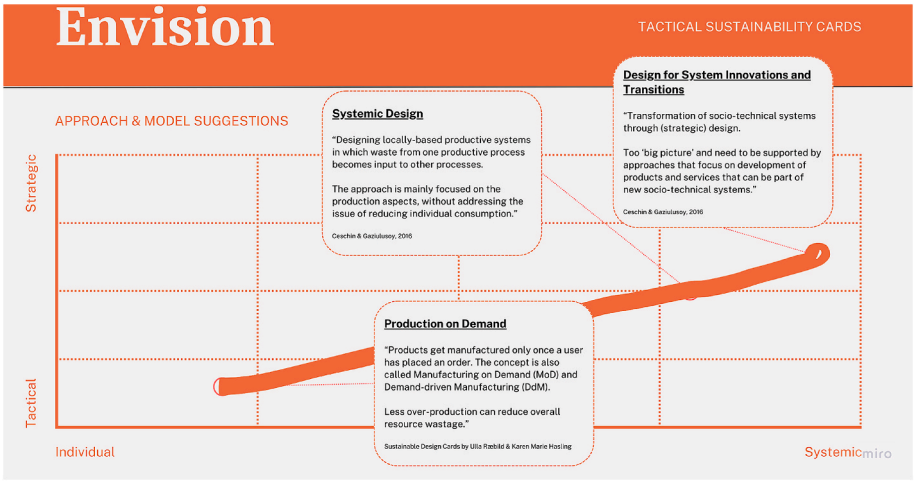

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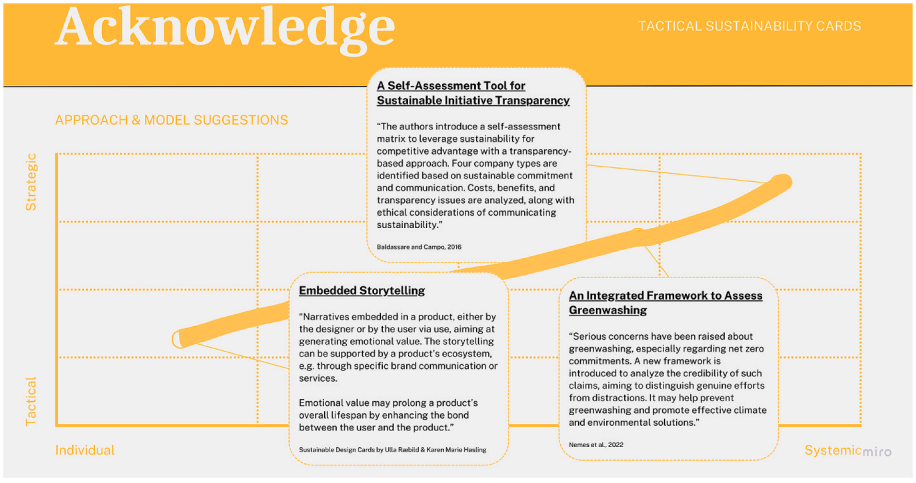

Data availability

Data will be made available on request.

References

Annarelli, A., Battistella, C., Borgianni, Y., Nonino, F., 2018. Estimating the value of servitization: a non-monetary method based on forecasted competitive advantage. J. Clean. Prod. 200, 74–85.

Aschehoug, S.H., Boks, C., 2011. Success criteria for implementing sustainability information in product development. DS 68-5: Proceed. 18th Int. Conf. Eng. Design (ICED 11), Impact. Soc. through Eng. Design 5, 145–154. Design for X/Design to X, Lyngby/Copenhagen, Denmark, 15.-19.08.2011.

Baldassarre, B., Calabretta, G., Bocken, N.M.P., Jaskiewicz, T., 2017. Bridging sustainable business model innovation and user-driven innovation: a process for sustainable value proposition design. J. Clean. Prod. 147, 175–186.

Baldassarre, B., Calabretta, G., Karpen, I.O., Bocken, N., Hultink, E.J., 2024. Responsible design thinking for sustainable development: critical literature review, new conceptual framework, and research agenda. J. Bus. Ethics 1–22.

Baldassarre, B., Konietzko, J., Brown, P., Calabretta, G., Bocken, N., Karpen, I.O., Hultink, E.J., 2020a. Addressing the design-implementation gap of sustainable business models by prototyping: a tool for planning and executing small-scale pilots. J. Clean. Prod. 255.

Baldassarre, B., Keskin, D., Diehl, J.C., Bocken, N., Calabretta, G., 2020b. Implementing sustainable design theory in business practice: a call to action. J. Clean. Prod. 273, 123113.

Barness, J., Mejía, G.M., 2018. The Colliding Discourse of "Cutting-edge" Design Practice and "Serious" Design Research.

Bhamra, T., Hernandez, R.J., 2021. Thirty years of design for sustainability: an evolution of research, policy and practice. Design Sci. 7, e2. https://doi.org/10.1017/dsj.2021.2.

Bhamra, T., Lofthouse, V., 2003. Information/inspiration: a web based sustainable design tool. DS 31: Proceedings of ICED 03, the 14th International Conference on Engineering Design, Stockholm, pp. 385–386 full paper no. DS31_1190FP.

Bhamra, T., Lofthouse, V., 2008. Design for Sustainability: A Practical Approach. Routledge. https://doi.org/10.4324/9781315576664.

Bhamra, T., Lofthouse, V., 2016. Design for Sustainability: a Practical Approach. Routledge.

Bocken, N.M., Short, S.W., Rana, P., Evans, S., 2014. A literature and practice review to develop sustainable business model archetypes. J. Clean. Prod. 65, 42–56.

Bohemia, E., 2004. The difference between in-house and contracted industrial designers: an Australian perspective. DRS Biennial Conference Series. https://dl.designresearch-society.org/drs-conference-papers/drs2004/researchpapers/156.

Ceschin, F., Gaziulusoy, I., 2016. Evolution of design for sustainability: from product design to design for system innovations and transitions. Des. Stud. 47, 118–163.

Coutts, E.R., Edward, J., Knight, R., Duffy, A., Grierson, H., 2017. In: Maier, A., Škec, S., Kim, H., Kokkolaras, M., Oehmen, J., Fadel, G., Salustri, F., Van der Loos, M. (Eds.), Is Product Design Evil?, vol. 1. The Design Society, pp. 209–218. https://www.designsociety.org/publication/39490/.

De Rooij, A., Dekker, E., Slegers, K., Biskjaer, M.M., 2021. How graphic designers rely on intuition as an ephemeral facility to support their creative design process. Int. J. Design Creat. Innov. 9 (4), 252–268.

Dewberry, E., Cook, M., Angus, A., Gottberg, A., Longhurst, P., 2013. Critical reflections on designing product service systems. Des. J. 16 (4), 408–430. https://doi.org/10.2752/175630613X13746645186089.
Efkolidis, N., Hernandez, C.G., Talon, J.L.H., Kyratsis, P., 2019. Promote sustainability through product design process by involving the user. Environ. Eng. Manage. J. 18 (9). Article 9.
Emans, D., Murdoch-Kitt, K.M., 2018. Connective methodologies: visual communication design and sustainability in higher education. In: Leal Filho, W., Marans, R.W., Callewaert, J. (Eds.), Handbook of Sustainability and Social Science Research. Springer International Publishing, pp. 83–105. https://doi.org/10.1007/978-3-319-67122-2_5.
Evans, D., 2011. Blaming the consumer – once again: the social and material contexts of everyday food waste practices in some English households. Crit. Public Health 21 (4), 429–440. https://doi.org/10.1080/09581596.2011.608797.
Fleming, A., Wise, R.M., Hansen, H., Sams, L., 2017. The sustainable development goals: a case study. Mar. Pol. 86, 94–103. https://doi.org/10.1016/j.marpol.2017.09.019.
Frecè, J.T., Harder, D.L., 2018. Organisations beyond Brundtland: a definition of corporate sustainability based on corporate values. J. Sustain. Dev. 11 (5), 184. https://doi.org/10.5539/jsd.v11n5p184.
Gaziulusoy, A.I., 2015. A critical review of approaches available for design and innovation teams through the perspective of sustainability science and system innovation theories. J. Clean. Prod. 107, 366–377.
Geissdoerfer, M., Bocken, N.M., Hultink, E.J., 2016. Design thinking to enhance the sustainable business modelling process–A workshop based on a value mapping process. J. Clean. Prod. 135, 1218–1232.
Gonzalez-Arcos, C., Joubert, A.M., Scaraboto, D., Guesalaga, R., Sandberg, J., 2021. "How do I carry all this now?" Understanding consumer resistance to sustainability interventions. J. Mark. 85 (3), 44–61.
Grobelnik, M., Cakir, F., Friedmann, D.-P., Maul, L., 2022. Rethinking user experience design: sustainability in the context of the user centered innovation process in power tool design. J. Phys. Conf. 2292 (1), 012008. https://doi.org/10.1088/1742-6596/2292/1/012008.
Grosse-Hering, B., Mason, J., Aliakseyeu, D., Bakker, C., Desmet, P., 2013. Slow design for meaningful interactions. Proceed. SIGCHI Conf. Human Fact. Comput. Syst. 3431–3440. https://doi.org/10.1145/2470654.2466472.
Irwin, T., 2015. Transition design: a proposal for a new area of design practice, study, and research. Des. Cult. 7 (2), 229–246.
Irwin, T., Tonkinwise, C., Kossoff, G., 2022. Transition design: an educational framework for advancing the study and design of sustainable transitions. Cuadernos del Centro de Estudios en Diseño y Comunicación. Ensayos (105), 31–72.
Jenks, A.B., Obringer, K.M., 2020. The poverty of plastics bans: environmentalism's win is a loss for disabled people. Crit. Soc. Policy 40 (1), 151–161. https://doi.org/10.1177/0261018319868362.
Jung, K., Mejía, M., 2023. Are service designers positioned to design for sustainability? IASDR Conf. Series. https://dl.designresearchsociety.org/iasdr/iasdr2023/fullpapers/107.
Karpen, I.O., Gemser, G., Calabretta, G., 2017. A multilevel consideration of service design conditions: towards a portfolio of organisational capabilities, interactive practices and individual abilities. J. Service Theor. Practice 27 (2), 384–407. https://doi.org/10.1108/JSTP-05-2015-0121.
Kulsbjerg Løgager, C., Simeone, L., Mejía, M., 2021. A foresight-oriented service design approach to foster longer-term thinking and sustainable practices: European Academy of Design Conference. European Academy of Design Conference.
Lee, K., 2021. Critique of design thinking in organizations: strongholds and shortcomings of the making paradigm. She Ji: The Journal of Design, Economics, and Innovation 7 (4), 497–515.
Lewis, J.R., Sauro, J., 2021. Usability and user experience: design and evaluation. Handbook. human fact. ergonom. 972–1015.
Lilley, D., Wilson, G.T., 2013. Integrating ethics into design for sustainable behaviour. J. Des. Res. 11 (3), 278–299. https://doi.org/10.1504/JDR.2013.056593.
Lowley, J., Gulden, T., 2016. Ethical bicycle consumption: from used frames to new products. Ds 83: Proceedings of the 18th International Conference on Engineering and Product Design Education (E&PDE16), Design Education: Collaboration and Cross-Disciplinarity, Aalborg, Denmark, pp. 132–137, 8th-9th September 2016.
Lubis, P.Y., Shahri, B., Ramirez, M., 2022. Integration of human-centred design and design for sustainability tool: proposal of design for amelioration tool. MIX Sustentável 8 (2), 19–30. https://ojs.sites.ufsc.br/index.php/mixsustentavel/article/view/5167.
Luchs, M.G., Phipps, M., Hill, T., 2015. Exploring consumer responsibility for sustainable consumption. J. Market. Manag. 31 (13–14), 1449–1471. https://doi.org/10.1080/0267257X.2015.1061584.
Mahajan, R., Kumar, S., Lim, W.M., Sareen, M., 2024. The role of business and management in driving the sustainable development goals (SDGs): current insights and future directions from a systematic review. Bus. Strat. Environ. 33 (5), 4493–4529.
Maher, R., Maher, M., Mann, S., McAlpine, C.A., 2018. Integrating design thinking with sustainability science: a Research through Design approach. Sustain. Sci. 13, 1565–1587.
Manzini, E., 2014. Making things happen: social innovation and design. Des. Issues 30 (1), 57–66. https://doi.org/10.1162/DESI_a_00248.
Mejía, G.M., Fischer, D., Silver, J., Xie, Y., Fehler, M., 2022. How do professional designers engage with sustainability? A systematic literature review. J. Des. Res. 20 (4), 297–317.
Niedderer, K., Ludden, G., Clune, S., Lockton, D., MacKrill, J.B., Morris, A., et al., 2016. Design for behaviour change as a driver for sustainable innovation: challenges and opportunities for implementation in the private and public sectors. Int. J. Des. 10 (2), 67–85.
Papanek, V., 1985. Design for the Real World. Thames & Hudson.
Peffers, K., Tuunanen, T., Rothenberger, M.A., Chatterjee, S., 2007. A design science research methodology for information systems research. J. Manag. Inf. Syst. 24 (3), 45–77.
Peters, D., Loke, L., Ahmadpour, N., 2021. Toolkits, cards and games–a review of analogue tools for collaborative ideation. CoDesign 17 (4), 410–434.
Ræbild, U., Hasling, K.M., 2018. Sustainable design cards: a learning tool for supporting sustainable design strategies. Sustainable Fashion in a Circular Economy, pp. 128–151.
Raja Ghazilla, R.A., Sakundarini, N., Taha, Z., Abdul-Rashid, S.H., Yusoff, S., 2015. Design for environment and design for disassembly practices in Malaysia: a practitioner's perspectives. J. Clean. Prod. 108, 331–342. https://doi.org/10.1016/j.Jclepro.2015.06.033.
Reyes, T., Gouvinhas, R.P., Laratte, B., Chevalier, B., 2020. A method for choosing adapted life cycle assessment indicators as a driver of environmental learning: a French textile case study. AI EDAM (Artif. Intell. Eng. Des. Anal. Manuf.) 34 (1), 68–79. https://doi.org/10.1017/S0890060419000234.
Rocha, C.S., Antunes, P., Partidário, P., 2019. Design for sustainability models: a multi-perspective review. J. Clean. Prod. 234, 1428–1445. https://doi.org/10.1016/j.jclepro.2019.06.108.
Rossi, E., Attaianese, E., 2023. Research synergies between sustainability and human-centred design: a systematic literature review. Sustainability 15 (17). https://doi.org/10.3390/su151712884.
Roy, R., Warren, J.P., 2019. Card-based design tools: a review and analysis of 155 card decks for designers and designing. Des. Stud. 63, 125–154.
Schneider, F., Buser, T., 2018. Promising degrees of stakeholder interaction in research for sustainable development. Sustain. Sci. 13, 129–142.
Shapira, H., Ketchie, A., Nehe, M., 2017. The integration of design thinking and strategic sustainable development. J. Clean. Prod. 140, 277–287.
Steg, L., Vlek, C., 2009. Encouraging pro-environmental behaviour: an integrative review and research agenda. J. Environ. Psychol. 29 (3), 309–317. https://doi.org/10.1016/j.jenvp.2008.10.004.
Sumter, D., Bakker, C., Balkenende, R., 2018. The role of product design in creating circular business models: a case study on the lease and refurbishment of baby strollers. Sustainability 10 (7). https://doi.org/10.3390/su10072415.
Thatcher, A., 2012. Affect in designing for sustainability in human factors and ergonomics. Int. J. Hum. Factors Ergon. 1 (2), 127. https://doi.org/10.1504/IJHFE.2012.048034.
Tukker, A., 2015. Product services for a resource-efficient and circular economy–a review. J. Clean. Prod. 97, 76–91.
UN, 1987. Our Common Future. of the World Commission on Environment and Development.
UN, 2015. Transforming Our World: the 2030 Agenda for Sustainable Development. United Nations.
Vandevyvere, H., Heynen, H., 2014. Sustainable development, architecture and modernism: aspects of an ongoing controversy. Arts 3 (4), 350–366. https://doi.org/10.3390/arts3040350.
van Zanten, J.A., van Tulder, R., 2021. Improving companies' impacts on sustainable development: a nexus approach to the SDGS. Bus. Strat. Environ. 30 (8), 3703–3720. https://doi.org/10.1002/bse.2835.
Vezzoli, C., Ceschin, F., Diehl, J.C., Kohtala, C., 2015. New design challenges to widely implement 'sustainable product–service systems'. J. Clean. Prod. 97, 1–12. https://doi.org/10.1016/j.jclepro.2015.02.061.
Vezzoli, C., Ceschin, F., Osanjo, L., M'Rithaa, M.K., Moalosi, R., Nakazibwe, V., Diehl, J. C., 2018a. Designing sustainable energy for all: sustainable product-service system design applied to distributed renewable energy. Sprin. Nature. https://doi.org/10.1007/978-3-319-70223-0.
Vezzoli, C., Ceschin, F., Osanjo, L., M'Rithaa, M.K., Moalosi, R., Nakazibwe, V., Diehl, J. C., 2018b. Design for sustainability: an introduction. Designing Sustainable Energy for All: Sustainable Product-Service System Design Applied to Distributed Renewable Energy. Springer, Cham, pp. 103–124. https://doi.org/10.1007/978-3-319-70223-0_5.
Weiland, S., Hickmann, T., Lederer, M., Marquardt, J., Schwindenhammer, S., 2021. The 2030 agenda for sustainable development: transformative change through the sustainable development goals? Polit. Govern. 9 (1), 90–95.
Whitmarsh, L., Poortinga, W., Capstick, S., 2021. Behaviour changes to address climate change. Curr. Opin. Psychol. 42, 76–81. https://doi.org/10.1016/j.copsyc.2021.04.002.