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An Interdisciplinary Design Process – Lowering Barriers to an Active Outdoor Life

Identifying stakeholders' functional and emotional needs in
concept development for outdoor textile products

Master's thesis in Industrial Design Engineering and Industrial Ecology

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Sketch of final concept, the Grab & Go cooking module. Design by the authors.
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Abstract

The European Green Deal sets the direction towards climate neutrality by 2050, with the textile industry identified as one of the sectors with the highest environmental impact. The transition towards a more sustainable society requires both environmentally responsible product development and increased opportunities for individuals to engage in healthy and meaningful lifestyles. The outdoor industry faces increasing pressure to align product development with circular economy principles and emerging European Union sustainability regulations.

Outdoor recreation contributes positively to physical health, mental well-being, and social community. However, outdoor participation is often hindered by practical, emotional and psychological related barriers.

A qualitative research approach was employed, combining stakeholder interviews, field observations, literature studies, and concept development design methods. Stakeholder needs, motivations, capabilities and opportunities were analyzed and synthesized to identify key barriers and opportunities related to outdoor cooking experiences.

This thesis explores how an interdisciplinary design process can identify stakeholders' functional and emotional needs to propose design criteria for outdoor textile product development in accordance with the EU's Strategy for Sustainable and Circular Textiles, with the goal of lowering barriers to an active outdoor life. The study focuses on outdoor cooking as an entry point and draws on human-centered design, stakeholder theory, behavioral design, and life cycle thinking.

The findings indicate that barriers to outdoor participation are influenced not only by functional and physical challenges, but also by emotional factors including uncertainty and perceived accessibility and complexity. The interdisciplinary design process enabled the integration of diverse stakeholder perspectives and sustainability considerations, resulting in a concept that simplifies outdoor cooking experiences for beginners while supporting circular design principles. The study is limited to early-stage concept development and does not include prototype testing or commercial implementation.

Keywords: interdisciplinary design, stakeholder-centered design, outdoor recreation, outdoor cooking, concept development, circular economy, sustainable textiles, human-centered design, behavioral design, life cycle thinking, sustainable transition, stakeholder participation, rethink

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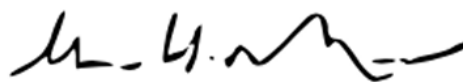
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Matilda Wrangdahl & Moa Hollén, Gothenburg, June 2026

A handwritten signature in black ink, appearing to read 'Matilda Wrangdahl'.

Matilda Wrangdahl

A handwritten signature in black ink, appearing to read 'Moa Hollén'.

Moa Hollén

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1 Introduction

The European Green Deal sets the direction towards climate neutrality by 2050, placing the textile industry under increasing pressure to transform its patterns of production and consumption. In response to environmental challenges such as climate change, resource depletion, and biodiversity loss, policy-makers and industries are adopting circular economy principles and life cycle thinking to reduce environmental impacts across product systems. The EU Strategy for Sustainable and Circular Textiles compels the industry to rethink.

At the same time, outdoor recreation has gained recognition for its positive contributions to physical health and mental well-being. As urbanization and increasingly sedentary lifestyles continue to shape modern society, participation in outdoor activities offers important opportunities for recreation, recovery and social engagement in nature. Despite these benefits, many individuals experience barriers that limit participation in outdoor life, including lack of knowledge, insufficient equipment, and perceived complexity related to planning and logistics.

The outdoor industry therefore faces a dual challenge. They need to support increased accessibility to outdoor recreation while simultaneously address the growing sustainability requirements. Meeting these challenges requires design approaches that consider not only technical performance but also environmental requirements and the needs, motivations, and behaviors of diverse stakeholders throughout the product life cycle.

Previous research has highlighted the importance of human-centered and interdisciplinary design processes in addressing complex sustainability challenges. However, there remains a need for greater understanding of how stakeholder insights can inform concept development for outdoor products that both lower barriers to participation and align with circular economy objectives.

This study explores an interdisciplinary design process for outdoor soft goods by identifying stakeholders' functional and emotional needs and translating these insights into concept development. By integrating stakeholder perspectives, behavioral considerations, and sustainability principles, the study seeks to contribute knowledge on how outdoor products can be designed to support a more accessible and sustainable outdoor life.

1.1 Aim

The purpose of the study is to explore an interdisciplinary design process by identifying stakeholders' functional and emotional needs in order to propose new design criteria for concept development in accordance with the EU's Strategy for Sustainable and Circular Textiles, which contribute to lowering the barrier to an active outdoor life.

1.2 Research Questions

The aim is addressed through the following three research questions:

1. How do stakeholder insights inform concept development?
2. How does an interdisciplinary design process contribute to concept development?
3. How can outdoor textile products be designed in alignment with the EU Strategy for Sustainable and Circular Textiles?

1.3 Limitations

This study is limited to the early phases of concept development and does not include detailed engineering development or commercial implementation. The project focuses primarily on sustainable stakeholder-centered concept development and interdisciplinary design methods. Further, it applies life cycle thinking to implement sustainability perspectives early in the design process.

The study does not include complete economic analyses, life cycle assessment calculations, or social life cycle assessment evaluations. Furthermore, extensive textile material testing and laboratory validation of technical performance have not been conducted within the scope of this thesis. The proposed concept should therefore be understood as a conceptual and exploratory design proposal rather than a finalized market-ready product.

2 Theoretical Framework

2.1 The European Green Deal: EU Strategies and Directives

This chapter outlines the EU policy framework that frames the transition towards sustainability and circularity. It introduces the European Green Deal, the Circular Economy Action Plan, the Ecodesign for Sustainable Products Regulation, the Digital Product Passport, the EU Ecolabel and the Waste Framework Directive.

2.1.1 The European Green Deal: 9 Policy Areas for Climate Neutrality

The European Green Deal is the European Union's (EU) growth strategy that aims to transform the Union into a modern, resource-efficient and competitive economy (European Commission, 2019). Its primary objective is to make Europe the first climate-neutral continent by 2050 while ensuring economic growth is decoupled from resource use (European Commission, 2019). The strategy responds to the urgent call for climate action and establishes a comprehensive plan to transform Europe's economy, energy, transport, and industries for a sustainable future (figure 1) (European Commission, n.d.-a). Through the European Climate Law, the 2050 neutrality goal is legally binding, supported by a target to reduce emissions by at least 55% by 2030 compared to 1990 levels (REGULATION (EU) 2024/17, n.d.).

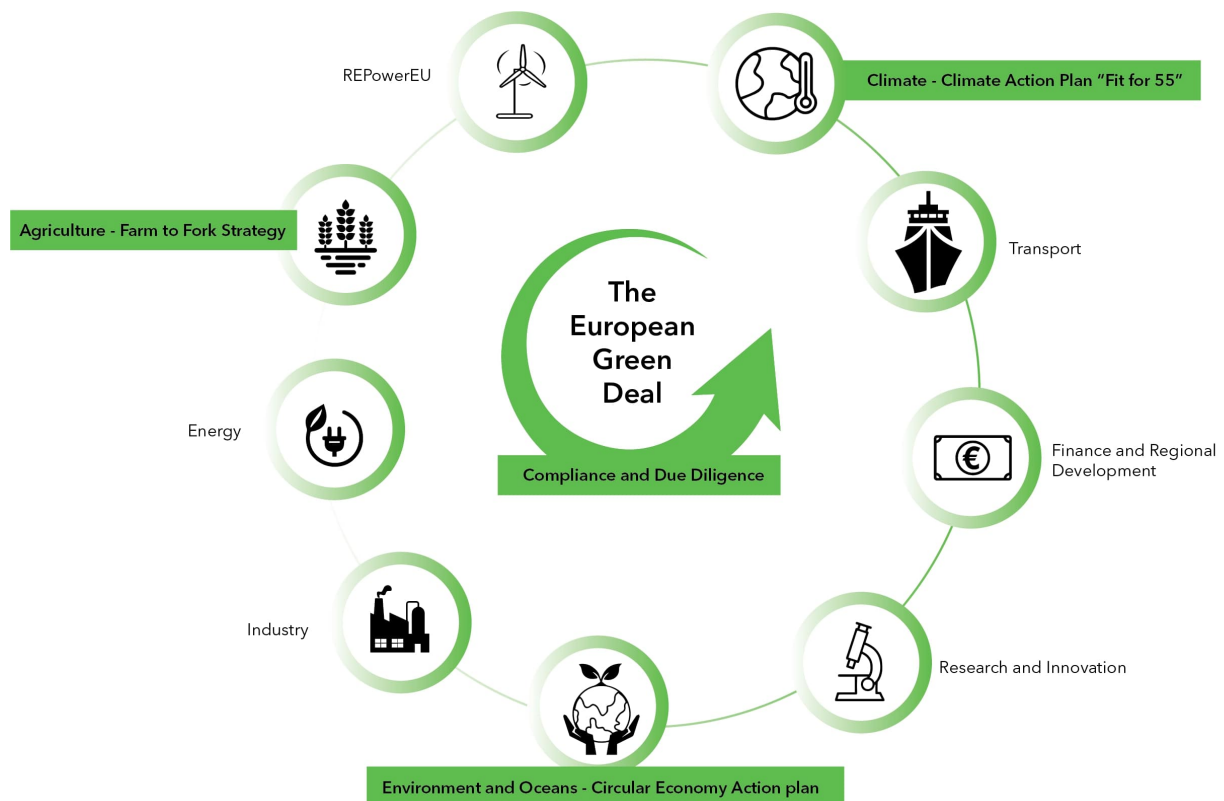


Figure 1. The European Green Deal - Compliance and Due Diligence[MH1.1]. Source: (DNV, n.d.)

The Green Deal pushes forward a clean transition that is economically sound and socially fair, ensuring a just transition for the communities most affected (European Commission, n.d.-a). It prioritizes protecting natural capital and the health and well-being of citizens from environment-related risks (European Commission, 2019). The strategy makes consistent use of all policy levers, including regulation, standardization, investment, and innovation, to achieve its objectives (European Commission, 2019). The European Green Deal identifies nine interconnected policy areas that are central to the transformation of the EU's economy (European Commission, 2019). These areas comprise:

1. **Climate** - aiming for climate neutrality by 2050 through legally binding targets. The Climate Law places a legal duty on every EU policy area to contribute to the neutrality objective, ensuring climate goals are built into decision-making across all sectors, not treated in isolation. Carbon pricing instruments and a revised Emissions Trading System are among the key tools for achieving cost-effective emission reductions across the economy.
2. **Energy** - ensuring a clean and efficient energy transition, guided by the energy efficiency first principle. Energy production and use account for more than 75 percent of the EU's greenhouse gas emissions, making decarbonization of the energy system essential. The transition requires a power sector based increasingly on renewable sources, rapid coal phase-out, and a fully integrated and digitalized energy market.
3. **Environment and oceans** - protecting biodiversity and ecosystems. Ecosystems provide essential services including fresh water, clean air, food security, and climate regulation, yet face increasing pressure from land use change, resource exploitation, and climate change. The Green Deal commits to a Biodiversity Strategy to halt biodiversity loss and a zero-pollution action plan targeting air, water, and soil pollution.
4. **Agriculture** - creating a healthy and fair food system through the 'Farm to Fork' strategy. The strategy aims to shift European agriculture toward more sustainable production by reducing pesticide and fertilizer use while promoting organic farming, agro-ecology, and stronger animal welfare standards. It is designed to make food healthier and more sustainable while supporting farmers in the environmental transition.
5. **Transport** - providing efficient, safe, and environmentally friendly transport solutions. Transport currently accounts for a quarter of EU greenhouse gas emissions, and a 90 percent reduction is required by 2050 to reach climate neutrality. The strategy targets all modes, including road, rail, aviation, and maritime, prioritizing affordable, accessible, and cleaner alternatives to current mobility habits.
6. **Industry** - implementing an industrial strategy for a competitive, green, and digital Europe. The Green Deal calls for climate and resource frontrunners in key sectors, with priority technologies including clean hydrogen, energy storage, and zero-carbon steelmaking by 2030. The circular economy is central to the industrial strategy, offering potential for new economic activity, green jobs, and reduced resource.

7. **Research and innovation** - driving transformative change through technological and social solutions. Horizon Europe plays a central role, with at least 35 percent of its budget dedicated to climate solutions relevant to the Green Deal. Four Green Deal Missions will drive large-scale change in climate adaptation, oceans, cities, and soil, uniting researchers, regions, and citizens around shared objectives.
8. **Finance and regional development** - directing sustainable investments to deliver the Green Deal. Meeting the EU's 2030 climate and energy targets requires approximately €260 billion in additional annual investment, requiring coordinated mobilization of public and private capital. Instruments including InvestEU and cohesion policy funds direct finance toward climate objectives, with the Just Transition Mechanism ensuring no region is left behind.
9. **New European Bauhaus** - connecting the Green Deal to living spaces and experiences through creative and interdisciplinary initiatives. The initiative promotes solutions that are not only sustainable, but also inclusive and beautiful, respecting the diversity of places, traditions, and cultures across Europe. It works at a grassroots level by engaging communities directly, offering tailored tools and guidance, and incorporating the views of various stakeholders into design and implementation processes.

2.1.2 Circular Economy Action Plan

The Circular Economy Action Plan (CEAP), adopted in March 2020, is a cornerstone of the European Green Deal and the broader EU industrial strategy. It plays a central role in the overarching framework for transitioning all sectors toward circular resource use, instead of the traditional linear model that overuses the planet's resources (European Commission, 2020). It introduces initiatives addressing the entire life cycle of products, focusing on design, waste prevention, and keeping used resources in the EU economy for as long as possible (European Commission, n.d.-b). While climate neutrality depends on parallel action across energy, transport, agriculture, and biodiversity policy, the circular economy is particularly significant for addressing natural resource pressure. Resource extraction and processing account for approximately half of total greenhouse gas emissions and more than 90% of biodiversity loss and water stress globally.

The CEAP targets resource-intensive sectors where EU-level action brings the most added value, including textiles, electronics, batteries, packaging, and plastics (European Commission, 2019). Up to 80% of a product's environmental impact is determined at the design phase, making product design the primary lever for environmental change (European Commission, n.d.-b). The plan is not a standalone strategy but forms the basis for a series of binding legislative instruments, including the Ecodesign for Sustainable Products Regulation (ESPR), the Digital Product Passport (DPP), the Batteries Regulation, and the revised Waste Framework Directive (European Commission, 2020). The ambition is to double the circular material use rate by 2030, contributing to a resource-efficient and low-waste economy (European Commission, n.d.-b).

2.1.3 Ecodesign for Sustainable Products Regulation

The Ecodesign for Sustainable Products Regulation (ESPR), which entered into force in July 2024, implements the Circular Economy Action Plan's ambition to make sustainable products the norm (European Commission, 2020; European Commission, n.d.-d). It establishes a framework for ecodesign requirements that products must comply with to be placed on the market. The regulation does not prescribe identical rules for all products but allows the Commission to adopt product-specific delegated acts that define relevant ecodesign performance and information requirements.

The ecodesign performance requirements cover durability, reliability, reusability, upgradability, reparability, maintenance, refurbishment, remanufacturing, recyclability, and recovery of materials. They further address substances of concern, energy, water and resource efficiency, recycled content, carbon and environmental footprints, and expected waste generation (REGULATION (EU)2024/17, n.d.). Information requirements complement these rules through reparability or durability scores, product use and repair information, end-of-life handling guidance, and the Digital Product Passport (DPP). The regulation also includes disclosure requirements for discarded unsold consumer products and allows the setting of minimum requirements for public procurement (REGULATION (EU) 2024/17, n.d.). By establishing uniform requirements at the EU level, the ESPR strengthens the single market and prevents divergent national legislation.

2.1.4 Digital Product Passport

The Digital Product Passport (DPP) is a mandatory information system introduced under the ESPR that requires products to be accompanied by structured data on their environmental sustainability and life cycle (European Commission, n.d.-e). It includes information such as unique product identifiers, compliance documentation, and details on substances of concern (European Parliament and Council, 2024).

The DPP is accessible via electronic means through a data carrier, providing essential information to actors along the value chain (European Commission, n.d.-e). It helps consumers make informed choices and assists repairers, recyclers, and market surveillance authorities in their respective tasks (European Parliament and Council, 2024). The system is decentralized, managed by economic operators, and based on open standards to ensure interoperability and data sharing. Products can only be placed on the market if a DPP is available, ensuring that accurate and up-to-date data follows the product throughout its life cycle (European Parliament and Council, 2024).

2.1.5 EU Ecolabelling

The EU Ecolabel is a Type I environmental label, signifying a voluntary, third-party certified scheme that identifies products with a reduced environmental impact throughout their entire life cycle (European Commission, n.d.-f). It is awarded to goods and services meeting high environmental performance standards based on scientific evidence (European Parliament and Council, 2010). The scheme aims to empower consumers and procurers to make sustainable choices while preventing greenwashing (European Commission, 2023).

Criteria for the EU Ecolabel are determined on a scientific basis considering the whole life cycle of products, focusing on the most significant environmental impacts such as climate change, biodiversity, and resource consumption (European Parliament and Council, 2010). While Type I labels like the EU

Ecolabel are based on multi-criteria life cycle considerations, they are distinct from Type II self-declared environmental claims and Type III Environmental Product Declarations (EPDs). Unlike Type I, Type III declarations require a comprehensive, quantitative Life Cycle Assessment (LCA) in accordance with ISO 14025 (ISO, 2006). The EU Ecolabel serves as a validated indicator of high environmental performance, ensuring compliance with stringent sustainability standards while supporting innovative and responsible businesses (European Commission, n.d.-f).

2.1.6 Waste Framework Directive

The Waste Framework Directive establishes the legal framework for waste prevention and management in the EU, aiming to protect the environment and human health (European Commission, n.d.-g). It introduces the five-step waste hierarchy (figure 2) as a priority order in legislation and policy: prevention, preparing for reuse, recycling, other recovery, and disposal (DIRECTIVE 2008/98/EC, n.d.). Prevention is the preferred option, while disposal in landfills is the last resort (European Commission, n.d.-g).



Figure 2. The five-step waste hierarchy [MH1.1] as defined in Waste Framework Directive (European Commission, n.d.-g).

The directive also implements the 'polluter-pays principle' and Extended Producer Responsibility (EPR), where producers bear financial or organizational responsibility for the waste stage of their products' life cycle (DIRECTIVE 2008/98/EC, n.d.). The 2025 revision of the directive introduces specific rules for textiles, requiring Member States to set up EPR schemes to ensure used and waste textiles are managed according to the hierarchy (European Commission, n.d.-g). These measures incentivize producers to design more sustainable products and increase the circularity of the textile sector (DIRECTIVE (EU) 2025/189, n.d.).

2.2 Lifecycle Thinking

This chapter outlines life cycle thinking as a framework for analyzing environmental impacts across the product life cycle, including system boundaries, key assessment tools, and the circular economy perspective.

2.2.1 Lifecycle Thinking and System Boundaries

Life cycle thinking forms the foundational perspective for understanding and managing the environmental impacts of products. It entails considering the full sequence of stages that a product passes through, from raw material extraction through production, distribution, use, and end-of-life treatment. This approach ensures that environmental burdens are not simply shifted from one life cycle stage to another but are addressed holistically (ISO 14040:2006, p. 10).

Flowcharts are a central visual tool in life cycle modelling. They map the product system by illustrating the unit processes, their interconnections, and the system boundaries that define which stages are included in the assessment (ISO 14044:2006, pp. 10-11). In a life cycle flowchart, boxes represent unit processes, which are the individual activities or processing stages within the product system for which data are collected, while arrows illustrate the flows of intermediate products and energy that interlink these processes. A well-constructed flowchart enables practitioners to identify data collection points, allocate input and output flows, and communicate the scope of the study transparently. Figure 3 provides a visual overview of the system boundaries in relation to the stages of the product life cycle, marking cradle-to-gate and cradle-to-cradle.

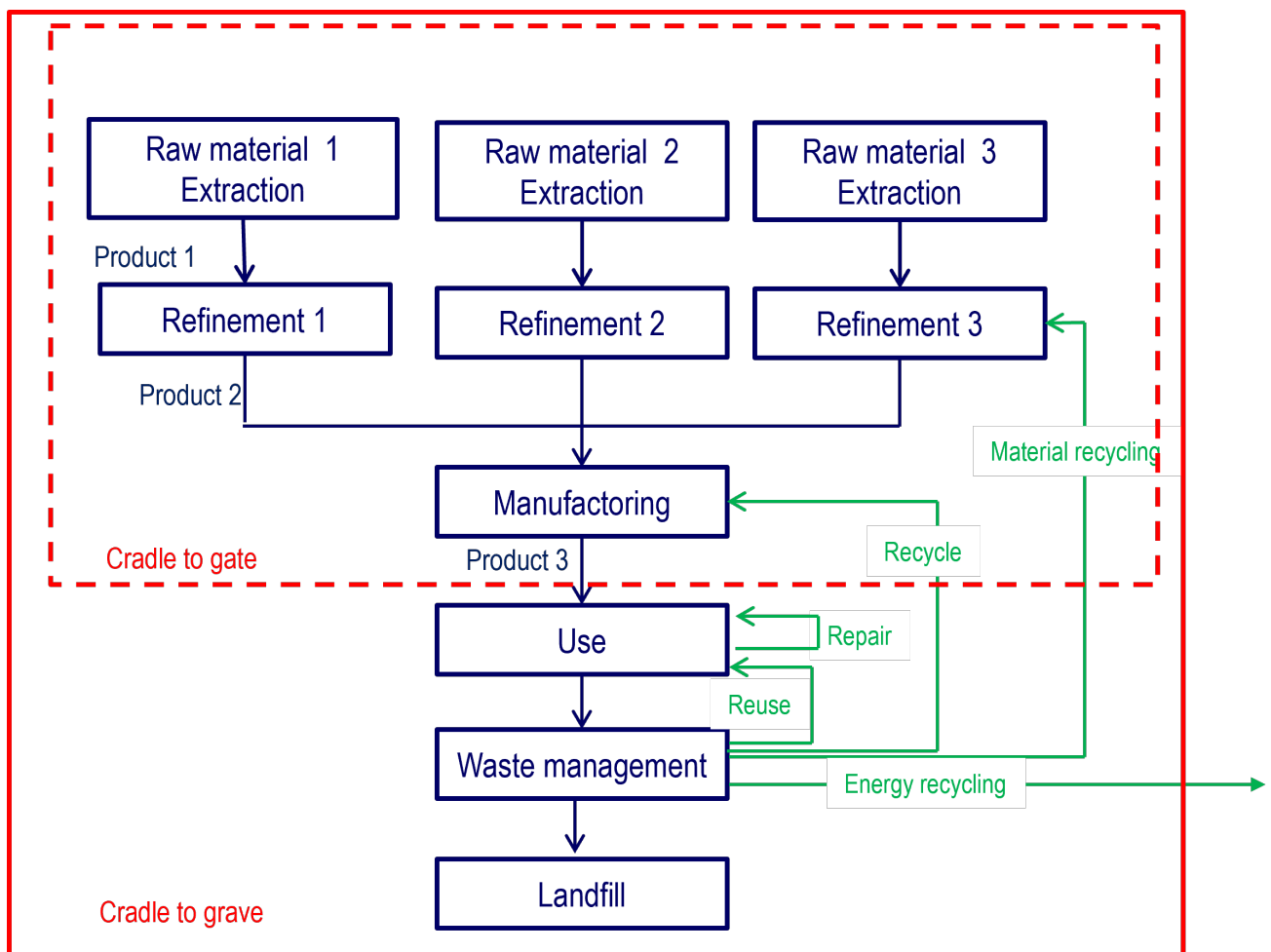


Figure 3. Flowchart over cradle-to-gate and cradle-to-grave lifecycle and system boundaries.

2.2.2 Applying Lifecycle Thinking 1: LCA, EPD and GHG protocol

Life cycle assessment is a standardized technique for evaluating the environmental aspects and potential impacts associated with a product throughout its life cycle (ISO 14040:2006, p. 10). The life cycle of a product is formally defined as the consecutive and interlinked stages from raw material acquisition or generation from natural resources to final disposal (ISO 14040:2006, p. 16). A complete life cycle assessment (LCA) adopts a cradle-to-grave system boundary, encompassing all stages from raw material extraction through manufacturing, use, and end-of-life treatment (Wiedemann et al., 2023). Alternative system boundaries include cradle-to-gate, which covers only up to the point when the product leaves the factory, and cradle-to-cradle, which incorporates recycling loops so that end-of-life materials re-enter the production cycle (Schumacher and Forster, 2022).

The methodology is governed by the ISO 14040 and ISO 14044 standards, which define four iterative phases (ISO 14044:2006, p. 10): goal and scope definition, life cycle inventory (LCI), life cycle impact assessment (LCIA), and interpretation. The functional unit defined in the first phase quantifies the service delivered, enabling comparison between products. In the LCI phase, data on inputs and outputs are collected for the product system, distinguished between primary data that is specific to the product and secondary data from databases such as ecoinvent (Miljögiraff, 2025). The LCIA phase translates inventory data into environmental impact categories, including climate change, water scarcity, eutrophication, and resource depletion. It evaluates the environmental significance of those flows, and the interpretation phase draws conclusions, limitations and recommendations from the results (ISO 14044:2006, p. 10; Zhang et al., 2023).

An Environmental Product Declaration (EPD) is a Type III environmental declaration, third-party verified and based on quantified life cycle data, standardized under ISO 14025, that communicates quantified life cycle environmental information for products fulfilling the same function (Miljögiraff, 2025, p. 14). EPDs are developed according to Product Category Rules (PCRs), which define the calculation rules, system boundaries, and data requirements for a given product category. They build on the ISO 14040/14044 framework and may be reported with cradle-to-gate or cradle-to-grave system boundaries, with optional inclusion of module D for reuse, recovery, and recycling benefits (Miljögiraff, 2025, pp. 14-15, 25).

The Greenhouse Gas (GHG) Protocol Product Life Cycle Accounting and Reporting Standard provides a framework for quantifying and publicly reporting greenhouse gas emissions associated with specific products (GHG Protocol, 2011, p. 5). It builds on the ISO 14040/14044 LCA framework and supports value chain greenhouse gas measurement. While LCA covers multiple environmental impact categories, the Product Standard focuses specifically on climate change. At the corporate level, emissions are categorized into scope 1, which covers direct emissions from owned or controlled sources, scope 2, which covers indirect emissions from purchased electricity, steam, heating, and cooling, and scope 3, which covers all other indirect emissions across the value chain (GHG Protocol, 2011, p. 5; GHG Protocol, 2004, p. 29).

2.2.3 Applying Lifecycle Thinking 2: Circular Economy and the R-strategies

The circular economy applies life cycle thinking to resource management by seeking to keep products and materials in use for as long as possible and to minimize waste. In contrast to the traditional linear model, it supports a transition towards more resource-efficient production and consumption and contributes to decoupling economic activity from resource use (European Commission, 2020).

The R-strategies translate this logic into a hierarchy of actions based on how much product and material value is retained. The hierarchy mirrors the priority structure of the Waste Framework Directive, which establishes the waste hierarchy as prevention, preparing for re-use, recycling, other recovery, and disposal (Directive 2008/98/EC). Refuse, rethink, and reduce correspond most closely to prevention, while reuse, repair, refurbish, remanufacture, and repurpose broadly sit between prevention and preparing for re-use because they retain products or components at a higher value than recycling. Recycling remains important but ranks lower because it reprocesses materials after continued product use is no longer feasible. Recovery and disposal remain lower-priority options.

The R-strategies also connect to the system boundaries shown in figure 3. Strategies such as reuse and repair retain value within existing product loops, corresponding to a cradle-to-cradle boundary. Recycling closes material loops at end-of-life, while recovery and disposal mark the terminal stages of a cradle-to-grave system. *See table 1* for summarize of the 9R-strategies and their broad relation to the legal waste hierarchy.

Table 1. 9R strategies and their relation to the legal waste hierarchy. Adapted from (Kirchherr et al., 2017)

R-strategy	Main function	Broad relation to the waste hierarchy
R0 Refuse	Avoid unnecessary products or material inputs altogether	Prevention
R1 Rethink	Reconsider product design, use patterns, or business models to reduce resource demand	Prevention
R2 Reduce	Minimize material and energy use through more efficient design and production	Prevention
R3 Reuse	Use a product or component again for the same purpose with minimal intervention	Preparing for re-use
R4 Repair	Restore product function so the product remains in use	Preparing for re-use
R5 Refurbish	Improve or restore a product while retaining its original function	Preparing for re-use
R6 Remanufacture	Rebuild a product or component so that value is retained through renewed performance	Preparing for re-use
R7 Repurpose	Redirect a product, component, or material to a different function	Preparing for re-use
R8 Recycle	Reprocess waste materials into new products, materials, or substances	Recycling

2.3 Stakeholders

This chapter outlines the theoretical foundations for working with stakeholders in an interdisciplinary design process, covering how stakeholder analysis is conducted and how relevant stakeholders are selected.

2.3.1 Stakeholder Analysis

Stakeholder analysis is a widely applied tool across disciplines including business management, environmental governance, and design processes for systematically identifying and representing perspectives relevant to a decision-making context (Reed, 2008). Joint problem framing involves eliciting relevant perspectives to define goals and criteria for effective solutions (Pearce and Ejderyan, 2020). Participation must be underpinned by empowerment, equity, trust, and learning, and requires clear objectives from the outset (Reed, 2008). Stakeholder analysis is defined as a process that (i) defines aspects of a system affected by a decision, (ii) identifies individuals and groups affected by or able to affect those parts, and (iii) prioritizes them for involvement (Reed, 2008). The analysis proceeds through three method categories: identifying stakeholders, differentiating and categorizing them, and investigating relationships between them (Reed, 2008).

Stakeholder analysis is operationalized through a four-step process: identification of relevant stakeholders and their relation to the system, determination of stakeholders' needs, establishment of a stakeholder and requirement matrix, and balancing of stakeholder requirements (Nilsson and Fagerström, 2006). Failure to identify a stakeholder result most probably in missing requirements (Nilsson and Fagerström, 2006). In circular economy contexts, a four-component framework consisting of identification, alignment, negotiation, and communication is proposed. The process begins with mapping actors along the entire value chain, from raw material suppliers through production, distribution, use, and end-of-life treatment, to ensure that the full system boundary is represented (Mahanty and Domenech, 2024).

2.3.2 Selection of Stakeholders

Not all stakeholders can be included, and selection requires well-defined decision criteria (Reed, 2008; Bryson, 2004). A stakeholder is defined as any group or individual who can affect or is affected by the product throughout its life cycle (Nilsson and Fagerström, 2006; Luyet et al., 2012). A distinction is made between those who affect a decision and those who are affected by it, further categorized into internal or external, and primary or secondary stakeholders (Welp et al., 2006; Reed et al., 2009).

Internal stakeholders belong to the organization and include management, marketing experts, designers, purchasing, manufacturing, assembly, and sales functions (Nilsson and Fagerström, 2006). External stakeholders exist outside the organizational boundary and include users or customers, distributors, governments, suppliers, communities, and regulatory bodies (Nilsson and Fagerström, 2006). A related categorization distinguishes between design teams, which are internal to the development department; executives, who are inside the company but outside the design team; and external stakeholders, who are outside the company, such as sales representatives or users (Jensen et al., 2017; Lauff et al., 2020). In value chain contexts, primary stakeholders are those with a direct stake in the organization and its success, whereas secondary stakeholders hold a public or special interest stake (Nilsson and Fagerström, 2006). Information regarding stakeholders and the nature of their relationships and interactions must therefore be identified and documented (Nilsson and Fagerström, 2006).

Stakeholder mapping can follow a top-down approach initiated by the project team or a bottom-up approach where actors are identified through interviews and surveys (Mahanty and Domenech, 2024). The mapping must recognize differences in influence, knowledge, interests, accessibility, and inclusivity (Mahanty and Domenech, 2024). The plurality of perspectives is the norm for complex problems, and the selection must account for diverse mental models (Pearce and Ejderyan, 2020). A stakeholder is broadly defined as anyone affected by the design, and stakeholder inclusion is shaped by product type, domain, and organizational structure (Rodriguez-Calero et al., 2023).

2.4 Design and Concept Development Processes

The theoretical foundation further included perspectives from human-centered design, design thinking, the Double Diamond framework, and behavioral design. Human-centered design provides the philosophical foundation by emphasizing the importance of understanding users and contexts before generating solutions (ISO 9241-210, 2019; Norman, 2013). Design thinking extends this perspective by offering a mindset that integrates creativity, experimentation, and iterative learning (Brown, 2008). The Double Diamond framework systemize these principles through a structured yet flexible process model that supports exploration and refinement (Design Council, 2007).

Furthermore, the Fogg Behavior Model (Fogg, 2009), the Behavior Change Wheel and COM-B framework (Michie, van Stralen and West, 2011) enable a theoretical understanding of behavioral barriers and opportunities, supporting the development of design interventions that address both user needs and behavioral determinants.

2.4.1 Design as a Problem-Solving Discipline

Design is widely recognized as a discipline for addressing complex problems, facilitating innovation, and shaping interactions between people and systems (Buchanan, 1992; Cross, 2008). It has evolved from primarily being associated with form and aesthetics into a multidisciplinary field concerned with understanding human needs and creating value for users, organizations, and society.

Simon (1996, p. 111) defines design as the process of “devising courses of action aimed at changing existing situations into preferred ones.” This highlights design as a future-oriented activity focused on creating new desirable outcomes. Unlike scientific disciplines that primarily seek to explain existing phenomena, design aims to transform them through intervention (Cross, 2006). Similarly, the International Council of Design (ICoD, 2024) defines design as a strategic problem-solving process that drives innovation and improves quality of life through products, services, systems, and experiences.

From this perspective, design can be understood as both an analytical and a generative activity. The analytical dimension involves investigating users, contexts, and problems of existing conditions. The generative dimension concerns the creation and evaluation of alternative solutions capable of addressing identified needs. Successful design therefore requires the integration of multiple perspectives, including technological feasibility, human needs, organizational objectives, and environmental considerations (Krippendorff, 2006).

2.4.2 Wicked Problems and the Need for Design

The need for design becomes particularly evident when addressing complex societal challenges that cannot be solved through traditional linear problem-solving methods. These challenges are commonly described as wicked problems and are characterized by uncertainty, ambiguity, conflicting stakeholder interests, and the absence of a single correct solution (Rittel and Webber, 1973). Unlike traditional engineering problems, wicked problems cannot be completely defined before attempts to solve them begin. Instead, understanding of the problem evolves simultaneously with the development of potential solutions.

Examples of wicked problems include climate change, public health challenges, and transitions toward more sustainable behaviors. Such issues involve complex interactions between technical systems, social structures, organizations, and human behavior. As a result, linear approaches that assume a clear problem definition before solution development are often insufficient (Dorst, 2015).

2.4.3 Human-Centered Design

Human-centered design (HCD) has emerged as one of the dominant paradigms for addressing the complex challenges of wicked problems by placing users and their needs at the center of the development process (ISO 9241-210, 2019). Successful solutions should be developed through an explicit understanding of users, their goals, and the contexts in which products and services are used. Rather than requiring individuals to adapt to technology, HCD seeks to adapt technology to human capabilities and expectations (Norman, 2013).

The international standard ISO 9241-210 (2019) identifies several key principles of human-centered design. These include an explicit understanding of users, active user involvement throughout development, iterative evaluation of design solutions, and multidisciplinary collaboration. Furthermore, it is argued that at the functional level, products and services must perform reliably and safely. At the cognitive level, they must be understandable, intuitive, and compatible with human capabilities and limitations. At the emotional level, they should create positive experiences that support user satisfaction, trust, and long-term engagement (Norman, 2004). Research has repeatedly demonstrated that user-centered approaches improve usability, increase adoption rates, reduce development risks, and enhance overall user satisfaction (Norman, 2013). Consequently, human-centered design has become a central foundation within both product development and service innovation.

2.4.4 Design Thinking as a Mindset and an Innovation Approach

While human-centered design establishes a philosophy that prioritizes user needs, design thinking provides an approach for translating this philosophy into practice. Design thinking is defined as a human-centered approach to innovation that integrates the needs of people, the possibilities of technology, and the requirements for business success (Brown, 2008). The origins of design thinking can be traced to research on “designerly” ways of knowing (Cross, 2006). It is argued that designers possess unique cognitive strategies that differ from traditional scientific and engineering approaches (Cross, 2006). Rather than focusing primarily on analysis and optimization, designers tend to frame problems iteratively, explore alternative solutions, and continuously move between understanding the problem and developing potential responses.

Design thinking mindset emphasizes empathy, experimentation and collaboration as mechanisms for navigating complexity. It accepts uncertainty and iteration as natural components of innovation, which is particularly important when addressing wicked problems (Foster, 2021). Another defining characteristic of design thinking is its multidisciplinary nature. Innovation increasingly occurs at the intersection of multiple domains, requiring expertise from engineering, business, psychology, sustainability, and design. By encouraging collaboration between individuals with diverse perspectives, design thinking supports the generation of novel insights and solutions that may not emerge within single disciplines. Consequently, design thinking has increasingly been adopted in areas outside of design disciplines, including business, engineering, and public-sector, as an approach for addressing complex and uncertain challenges (Ulrich and Eppinger, 2012).

2.4.5 The Three Lenses of Innovation

A central concept within design thinking is the notion that successful innovation occurs at the intersection of desirability, feasibility and viability (Brown, 2008). These dimensions provide a framework for evaluating whether a proposed solution is likely to create meaningful and sustainable value.

Desirability refers to the extent to which a solution addresses genuine user needs and creates value from a human perspective. This dimension emphasizes empathy, user understanding, and contextual relevance.

Feasibility concerns whether a solution can realistically be developed using available technologies, resources, and competencies. This dimension requires consideration of engineering constraints, manufacturing possibilities, implementation challenges, and operational requirements.

Viability relates to the economic and organizational sustainability of a solution. A concept must not only create value for users but also generate sufficient value for the organization responsible for delivering it. This includes considerations such as business models, strategic alignment, operational costs, and long-term sustainability.

Solutions that emphasize only one or two of these dimensions often struggle to achieve long-term success. For example, highly desirable products may fail if they cannot be produced efficiently, while technically feasible solutions may fail if they lack user value or economic sustainability.

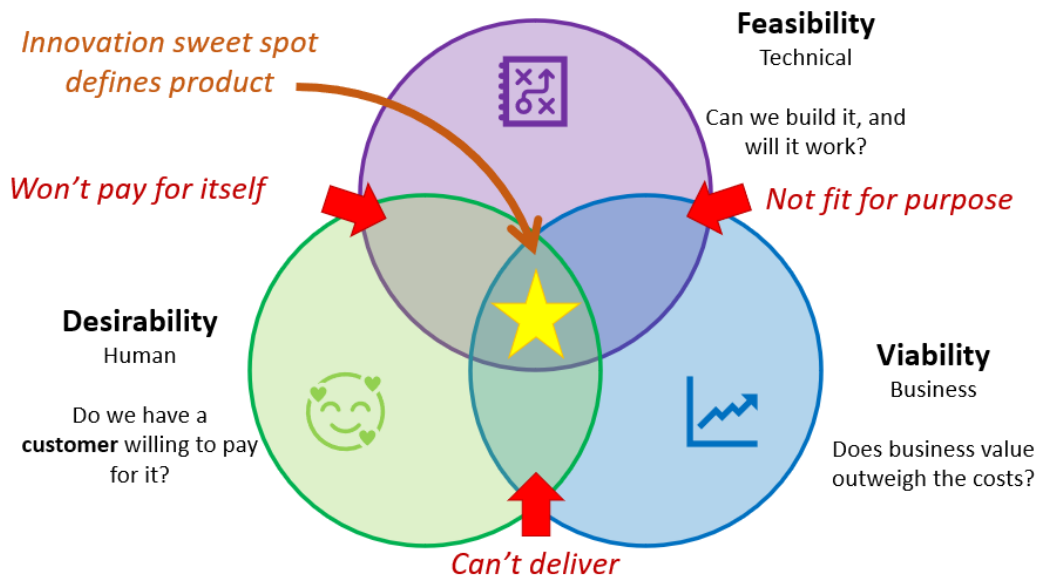


Figure 4. The intersection of desirability, feasibility, and viability as a framework for innovation (adapted from Brown, 2008)

2.4.6 Divergent and Convergent Thinking

A fundamental mechanism underlying design thinking is the alternation between divergent and convergent thinking. Divergent thinking focuses on generating multiple perspectives, alternatives, and possibilities. During divergent phases, the objective is to expand the solution space, meaning the number of possible solutions, rather than identify a single correct answer. Designers seek to challenge assumptions, explore different interpretations of the problem, and generate a broad range of ideas.

Convergent thinking, in contrast, focuses on synthesizing, evaluating and refining information. Insights gathered during divergent phases are analyzed and evaluated to create coherent concepts and actionable decisions. Convergence enables designers to move from ambiguity toward clarity while maintaining alignment with project objectives and user needs.

The iterative movement between divergence and convergence creates a dynamic process of learning and refinement. According to the Hasso Plattner Institute of Design (2010), innovation emerges not from creativity alone but from the disciplined integration of exploration and evaluation. This cognitive process enables designers to balance creativity with critical evaluation throughout the innovation process (Lawson, 2006). This principle forms the foundation of several contemporary design process models, most notably the Double Diamond framework.

2.4.7 The Double Diamond Framework

While design thinking describes how designers approach problems, different models provide guidance on the process of design thinking activities as a method. One of the most widely adopted frameworks is the Double Diamond model developed by the UK Design Council (2007). This model divides the design process into four phases: Discover, Define, Develop, and Deliver. These phases are organized into two consecutive diamonds representing divergence and convergence within both the problem space and the solution space.

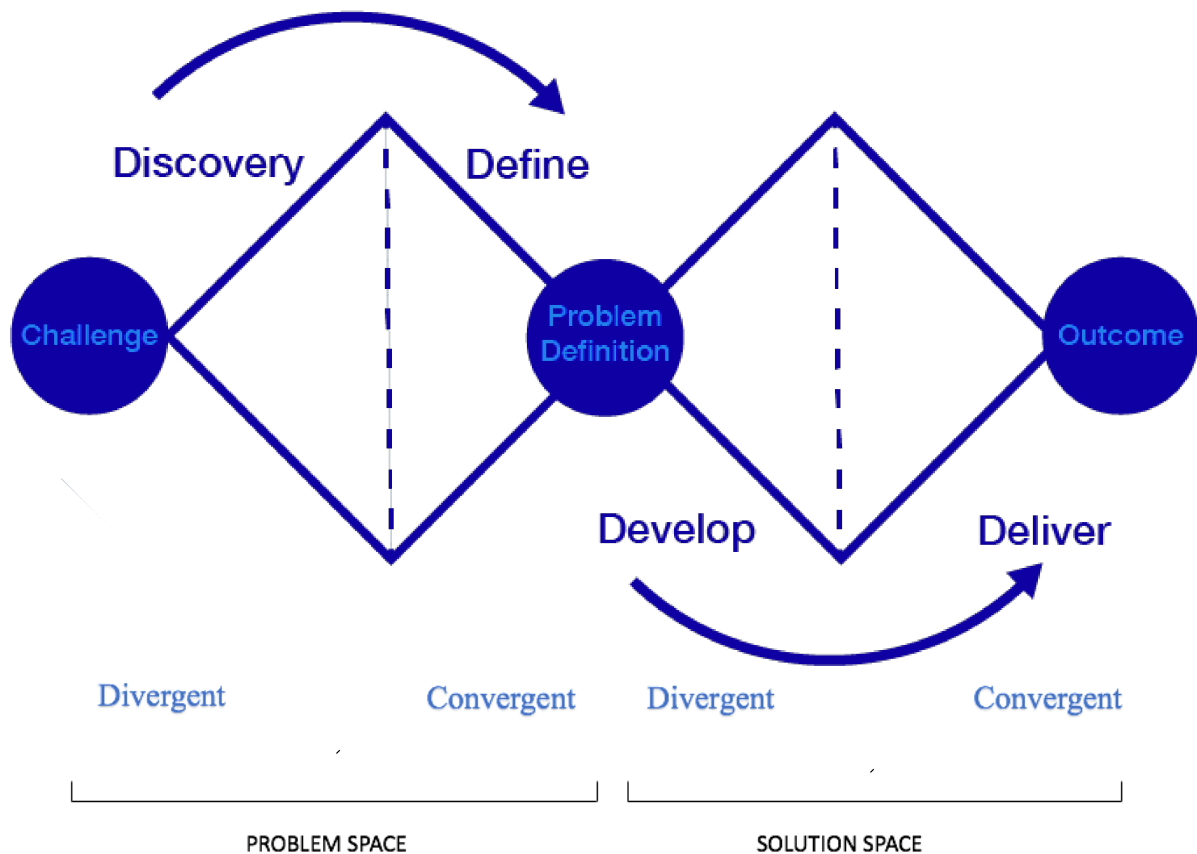


Figure 5. The Double Diamond design process (adapted from Design Council, 2007).

The first diamond focuses on understanding the problem. During the Discover phase, designers gather insights through user research, observations, stakeholder engagement, and contextual analysis. The objective is to build a comprehensive understanding of the challenge before drawing conclusions. The subsequent Define phase synthesizes these findings into a focused problem statement that guides further development. The second diamond focuses on creating solutions. During the Develop phase, multiple concepts are generated and explored through ideation, experimentation, and prototyping. Finally, the Deliver phase involves evaluating, refining, and implementing selected concepts.

The popularity of the Double Diamond stems from its ability to visualize the iterative nature of design work. Rather than assuming that problems are clearly defined from the outset, the framework acknowledges that problem understanding and solution development co-evolve throughout the project (Design Council, 2007; Cross, 2008). As new information emerges, designers frequently revisit earlier assumptions and refine their understanding of both the challenge and the proposed response. Consequently, movement between phases should be viewed as iterative rather than strictly sequential (Cross, 2008).

2.4.8 Concept Development

Concept development represents the transition from understanding a problem to defining potential solutions. Within product and service development, concepts serve as intermediate representations that connect user insights, technical requirements, and strategic objectives shaping a product idea into a meaningful direction (Ulrich and Eppinger, 2016). A concept can be defined as the fundamental idea or organizing principle underlying a proposed solution. Unlike detailed designs, concepts describe the intended functionality, value proposition, and interaction of a product or service without specifying all implementation details.

Research within engineering design consistently highlights concept development as one of the most influential stages of the development process (Pahl and Beitz, 2013; Ullman, 2010). Decisions made during this stage often determine a product's lifecycle cost, usability, sustainability, and overall success. The objective of concept development is therefore not to identify a single solution immediately but to systematically explore alternative possibilities. By generating multiple concepts, development teams can evaluate different approaches before committing substantial resources to implementation. This reduces risk while increasing the likelihood of identifying innovative and user-centered solutions.

2.4.9 Behavioral Design and the COM-B Model

Many design challenges involve influencing human behavior. Examples include encouraging sustainable consumption, increasing recycling rates, reducing energy use, promoting healthy lifestyles, and improving workplace safety. In these contexts, technical functionality alone is often insufficient, instead solutions must also support behavioral change.

Behavioral design is an interdisciplinary field that combines insights from psychology, sustainability, cognitive science, and design to understand and influence human behavior (Selvfors, Renström and Strömberg, 2023). The central premise is that behavior is not solely determined by individual preferences but is strongly influenced by environmental conditions, cognitive limitations, social norms.

The behavioral design perspective is closely connected to research in behavioral economics, demonstrating that human decision-making is often shaped by cognitive biases rather than rational analysis (Kahneman, 2011). Small changes in choice architecture can significantly influence behavior without restricting individual freedom of choice (Thaler and Sunstein, 2008). These findings have important implications for design. Rather than relying solely on information or persuasion, designers can create environments, products, and services that make desired behaviors easier, more attractive, and more likely to occur.

One influential framework for understanding behavior is the Fogg Behavior Model (Fogg, 2009). According to the model, behavior occurs when three factors converge simultaneously: motivation, ability, and a prompt. Motivation represents the desire to perform a behavior, ability refers to the ease with which the behavior can be performed, and prompts act as triggers that initiate action. Fogg argues that even highly motivated individuals may fail to act if a behavior is perceived as difficult, while simple behaviors often require little motivation to occur. The model therefore highlights the importance of reducing friction and increasing user ability through thoughtful design interventions.

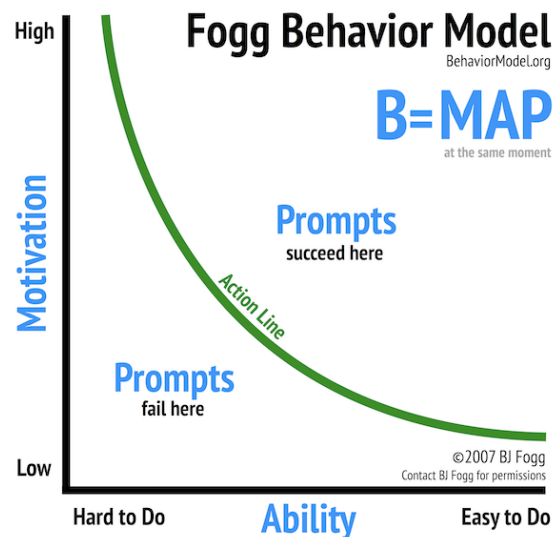


Figure 6. The Fogg Behavior Model (Fogg, 2007).

Although the Fogg Behavior Model provides a useful explanation of the conditions required for behavior to occur, it offers limited guidance regarding how to systematically design behavior change interventions. To address this limitation, the Behavior Change Wheel (BCW) provides a comprehensive framework for understanding behavior and selecting appropriate intervention strategies (Michie, van Stralen and West, 2011).

The Behavior Change Wheel was developed through a synthesis of nineteen existing behavior change frameworks and provides an integrated approach to behavior change research and practice. The framework consists of three interconnected layers. At its center is the COM-B model, which explains the determinants of behavior. Surrounding COM-B is a layer of intervention functions, representing broad categories of actions that can be used to influence behavior. The outer layer consists of policy categories that support the implementation of interventions at organizational or societal levels (Michie, van Stralen and West, 2011).

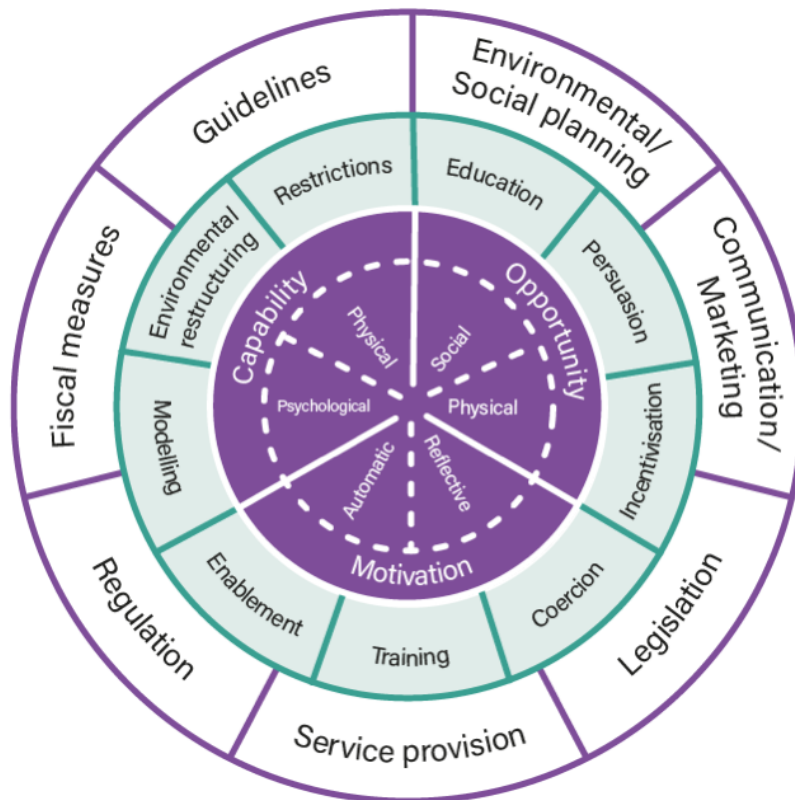


Figure 7. The Behavior Change Wheel including COM-B framework (adapted from Michie, van Stralen and West, 2011).

At the core of the Behavior Change Wheel, the COM-B model proposes that behavior results from the interaction between capability, opportunity, and motivation. Capability includes the physical and psychological abilities necessary to perform a behavior. Opportunity refers to physical and social conditions that enable or constrain action. Motivation encompasses both reflective processes, such as goals and intentions, and automatic processes, such as habits and emotions (Michie, van Stralen and West, 2011).

The COM-B model has become widely used within behavior change research because it provides a structured method for identifying barriers and facilitators of behavior. For example, low recycling rates may result from insufficient knowledge about recycling procedures (capability), limited access to recycling infrastructure (opportunity), or weak environmental commitment (motivation). Because different barriers require different solutions, understanding the underlying determinants of behavior is essential when designing effective interventions.

The broader Behavior Change Wheel builds upon this behavioral diagnosis by linking identified barriers to appropriate intervention strategies. For instance, a lack of knowledge or skills may indicate the need for educational or training interventions, whereas environmental constraints may require environmental restructuring. Similarly, motivational barriers may be addressed through persuasive techniques, incentives, or habit-forming mechanisms. In this way, the framework provides a systematic bridge between behavioral theory and practical design action.

Within behavioral design, the Behavior Change Wheel and the COM-B model support the development of interventions that are evidence-based, user-centered, and tailored to the specific factors influencing behavior. (Michie, Atkins and West, 2014). By linking observed behaviors to their underlying determinants, the framework supports a systematic and evidence-based approach to concept development.

2.5 Design Methods Supporting Concept Development

Theoretical frameworks such as human-centered design, design thinking, behavioral design and the Double Diamond model provide guidance regarding how innovation and design processes should be approached. However, practical concept development also requires specific methods that support the collection, synthesis, generation, and evaluation of information throughout the design process. These methods function as operational tools that translate theoretical principles into concrete design activities and facilitate the transition from user insights and problem understanding to concept generation, evaluation, and refinement (Cross, 2008; Ulrich and Eppinger, 2016).

Table 2. Relationship between the Double Diamond process and supporting design methods.

Double Diamond Phase	Primary Objective	Supporting Methods
Discover	Understand users and context	Interviews, observations, data collection, literature research
Define	Synthesize insights and establish requirements	KJ-analysis, functional analysis
Develop	Generate and explore concepts	Brainstorming, morphological matrix, sketching, image boards
Deliver	Evaluate and refine concepts	Pugh matrix, prototyping, user testing

2.5.1 Synthesis and Problem Definition

The initial stages of concept development involve collecting and interpreting large amounts of qualitative information. User interviews, observations, workshops, and contextual studies often generate extensive datasets that must be organized before meaningful conclusions can be drawn (Wikberg Nilsson et al., 2024). One widely used synthesis method is KJ-analysis, also known as affinity diagramming, originally developed by Kawakita (1982). The method involves breaking qualitative findings into individual observations and systematically grouping them according to perceived relationships and similarities. Through this bottom-up process, patterns, themes, and user needs emerge from the data without imposing predetermined categories. Affinity diagramming aligns closely with the principles of human-centered design because it enables user insights to drive problem definition rather than designer assumptions (Martin and Hanington, 2012). Furthermore, the method supports collaborative interpretation, allowing multidisciplinary teams to establish a shared understanding of the problem space.

Beyond organizing raw data into thematic clusters, the analysis and synthesis phases often employ personas and scenarios to transform qualitative insights into empathetic and actionable design directions. Personas serve as archetypal representations of the target user's recurring behaviors and values identified during the empirical research phase into distinct user profiles. These profiles are then integrated into contextualized scenarios, which are narrative user journeys describing realistic use situations. By framing the problem through both human archetypes and situational narratives, this synthesis method ensures that the overarching design process remains anchored in the users' true emotional and practical mental models. (Wikberg Nilsson et al., 2024)

Following synthesis, design teams must define what a proposed solution is expected to accomplish. Functional analysis provides a systematic approach for identifying and structuring product requirements independently of specific solutions (Pahl and Beitz, 2013). Rather than focusing on how a solution should be implemented, functional analysis concentrates on what functions must be fulfilled.

Functions are commonly categorized as main function, sub-functions, and supporting functions. This decomposition helps ensure that concept development remains focused on solving the underlying problem rather than prematurely converging on specific technical solutions. Functional analysis is therefore particularly valuable during the Define phase of the Double Diamond, where project requirements and design criteria are established.

2.5.2 Ideation and Concept Generation

Once user needs and functional requirements have been identified, the design process shifts from problem understanding to solution exploration. This transition corresponds to the divergent phase of the second diamond, where multiple concepts are generated before evaluation occurs. Common ideation methods used during this stage include brainstorming, rapid sketching and the used of morphological matrixes and image boards.

Brainstorming remains one of the most widely applied ideation techniques in design and innovation projects (Osborn, 1953). The method encourages participants to generate a large number of ideas without immediate criticism or evaluation. By postponing judgment, brainstorming seeks to expand the solution space and stimulate creative thinking. Similarly, mind mapping can be used to visualize relationships between ideas and identify unexpected connections. Buzan and Buzan (2010) argue that visual representation of information supports associative thinking and can facilitate the exploration of complex problem spaces.

Rapid sketching represents another important ideation method. Designers frequently use sketches as external representations of emerging ideas because they allow concepts to be visualized, communicated, and modified quickly (Buxton, 2007). Unlike detailed drawings, early sketches are intentionally ambiguous, encouraging discussion and exploration rather than commitment to a specific solution.

Another systematic approach to concept generation is provided by the morphological matrix (Zwicky, 1969). The method decomposes a system into key functions and identifies multiple solution principles for each function. Primary sub-functions or requirements are listed along the vertical axis. For each sub-function, corresponding technical solutions, mechanisms, or principles are generated and placed along the horizontal axis. Designers navigate this matrix by associating and combining different configuration elements across the grid. By systematically selecting and combining one solution from each functional category, the matrix facilitates the creation and synthesis of diverse and novel concepts. The strength of morphological analysis lies in its ability to support comprehensive exploration of the solution space while maintaining a direct connection to identified requirements. Research within engineering design has demonstrated that systematic concept generation methods increase both the quantity and diversity of generated concepts (Pahl and Beitz, 2013).

Visual inspiration tools such as different image boards also play an important role during ideation. Mood boards, inspiration boards, and usage boards help communicate intended experiences, aesthetic directions, contextual influences, and design references (Martin and Hanington, 2012). Such tools facilitate collaboration and create a shared vision among stakeholders before detailed concepts are developed.

2.5.3 Concept Evaluation and Selection

The generation of multiple concepts introduces the challenge of selecting which alternatives should be developed further. Design literature emphasizes the importance of systematic evaluation methods to reduce subjectivity and support evidence-based decision-making (Pugh, 1991). Concept evaluation is particularly important within human-centered design because solutions must be assessed not only according to technical performance but also according to their ability to create meaningful user experiences. Consequently, evaluation criteria should reflect both user-centered and organizational objectives.

One commonly used approach is the Pugh matrix, which compares alternative concepts against a reference concept using predefined evaluation criteria. Criteria may include usability, sustainability, manufacturability, cost, technical feasibility, or user value depending on the objectives of the project. The primary advantage of the Pugh matrix is that it facilitates transparent decision-making while encouraging discussion among stakeholders. Rather than identifying a single winner immediately, the method highlights strengths and weaknesses of competing concepts, often leading to the synthesis of improved hybrid solutions. Weighted decision matrices represent a further development of this approach by assigning different levels of importance to evaluation criteria. This enables decision-making to better reflect project priorities and stakeholder requirements.

2.5.4 Prototyping and User Testing

Following concept selection, proposed solutions must be materialized and evaluated in practice. Prototyping is widely recognized as one of the most important activities within design thinking because it transforms abstract ideas into tangible representations that can be explored and tested (Brown, 2008). Prototypes can vary significantly in fidelity depending on project objectives. Low-fidelity prototypes such as paper mock-ups and cardboard models are often used during early development to explore fundamental aspects of a concepts, such as volume, dimensions and user interactions. High-fidelity prototypes, including functional prototypes and CAD models, enable more detailed evaluation of technical and experiential aspects of a design.

User testing constitutes a natural extension of prototyping within human-centered design. By observing representative users interacting with prototypes, designers can identify usability issues, misunderstandings, unmet needs, and unexpected behaviors before implementation occurs (Nielsen, 1994). Usability testing is closely aligned with the iterative principles of both human-centered design and design thinking. Rather than viewing testing as a final verification step, contemporary design approaches emphasize continuous cycles of testing and refinement throughout development (Norman, 2013). The combination of prototyping and user testing enables designers to reduce uncertainty, improve concept quality, and ensure that final solutions remain grounded in actual user needs. Consequently, these methods serve as critical mechanisms for transforming conceptual ideas into validated and implementable design solutions.

2.5.5 Stakeholders in a Design Process

Stakeholders can be categorized into design teams, executives, and external stakeholders (Lauff et al., 2020). Prototypes mediate communication between these groups through four modes (explain, feedback, negotiate, and persuade), and prototypes remain constant across contexts while the spokesperson changes (Lauff et al., 2020). Basic decisions concerning stakeholders, requirements, functions, and concepts are made during early design phases, and conflicting stakeholder requirements must be negotiated to develop a competitive product (Nilsson and Fagerström, 2006).

Engaging stakeholders through prototypes enables discussion of values and priorities (Rodriguez-Calero et al., 2023). Stakeholder participation should extend beyond input to equitable decision-making across all design phases (Hendricks et al., 2018). Stakeholder dialogues build common language and mutual trust (Welp et al., 2006). Stakeholders possess knowledge needed to understand decision-makers' and managers' mental models, and formal representation of these mental models is a key aim of structured dialogue (Welp et al., 2006).

Human-centered design situates stakeholder involvement through tools for information visualization that assist boundary selection and communication between stakeholders (Laurenti, 2013). Participation must be underpinned by empowerment, equity, trust, and learning, and requires clear objectives and skilled facilitation from the outset (Reed, 2008). Stakeholder workshops enable social learning, where participants recognize barriers and drivers across different perspectives (Mahanty and Domenech, 2024).

2.6 What Is Outdoor Recreation and Why Is It Needed?

Outdoor recreation has gained increasing attention within research and planning due to its importance for public health, environmental sustainability, and quality of life. As urbanization and sedentary lifestyles continue to grow, natural environments and recreational spaces play an important role in supporting physical activity, mental well-being, and social interaction (Kaplan and Kaplan, 1989).

Contemporary outdoor recreation is no longer limited to remote wilderness areas. Instead, a growing proportion of outdoor activity takes place within urban and near-urban natural environments. In the Scandinavian context, the concept of *tätortsnära natur* refers to accessible natural areas located close to cities and residential areas. These often include municipal forests, parks, and protected green spaces (Rydberg and Aronsson, 2004).

Outdoor recreation includes a broad range of activities that differ in environmental context and physical demands. Within product development research, outdoor activities are often categorized into distinct recreational domains rather than treated as a uniform market (Jenkins and Pigram, 2006). These often include land-based recreation, water-based recreation, winter recreation and mechanized recreation. This distinction is important because different activities create different functional requirements for equipment, materials, and product performance.

Land-based recreation represents one of the largest segments of the outdoor industry. Activities range from low-intensity urban walking and day hiking to extended back-country trekking and camping. Near-urban recreation generally requires products that combine comfort, low weight, weather protection, and aesthetic adaptability, since users frequently move between urban and natural environments during the same outing. In contrast, backcountry trekking places greater emphasis on durability, performance and optimized strength-to-weight ratios due to prolonged exposure to unpredictable environments and limited access to external support (Cloutier, 2014).

Other outdoor segments involve more specialized environmental and technical conditions. Water-based recreation, such as kayaking or surfing, requires equipment with effective moisture management and adaptation to water exposure. Winter recreation, such as alpine and cross-country skiing, demands products capable of functioning in sub-zero temperatures and harsh weather conditions. Mechanized recreation, such as mountain biking and motorsports, exposes equipment to vibration, impact, and high mechanical stress, which increases the need for robust mechanical design (Cloutier, 2014).

Understanding what environment and what type of outdoor recreation, is essential in outdoor-oriented product development. Equipment intended for near-urban recreation must combine technical outdoor functionality with everyday usability and visual adaptability. Products are expected to perform under changing conditions while remaining lightweight, portable, and suitable for both recreational and urban settings. The increasing overlap between urban life and outdoor recreation has contributed to the emergence of multifunctional products that blur the boundaries between technical outdoor equipment and everyday consumer goods.

2.6.1 Outdoor Life and Mental Health

Research within environmental psychology demonstrates a powerful relationship between outdoor activity and well-being. Exposure to natural environments is consistently associated with reduced psychological stress, improved mood, and the restoration of cognitive capacity (Kaplan, 1995). This restorative function has become increasingly critical due to rapid technological development and the pervasive societal pressure to remain continuously online.

Modern lifestyle patterns subject individuals to information overload from social media, high volume feeds, continuous updates, and social overload from communication pressure and constant availability expectations. This constant digital saturation triggers problematic behaviors like doomscrolling. Continuous screen engagement triggers dopamine driven feedback loops and forces a state of divided attention. Over time, this chronic digital stimulation depletes human cognitive reserves, leading to severe attention fatigue and heightened psychological strain. Recreation in natural settings functions as a direct mechanism for psychological recovery from these pressures of urban living and digital saturation.

Two primary theoretical frameworks explain how natural spaces counteract these modern stressors. The first is Attention Restoration Theory, which posits that natural settings restore human cognitive capacity by engaging effortless, involuntary attention (Kaplan, 1995). While digital and urban environments demand continuous, effortful directed attention that eventually leads to cognitive exhaustion, nature provides soft fascination. This is a state where the mind can rest and automatically recover from the mental fatigue caused by constant digital connectivity and everyday urban demands (Kaplan, 1995).

Complementing this cognitive perspective is Stress Recovery Theory, which focuses on the physiological and emotional benefits of nature exposure. Viewing or experiencing natural landscapes triggers an immediate, evolutionary response that lowers autonomic nervous system arousal (Ulrich et al., 1991). This physiological recovery includes rapid reductions in blood pressure, heart rate, and muscle tension, occurring within minutes of entering a green space. Consequently, regular engagement with outdoor settings significantly mitigates the long-term risks of chronic anxiety and depressive disorders by disrupting the patterns of negative rumination reinforced by high density urban living (Bratman et al., 2019).

Beyond individual physiological recovery, camping and outdoor experiences contribute heavily to social and emotional well-being. These activities create critical opportunities for relaxation, deep social interaction, and a shared sense of belonging (Brooker, Joppe and McLean, 2012). For many individuals, participation in outdoor recreation represents far more than a temporary leisure activity. It is increasingly associated with personal identity and lifestyle (Lu, Hung and Wang, 2022).

2.6.2 Cultural and Social Relevance of Outdoor Life

Outdoor recreation holds a strong cultural position within Scandinavian society. The concept of *friluftsliv*, commonly translated as “open-air life,” describes a cultural tradition centered on regular and meaningful engagement with nature in everyday life (Gelter, 2000). Unlike performance-oriented outdoor cultures focused primarily on extreme sports, *friluftsliv* emphasizes simplicity, accessibility, and long-term well-being through nature experiences.

This cultural relationship with nature is further supported through *Allemansrätten*, the Scandinavian right of public access, which permits individuals to move freely through natural landscapes and camp responsibly on both public and private land (Swedish Environmental Protection Agency, n.d.). Together, these cultural and legal traditions contribute to high levels of outdoor participation across different age groups and social backgrounds. As a result, Scandinavian outdoor product development often prioritizes multifunctionality, durability, and accessibility. Products are expected to function across varying conditions, ranging from short recreational outings in local forests to more demanding expeditions in remote Nordic environments.

In addition to individual health outcomes, outdoor recreation strengthens long term social cohesion and community well-being. Shared recreational experiences create a collective sense of belonging and encourage positive social interaction across diverse demographic groups. Outdoor environments therefore contribute not only to personal health benefits, but also to broader social sustainability goals.

The outdoor industry has historically been associated with highly specialized activities, experienced users, and expensive technical equipment. Social innovation in outdoor contexts involves designing products and services that reduce barriers to participation for underrepresented or inexperienced user groups. This may include adaptive equipment for varying physical abilities, intuitive product interfaces for novice users, or systems that support shared and community-based use. Inclusive design strategies are also used by public organizations and non-governmental initiatives to promote public health, environmental awareness, and social participation through outdoor recreation.

2.7 What Is the Outdoor Industry?

This chapter introduces the EU Strategy for Sustainable and Circular Textiles, examines industry niches and sustainability practices among leading outdoor companies, and analyses lifecycle thinking in the textile industry. It further presents Thule as the case company and collaboration partner in this thesis.

2.7.1 EU Strategy for Sustainable and Circular Textiles

The EU Strategy for Sustainable and Circular Textiles is in line with the European Green Deal ambition for sustainable, climate-neutral and resource-efficient growth. It builds on the CEAP's identification of textiles as a key product value chain with an urgent need for transition toward sustainable and circular production, consumption, and business models. The textile value chain has a significant environmental impact, accounting for the fourth-highest impact on the environment and climate change and the third highest for water and land use in the EU (European Commission, 2022).

The strategy addresses the entire life cycle of textile, aims to create a greener and more competitive sector based on four central objectives for 2030 (European Commission, 2022):

- All textile products on the EU market are durable, repairable, recyclable, and, to a great extent, made of recycled fibers, free of hazardous substances, and produced in respect of social rights and the environment.
- Fast fashion is out of fashion, and consumers benefit longer from high-quality, affordable textiles.
- Profitable reuse and repair services are widely available.
- The textiles sector is competitive, resilient, and innovative, with producers taking responsibility along the value chain and minimal incineration and landfilling.

The strategy is implemented through a layered legislative framework. Several of the instruments it builds on are general EU directives and regulations that apply across sectors, but each is applied here with a specific focus on the textile value chain. The key directives are the Waste Framework Directive (WFD), which introduces Extended Producer Responsibility (EPR) schemes and mandatory separate textile collection (European Commission, n.d.-g); the Corporate Sustainability Due Diligence Directive (CSDDD), which requires companies in high-impact sectors to conduct due diligence on human rights and environmental impacts across their global supply chains; and the Green Claims Directive, which ensures the reliability of environmental claims and prevents greenwashing.

The key regulations are the Ecodesign for Sustainable Products Regulation (ESPR), which sets binding performance requirements for durability, recyclability, and recycled fibre content and establishes the Digital Product Passport (DPP) as an operational transparency tool within its framework; and the Waste Shipment Regulation, which restricts the export of textile waste to non-OECD countries. In addition, supporting instruments such as the REACH Regulation, the Textile Labelling Regulation, and measures restricting microplastic releases provide more targeted regulatory tools for specific aspects of the textile life cycle. These legal instruments collectively enable the strategy's six headline actions, which translate the legislative framework into operational priorities for the textile sector (European Commission, 2022).

The strategy identifies six headline actions to achieve this vision (European Commission, n.d.-c):

- **Setting design requirements for textiles** - making them last longer and easier to repair and recycle
- **Introducing a Digital Product Passport** - improving transparency and information accessibility along the value chain
- **Addressing microplastics release** - implementing measures to tackle the unintentional release of synthetic fibers
- **Introducing harmonized Extended Producer Responsibility rules** - incentivizing sustainable design through eco-modulation of fees
- **Restricting the export of textile waste** - ensuring sustainable management of used textiles globally
- **Incentivizing circular business models** - supporting the growth of the reuse and repair sectors

2.7.2 Industry Niches, Companies and Sustainability Practices

The sport and outdoor industry are defined by an emphasis on functional reliability and longevity, distinguishing it from faster-moving apparel categories and orienting its sustainability strategies toward durability and lifetime extension rather than high-volume replacement. Within this, the camping assortment constitutes a distinct niche, encompassing for example shelters, sleeping systems, cookware, lighting, tableware, and carry solutions (Fuchs and Hovemann, 2022, p. 17). This orientation shapes how companies approach product design, pricing, and end-of-life strategies, rooted in a consumer culture that values quality and a connection to nature.

Sweden has established itself as one of Europe's most prominent hubs for outdoor companies with sustainability at the core of their identity. Table 3 provides a structured overview of how leading global and regional brands operationalize these principles across their identity, services, and broader sustainability practices (Snow Peak, 2025; Fjällräven, 2026; Houdini Sportswear, 2024; Patagonia, 2025; The Spin-Off, 2025; Naturkompaniet, 2020).

Table 3. Compares sustainability practices across four brands. Compiled by the authors.

Company	Brand Identity	Services	Other Sustainability Practices
Snow Peak	Restoring humanity through nature.	Lifetime warranty; in-house repair.	JEPLAN recycling partnership; PFAS-free titanium.
Fjällräven	Durable, ageless design.	Repair and re-waxing; rental via Naturkompaniet.	PFAS-free since 2009; traceable down.
Houdini	Minimalist circularity.	Rental, repair, second-hand, remake.	100% circular material goal; Planetary Boundaries leader.
Patagonia	Activism and supply chain accountability.	Worn Wear resale; DIY repair guides.	1% for the Planet; recycled and organic materials.

The broader institutional landscape supports these efforts through industry associations and local initiatives. The Scandinavian Outdoor Group (SOG) unites Nordic brands to align with the Paris Agreement, while the European Outdoor Group (EOG) coordinates policy advocacy aligned with EU Green Deal legislation (SOG, 2025; EOG, 2025). Europe is, alongside China, the region where the circular economy concept is most actively promoted at the political level, making it a strategically important context for the outdoor sector (Fuchs and Hovemann, 2022, p. 2). Friluftsförbundet (the Swedish Outdoor Association) is a national non-profit NGO that promotes an active and sustainable outdoor lifestyle and advocates for the right of public access to nature (Friluftsförbundet, 2025).

At the local level, the Gothenburg area hosts actors at the intersection of circularity, social inclusion, and outdoor culture: TRACKS Recycle is a second-hand store specializing in outdoor and sport products; Fabrikörerna is a sewing factory that takes social and environmental responsibility; and Smarta Kartan is a non-profit working to facilitate a sustainable lifestyle through participation in the local sharing economy. Together, these actors represent a growing ecosystem of practitioners who operationalize circular economy principles at the city scale.

2.7.3 Lifecycle Thinking in the Textile Industry

The material challenges of the outdoor industry require a shift from linear cradle-to-grave models to circular cradle-to-cradle systems. The industry remains highly material-intensive, with polyester the most widely used textile fiber globally at 71 million tons produced annually, and approximately 60 percent of all clothing fibers being synthetic (Syre, 2025; European Commission, 2022). Virgin polyester is derived from crude oil and is structurally necessary for outdoor products, which require moisture management, durability, and technical performance. While recycled polyester from PET bottles is a common response, it often leads to a "polyester paradox" where bottles are diverted from closed-loop systems into a linear textile path that rarely enables further recycling (European Commission, 2022). Currently, less than one percent of the global textile market comes from textile-to-textile recycled fibers, making fiber-to-fiber recycling a critical circular solution (Syre, 2025). A circular approach integrates material innovation and end-of-life management to close these loops. Across the life cycle, technical solutions are emerging to address structural barriers:

Chemical Safety: DWR treatments have historically depended on PFAS, classified as Substances of Very High Concern under REACH (Schumacher and Forster, 2022). Biobased alternatives such as OrganoTex now offer PFAS-free water repellency that mimics plant leaf chemistry (OrganoTex, 2025).

Microplastic Mitigation: An estimated 40,000 tonnes of synthetic fibres enter washing machine effluent annually, accounting for 20 to 35 percent of primary microplastics in the marine environment (European Commission, 2022). Filtration technologies like Mimble's Mimbox address this at the use phase (Mimble, 2025).

Advanced Recycling: Mechanical recycling degrades quality with each cycle, while chemical recycling depolymerises fibres to molecular components but requires energy-intensive processes. Breakthroughs such as supercritical CO₂ for waterless dye removal target dye contamination, a persistent barrier to both pathways (University of Borås, 2026; Renasens, 2025).

Scaling these solutions is critical to bridge the gap between 71 million tons of annual virgin production and a sub-one-percent textile recycling rate (Syre, 2025). At the production level, the bluesign® system certifies manufacturing processes for resource productivity, while OEKO-TEX Standard 100 certifies finished products against harmful substances; both are adopted by leading outdoor brands as supplier requirements (Fuchs and Hovemann, 2022). Adopting these strategies connects to multiple UN Sustainable Development Goals, particularly SDG 12 (Responsible Consumption and Production) and SDG 13 (Climate Action), by decoupling growth from virgin resource extraction and reducing the environmental footprint of the industry's material flows.

2.7.4 Thule as a Case Company

Thule is a global sport and outdoor company founded in 1942 in Hillerstorp, Sweden, with more than 80 years of product-driven growth and approximately 3,000 employees across 138 markets. The company develops premium products under the motto "Bring your life," guided by core values of quality, safety, design, and ease of use (Thule, 2025). Thule's target consumer is highly active, family-oriented, and experience-driven, with outdoor activities forming a central part of their lifestyle identity (Thule, 2025). This premium, outdoor-active demographic aligns closely with Thule's sustainability strategy, which is built on three priorities: eco-design for long product life, a responsible supply chain, and leadership in product safety. Since January 2024, PFAS are no longer intentionally used in new Thule-branded textiles, and several textile products are certified according to bluesign® and OEKO-TEX® Standard 100 (Thule, 2025). Life cycle analyses and eco-design are integrated into product development to support long product life. The EU region accounts for 67 percent of Thule's sales, with the Bags & Mounts category representing 21 percent of total revenue (Thule, 2025). *See table 4*, for the current Thule consumer.

Table 4. Overview of the key characteristic defining the Thule consumer. Compiled by the authors (Thule, 2025).

Characteristic	Findings
Family-oriented	Nearly two-thirds of households have children
Outdoor active	Majority exercise 3-4 times per week
Mobility-oriented	Strong connection to cycling and camping
Pet ownership	Above-average dog ownership
Premium consumer	70% report income above national median
Experience-driven	Outdoor activities are central to lifestyle identity

3 Method

This section details the methods used to collect and manage data, translating stakeholder insights into design criteria through concept development.

3.1 Data Collection

The data collection where an iterative process where different sources of information were revisited at different stages in the design process (figure 8). It began with a problem identification phase, in which a company analysis, stakeholder mapping and market research was done, as well as a first round of interviews with cohort 1. It then proceeded through a problem formulation phase with multiple interactions with stakeholders, including a second round of interviews, field observations and a picture study. In addition, a literature study focusing on environmental, material and contextual research was conducted to complement the empirical research data.

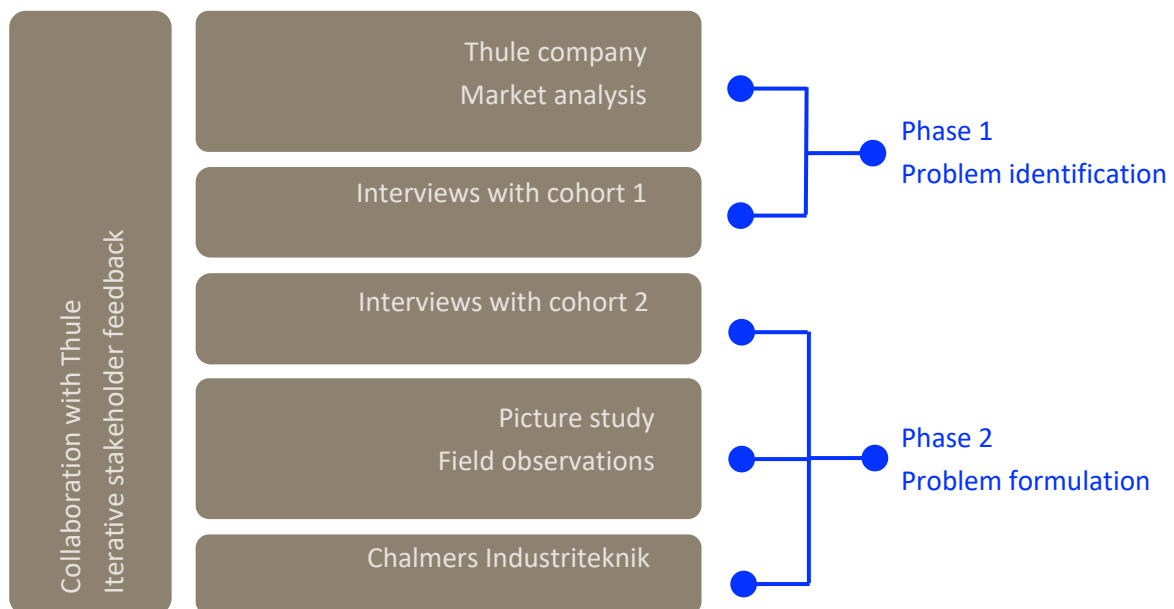


Figure 8. Overview of stakeholder interaction during the data collection process.

3.1.1 Problem Identification

The beginning stage of the project included a problem identification phase, in which data was collected from different sources to create a context for the design project. An initial project pitch was introduced, establishing the broad scope of developing a “multi-purpose bag” concept with Thule as the main collaboration partner. A company analysis was conducted focusing on Thule Group as the primary industry partner. The information was collected from Thule’s website and sustainability report. The data collected was the company’s sustainable strategic positioning, core values, priorities, brand identity, sustainability commitments and existing product designs. Particular attention was paid to the camping and outdoor product assortment. The website was continuously revisited in the design process to collect data on their products used for outdoor cooking.

Furthermore, a market analysis was conducted, in which data was collected on competitors' product portfolios, brand identities, sustainability commitments. At a later stage of the market analysis, the brand's websites as well as the retailer stores were visited to observe and evaluate the different brands

outdoor cooking products to observe the products proportions, packaging logic and material qualities. Part of the market analysis was to identify current trends in the competitors' collection by documenting the product's form, function, expression, and detailing in similar solutions as part of a benchmarking. The trend analysis used different social media platforms, WGSN forecasting, Japanese camping publications, outdoor cookbooks, and specialized magazines to capture evolving lifestyle shifts in outdoor cooking.

3.1.2 Stakeholder Selection and Integration

Because the project was developed in collaboration with Thule, the company served as a central institutional stakeholder throughout the entire design process. Structured meetings, both online and physically at Thule's facilities in Hillerstorp, were conducted with Thule's design team, providing opportunities to verify, challenge, and deepen the insights gathered from the initial company analysis. Additionally, these meetings functioned as a forum to clarify the project brief and establish a shared understanding for subsequent concept development.

To maintain alignment, regular visits were made to Thule's facilities in Hillerstorp for in-person co-creation, feedback sessions and a mid-term presentation. This continuously cross-examined user data against organizational requirements, brand strategies, and manufacturing constraints. All interactions were documented through meeting notes to maintain traceable records.

Throughout the project, input from end-users was used to identify the problem statement, understand outdoor cooking dynamics, and evaluate conceptual designs. Empirical user research was split into two distinct cohorts. Cohort 1 focused on problem identification and cohort 2 focused on deeper problem formulation. Stakeholders who participated in cohort 1 (attachment 1) were selected from the Gothenburg area based on the criteria that the participant had:

- a connection to urban life
- interest in outdoor activities

As the problem was identified, the problem needed to be investigated further to later formulate a problem statement. A second round of deeper semi-structured interviews was conducted with a new sample of individual respondents (attachment 2). The stakeholders participating in defining the problem statement was partly different from the first cohort and was selected based on the stricter criteria that the participant:

- possessed significant prior outdoor experience, preferably with outdoor cooking or camping
- advanced knowledge of equipment and user needs in outdoor settings.

This expertise was considered essential to inform specific technical and functional concept requirements in cohort 2. Beyond the mentioned criteria, participants were selected to represent a balanced spectrum of target users. Both samples covered a diverse range of genders, ages, occupations and household situations. In addition, a semi-structured interview was conducted with the textile department at Chalmers Industriteknik. This meeting positioned the department as an institutional stakeholder representing research expertise at the intersection of textile development, sustainability, and industry application.

3.1.3 Stakeholder Interviews

Interviews with cohort 1 focused on gathering information about general structural and emotional barriers and behavioral patterns connected to outdoor recreation. The goal was to identify potential problem areas and opportunities for subsequent concept development. The interviews followed a standardized guide structured into four main sections, inspired by the COM-B model to ensure consistency and measurability across sessions (attachment 3). The first section gathered general background information and current behaviors. The second section focused on motivation factors. These included reflective motivations, such as values, goals, and conscious choices, alongside automatic motivations, like emotions, reactions, and mental barriers. The third section addressed capability, covering psychological aspects like knowledge and confidence, as well as physical aspects like limitations and physical load. The fourth section explored opportunities, including physical opportunities, like external practical conditions, access, and infrastructure, and social opportunities, like social context and norms.

Interviews with cohort 1, were designed to last approximately 20 minutes. However, the semi-structured nature of the interviews included many open-ended questions and respondents were encouraged to elaborate freely and broadly to uncover underlying frustrations, values, and factors that might encourage more frequent outdoor visits. Because of this, many sessions extended to 30 or 40 minutes.

Interviews with cohort 2, focused on the opportunities and problem areas identified during the pre-study, specifically targeting the physical needs and gear related aspects connected to outdoor cooking. The interview guide for the second was structured into five thematic sections (attachment 4). These included background and experience, a step-by-step walkthrough of a recent outdoor cooking event, a step-by-step mapping of an ideal outdoor cooking scenario focusing on values and wishes, challenges and frustrations, and needs and improvement opportunities. They were designed to last approximately 30 to 45 minutes and followed the same qualitative techniques used in the pre-study interviews. In addition, continuous follow-up interactions with selected interview respondents were conducted in the design process.

The interview with the textile department at Chalmers Industriteknik, followed a semi-open structure. The purpose was to acquire to a broader understanding of the material and sustainability landscape, complementing the insights from end-users and internal stakeholders at Thule. The interview questions discussed specialized perspectives on natural fiber use, textile durability, repairability, circular textile systems, and end-of-use solutions.

3.1.4 Picture Study and Field Observations

To complement the self-reported interview data, visual and observational data was collected through a picture study and field research. The purpose was to capture additional data on implicit user needs. The field research consisted of two separate outdoor sessions, with participants chosen to represent variety within the target group across two typical outdoor scenarios (table 5). Participants were observed before, during, and after outdoor cooking activities, authentically documenting the complete user journey, practical struggles and gear set-ups of outdoor cooking. Observations included continuous informal discussions and systematic photographic documentation. This approach captured unspoken needs, subconscious behaviors and challenges in real time and environment.

Table 5. Overview of observation sessions.

Session	Participants	Genders	Ages	Duration	Location
1	3	1 F, 1 M	28, 28, 27	2,5 h	At respondents' home and at Delsjön
2	5	2 F, 3 M	22, 27, 29, 34, 42	2h	Store Mosse National Park

In the picture study, interview participants from both cohorts provided images documenting their personal gear and experiences. These submissions showed personal equipment, user setups, packing methods, and real-life outdoor cooking scenarios. The purpose was to visually analyze the physical environments and gear configurations described by the participants. This analysis cross-referenced and validated their expressed needs and challenges.

In addition, exploratory fieldwork in public outdoor environments and camping retailers was conducted across Gothenburg. The purpose was to build contextual awareness of how people currently encounter outdoor and camping products and settings in daily use. Product catalogs and brand communications, regional outdoor communities, retail channels, rental options, and repair or reuse services was observed. A store visit was carried out to Naturkompaniet in Gothenburg to observe proportions, packing logic, material qualities on relevant camping related products. Observations were documented through pictures and informal notes.

3.1.5 Literature Study and Other Written Documents

A structured literature and document search was conducted, combining peer-reviewed academic literature with relevant grey literature and design-oriented source material. The purpose was to collect knowledge on circular economy, lifecycle thinking, stakeholder process, design process, sustainable textiles, outdoor recreation, outdoor industry current market and regulatory developments.

Peer-reviewed literature was identified through systematic searches in Scopus, Chalmers University of Technology library search system, Web of Science, and ScienceDirect using combinations of keywords like interdisciplinary process, sustainable textiles, outdoor recreation, user-centered design, stakeholder participation, stakeholder design process, circular thinking, textile innovation, redesign, life cycle assessment textiles, environmental impact clothing and circular economy. The search strategy was iterative, refining initial broad searches to improve relevance. Academic sources were screened via titles and abstracts first, then conclusions were reviewed, and finally full texts were assessed against inclusion criteria.

In addition to academic literature, regulatory and strategic framework policy documents were included to ensure alignment with current sustainability directions. These included the EU Green Deal, the Circular Economy Action Plan, the EU Strategy for Sustainable and Circular Textiles, Ecodesign for Sustainable Products Regulation (ESPR), Digital Product Passport (DPP), EU Ecolabel and the Waste Framework Directive. These sources were used as guiding references for defining the sustainability direction of the design criteria.

A broad set of non-academic grey literature and industry sources was used to capture current textile innovations, sustainable practices, brand strategies, and design expressions. Desk research was conducted using company websites, product pages, sustainability reports, and retail pages from the outdoor and textile industry, including Thule's own research sources. Organizations like the Research Institutes of Sweden (RISE), The Swedish School of Textiles, and selected NGO websites were monitored to track textile technology news and circularity discussions. Trend platforms such as WGSN and the Pantone website were used as design-oriented reference sources for color, expression, and broader trend direction. Magazines and social media, such as Instagram video content, were used as supplementary sources to observe design language, outdoor culture, and emerging references relevant to the visual and contextual development of the project.

Material and environmental data was also collected to build a understanding of the concept's fundamental requirements. Common materials and construction details used in comparable bags and outdoor products were reviewed. This review deepened the understanding of environmental implications connected to material choice, durability, and detailing. The collected references were evaluated against environmental and social requirements, integrating circular economy and life-cycle thinking. EU Strategy for Sustainable and Circular Textiles was used as a guiding reference, to make sure the concept development remained aligned with the project's interdisciplinary process and circular design aims.

3.2 Data Management

The analysis of the collected data was conducted through a structured and iterative approach to ensure systematic processing, synthesis, and traceability, transforming qualitative data input into actionable design insights.

3.2.1 Evaluation and Integration of Data

Interviews were audio-recorded and transcribed to ensure accuracy and enable systematic processing and traceability of the material. The transcriptions formed the primary dataset for analysis, laying the base for transforming qualitative input into actionable design insights. A thematic analysis was applied using the KJ-analysis method. The transcribed material was first reviewed to identify meaningful units of data, which were then extracted and transferred onto digital notes in Mural. These statements were iteratively clustered based on similarities and relationships, allowing patterns, behavioral tendencies, and underlying user needs to emerge organically from the data. The purpose of this step was to organize the qualitative data into coherent themes that could support further analysis and design activities.

Based on the findings in the KJ-analysis, a synthesized problem statement was formulated. This statement aimed to clearly define the core challenges identified throughout the research. Later, a functional analysis was carried out in which identified stakeholder needs were reformulated into functional requirements. These were organized hierarchically into a main function, sub-functions, and supporting functions. This structure was used as a framework to guide subsequent concept development.

In parallel with the functional analysis, an inventory of equipment relevant to the studied context was compiled. Items mentioned in interviews and documented in the picture study were listed and categorized according to their level of necessity. This mapping was supported by visual references, and additional research observations including size, weight and proportions of existing products in retail environments. The purpose was to acquire a more comprehensive understanding of current products within the context and how they establish design criteria for the concept development.

Insights from the analysis were synthesized into personas and scenarios based on the collected data. Personas were developed as generalized representations of the target user, based on recurring characteristics identified in the data, capturing the goals, motivations, and barriers of the user. The personas were then placed within contextualized scenarios describing realistic use situations. Two scenarios were constructed. First, a scenario describing a typical current situation, and actions based on the existing barriers mentioned by stakeholders and documentation from observations and the picture study. Later in the design process, a new scenario was constructed outlining an ideal situation according to the stakeholder's input, integrating the use of the final concept. These methods were used to define the primary use case and guide design decisions while maintaining a user-centered perspective throughout the design process.

3.2.2 Concept Development Method

The concept development followed an iterative and user-centered design process structured according to the Double Diamond framework. The process combined divergent and convergent methods to explore, evaluate, and refine design solutions related to outdoor cooking, based on stakeholder insights gathered during previous research stages.

The initial stage focused on visual exploration and contextualization, where insights were synthesized into image boards. The collected observations, references, and material insights were organized into visual boards that functioned as the analytical and inspirational foundation for the concept development. These boards collected references related to outdoor cooking, technical bags, modular storage systems, materials, outdoor environments, and social outdoor activities, and were used to identify visual themes, form language, material expressions, and experiential qualities. The image boards also functioned as a communication tool during discussions and workshops throughout the design process to guide the upcoming ideation, sketching, brainstorming, and experimental design activities.

Following the visual exploration, several ideation methods were applied to generate a wide range of potential concept solutions. An initial ideation session was conducted freely and completely unstructured. This was complemented by brainstorming, mindmapping and group discussions to explore different approaches to the identified problems and functional requirements. Focus points included portability, cooking organization, modularity, accessibility, and user interaction. These activities were based on insights derived from the stakeholder's input in the data collection and analysis steps. Ideas were documented iteratively through notes and sketching, enabling rapid visualization and communication of concepts.

To support systematic exploration of solutions, a morphological matrix was developed based on the previously established function list. Different alternatives for functions were mapped and combined in various ways to expand the solution space and generate combinations of ideas for further exploration. The generated material was analyzed through clustering and comparison of recurring characteristics and themes, allowing four main concept directions to be formulated. The concepts were subsequently assessed using stakeholder feedback sessions, reflective discussions, and decision-making tools. Evaluation criteria were derived from the function analysis, problem statement and project aim. This included functionality, usability, portability, adaptability, sustainability considerations, production feasibility, and user experience. However, extra emphasis was put on social and environmental aspects connected to the project aim.

After the initial concept evaluation, a second wave of broad ideation and experimental design methods were employed, to refine the selected design direction. This included continued brainstorming, sketching, and discussion-based exploration of form, attachment systems, spatial organization, and user interaction. Different placement alternatives and structural configurations were explored through sketching and concept comparisons. To support the assessment of qualitative attributes, a semantic evaluation was applied using a semantic differential scale. Feedback sessions with internal Thule stakeholders and interview respondents were also conducted to support reflection and further development of the concept.

Prototyping was used extensively throughout the development process as a method for exploring and evaluating spatial, ergonomic, and functional aspects of the concept ideas. Initial volumetric studies were carried out through simple paper mock-ups based on the dimensions of the cooking equipment and intended contents to evaluate scale and positioning in relation to a chosen carrier bag. In addition several low-fidelity mock-ups were produced using paper and cardboard to further investigate proportions, dimensions, packing configurations, accessibility, attachment methods, and user interaction. Based on these explorations, digital patterns were created in Adobe Illustrator and plotted in full scale to produce detailed paper mock-ups for continued refinement and evaluation. In addition, sewing trials using scrap textile materials were conducted to explore seam placement, material behavior, and assembly methods.

In the later stages of development, a high-fidelity prototype was produced to communicate the concept and its final design. This was completed using existing textile materials and tools available in Thule's sewing facilities. The production of the final prototype provided the possibility to evaluate user interaction, packing, attachment, and material. The process of making of the final prototype was therefore highly iterative, involving continuous adjustments and refinements.

To support communication and presentation of the final concept, digital visualization methods were used to complement the physical prototype. High-fidelity two-dimensional sketches and technical package were produced in Adobe Illustrator and Fresco to communicate dimensions, color combinations, materials, construction details, and functionality into a cohesive tech pack. The final concept was evaluated and refined in relation to the established design criteria and the strategic objectives outlined in the EU Strategy for Sustainable and Circular Textiles. Consideration was given to principles including durability, modularity, material efficiency, multifunctionality, repairability, adaptability, and extended product lifetime.

4 Results

This section presents the results obtained from the empirical data collection and design process. By integrating insights from stakeholders, the primary needs, barriers and behaviors connected to outdoor cooking were mapped and translated into a final design solution.

4.1 Identifying the Problem Through Stakeholder Needs in Outdoor Settings

This section presents the findings from the initial stakeholder analysis, user interviews in cohort 1 and market research. By examining user motivations, capabilities, opportunities, and existing barriers, a key problem was identified connected to the high mental and practical effort associated with planning and carrying out outdoor cooking experiences.

4.1.1 Outcome of the Problem Identification

The analysis of Thule's product catalog, brand identity and corporate strategy identified a gap in the company's camping assortment. It also indicated a potential product proposition and new customer groups within Thule's existing system. The customer analysis showed that the current Thule consumer is associated with active outdoor lifestyles, family-oriented mobility, and premium consumption patterns. The findings also indicated opportunities to address users with different levels of outdoor experience, accessibility needs, and mobility patterns. Trends related to sustainability, flexible lifestyles, and simplified outdoor participation further support these opportunity areas. Table 6 illustrates the potential user and opportunity area.

Table 6. Thule potential users and opportunity areas.

Current User Focus	Potential User and Opportunity Area
Experienced outdoor users	Beginner outdoor users
Premium outdoor consumers	Accessibility-oriented users
Family Car-based mobility	Individual, lightweight, flexible mobility
Performance-driven lifestyle	Ease-of-entry participation
Sport-oriented outdoor culture	Social recreational outdoor culture

Thule's strategy emphasizes innovative high-quality products for active lifestyles and responsible manufacturing. Within this context, the Thule Chasm series is selected as the focus for further concept development. The reference product for the design process is the Thule Chasm 40L duffel (figure 9).



Figure 9. Thule Chasm 40L as reference bag (Thule, 2026).

4.1.2 Stakeholders Motivations, Capabilities, and Opportunities

The initial user interviews provided a foundational understanding of user behaviors, motivations, capabilities and opportunities related to outdoor recreation. Reflective motivations for engaging in outdoor activities were primarily linked to mental recovery, physical well-being, and a desire to disconnect from digital environments. Users consciously sought out fresh air, a sense of peace, and a deeper connection to nature as an antidote to urban stress. Overall, outdoor experiences were perceived as meaningful, restorative and highly valued.

"I know I need the time to going away from the screen and moving your body, I feel more present" – Respondent 2

However, these reflective motivations were frequently counteracted by automatic barriers, particularly emotional and cognitive factors. Stress, fatigue, and the mental effort of planning and executing often resulted in cognitive overload, reducing the likelihood of spontaneous engagement. Weather conditions further amplified this resistance, especially during cold and dark winter months. Furthermore, a tendency toward "all-or-nothing" thinking increased the psychological threshold for participation. If an outing felt like too much of a project, users frequently choose to do nothing at all.

"A lot of times I want all or nothing, like I want a "proper" outdoor day in actual woods but then that feels a bit more of a project so instead I don't do anything". – Respondent 7

In terms of capability, most users felt they possess adequate basic knowledge for simple outdoor activities. However, uncertainty arose regarding outdoor cooking, overnight camping, or managing unfamiliar equipment, especially for beginners or less experienced users. The most significant barrier within capability was psychological, specifically related to the planning and preparation of gear. Deciding where to go, what to bring, how to pack, and remembering small essentials required significant mental effort. Physical capability was closely linked to the manageability of equipment, as heavy, bulky or unstructured gear limited mobility. Preferred hiking distances for smaller everyday adventures generally ranged between 3 to 10 kilometers, heavily dictated by the physical burden of carrying gear.

"I don't know how to for example set up a tent. I feel it's a big step for me to go outdoors, because lack of knowledge" – Respondent 5

Opportunities were strongly dictated by external logistics and social conditions. A lack of specialized gear or appropriate carrying solutions restricted users from extending their trips. Transportation acted as another major factor, where accessibility to a car strongly dictated physical opportunity to engage in outdoor recreation. Carrying heavy or unstructured equipment on public transportation, bicycles, or by foot was a primary pain point. Socially, while daily walks were often done alone, many outdoor activities were strongly associated with social interaction and were perceived as more meaningful when shared with friends, family or a partner. However, gear-intensive sports could feel exclusionary due to high costs and the social pressure of appearing inexperienced among well-equipped peers, creating a distinct barrier to entry for less experienced users.

"General hiking feels pretty inclusive, but other outdoor activities like skiing, camping, biking, climbing can be very materialistic and a bit posh." – Respondent 11

4.1.3 Identifying the Problem

The combined findings indicated that outdoor experiences are highly valued, but users primarily experienced emotional and psychological barriers to engagement rather than purely physical ones. A lack of routine and the heavy mental load associated with planning and organizing were prominent obstacles (figure 10). Within this mental barrier of planning, a key finding was that users expressed a desire to cook and eat outdoors. However, many experienced significant frictions related to the logistics and execution of it. This insight identified spontaneous outdoor cooking in everyday nature settings as the primary problem.



Figure 10. Word cloud generated from interviews with cohort 1 during problem identification.

4.2 How Do Experienced Outdoor Users Behave?

This section explores how experienced outdoor users currently approach outdoor cooking, including their behaviors, routines, and equipment needs. Through interviews and observations, recurring challenges related to preparation, organization, transportation, and on-site cooking were identified. These insights were used to define the functional requirements and practical considerations for the design solution.

4.2.1 Current Experiences and Behaviors

Stakeholder interviews indicated that outdoor cooking is rarely an isolated activity, but rather an integrated part of a broader social and recreational experience. It was often combined with activities such as hiking, kayaking, skiing, or casual gatherings. While some users preferred to cook food outdoors by themselves, a clear majority of users connected outdoor cooking with social interaction. It was strongly associated with slowing down, spending quality time together, and creating memorable shared experiences in beautiful natural locations. For the everyday occasions, users typically preferred accessible locations like nearby forests, lakes, coastal areas, or nature reserves within short travel distances from urban centers.

When analyzing current outdoor cooking occasions, typical meals varied significantly. They ranged from simple sausages, cold sandwiches, and pre-prepared pancake batter to more elaborate cooking involving pasta dishes, woks, or stews prepared on gas stoves, storm kitchens or open fires. However, users expressed a clear desire to cook more ambitious meals and mentioned how it enhances the outdoor experience. Still, independent on meal complexity, the general structure of the cooking scenario followed a rigid pattern. This included extensive preparation at home, packing, transportation, setup at the site, cleaning up and repacking before returning home. The actual cooking represented only a small part of the experience.

“To set everything up and to make sure that you have everything is the most annoying and time-consuming part. Not the cooking itself, once you start cooking the time flies by because you enjoy the activity. It’s not so hard.” – Respondent 4

The preparation phase was consistently identified as the most mentally demanding and time-consuming part of the experience. It required a "project mindset" where gathering equipment from different areas of the house, planning ingredients, and remembering small items collectively create a high threshold for participation. While users rarely forgot larger equipment like stoves, they frequently forgot minor but essential support items such as lighters, cutlery, gas, oil, salt, dishcloths, or trash bags. These became a critical source of frustration on-site. To compensate, many users simplified their meals or prepare food extensively at home by chopping, grating or portioning ingredients in advance. While this behavior reduced complexity on-site, it simultaneously increased the preparation effort beforehand and reduced spontaneity. It also diminishes the actual enjoyment of cooking and the sense of ceremony on-site.

“There’s so many small little kitchen things you need, and it’s like ‘how do I bring all of that stuff?’. That can sometimes make me think like ‘aah, it’s not really worth it’.” – Respondent 7



Figure 11. Picture from picture study describing a user's current set-up and gear.

4.2.2 Gear Needs Connected to Outdoor Cooking

Field observations and interviews confirmed a consistent pattern of adaptation and improvisation driven by gear limitations. Existing backpacks and carrying solutions were generally not adapted for cooking-related equipment and often acted as unstructured cavities where objects become disorganized, difficult to access and poorly protected. Fragile food items risked being crushed, ingredients leak, and users were forced to unpack the entire bag to locate smaller objects stored at the bottom.

Furthermore, nature rarely provided flat, clean, and stable surfaces for food preparation. Chopping vegetables, placing stoves safely, or organizing ingredients became difficult on uneven ground, rocks, or wet surfaces. In addition, wind frequently disrupted the cooking process, and the inability to keep important ingredients cool reduced meal opportunities.

Cleaning and waste management emerged as another major source of frustration. Managing dirty dishes, greasy utensils, soot-covered pans, and food waste without access to proper cleaning facilities was perceived as unhygienic and inconvenient. It forced users to improvise with temporary plastic bags and elevated the risk of contamination and potential littering.

“Cleaning up is also cumbersome, whether washing dishes on-site or bringing them home together with all the waste. The logistics surrounding dishes and waste are energy consuming.” – Respondent 13

Notably, users generally placed a high value on comfort. They continuously expressed a willingness to sacrifice weight for comfort if the gear simplifies the experience and provides a ready-to-go routine. For everyday near urban outdoor cooking, many users valued comfortable seating and setups. However, there was a continuous trade-off between comfort and portability.

"We normally carry a bit more weight because we want more luxury, for example nicer food and fresh coffee. We can sacrifice weight for a bit of comfort." – Respondent 3

Ultimately, the user's favors a pre-configured framework that minimizes individual decision-making before an excursion. Respondents explicitly requested a system that streamlines the preparation steps and provide guidance.

“If you made a bag that was always packed and ready to use, that would be fantastic.” – Respondent 12

“That the backpack itself, in some way, indicates how it should be used.” – Respondent 5



Figure 12. A sample of pictures collected from picture study and field study.

Data based on stakeholder and user insights, identified certain items as essentials for outdoor cooking which notified the following packing requirements:

- Water
- Kitchen setup (stove and fuel)
- Cooking tools and utensils
- Cutting board
- Firewood and fire-starting kit
- Meal ingredients and food containers
- Plates, cutlery, and cups
- Coffee press
- Multi-tool and knife
- Cleaning tools and hygiene products
- Sitting pad/or portable chair solution
- Trash bag
- First aid kit

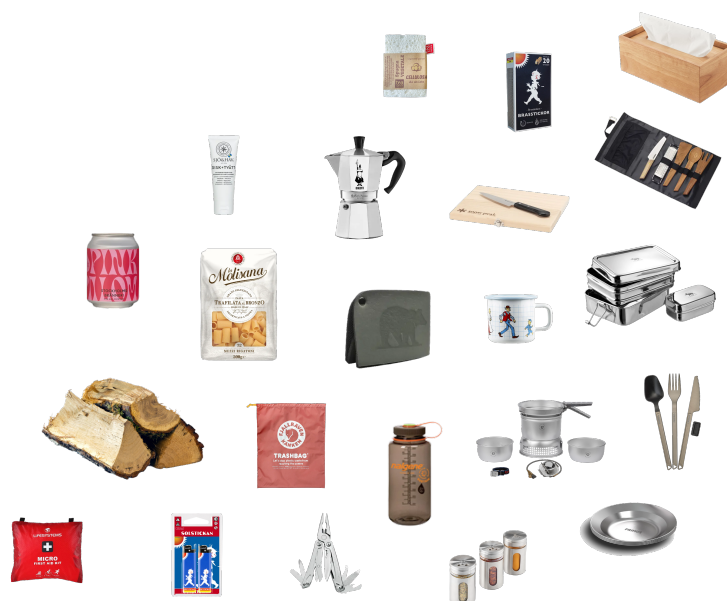


Figure 13. Visual references of identified essential items.

4.3 Creating an Outdoor Cooking Solution for Beginners

This section describes the translation of stakeholder insights into design requirements and concept development. Through synthesis of user needs, personas, scenarios, and iterative ideation, several concept directions were explored and evaluated. The process ultimately resulted in the selection and refinement of final concept, designed to lower barriers to outdoor cooking and support more spontaneous participation in outdoor recreation.

4.3.1 Identified Requirements from Stakeholders and Users

The qualitative data from interviews, observations and picture study, established requirements expressed from stakeholders. The product had to prioritize structure, modularity and visual overview. Users required a solution that opens easily, allowing them to immediately see and access all contents. Dedicated, adaptable compartments were useful to separate fragile objects, cooking equipment, fresh food, and dirty items. Hygiene and cleaning functionality were critical. Furthermore, the product had to employ behavioral guidance through design, using clearly defined storage locations to help users establish routines and reduce the mental effort of packing. Finally, ergonomic carrying comfort was essential, requiring adjustable straps, chest clips, and supportive hip belts to ensure usability during walking, cycling, and public transportation.

4.3.2 Synthesis of Personas and Scenarios

To contextualize these requirements, user archetypes were developed to map the mental model of the process and identify specific pain points across different demographics:

Persona 1: Focuses on creating lasting memories in nature with family while reducing screen time. The main goal is a seamless, easy cooking experience with minimal effort, lowering the mental load of planning and prepping. Key pain points included a dislike for the post-cooking, managing trash and cleaning greasy pans on-site while dealing with tired children.

Persona 2: Combines a passion for the outdoors with more elaborate cooking, seeking a premium experience inspired by cooking rituals and high-quality aesthetics. The process is viewed as a shared social ceremony. Key pain points include the trade-off between comfort and portability, and the frustrating lack of flat, stable surfaces in nature for food preparation.

Persona 3: An active, spontaneous student who values affordable, easy-to-use and approachable gear for short hikes and casual gatherings with friends. Relies on public transport or walking. Key pain points center on unstructured bags where gear becomes a disorganized mix, making items difficult to locate, as well as the difficulty of keeping beverages cool.

The following scenario was constructed to communicate the problem scenario:

It's a beautiful, sunny Tuesday afternoon. Oscar finishes work early and Clara suggests they bike down to the nearby lake to cook dinner outdoors with their friends Elias and Maja. Oscar opens their cramped storage closet and sighs. He has to gather the gas stove, find the camping mugs, pack the bulky cutting board, remember the lighter, and oil etc. "Will the chicken have time to go bad?"

He stuffs everything into his 25L backpack. Because the bag is just a large, unstructured sack, the gear sits awkwardly at the bottom. When they arrive at the lake, Oscar has to dig to find the gas and realizes he forgot the salt. Cooking is messy because they have no flat surface to chop the vegetables.

After a nice meal, the mood drops. Everything is covered in soot and grease. Oscar tries to wipe plates and utensils with a napkin, but he still has to put them back into his nice everyday backpack dirty, worrying it will stain his jacket. When they get home, unpacking feels like a chore, and Oscar thinks, "That was nice, but way too much effort for a Tuesday."

4.3.3 Problem Statement and Functional Analysis

The synthesis of identified barriers and user pain points resulted in the following problem statement and functional analysis:

Outdoor cooking in everyday nature settings has the potential to create meaningful social experiences, but is limited by high mental effort, fragmented equipment and a lack of integrated solutions. These barriers reduce spontaneity, limit cooking quality, and make the overall experience cumbersome, preventing users from incorporating outdoor cooking into their daily routines.

PROBLEM STATEMENT

- The mental load of planning and packing, and lack of a “ready to go” routine makes spontaneous trips difficult
- Current bags are hard to organize, lack structure and provide no visual overview
- Handling the trash and dirt is highly inconvenient
- Lack of flat surfaces in nature makes preparing food challenging
- Comfort on-site is highly valued but feels limited by weight restriction and bulkyness

Figure 14. Problem statement summarized into five key areas.

The following function list translates the qualitative insights into a structured functional framework consisting of a Main Function, critical Sub-Functions, and enhancing Support Functions:

Main Function

- Enable spontaneous and accessible outdoor cooking in everyday nature by reducing planning effort and supporting comfort

Sub-Functions (Critical Requirements)

- Enable a quick “ready-to-go” routine
- Improve organization and visual overview
- Support quick set-up
- Integrate cooking components and enable cooking capability
- Ensure safe transport
- Provide storage
- Facilitate easy clean-up

Support Functions (Enhancing Features)

- Provide a flat preparation surface
- Facilitate on-site comfort/seating
- Provide ergonomic carrying comfort
- Allow modularity/extra attachment
- Protect from dirt and soot
- Ensure quick access to essentials
- Support shared use

Figure 15. Function list including Main Function, Sub- and Support Functions synthesized during functional analysis.

4.3.4 Concept Development

The concept development phase resulted in the exploration, evaluation and refinement of several design directions addressing the identified barriers connected to outdoor cooking. Through iterative ideation, evaluation, and prototyping, the process gradually narrowed from broad conceptual exploration toward a refined final concept focused on accessibility, modularity and ease of use.

The image board exploration established a visual and semantic direction for the project. Multiple mood boards and usage boards were created. The collected references highlighted themes related to portability, aesthetics, modularity, technical outdoor equipment, and social outdoor experiences. Several recurring visual characteristics emerged, including compact organization, layered storage, durable textile materials, bright accent colors, and adaptable carrying solutions. These themes became central throughout the continued concept development process and provided inspiration regarding form language, interaction, and material expression. The mood board synthesized observed trends in outdoor cooking, particularly within Japanese camping culture, where comfort and multifunctionality were highly valued (figure 16). At the same time, it illustrated how circular R-strategies were being implemented and commercialized within the outdoor industry.



Figure 16. Visual on observed trends in outdoor industry.

The inspiration board explored design elements such as form, function, expression, and detail (figure 17). The analysis positioned the concept at the intersection of technical outdoor equipment and everyday usability, drawing on local textile craftsmanship, the multifunctionality of sling bags, and Pantone's Color of the Year, Cloud Dancer.



Figure 17. Visual references synthesized into a mood board for inspiration.

The initial ideation phase generated a wide range of concepts and design ideas exploring different approaches to outdoor cooking organization and portability. Brainstorming sessions, sketch explorations, and brain drawing activities resulted in numerous ideas related to modular packing, integrated cooking systems and interaction between cooking equipment and carrying solutions.

The morphological matrix further supported systematic exploration ideas and combinations of functions and configurations. The ten rows represent identified functional requirements and each post-it note placed horizontally represent an idea to solve the corresponding function, *figure 18*. By combining ideas vertically through the matrix, a big amount of new concept opportunities emerged.

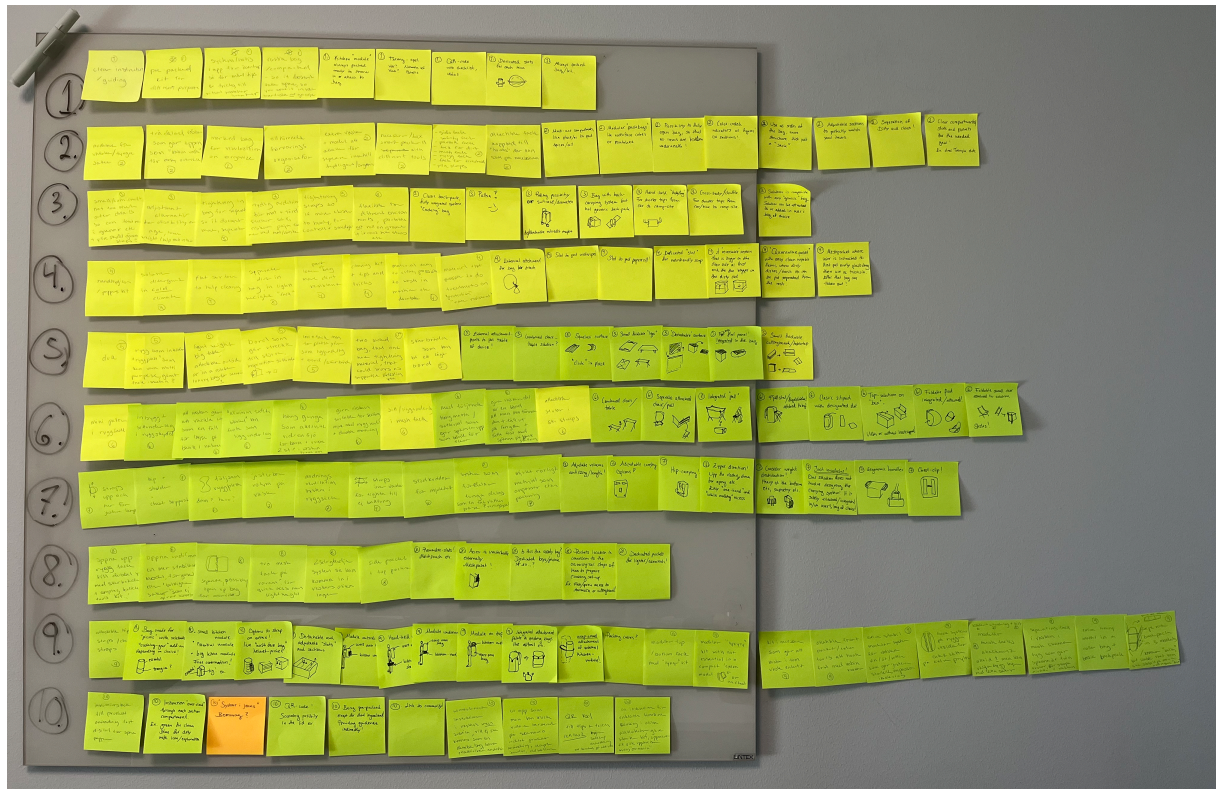


Figure 18. Picture of morphological matrix generated during ideation.

The generated ideas varied significantly in complexity, portability, and degree of integration. Through clustering and comparison of sketches and ideas, four primary directions were identified. These include the Luxury Box, the Hybrid Bag, the Versatile Bag and the Grab & Go Module. Each concept direction represented a collection of ideas that together defines a distinct approach to solving the identified stakeholder needs and barriers. However, some ideas overlapped and varied within the defined directions.

A highly integrated outdoor cooking storage system maximizing comfort and functionality. The concept incorporated dedicated compartments for extensive cooking equipment, preparation surfaces and chairs, supporting larger gatherings and more advanced and luxurious outdoor cooking experiences.

[illegible]

The Hybrid Bag:

Compared to the Luxury Box, the Hybrid Bag reduced size and complexity while still offering integrated organization and storage without compromising the cooking experience. However, the concept still relied on a high level of structural integration, that might not be very versatile.

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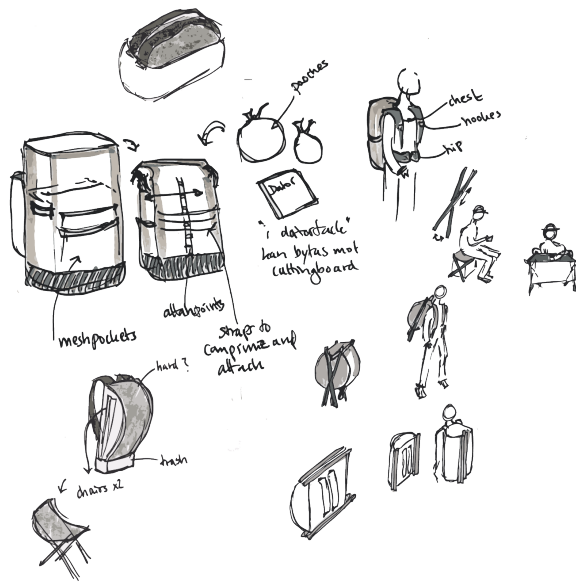


Figure 21. Collection of ideas surrounding the "versatile bag" direction (made by the authors).

The Grab & Go Module:

The Grab & Go Module proposed a dedicated, compact and modular "all in one" cooking kit designed to integrate with existing bags. Rather than functioning solely as a standalone solution, the concept focused on complementing products already owned by the user. The concept emphasized portability, simplicity, flexibility by being an independent unit.

Compared to the other concepts, the Grab & Go Module minimized material usage and reduced structural complexity while still supporting the essential functions required for outdoor cooking. However, a risk for less luxury and place for comfort items.



Figure 22. Collection of ideas surrounding the "grab & go module" direction (made by the authors).

The Versatile Bag:

The Versatile Bag focused on flexibility and adaptability through a modular packing approach using packing cubes and semi-integrated organization systems. The concept was based on a more traditional back-pack structure, allowing users to customize the setup completely depending on travel duration, activity, and cooking needs.

This direction emphasized versatility and adaptability but relied heavily on users' own organization. The concept offered flexibility at the expense of intended use purpose.

The evaluation of the four concept directions revealed several trade-offs between integration, functionality, portability and complexity. The Luxury Box and Hybrid Bag offered highly integrated cooking experiences but were associated with increased material use, higher production complexity and reduced flexibility. They would most likely also only be suitable for users with a better economic situation. The Versatile Bag provided adaptability but relied heavily on user organization and preparation, losing bit of the conceptual and functional essence.

The Grab & Go Module was identified as the concept that most effectively balanced the project objectives. The concept required fewer material-intensive solutions and could be integrated with existing bags, reducing the need for additional carrying products. This contributed to lower complexity and improved adaptability across different travel situations.

Furthermore, social and environmental aspects became particularly influential during the evaluation process. The simplified structure and intuitive organization were believed to most effectively lower the threshold for engaging in outdoor cooking, especially for less experienced users. The modular format also supported more flexible and long-term use by allowing the concept to adapt to existing equipment and changing user needs.

Furthermore, feedback sessions with internal stakeholders and previous interview respondents reinforced the value of creating a lightweight and approachable solution rather than a highly specialized system. Based on the combined evaluation results, the Grab & Go Module was selected for continued development.



Figure 23. Picture taken at feedback session with previous interview respondents.

4.3.5 Refinement of the Grab & Go Concept

After the selection of the Grab & Go Module, a second ideation phase focused on refinement of the concept direction. Continued sketching and brainstorming explored structural organization, user interaction, form language and attachment methods through exploratory design methods.



Figure 24. Exploration of placement options during second ideation of the "grab & go module" (made by the authors).

Three primary placement alternatives were explored for attaching the concept to the carrier bag, Chasm 40L (figure 19). These included a centered placement on the exterior surface, a split placement on each side of the bag, and a placement on top of the carrier bag, behind the user's head. Furthermore, two primary organizational variations also emerged. A two-sided module inspired by suitcase configurations and a top-loaded solution.

Comparative evaluations highlighted advantages and disadvantages related to accessibility, balance, ergonomics, and visual overview. Feedback sessions with designers at Thule contributed to the continued refinement of the divided side-mounted solution with the suitcase opening configuration. Separating the concept into two connected modules created opportunities for more organized packing and improved weight distribution during use.

The prototyping process resulted in a series of increasingly refined physical mock-ups used to investigate scale, interaction, proportions and construction (figure 20). Early volumetric studies using simple paper mock-ups established approximate dimensions based on the cooking equipment and intended contents. These studies helped visualize the concept in three dimensions and evaluate its relationship to the carrier bag.



Figure 25. A sample of pictures during prototyping including paper and textile mockups (made by the authors).

Subsequent prototypes explored proportions, structural solutions, and opening mechanisms through medium-fidelity mock-ups constructed from mainly paper and cardboard. These prototypes enabled evaluation of ergonomics, accessibility, and spatial organization. In addition, textile experiments and sewing trials were investigated construction methods, seam placement, and material behavior.

The final high-fidelity prototype demonstrated the complete concept and enabled realistic testing of packing, carrying, attachment, and user interaction. The prototype illustrated how cooking equipment could be organized, transported, accessed, and repacked within the modular system. It also enabled evaluation of material qualities and overall interaction flow.

4.3.6 The Final Grab & Go Concept

The final concept resulted in a modular outdoor cooking system designed to integrate with existing travel equipment while supporting accessible and socially engaging outdoor cooking experiences. The concept consisted of two side-mounted modules attached to the carrier bag (figure 27) enabling balanced weight distribution and organized storage of cooking equipment. The two modules could also be connected into one “easy-to-grab” unit or carried individually as sling bags in-between friends.



Figure 27. Picture of final prototype attached to reference bag (developed by the authors).



Figure 26. Picture of the two modules in open position, packed with essential equipment and fresh ingredients (developed by the authors).

The final design emphasized simplicity, modularity and accessibility. The modular structure also supported flexibility by allowing users to adapt the setup depending on activity and duration of travel. Dedicated compartments supported intuitive organization, instructing the user what to bring and how to pack. One side was intended to store all essential utensils, always pre-packed and ready to go. The other side provided a big cooling compartment, functioning as storage of fresh ingredients before cooking and doubled as compartment for trash and dirty utensils post cooking.

The form language combined technical outdoor aesthetics with simplified and approachable visual qualities (figure 28). Rounded yet structured forms communicated durability and portability, while also fitting in with the existing Thule Chasm product line.

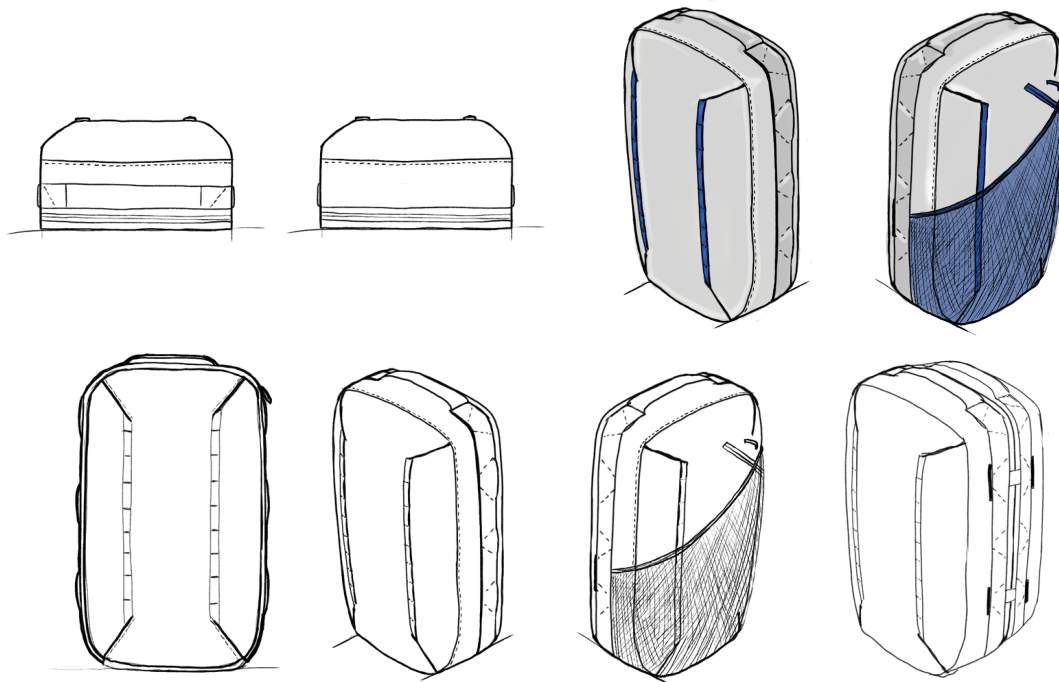


Figure 28. Informative sketches of the "grab & go module" concept proposal (made by the authors).

The concept was designed to support the entire user journey:

It's a beautiful, sunny Tuesday afternoon. Clara suggests they meet up with their friends, Elias and Maja to have dinner down by the lake. This time, Oscar simply walks into the hallway and picks up his Grab & Go Cooking Module.

The compact module is always pre-packed with their outdoor kitchen essentials: the stove, gas, lighter, cutting board, cutlery, plates, mugs and spice containers. Oscar just attaches the entire organized unit into his everyday Thule backpack, throws in a bag of pasta and some fresh ingredients from the fridge into the dedicated cooling compartment. They are out the door in five minutes.

They arrive at the lake with nice scenery. Oscar pulls out the module. Everything is perfectly organized and visible at a glance. He uses the module's integrated and foldable flat surface as a cutting board to chop vegetables. Elias sets up the storm kitchen and the girls get a fire going. The cooking process becomes a shared, relaxed ritual that creates a sense of ceremony and connection among the four friends. Once the food is ready, they sit down, talk and enjoy the atmosphere.

When the meal is over, Oscar places the dirty plates and their trash into the same cooling compartment which now doubles as an easy-to-clean "dirty compartment". He zips the module shut and places it back onto his backpack. His bag stays clean and organized. When they get home, he cleans the kitchen gear, attaches the two sides together, and places the module back on the shelf, ready for the next spontaneous adventure.

4.4 The Sustainability Aspects of the Design

The final Grab & Go cooking module concept proposal was developed from a systems perspective in order to incorporate life cycle thinking into the design and ensure alignment with the EU Strategy for Sustainable and Circular Textiles. In this section, the concept presented sustainable and circular design through strategic choices in color, material and finish, connected systems and services and design for disassembly.

4.4.1 Color, Material and Finish

From the Thule color, material, and finish catalogue, the main body material was a 100% recycled, solution-dyed polyester ripstop 600D with PU coating in the color Pelican Grey. For design details and the desired texture on the Grab & Go cooking module, part of the body fabric was a 300D ripstop. This material consisted of 97% recycled polyester and 3% virgin polyester, used for color plastic pellets in the solution-dyeing process. It was PU-coated and came in the color Faded Khaki. The back panel fabric was a plain weave made of 97% recycled polyester and 3% virgin polyester, with a 600D denier and PU coating, solution-dyed in Faded Khaki. The lining consisted of a combination of the 600D and 300D polyester ripstop body fabrics.

The cooling compartment had an insulated lining made of 100% PEVA containing PE foam. The mesh detail pocket was made of 100% polyester warp knit 75D in yellow. For potential straps or areas requiring breathability, the proposed material was a bluesign-approved 100% recycled polyester warp knit, specifically a basic air mesh in white. The zippers were a combination of YKK reversed coil zippers and regular coil zippers. The main exterior zippers were watertight, while the smaller and interior zippers were non-watertight.

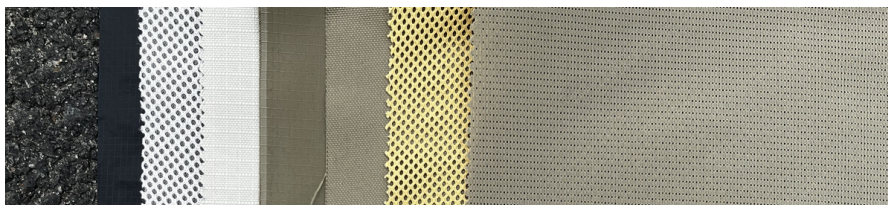


Figure 29. Selection of material chosen from Thule.

This material composition applied monomaterial construction where possible to facilitate recycling pathways. The selected materials provided weatherproof qualities, high tear resistance and the technical properties required for the concept. Developed as an add-on concept to the reference product Thule Chasm 40L, which used a body fabric made of 100% PVC, the final concept proposed a PVC-free solution to reduce toxicity and improve the environmental profile of the material selection. The use of solution-dyed recycled polyester also reduced water consumption and chemical waste during manufacturing. However, full monomaterial construction was not achieved, as the PEVA insulation, zippers, webbing, and other trims remained obstacles to a fully monomaterial solution. These components were still required to meet functional demands but limited the product's overall material uniformity and recyclability.

The material used in the hygiene-clean compartment was lightweight and solution-dyed. It provided a waterproof barrier that resisted grease and dirt, allowing the user to wash out residue easily with mild soap and water, thereby extending the product lifecycle. The final concept also proposed a color

selection of Pantone Vaporous Grey and Blue Tattoo. This color proposal supported the visual identity of the design concept, although no exact material match for these colors was identified in the current Thule material catalogue. Overall, the material and finish selection reflected an effort to reduce environmental impact through recycled content, solution-dyeing, PVC-free material choices and design decisions that supported durability and easier maintenance, while acknowledging that some components still limit full monomaterial construction and recyclability.

4.4.2 Connected System and Services

To extend product longevity and support circular economy, a rental and maintenance infrastructure was suggested as a complementary service proposal. The Rent Hub system allowed beginner outdoor users and casual participants to rent the Grab & Go Module through established retail environments, thereby lowering the financial barrier to entry and reducing the overproduction of underutilized gear. Rent Hub was proposed as an in-store service delivered through an interconnected network of Thule stores, outdoor retailers, community-oriented retail actors and second-hand stores specializing in outdoor and sports products.

Further recommerce channels were introduced through Thule's online platform. Recommerce included the resale of returned and pre-owned goods and accepted only products in good condition that require only minor refurbishment. The concept also proposed the development of local repair services, initially through selected store locations in Sweden, where customers can hand in soft goods that require repair in order to prolong product lifespan. In this context, Thule was recommended to utilize local textile craftsmanship and relevant stakeholders.

The proposal further suggested collaboration with a sewing factory that takes social and environmental responsibility and worked to bring people together while facilitating a sustainable lifestyle through increased participation in the local sharing economy. Within a system that emphasizes sharing and preserving resources, this supported a circular and socially oriented business model that lowers the barrier to an active outdoor life and builds a stronger community around outdoor cooking.

4.4.3 Design for Disassembly

The concept applied design-for-disassembly principles through separable modules, detachable buckles and replaceable high-wear components. The Grab & Go cooking module consisted of a tool module and a cooling compartment connected through a mesh pocket and buckles, which enabled easier detachment and simpler separation at end-of-life.

High-wear components, particularly zippers, were treated as replaceable parts together with the mesh connecting pocket, buckles, cords, straps, and selected attachment points. In the continued product development phase, detachable straps were explored as a design requirement to further support disassembly and create the possibility for the modules to be carried separately.

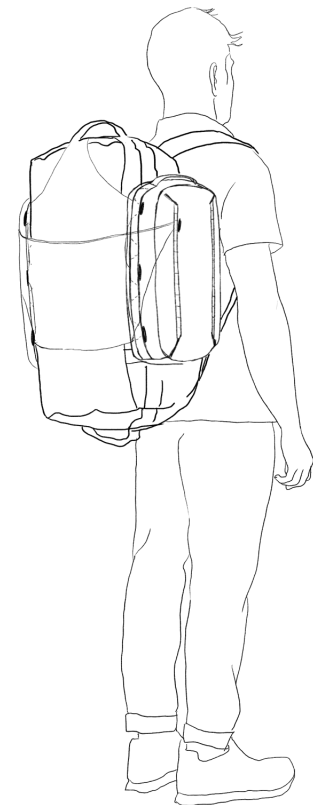


Figure 30. The "Grab & Go module" integrated with carrier bag on user (made by the authors).

From a life cycle perspective, the concept was intended to support longer product use and more controlled end-of-life handling. The main fabric parts were primarily polyester-based, while the cooling compartment included integrated PEVA insulation. The construction also included PU coating, webbing, zippers and other trims. These material combinations still complicated full disassembly and material separation, but the concept aimed to make the main components easier to separate for repair, reuse, and recycling before lower-priority waste treatment.

The concept also included a care label and QR code containing care instructions for longevity, washing guidance, fiber content, country of origin and manufacturer identity. This supported user care during use, future traceability at end-of-life, and care practices intended to support durability and reduce unnecessary fiber release during use.

5 Analysis

This chapter analyses the results in relation to the project research questions. It reflects on how stakeholder insights informed design decisions, evaluates the interdisciplinary development process, and examines the developed concept through the lens of circular economy principles.

5.1 How did stakeholder insights inform the design decisions?

Stakeholder insights played a central role in shaping both the design problem and the resulting concept. Rather than validating predefined ideas, stakeholders influenced the project from its earliest stages, before a product category or design challenge had been established. This allowed the problem and solution to co-evolve throughout the process, consistent with Human-Centered Design (ISO 9241-210, 2019), the Double Diamond framework (Design Council, 2007), and the description of design thinking as an iterative dialogue between problems and solutions (Cross, 2008).

An important consequence of this stakeholder-centered approach was that the project focus emerged inductively from stakeholder insights rather than from assumptions made by the design team. Initially, the design space included numerous possible directions within outdoor recreation. Through stakeholder interviews, observations and qualitative synthesis, outdoor cooking gradually emerged as the area with the greatest potential to reduce barriers to outdoor participation within the project scope.

Stakeholder contributions continued throughout the full design process but served different purposes across its phases. Early engagement was primarily used to identify and frame the design problem, while later involvement translated user insights into functional requirements and supported concept refinement. The following sections discuss in more detail how this differed from standard design processes and how stakeholder contributions evolved throughout the different phases of the project.

5.1.1 Similarities and differences between stakeholder-driven design and standard design processes

Although the project was structured according to the standard Double Diamond framework, the way in which stakeholders were integrated differed from more conventional product development processes. Traditional product development commonly assumes that the design problem has already been defined before stakeholders become involved. In these more linear engineering development models, objective performance indicators such as weight, cost or technical optimization often dominate early development stages. Stakeholder participation is therefore often concentrated in concept evaluation or product validation, where users provide feedback on predefined ideas rather than shaping the definition of the problem itself (Design Council, 2007; Ulrich and Eppinger, 2016).

In contrast, this project deliberately prolonged the first divergent phase of the Double Diamond. Stakeholders in this study participated while the research remained open to multiple opportunity areas within outdoor recreation. They were therefore involved before a design challenge had been established. This shifted the stakeholder's role from evaluators to co-creators of the problem framing itself, consistent with the concept of *joint problem framing*, where diverse stakeholder perspectives collectively define the problem space before solution generation begins (Pearce and Ejderyan's, 2020). This also aligns with stakeholder participation theory, which argues that stakeholder engagement is most valuable when it contributes to defining objectives rather than merely validating decisions (Reed, 2008).

Rather than solving an assumed problem, the problem itself co-evolved together with the emerging solution, consistent with Cross' (2008) description of iterative design as the co-evolution of problems and solutions. It also supports the argument that wicked problems cannot be fully understood before exploration begins (Buchanan, 1992).

Another distinguishing feature of the stakeholder integration during the project's early discovery phases, was the implementation of behavioral perspectives. Conventional human-centred design primarily seeks to understand functional user requirements (Norman, 2013; ISO 9241-210, 2019). However, rather than focusing on functional product requirements immediately, the COM-B framework (Michie et al., 2011) was used to analyse stakeholder's psychological capability, motivation and opportunity as determinants of outdoor participation during the interviews with cohort 1. Instead of asking only *what users needed*, the study explored *why users failed to perform the desired behavior*.

The behavioral insights from stakeholder interviews, field observations and picture studies enabled the realization that the primary challenge was not insufficient products, but rather the psychological complexity surrounding spontaneous outdoor cooking. For example, participants consistently described the mental effort associated with planning, remembering equipment and establishing packing routines as more discouraging than the actual outdoor activity itself. This finding would likely have remained hidden in a conventional needs assessment focused solely on functional requirements. Instead, behavioral theory redirected attention from designing "better outdoor equipment" towards designing a product that reduced cognitive effort and increased users' confidence in outdoor cooking.

Furthermore, combining stakeholder interviews with contextual observations enabled the identification of more implicit stakeholder needs and their automatic behaviors. This revealed a discrepancy between stated preferences and observed behavior. Participants frequently expressed a desire for elaborate outdoor cooking experiences with fresh ingredients and extensive equipment. However, field observations and picture studies demonstrated that this aspiration often resulted in decision fatigue, poor organization and trade-offs in user experience, reducing the likelihood of spontaneous outdoor participation. This discrepancy supports the argument that designers should not rely solely on stated user preferences, but seek to understand users within their real context of use (Norman, 2013)

5.1.2 In the design process, when and how did stakeholders contribute the most?

Stakeholder contributions varied throughout the design process, with different stakeholder groups influencing different phases of the Double Diamond. Early stakeholder engagement primarily determined what problem should be solved, whereas later stakeholder involvement increasingly informed how the solution could be realized.

As described in 5.1 stakeholders had a large influence during the Discover phase. Both novice and experienced outdoor users shaped the problem definition by demonstrating that barriers were driven more by psychological uncertainty than by insufficient equipment, which ultimately redirected the projects focus towards simplifying outdoor cooking scenarios. This corresponds with ISO 9241-210 (2019), which emphasizes understanding users and their contexts before solution generation.

During the Define phase, experienced outdoor users was highly influential in translating behavioral insights into functional requirements. For example, repeated observations of disorganized equipment, damaged food during transportation and insufficient preparation surfaces directly informed features such as the suitcase-style construction, permanently organized compartments and a dedicated washable compartment for dirty equipment. Consequently, design decisions were often direct translations of observed stakeholder needs, reflecting the argument that functional analysis should derive from identified user needs rather than preconceived technical solutions (Pahl and Beitz's, 2013).

Stakeholder influence shifted during the Deliver phase. While end-users still contributed with feedback connected to user desirability during concept devaluation and refinement, Thule became more influential as the primary constitutional stakeholder contributing expertise regarding manufacturing feasibility and industrial implementation constraints.

5.2 How did an interdisciplinary design process contribute to concept development?

The interdisciplinary design process contributed to concept development by integrating multiple disciplinary perspectives throughout the entire design process rather than treating them as individual sequential phases. Instead of first developing a desirable product concept and subsequently evaluating its environmental performance or material feasibility, considerations related to human behavior, textile engineering and circularity continuously informed one another. Consequently, design decisions were evaluated simultaneously from the perspectives of user desirability, technical feasibility and business viability, consistently with the three lenses of innovation (Brown, 2008). However, it also extends the framework to include environmental sustainability as an equally important design criterion.

This interdisciplinary approach proved particularly valuable because the project addressed a wicked problem rather than a clearly defined engineering challenge. Lowering barriers to outdoor participation while simultaneously contributing to circular economy objectives involved conflicting stakeholder interests, uncertain problem boundaries and multiple interacting systems. As Rittel and Webber (1973) argue, wicked problems cannot be solved through linear optimization because both the problem and the solution evolve together throughout the design process. By integrating perspectives from industrial design engineering, industrial ecology and textile engineering from the outset, the project was able to continuously redefine both the problem and the proposed solution as new insights emerged. The result was a design process characterized by continuous negotiation between competing objectives instead of sequential optimization. This illustrates the concept of reframing within wicked problem solving (Dorst, 2015), where understanding the problem is itself one of the principal outcomes of the design process.

5.2.1 Characteristics of the interdisciplinary design process

A defining characteristic of the interdisciplinary design process was the coexistence of three complementary yet sometimes conflicting design logics, Industrial Design Engineering, Industrial Ecology and Textile Engineering. These disciplines contributed different forms of knowledge throughout concept development, with each perspective influencing both the generation and evaluation of concepts.

Industrial Design Engineering primarily contributed a human-centred perspective, emphasizing usability, functionality and the reduction of barriers to outdoor participation. Through Human-Centered Design (ISO 9241-210, 2019) and behavioral design (Michie et al., 2011), the project prioritized users' emotional experiences and practical interaction with the product.

Industrial Ecology introduced a bigger systems perspective extending beyond the immediate user experience. Rather than evaluating only product functionality or desirability, concepts were continuously assessed in relation to life cycle impacts, circular economy principles and upcoming European regulations such as the Ecodesign for Sustainable Products Regulation (ESPR). This perspective frequently challenged otherwise attractive design solutions by questioning their implications for resource efficiency, reparability and end-of-life management. For example more material intensive concept ideas was eliminated in favor of concept direction with lower environmental impact.

Textile Engineering contributed detailed knowledge regarding material properties, manufacturing processes and textile construction. Decisions concerning seam placement, reinforcements, waterproofing, insulation and production methods therefore became integral parts of the projects concept development instead than postponed until later development stages.

Rather than operating independently, these disciplinary perspectives continuously cross-corrected one another. Human-Centered Design encouraged solutions that maximized usability and user needs, while Life Cycle Thinking questioned whether these solutions also supported long-term environmental sustainability. Conversely, circular design principles occasionally proposed environmentally preferable solutions that risked reducing product desirability or performance. This process aligns with the argument that successful design requires balancing human needs with technological possibilities (Norman, 2013).

5.2.2 Which phases were particularly important for interdisciplinary collaboration?

Although interdisciplinary collaboration occurred throughout the whole project, certain phases became particularly important because they required explicit integration of different disciplinary perspectives. In addition, the process illustrates a gradual shift from having a slight disciplinary emphasis on Industrial Design Engineering in the beginning stages towards Textile Engineering in later stages.

Generally, the Define and Develop phases represented major points of interdisciplinary convergence. During the synthesis of stakeholder insights, the qualitative data had to be evaluated against interdisciplinary perspectives for example through the functional analysis. Subsequently, the need for interdisciplinary collaboration was apparent during concept generation as it required balancing conflicting objectives, for example how could a product be designed both modular and material-efficient while still enabling a luxury user experience.

Prototyping became another key interdisciplinary activity. To mediate the complex interactions between different fields of expertise and the stakeholders, physical prototypes functioned as crucial *boundary objects* between disciplines and stakeholders throughout the process (Lauff, Menold and Wood, 2020). Rather than serving only as design representations, prototypes facilitated communication between different disciplinary languages and priorities. Abstract discussions concerning usability, ergonomics, textile behavior and circularity became tangible when translated into physical artefacts that could be jointly evaluated. This was particularly evident during collaboration with Thule, where textile construction and user interaction could be discussed simultaneously through increasingly refined prototypes. As concepts progressed from sketches and paper models to pattern construction and sewn textile prototypes, disciplinary perspectives gradually converged into integrated design solutions. In this way, prototyping did not merely validate concepts but actively supported interdisciplinary learning throughout the process.

The contribution of each discipline shifted across the design process. Industrial Design Engineering dominated the early stages, translating stakeholder insights into behavioral requirements and concept directions through methods such as KJ-analysis, functional analysis, and the morphological matrix. At this stage, the emphasis was on user interaction rather than textile manufacturability. As concepts matured, Textile Engineering became increasingly influential, as material characteristics, pattern development, and seam construction determined whether ideas could be realized. Industrial Ecology provided a continuous systems perspective throughout, ensuring that life cycle thinking and circular economy principles informed decisions rather than being applied as an afterthought.

5.3 How can outdoor textile products be designed in alignment with the EU Strategy for Sustainable and Circular Textiles?

The findings suggest that designing outdoor textile products in alignment with the EU Strategy for Sustainable and Circular Textiles requires more than substituting individual materials or reducing environmental impacts within existing product systems. Instead, the transition requires reconsidering how products are designed, used and maintained throughout their entire life cycle. This reflects the principles of Life Cycle Thinking (ISO 14040, 2006; ISO 14044, 2006) and the Circular Economy Action Plan (European Commission, 2020), which emphasize that environmental performance is largely determined during the early design stages.

The concept developed in this project therefore sought to integrate circularity from the outset rather than treating sustainability as a final optimization step. This approach aligns with the Ecodesign for Sustainable Products Regulation (ESPR), which places increasing emphasis on durability, reparability, recyclability, recycled content, minimisation of substances of concern, and product information throughout the product life cycle (Regulation (EU) 2024/1781, 2024). Instead of viewing sustainability solely as a material selection problem, the project considered how product architecture, user behavior, service systems and end-of-life management collectively influence circularity. This broader perspective also reflects the increasing emphasis on producer responsibility within EU textile policy, where manufacturers are expected to support products throughout their entire life cycle rather than only at the point of sale (European Commission, 2022; Directive (EU) 2025/1892, 2025).

Importantly, the project also illustrates that circular design extends beyond environmental performance to include behavioral dimensions. A technically circular product provides limited environmental benefit if users do not use it, repair it or keep it in circulation. Consequently, reducing barriers to outdoor participation simultaneously supports product longevity by increasing the likelihood that products remain in active use. This finding reflects the interaction between Human-Centered Design (ISO 9241-210, 2019), behavioral design (Michie et al., 2011) and circular economy thinking, suggesting that user desirability and circularity should be considered as mutually reinforcing rather than competing objectives. Overall, the findings suggest that the EU Strategy for Sustainable and Circular Textiles functions not only as a policy document but also as a practical design framework that can guide material selection, product architecture, service systems and end-of-life planning throughout product development (European Commission, 2022).

5.3.1 From linear to circular material flows: incremental improvements or systemic change?

The project demonstrates that the transition from linear to circular material flows requires both incremental improvements and more fundamental changes in product systems. While material substitutions contribute to reduced environmental impacts, they alone are unlikely to achieve the systemic transformation envisioned by the EU Strategy for Sustainable and Circular Textiles.

During concept development, incremental improvements were implemented through the selection of recycled polyester, solution-dyed textiles and PVC-free materials, thereby reducing resource consumption, greenhouse gas emissions and hazardous substances during production. These decisions primarily correspond to the *Reduce (R2)* strategy within the circular economy hierarchy (Kirchherr et al., 2017) by improving the environmental performance of existing material flows. The selection of these materials also contributes to reducing substances of concern, reflecting current ecodesign requirements for safer and more sustainable textile products (Regulation (EU) 2024/1781, 2024).

However, the more significant contribution emerged from challenging the assumption that sustainability necessarily requires developing entirely new standalone products. Rather than designing another multi-functional backpack, the final Grab & Go concept was intentionally developed as an add-on module compatible with equipment users already owned. This represents a higher-order circular strategy corresponding to *Rethink (R1)*, where product architecture and patterns of consumption are reconsidered rather than merely improving individual products.

The concept further incorporated principles of Design for Disassembly through replaceable and detachable components together with care-label and QR-based product intended to facilitate repair, maintenance, traceability and eventual material recovery. These decisions support several higher-value R-strategies, including *Repair (R4)* and *Reuse (R3)*, by extending product lifetime before recycling becomes necessary. Such design decisions are consistent with the Waste Framework Directive, which prioritizes prevention and reuse above material recycling (Directive 2008/98/EC, 2008).

Beyond product design, the proposed Rent Hub service, local repair services and recommerce channels illustrate how circularity increasingly depends upon product-service systems rather than products alone. Access-based models can increase product utilization while reducing redundant ownership, thereby contributing to more resource-efficient consumption patterns. These proposals are also consistent with the

growing policy emphasis on repair services, second-hand markets and extended producer responsibility as mechanisms for reducing textile waste and extending product life (European Commission, 2022; Directive (EU) 2025/1892, 2025). This reflects growing recognition within circular economy research that business model innovation is often as important as material innovation for reducing overall environmental impacts. However, the feasibility of such access-based systems depends on consumer acceptance, logistics and economic viability, which were beyond the scope of the present project. Consequently, the proposed service should be understood as a conceptual contribution rather than a validated implementation model.

Overall, the findings indicate that the greatest opportunities for circularity arise not from isolated material substitutions but from redesigning relationships between users, products and resource flows. Taken together, these findings suggest that alignment with the EU Strategy requires prioritizing higher-order circular strategies, such as rethink, modularity and product-service systems, rather than relying solely on improved materials.

5.3.2 Challenges for the transition within the outdoor textile industry

Although circular design principles are increasingly supported by European legislation, the findings demonstrate that substantial challenges remain for the outdoor textile industry. One of the most significant challenges concerns the inherent tension between functional performance and material circularity.

Outdoor products are expected to withstand demanding environmental conditions, requiring high durability, weather resistance, thermal insulation and mechanical strength. Achieving these performance requirements often relies on complex multi-material constructions involving coatings, foams, laminates and synthetic reinforcements. While these combinations improve product performance, they simultaneously complicate fibre-to-fibre recycling and material separation at end-of-life. Consequently, the pursuit of maximum durability may conflict with ambitions for material circularity.

A similar trade-off exists regarding chemical performance. The industry's transition away from PFAS-based durable water repellent (DWR) treatments represents an important environmental improvement, yet many emerging bio-based alternatives currently provide lower long-term water repellency and require more frequent maintenance by users. From a purely environmental perspective this transition is desirable, but from a user perspective reduced functionality may negatively influence product satisfaction and lifespan. The findings therefore illustrate that regulatory ambitions and product performance do not always progress in parallel. While the phase-out of PFAS supports environmental objectives, it may simultaneously create new usability challenges that risk shortening product lifespans if users perceive reduced functionality. This highlights that sustainability transitions involve managing trade-offs rather than optimizing single environmental indicators.

The findings also suggest that product development should increasingly prioritize identifying genuine user needs before introducing new products to the market. From a circular economy perspective, the most sustainable product is not necessarily the one with the lowest environmental footprint per unit, but the one that fulfils a meaningful need, remains in use for a long time and prevents unnecessary consumption. In this respect, stakeholder-centered design becomes an important strategy for sustainability because understanding actual behavioral barriers reduces the risk of developing products that are rarely used or quickly discarded.

Finally, several challenges extend beyond the responsibilities of individual product developers. Effective circularity ultimately depends on broader industrial infrastructure. Large-scale systems for textile collection, automated sorting, material identification and fibre recycling remain underdeveloped for technical outdoor textiles. Consequently, even well-designed circular products may struggle to achieve closed material loops without corresponding investments across the wider value chain.

These findings therefore suggest that the transition towards circular outdoor textiles should not be understood solely as a product design challenge. Rather, it represents a socio-technical transition requiring coordinated changes in product development, manufacturing, business models, consumer behavior, recycling technologies and regulatory implementation. This systems perspective reflects the principles of Life Cycle Thinking (ISO 14040, 2006; ISO 14044, 2006) and demonstrates that achieving the ambitions of the EU Strategy for Sustainable and Circular Textiles depends upon coordinated innovation across the entire product system rather than isolated improvements within individual products. Product designers therefore become important facilitators of circular systems rather than solely developers of more sustainable products.

6 Discussion

This chapter discusses the strengths and limitations of the study, evaluates the credibility and applicability of the findings, and reflects upon the study's contribution to the research field.

6.1 Strengths and Limitations

The following discussion examines the methodological strengths of the study, including triangulation and interdisciplinary collaboration, alongside limitations such as geographic scope and the early-stage nature of the concept development. It further addresses the transparency of the research process and the generalizability of the findings beyond the specific product context.

6.1.1 Method

The chosen methodology proved suitable for addressing the aim of the study, which was to explore how stakeholder insights can inform concept development while integrating sustainability considerations in accordance with the EU Strategy for Sustainable and Circular Textiles.

A major strength of the methodology was the front-loaded application of the Double Diamond framework, emphasizing an extensive exploration of the problem space before transitioning into developing solutions. Significantly, by dedicating significant time to understanding the problem through early and continuous integration of diverse stakeholders, the project avoided premature assumptions and remained anchored in validated user needs.

Splitting the empirical research into two distinct cohorts allowed the focus to shift effectively from broad problem identification in Cohort 1 to highly specific technical and functional requirements Cohort 2. Using the established COM-B framework as an interview guide effectively mapped user capabilities, opportunities, and motivations. This approach revealed that the primary barriers to spontaneous outdoor participation are often psychological rather than physical.

Field observations and picture studies further complemented these interviews by capturing practical struggles and implicit insights in real-world contexts. The combination of multiple data sources and design methods proved highly valuable, and the iterative process allowed findings to be continuously tested and refined throughout concept development.

The interdisciplinary collaboration between Industrial Design Engineering, Industrial Ecology and Textile Engineering proved essential for bridging technical performance with emotional desirability and sustainable responsibility. However, an interdisciplinary, stakeholder-driven design process is inherently complex and demands a high degree of reflexivity to reconcile conflicting perspectives between corporate values, sustainability requirements and end-user desires.

The front-loaded Double Diamond framework prioritized a heavy exploratory phase, utilizing contextual analysis, extensive interviews and field observations. Gathering and analyzing this volume of qualitative data systematically is highly time-consuming and can strain project resources and timelines. The heavy reliance on qualitative methods also introduces the risk of subjective interpretation and researcher bias. Although structured methods such as affinity mapping and functional analysis were used to support decision-making, complete objectivity cannot be achieved in an interpretive design process.

A further limitation is that the project focused on early-stage concept development. While the concept was iteratively refined, it was not tested through long-term implementation or market introduction. Consequently, the study can demonstrate how stakeholder insights informed concept development, but it cannot verify long-term behavioral changes or product success.

Finally, sustainability requirements were primarily used to evaluate and refine concepts rather than functioning as explicit constraints from the very beginning of the process. In our method, stakeholder input mainly shaped the early concepts. Future projects could benefit from integrating circular economy requirements even earlier in concept generation.

6.1.2 Validity of Data Collection

The validity of the data collection was strengthened through methodological triangulation. By combining interviews, field observations, picture studies, and literature reviews, the study collected information from multiple sources and perspectives. The use of different methods allowed findings to be compared and validated across datasets rather than relying on a single source of information.

The consistency of the findings across methods further supports the credibility of the results. Difficulties related to planning, packing, and organizing equipment emerged consistently throughout the data collection process. These themes appeared both in interviews and observations, suggesting that they represent genuine barriers rather than isolated opinions.

However, a limitation regarding the validity of the data collection is the geographic and demographic concentration of the samples. Most participants were recruited from the Gothenburg region and represented individuals with at least some interest in outdoor recreation. While the samples successfully captured a balanced spectrum of ages, occupations, and household configurations, the study may not fully capture the experiences of groups with no connection to outdoor activities. Furthermore, the field observations were conducted in specific locations and during a limited time period, meaning that seasonal conditions and local infrastructure may have influenced the findings.

6.1.3 Transparency of the Results

Transparency was maintained throughout the synthesis phase through systematic documentation of the progression from stakeholder research and problem identification to concept generation, evaluation, and refinement. The use of digital KJ-analysis (affinity diagramming) enabled an inductive transition from interview data to the final problem statement, while the functional analysis hierarchy (main, sub-, and support functions) made it possible to trace how stakeholder needs were translated into functional requirements. In addition, feedback loops with Thule designers and interview participants further supported the validation of emerging findings and design decisions.

These methods provided a traceable link between raw qualitative data and resulting design decisions. For example, challenges related to planning and organization were translated into features such as dedicated guidance compartments and a suitcase-style opening. However, transparency in qualitative design research is inherently limited by the interpretive nature. Although systematic methods and stakeholder feedback were employed to reduce bias, the interpretation and prioritization of findings ultimately relied on researcher judgement. Consequently, the transparency of the process should not be interpreted as complete objectivity, but rather as a clear description of how conclusions were reached.

6.1.4 Generalizability of the Results

The study was conducted as an exploratory qualitative study within a specific context involving Thule Group as primary corporate partner and the development of a narrow product segment, outdoor soft goods. Consequently, the direct generalizability of the final physical design solution itself is constrained. The structural design requirements were optimized around a specific reference bag, the Thule Chasm 40L duffel, meaning attachment mechanisms and volumetric proportions may not be transferable to other carrying systems without modification.

However, the broader findings possess greater transferability. The identification of psychological barriers as a significant obstacle to outdoor participation is likely relevant beyond outdoor cooking. Similar challenges related may exist within other complex and equipment-intensive activities such as climbing, skiing, and bikepacking. The findings therefore contribute to a broader understanding of accessibility within outdoor recreation.

Furthermore, the methodological approach may be transferable to other design contexts. The integration of stakeholder-centered design, behavioral design, and life cycle thinking demonstrates a practical approach for balancing user needs and sustainability requirements during early concept development. This underlying process provides a generalizable framework for future product development for companies navigating the green transition.

6.2 Contribution to the Research Field

This section outlines how the study contributes to the research field by integrating human-centered design with life cycle thinking, and by expanding the understanding of psychological barriers to outdoor participation. It also evaluates how the findings align with or expand upon existing research on behavioral models and circular economy.

6.2.1 Knowledge Contributed by the Study

The primary novelty and academic value of this thesis lie in the integration of human-centered design and life cycle thinking within a single concept development process. While these perspectives are often applied separately, this study demonstrates how they can complement each other into a unified development for circular soft goods.

Individually, these theories exhibit limitations when addressing complex sustainable innovations. Human-Centered Design frequently prioritizes immediate user desirability but may fail to consider long-term global system impacts, and Life-Cycle Thinking offers robust sustainability frameworks but often neglects the human behavioral factors that dictate whether a product is adopted or used correctly in

reality. By synthesizing these frameworks together, this study demonstrates a collaborative value where the theories cross-correct each other. Rather than treating sustainability as a separate activity, the project demonstrates how circular design principles can be translated into concrete design criteria related to modularity, repairability and design for disassembly. The results therefore provide an example of how sustainability requirements can be integrated alongside user-centered considerations.

Furthermore, the findings contribute to the growing body of research examining barriers to outdoor participation. Existing discussions frequently emphasize access to equipment, cost, or physical constraints. In contrast, this study highlights the importance of psychological and cognitive barriers. The findings suggest that reducing cognitive effort may be as important as providing physical access to equipment. This indicates that improving accessibility to outdoor recreation may require solutions that address psychological factors rather than focusing solely on equipment availability.

6.2.2 Results That Support or Contradict Previous Research

The findings largely support previous research on human-centered design, circular economy and behavioral design. Consistent with human-centered design literature, the study demonstrates that a deep understanding of stakeholder contexts is essential for developing successful and meaningful solutions, validating the foundational principles of Norman (2013), Brown (2008), and ISO 9241-210.

The study validates the COM-B framework and the Fogg Behavior Model (Fogg, 2009), that behavior occurs when motivation, ability, and a prompt align. The empirical data proved that while motivation for outdoor recreation is high, behavior fails to manifest because user "ability" is compromised by capability and opportunity barriers, specifically the cognitive friction and planning complexity of organizing gear.

The findings also support existing research regarding the restorative benefits of nature. Participants frequently described outdoor activities to disconnect from digital environments, reduce stress, and improve well-being, which aligns with Attention Restoration Theory (Kaplan, 1995) and Stress Recovery Theory (Ulrich et al., 1991).

Furthermore, the results expand upon circular economy literature by applying a strict "Rethink" philosophy. Rather than manufacturing an entirely new standalone backpack system, the final concept was designed as an add-on module for existing bags. This structural decision directly advances the higher-level R-strategies, including R1: Rethink and R2: Reduce, by minimizing raw material usage and preventing product redundancy. By designing for adaptability, the concept lowers the economic threshold for beginners while structurally preventing the overproduction of underutilized consumer goods.

Outdoor products often emphasize increased functionality and specialized equipment. In contrast, the results suggest that users may place greater value on simplicity, routine and ease of use than on advanced functionality, motivating the selection of the Grab & Go concept over the more feature-intensive concept directions presented.

6.3 Further Material and Sustainability Reflections

From a sustainability perspective, the design aligns with circular economy principles through its material and structural configuration. However, evaluating the transition from a conceptual design to a physical market solution reveals critical trade-offs that requires deeper reflection.

Utilization of a monomaterial construction paired with a PFC-free durable water-repellent (DWR) finish ensures weather resistance without persistent environmental toxicity, while also facilitating future textile-to-textile recycling streams. Furthermore, applying a design-for-disassembly approach ensures that individual elements can be repaired or replaced, extending the product's overall lifetime.

However, because current PFC-free technologies often lack the long-term water repellency and durability of traditional toxic chemicals, extreme weather performance may be compromised. In addition, while a 100% polyester construction optimizes future recyclability, it may create some functional trade-offs. For example, eliminating elastane restricts fabric stretch, and polyester zippers instead of stronger polyamide or steel reduces mechanical robustness in high-wear areas. This emphasizes how reconciling extreme durability with complete recyclability, is still challenging.

Further research must be conducted into the supply chain to verify the exact sourcing of the recycled polyester materials and to establish formal end-of-life recycling pathways, ensuring that the monomaterial design achieves true circularity in practice rather than just in theory.

7 Conclusion

This study demonstrates that an interdisciplinary design process can identify stakeholders' functional and emotional needs and translate these into concept development that lowers barriers to outdoor recreation. By involving stakeholders throughout the design process, the study captured not only practical and functional requirements but also the emotional factors that influence participation, such as confidence, perceived complexity and motivation. These insights formed the basis for a set of design criteria that support the objectives of the EU Strategy for Sustainable and Circular Textiles by encouraging longer product use, easier maintenance and repair, and more conscious use of materials from the earliest stages of development.

The findings show that stakeholder insights strengthened concept development by providing a broader understanding of users' needs, experiences, and motivations than could have been achieved through technical requirements alone. Bringing together perspectives from industrial design, textile engineering, sustainability and behavioral science created a more comprehensive understanding of the problem and supported design decisions that balanced user needs with circular economy principles. The study therefore highlights the value of interdisciplinary collaboration when addressing complex sustainability challenges within product development.

The results further demonstrate that outdoor textile products can be designed in line with the EU Strategy for Sustainable and Circular Textiles by considering circularity as an integral part of concept development rather than as a later addition. The proposed design criteria emphasize product longevity, repair, adaptability, and responsible material choices while maintaining a strong focus on usability and accessibility. In this way, the study shows that environmental sustainability and increased participation in outdoor recreation can be supported simultaneously. The final concept proposal illustrates how textile products can be designed to support the high-performance requirements of outdoor use while simultaneously aligning with broader sustainability ambitions within the outdoor industry.

Additional conclusions from the study include:

- Early and continuous stakeholder involvement improves concept development by identifying both functional and emotional user needs.
- Emotional barriers can be as significant as practical barriers in preventing participation in outdoor recreation.
- Behavioral design frameworks, such as COM-B, provide valuable support for translating stakeholder insights into design opportunities.
- Integrating sustainability requirements during concept development enables more holistic design decisions than addressing them later in the product development process.
- Lowering barriers to outdoor recreation has the potential to contribute not only to more inclusive outdoor experiences but also to broader environmental and societal sustainability goals, including improved health and social well-being.

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Attachments

Attachment 1

Table 7. Table with interview participants in cohort 1, during problem identification phase.

Respondent	Gender	Age	Occupation	Main Outdoor Activities	Level of Experience (1-4)
Respondent 1	F	28	IT/engineering consultant	Cross-country skiing, running, ice-skating, hiking, mountain biking, camping, and bikepacking.	3 - Experienced
Respondent 2	M	29	Tech consultant	Surfing, biking, hiking, camping, and fishing.	4 - Very experienced
Respondent 3	M	67	Retired IT consultant	Skiing, walking, playing golf, and ice-skating on lakes.	2 - Some experience
Respondent 4	M	26	Student	Easy camping, fishing, climbing, and taking walks.	1 - Beginner
Respondent 5	M	26	Student	Camping, hiking, fishing, and indoor climbing.	2 - Some experience
Respondent 6	F	27	Extra event worker/ unemployed	Walking, camping, having bonfires, and skiing.	3 - Experienced
Respondent 7	F	26	Teacher/Student	Forest walks, hikes, swimming in the ocean, surfing, and skiing.	2 - Some experience
Respondent 8	M	27	Season worker	Hiking, skiing, and sometimes camping.	2 - Some experience
Respondent 9	F		Student	Nature walks close to nature.	1 - Beginner
Respondent 10	M	78	Retired	Walking in the forest, picking berries and mushrooms. Previously engaged heavily in tent camping and boating.	4 - Very experienced
Respondent 11	M	35	Sales Associate and student	One-day hikes, setting up camp, fika, and preparing dinner outdoors	2 - Some experience
Respondent 12	F	27	Office worker	Camping, hiking with dogs, kayaking, horseback riding, and skiing.	3 - Experienced
Respondent 13	F	54	Teacher	Walking, skiing, mushroom picking, and playing golf.	2 - Some experience

Attachment 2

Table 8. Table with interview participants in cohort 2, during problem formulation phase.

Respondent	Gender	Age	Occupation/Background	Main Outdoor Activities	Experience: 1 (beginner) – 4 (very experienced)
Respondent 1	M	30	Chemical engineer	Hiking and taking stops during road trips.	3 - Experienced
Respondent 2	M	35	Industrial Design engineer	Hiking, kayaking, ski touring, and ice-skating.	4 – Very Experienced
Respondent 3	F	30	Textile engineer, mother	Walks, hiking, and ice-skating.	3 - Experienced
Respondent 4	M	28	Student	Running, skiing, sailing, and hiking.	3 - Experienced
Respondent 5	F	29	Student	Cross-country skiing, slalom, running, and hiking.	3 - Experienced
Respondent 6	M	35	Sales associate/Student/Dad	One-day hikes in nature reserves or by the ocean.	4- Very Experienced
Respondent 7	M	78	Retired, former leader in Friluftsförbundet.	Walks in the forest, picking berries and mushrooms.	4 - Very experienced
Respondent 8	F	29	Works with kids outdoors, lives in Switzerland.	Snowboarding/skiing, cycling, hiking, and camping.	4 - Very experienced
Respondent 9	M	53	Father to young adult/teen children.	Walking, paddling, and tent camping.	3 - Experienced
Respondent 10	F	52	Chemical engineer / Medtech corporation	Walking, paddling, and tent camping.	3 - Experienced
Respondent 11	M	29	Tech consultant	Surfing, biking, hiking, camping, and snowboarding.	4 - Very experienced
Respondent 12	F	28	IT/engineering consultant	Cross-country skiing, running, ice-skating, hiking, MTB, camping.	3 - Experienced
Respondent 13	M	25	Student	Hiking, camping, and outdoor climbing.	3 - Experienced

Attachment 3

The following interview guide was used in interviews with cohort 1:

Background and current behavior

- Age
☐ Under 18 ☐ 18–24 ☐ 25–34 ☐ 35–44 ☐ 45–54 ☐ 55+
- Gender
☐ Female ☐ Male ☐ Non-binary ☐ Prefer not to say ☐ Other: ____
- Occupation
☐ Student ☐ Employed ☐ Self-employed ☐ Unemployed ☐ Retired ☐ Other: ____
IT/engineering consultant
- Household situation
☐ Single
☐ In a relationship but living alone
☐ Living with partner
☐ Living with children (wife, teenager, and adult children)
☐ Shared household
- Do you have access to a car?
☐ Yes ☐ No
- What means of transport do you most often use in everyday life and to get to nature?
- How would you describe your experience with outdoor activities and camping?
☐ Beginner ☐ Some experience ☐ Experienced ☐ Very experienced
- What type of outdoor activities do you most often do?

Motivation

Reflective – Values, goals, conscious choices

- What motivates you to spend time outdoors?
- Would you like to engage in outdoor activities more than you currently do? Why or why not?

Automatic – Emotions, mental barriers, energy

- Are there any feelings or mental barriers that often influence your decision to stay indoors instead of going out? (for example stress, uncertainty, fatigue)

Capability

Psychological – Knowledge, planning, confidence, decision-making

- Do you feel you have the knowledge to support your outdoor activities?
- Have there been situations where you decided not to go because of lack of knowledge?
- When you consider spending time outdoors, how do you usually decide what to bring? What do you find most difficult to know or plan in advance?

Physical – Physical limitations, manageability, physical load

- Are there any physical aspects of current outdoor gear that make it harder for you to use or bring along? How far would you like to go?

Opportunity

Physical – External practical conditions, access, infrastructure

- Have there been occasions when you wanted to go outdoors or stay longer but lacked the right equipment with you?

Social – Social context, norms, companionship

- Do you usually spend time outdoors alone or with others, and how does this affect how often you go?
- Do you feel that outdoor activities are accessible and inclusive, or do they sometimes feel reserved for more experienced or well-equipped people?

Attachment 2

The following interview guide was used in interviews with cohort 2:

Respondent X - Name

Intro

We are exploring how people cook outdoors in everyday situations. The goal is to understand experiences, challenges and needs. There are no right or wrong answers!!! Be creative and think broad.

General (quick questions)

Age

☐ Under 18 ☐ 18–24 ☐ 25–34 ☐ 35–44 ☐ 45–54 ☐ 55+

Gender

☐ Female ☐ Male ☐ Non-binary ☐ Prefer not to say ☐ Other: ____

Occupation

☐ Student ☐ Employed ☐ Self-employed ☐ Unemployed ☐ Retired ☐ Other: ____

Household situation

- ☐ Single
- ☐ In a relationship but living alone
- ☐ Living with partner
- ☐ Living with children
- ☐ Shared household

How would you describe your experience with outdoor activities and camping in general?

☐ Beginner ☐ Some experience ☐ Experienced ☐ Very experienced

- How much experience do you have with outdoor cooking? (anything from preparing food on open fire, trangia, bringing a picnic, or eating during multiday camping)

How often do you spend time outdoors in everyday life? What do you usually do?

Are there any activities where you would like to have accessible cooking opportunities?

In what environments would you like it to be in? (by the lake, in the park, at the beach, forest..)

Experience

Can you describe step by step the last time (or any specific time) you brought or cooked food outdoors?

- Where did you go?
- Who were you with?
- What did you bring?
- Was there anything you wanted to bring but didn't? Why? (did you miss it, was it intentional or forgot)

During the planning of this event, what did you need to think about? And how long did it take?

- What takes the most time or energy when preparing for outdoor cooking?

Problems

From now on let's focus on the day adventure activity.

What parts of outdoor cooking feel difficult or inconvenient?

- Packing? Why or why not?
- Carrying? Why or why not?
- Cooking? Why or why not?
- Does the weather have an effect? Why or why not?

Do you ever choose simpler food or avoid cooking outdoors completely because it is easier?

- Can you give an example?

Needs

In an ideal scenario, imagine an outdoor dinner after work or during the weekend. What would it look like?

- Where would you go?
- Who would be there?
- What would you like to bring if you could?
- What would you cook?
- How would you like to cook your food? (trangia, bonfire or just bring easy alternative)
- How do you transport your food and equipment? (Backpack? Bags? Multiple items?)

What makes a bag comfortable or uncomfortable to carry and easy to use?

How important is weight versus comfort for you? Which matters more?

What would make outdoor cooking easier for you?

Is there any item or factor that you find can ruin the whole experience?

If one product could help you cook outdoors more often, what should it do?

Design:

What functions and technical features would you want in a bag suited for storing and organizing outdoor cooking?

Would you find it useful if your bag included: (one by one!)

- A flat surface or table?
- Seating?
- Cooling compartment?
- Any extra tools or equipment? (Knife, cutting board, thermos, drinking glass, plates and cutlery)
- Features for cleaning or hygiene?
- Which of these would be most important? Why?

Do you have any preferences:

- In terms of volume and size?
- The carrying system? Handling?
- Usability requirements?
- Design aspects?

Is there any design aspect that would make you leave a bag at home? Anything that you definitely don't want?

(Now the interview is pretty much over)

- Do you have any pictures from previous camping experiences you could share with us, maybe on your set-up, packing or when you've cooked outdoors?
- Would you like to add something you would like to add to make? Any ideas on what could lower the barrier to enter the outdoors and strengthen the sense of community and ceremony around outdoor cooking?



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