Development of a Startup Guideline for Creating a Sustainable Product/Service-Systems Enabling a Circular Economy within the Field of Consumer Goods.

A collaboration between MSc. Design and Innovation & MSc. Sustainable Design Engineering
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Title Page

Dansk titel: Udvikling af en Startup Guideline til Bæredygtige Produkt/Service-Systemer ved Inkorporering af Cirkulær Økonomi inden for forbrugsvarer.

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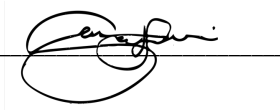

Abstract

Startups are successful drivers for developing innovative product/service-system business models enabling a circular economy that mitigates the environmental and social challenges in today's society while sustaining economic growth and meeting user needs. Thus, there is a gap in research on guidelines gathering methods within the areas of product/service-systems, circular economy, and sustainability to support the development of a product/service-system startup. This study aims to investigate, test and evaluate on what process and methods are needed to create a guideline that supports the development of a sustainable product/service-system business model enabling a circular economy. Using a design research approach, the guideline was developed, tested and revised. The test was conducted by applying the proposed methods in the guideline to a case study of developing a sustainable products/service-system startup targeting the baby equipment and toys market. The development of the product/service-system startup and hereby the test of the guideline follows a proposed design framework. A proposal for a guideline gathering methods relevant to the areas of product/service-systems, circular economy, and sustainability is introduced. The guideline proves to support the facilitation of the development of a product/service-system startup concept focusing on all three sustainable dimensions and incorporating circular economy strategies. The project proposes that future research investigates the area of frameworks for supporting the development of product/service-systems implementing sustainable and circular strategies. Additionally, future studies should investigate and test the applicability of the guideline to other consumer goods markets and with practitioners of different backgrounds.

Keywords: Product/Service-System, Circular Economy, Economic Sustainability, Environmental Sustainability, Social Sustainability, Guideline, Startup

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Similarly, the authors would like to thank the Co-founder of the startup Søuld Gunnar Agerskov Madsen, HR & Communication specialist Sarah Patocska and Customer Support & Communication specialist Mie Hammerich from the startup Rask Rask for their contributions towards gaining insights around developing a startup and its potential challenges and opportunities.

Finally, the authors would like to acknowledge the research participants, not least the 15 users contributing to the workshops throughout the study. Furthermore our deepest gratitude to the 1512 respondents to the different surveys allowing the authors to develop concepts based on a significant amount of data.

Learning objectives

DTU

1. Identify and summarise knowledge about PSS development within startups
2. Systematically compare and analyse startups' approaches for PSS development
3. Compare and evaluate user needs and existing solutions to find PSS business opportunities
4. Outline the existing market and illustrate insights through a Value Offering Gallery
5. Demonstrate how a PSS development process can help develop a PSS startup
6. Illustrate a minimum viable product (MVP) for the PSS startup
7. Demonstrate User Experience (UX) guidelines to design the prototype
8. Analyse the sustainability potential of the PSS startup
9. Calculate and analyse the economic viability of the PSS startup
10. Summarise the advantages and disadvantages of developing sustainable PSS startups
11. Design a guideline for startups creating sustainable PSSs
12. Evaluate the final guideline using external feedback to improve the guideline

AAU

Knowledge

1. Has knowledge about and understanding of the latest international research in the fields of sustainability, design and innovation
2. Has knowledge about how to critically assess knowledge and identify problems with regards to sustainability, design and innovation, within the chosen subject

Skills

3. Can frame a design assignment or a sustainability challenge using professional tools and methods
4. Can motivate choices of methods and/or theoretical approach behind the design project
5. Can select appropriate research-based knowledge for use in the design process and has awareness regarding their value and limitations
6. Can argue for a solution with regards to its business potential
7. Can analyse market conditions (users, technologies, competitors, etc.) and describe how own solution will perform in this market
8. Can stage design and innovation processes
9. Can communicate design and design proposals in a professional manner

Competencies

10. Is able to present the results of the project work in a project report and during an oral examination and argue for the approach taken and the results
11. Is able to independently manage a project from start to finish and reflect on the processes, theories, methods and tools used. Type of instruction: Project work with supervision, supporting seminars and milestones.

Table of Content

Introduction

Introduction

In consumerism, where the living standard is increasing globally year by year, more and more money is spent on baby equipment and toys. The market is projected to reach US $184.161,00 million in 2021, resulting in an annual growth rate of 8.32% projected from 2021 to 2025 (Statista, 2021). As a parent, new to this market, it can be extremely difficult to differentiate between what equipment and toys are *nice-to-have* and what are *need-to-have* as you are introduced to thousands of must-have-lists, sponsored ads on social media and trendy parents on the street scene. Baby equipment and toys have become identity shaping elements for the modern parent with huge expectations for the newest and best high-class products to become 'the perfect parent'. Meanwhile, a paradox arises as these 'perfect parents' are the same users that aim to be more environmentally sustainable.
The toy and baby equipment industry uses 40 tons of plastic for every $1 million in revenues and is the most plastic-intensive industry in the world (The World Counts, 2021).1 in 3 parents admit to having thrown away equipment and toys in working condition. Paradoxically, a study by (Waight, 2013) shows that parents agree that it makes practical sense to acquire used items if they are good value for money and fit the purpose as kids grow out of clothes, toys and equipment long before the items reach the end of life.
As a result, reusable products are thrown out, and valuable resources like plastics are lost (The World Counts, 2021).
Product/service-system as a concept has been proposed to tackle the environmental challenges by finding potentials to sustain the economic growth and consumer demand by using fewer resources and thereby causing less pollution while adding value to the users (O. Mont, 2004).

This master thesis project aims to develop a startup guideline for creating a sustainable product/service-system within the field of consumer goods, that enables a circular economy. The guideline will be tested through the case study of building a startup within the baby equipment and toys industry to solve identified challenges of becoming a new parent.
The thesis and the creation of the guideline will follow the *Design Research Methodology* phases described in the methodology section (Blessing & Chakrabarti, 2009). The development of a startup within the baby equipment and toys market and the guideline test will follow the *Systemic Design Framework, a* revised version of the Double Diamond framework for innovation design (Design Council, 2021).

The profit generation and the market success of a product/service-system critically depend on the decisions made during the initial lifecycle stages covering the *conceptualisation*, *design*, and *development* of a product/service-system (Sassanelli et al., 2015). Additionally, decisions regarding environmental and social aspects of a product/service-system business model, that can potentially increase the competitive advantage on the market, are advantageously taken during the initial stages of the development. In exploring the plethora of models and methods supporting the development of startups, it becomes clear that there is no sufficient guideline in the literature supporting sustainable product/service-system startups enabling a circular economy (Barquet et al., 2016); (Scherer et al., 2016). Current models and methods are often relevant to large companies and are not necessarily applicable for developing startups or Small and Medium-sized Enterprises. Furthermore, research provides no consolidated framework gathering strategies for overcoming sustainability barriers when developing and implementing sustainable product/service-systems (de Jesus Pacheco et al., 2019).

Entrepreneurship and startups play a major role in accelerating the transformation of society and businesses towards sustainable development. A startup is often established by a few people and can therefore be seen as a small business. Startups can deliver innovative business models and take advantage of existing market failures (Trautwein, 2021). Thus, startups face challenges, as they have to deal with limited resources and limited knowledge of markets and at the same time compete with technologies, products, and services that are continuously evolving. These characteristics influence the possibilities for startups to assess the sustainable impact of a business idea.
It is seen in the literature that there are hardly any product/service-system development nor assessment approaches explicitly designed for the needs of startups. Furthermore, the few existing methods, models, and guides for developing startups within the field of product/service-systems are often too comprehensive for startups to apply in the initial phases or lack guidance on using the method (Trautwein, 2021).

To change the current production and consumption patterns of products, a new strategy is needed. However, decreasing the consumption patterns does not seem an option as the industrialised countries do not seem willing to lower their consumption (O. K. Mont, 2002).
Traditionally, selling products is turning into an old-fashioned business, and companies have started to focus on selling experiences and satisfaction as an integrated solution (Tukker & Tischner, 2017). Today, the notion of product/service-system is well known but still appears under various names such as *shared economy*, *solution development,* and functional *sales (Tukker, 2004)*.

The research area of circular economy needs to be explored, as the guideline aims at developing product/service-system startups enabling a circular economy. The concept has recently gained increased popularity amongst scholars and practitioners worldwide, and the Chinese government has even enforced a law supporting a circular economy adopted in 2008 (Kirchherr et al., 2017; Korhonen et al., 2018). The theoretical foundation of circular economy originates from the definition of industrial ecology from the early 1990s. Still, it has achieved rapid growth in peer-reviewed articles on circular economy in the last ten years, which indicates a divergence in the research field of circular economy (Nancy M. P. Bocken et al., 2016; Kirchherr et al., 2017). The circular approach replaces the linear *'take-make-dispose'* pattern that dates back to the industrial revolution. Here businesses see production and resources as unlimited, and products are sold to users who dispose of them when they are no longer helpful. Circular economy aims to replace this *'cradle-to-grave'* approach, where waste is created, with a *'cradle-to-cradle'* approach, where materials are kept in a closed loop (Ellen MacArthur Foundation, 2013). Companies are starting to adapt to a circular economy as their former linear approach to resource consumption leads to substantial losses along the value chain of products and increases their exposure to risks like high resource prices (Ellen MacArthur Foundation, 2013).

The research area of sustainability has been explored, as the guideline aims to develop sustainable product/service-system startups. Over time, sustainability as a concept has been bent, shaped, and re-interpreted. Famously, scholar (Elkington, 1998) proposes the *'triple bottom line*' of sustainability containing social, economic, and environmental aspects which in literature occasionally are referred to as people, profit, and planet. According to (Holden, 2007), the concept was introduced by (Elkington, 1998), who found that social and economic dimensions needed to be addressed in an integrated manner to achieve sufficient environmental progress (Holden, 2007).

The thesis investigates and identifies a gap in the literature on guidelines gathering methods within the areas of product/service-systems, circular economy, and sustainability to support the development of a product/service-system startup. This study will contribute to closing the identified gap by developing

such a guideline. An understanding of the concepts of product/service-systems, circular economy, and sustainability and their interrelationship, as defined in literature, is gained to support the development of the guideline. The guideline will be co-developed and tested by creating a product/service-system within the field of baby equipment and toys and validated through workshops with external actors.

Research Question

The thesis aims to create a guideline that applies to the early phases of business development of startups intending to develop sustainable product-service systems within consumer goods while enabling a circular economy. A research question, to be answered to meet the goal of the thesis, is formulated as follows:

Which process and methods are needed to create a guideline that supports the development of a sustainable product/service-system business model enabling a circular economy?

Three sub-questions (SQ) were formulated to give further insights to the research question;

- *SQ1: Which sustainable product/service-system startup guidelines enabling a circular economy exist in the literature and online?*
- *SQ2: What are the criteria for a guideline for developing a sustainable product/service-system startup enabling a circular economy?*
- *SQ3: How can a guideline through a startup case study be tested and evaluated?*

Methodology

Methodology

The Design Research Methodology

The research in this thesis will be structured around the *Design Research Methodology* (DRM) proposed by (Blessing & Chakrabarti, 2009). The DRM was developed to meet the need for a standard methodology for conducting design research to develop academic and practical knowledge.
DRM provides a systematic way for design research and seeks to link research questions together through the four main phases: Research Clarification (RC), Descriptive Study I (DS I), Prescriptive Study (PS), and Descriptive Study II (DS II). Design in this context is '(...) *those activities that actually generate and develop a product from a need, product idea or technology to the full documentation needed to realise the product and to fulfill the perceived needs of the user and other stakeholders*' (Blessing & Chakrabarti, 2009). Although DRM is composed of four phases, it is not a linear process but a process with iterations running back and forth.

The guideline for developing sustainable product/service-system startups enabling a circular economy developed throughout this project will follow the DRM phases RC, DS I, PS, and DS II. The set guideline from the RC, DS I, and PS will be tested in the DS II through the *Systemic Design Framework*, a revised version of the Double Diamond framework for innovation design by the British Design Council (Design Council, 2021). The process is shown in Figure 1.

In the following sections, we wish to delve into the specific phases, define the intent, and highlight how it appears in this particular research context.

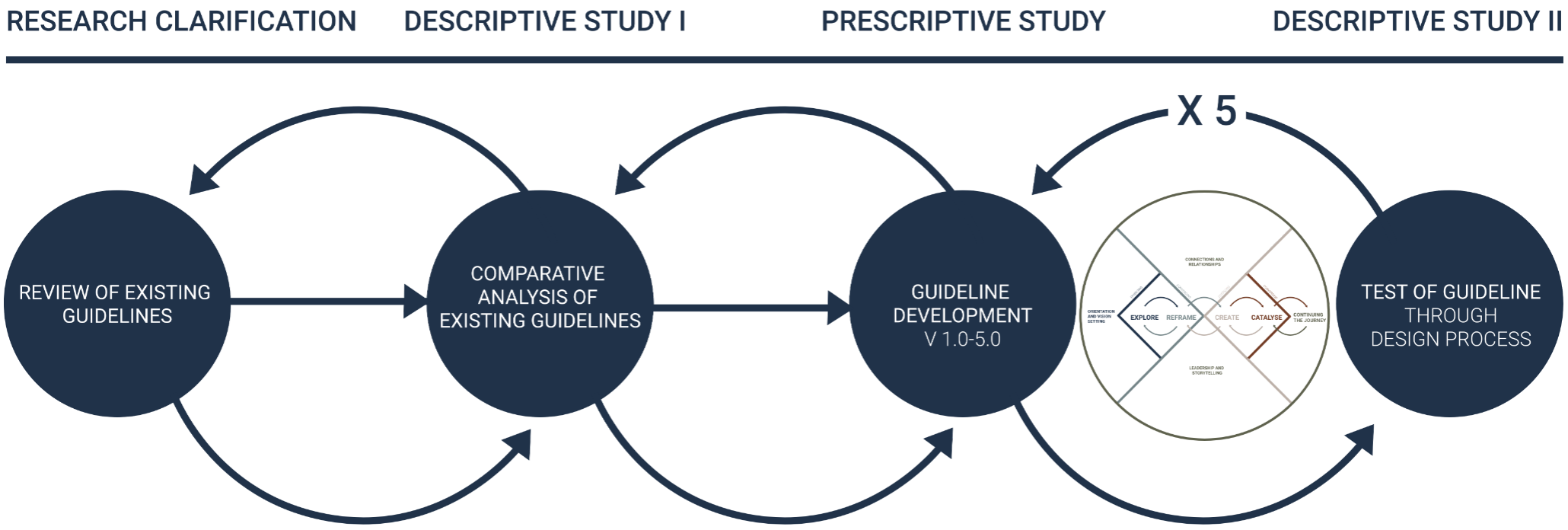

Figure 1: DRM phases and activities and the *Systemic Design Framework* of the guideline through the creation of a product/service-system startup

Research Clarification

To identify and verify the research goals of the thesis, a research clarification is performed. A systematic literature review and a literature review is conducted to investigate different guidelines proposed in the literature. The research clarification aims to examine and answer the following questions:

- *What product/service-system, circular economy, and sustainability guidelines and methods exist in the literature, and how do they contribute to the development of a startup?*
- *How is the interrelationship between the concepts of product/service-system, circular economy, and sustainability defined in the literature?*
- *What notion of the relationship between product/service-system concepts, circular economy, and sustainability should be followed throughout the project?*

The outcome of the research clarification is a representation of existing literature on guidelines for developing sustainable product/service-systems functioning as a reference for the master thesis study.

Descriptive Study I

In the descriptive study, the aim is to increase the understanding of the preliminary diagnosed problems by building on the initial reference from the research clarification. It is achieved through a comparative analysis of existing guidelines which will be done by comparing the guidelines to the *Systemic Design Framework* by (Design Council, 2021) and by examining the guidelines against created criteria to develop a product/service-system startup closing identified gaps in the literature. The outcome will highlight the topic's relevance, illustrate and point towards how to improve the situation (Blessing & Chakrabarti, 2009). The questions to be answered in the Descriptive Study I are:

- *How do product/service-system, circular economy, and sustainability guidelines and methods in literature contribute to the different phases of the revised double diamond from the Systemic Design Framework?*
- *What are the criteria for developing a guideline for startups and which of these do the guidelines and methods identified in the literature meet?*

Prescriptive Study

The prescriptive study is about building the support that can help improve the design. Elaborating on the two previous phases, there is now a clear understanding of diagnosed problems and a vision on how to solve them. In this phase, it is essential to develop explicit support that demonstrates the concept and desired situation. Therefore, the support builds upon empirical data and the understanding obtained in both the research clarification and descriptive study. The deliverables for this phase include a description of the intended design together with an introduction plan. How will the concept take form, how will it function, and a plan to introduce it, develop and maintain it (Blessing & Chakrabarti, 2009). Therefore, the Prescriptive Study will include the final guideline development created from the identified design criteria. The questions to be answered in the Prescriptive Study are:

- *What criteria should be met by methods and guidelines to be applicable in Guideline 1.0?*
- *What methods from literature and online guidelines meet these criteria and contribute to Guideline 1.0?*

Descriptive Study II

The second descriptive study is aiming at evaluating the design support. This phase is closely linked with the previous, meaning that descriptive study II will most likely run parallel with the previous prescriptive study. The outcome of the phase should be concept improvement goals and a refined and feasible introduction plan. Here it is essential to evaluate the assumptions behind the contextual layout, the influential factors, the vision, and the success criteria (Blessing & Chakrabarti, 2009).
The created guideline from the Prescriptive Study will be tested by creating a product/service-system startup. The testing will follow guideline 1.0, which follows the *Systemic Design Framework* (Design Council, 2021). Furthermore, the final tested guideline will be presented, and a decision tree will be created to ease the choice between methods when developing a startup. The questions to be answered in the Descriptive Study II are:

- *How can the methods of the guideline be tested and evaluated through a startup case study and how can the Systemic Design Framework contribute to it?*

The Systemic Design Framework

The design framework proposed in the guideline developed throughout the RC, DS I, PS, DSII phase of the DRM follows the *Systemic Design Framework (*SDF). This is a revised version of the Double Diamond framework for innovation design by the British Design Council (Design Council, 2021). The SDF aims to provide support for a more sustainable and systematic design process by following the six principles below (Design Council, 2021):

- **People and planet centered**
  Focusing on the shared benefits of all living things.
- **Zooming in and out**
  From the micro to macro, from root cause to hopeful vision, from the present to the future, from personal to more comprehensive.
- **Testing and growing**
  Making things to test how they work and help more things emerge.
- **Inclusive and welcoming difference**
  Creating safe, shared spaces and language to bring in multiple and marginalised perspectives.
- **Collaborating and connecting**
  Seeing a project as one element in the broader movement for change.
- **Circular and regenerative**
  Focus on existing assets - physical and social - and how we can reuse, nurture and grow these.

The SDF continues to follow a double diamond framework. Therefore, the process similarly involves divergent and convergent thinking and provides space and confidence to challenge the brief (Design Council, 2021).

The SDF is visualised in Figure 2 and is applicable by designers and non-designers providing a design process that recognises the interconnected, complex nature of challenges and prioritises the planet and its people (Design Council, 2021).

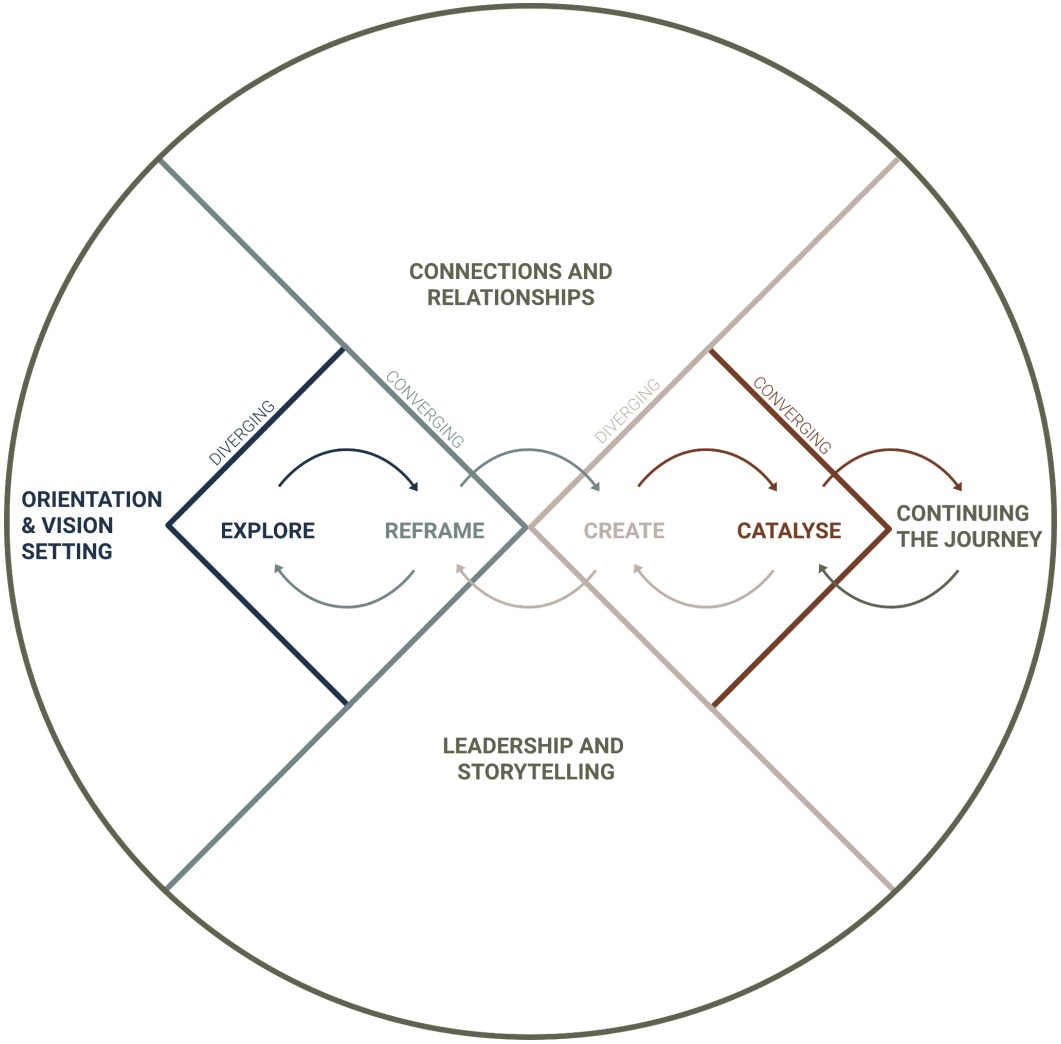

Figure 2: The SDF, a revised version of the Double Diamond framework for innovation design by the British Design Council (Design Council, 2021)

From the SDF *orientation and vision setting, connections and relationships,* and *leadership and storytelling* are used as guiding stones for developing the guideline.
Orientation and vision setting is used as a starting point of the guideline and developing the startup. It is crucial to start with a hopeful vision of a clear mission wanting to be achieved (Design Council, 2021). *Leadership and storytelling* are used throughout the project, as it is important to self-reflect and learn throughout the work. Furthermore, it has been necessary to share stories and approaches with others and work openly (Design Council, 2021). *Connections and relationships* with stakeholders have been a core step in the thesis as relationship building happens throughout the design process and is as vital as the design itself. It builds empathy around the users, stakeholders, and the environment (Design Council, 2021). Participatory design is incorporated as a mindset for engaging users throughout the startup development and designing with the users (B.-N.Sanders, 2002). Participatory workshops have been a core element of conducting empirical data throughout the study. A process of investigating, understanding, reflecting upon, establishing, developing, and supporting mutual learning between multiple users in collective 'reflection-in-action' has happened throughout the guideline development and testing (Simonsen & Robertsen, 2013)

The baby equipment and toys product/service-system startup will be developed through the five phases of the SDF. These are: *explore, reframe, create, catalyse,* and *continuing the journey.* A design team can follow the phases one by one or go back and forth between these through an iterative process (Design Council, 2021). Below is an outline of the different elements of these phases (Design Council, 2021):

- **Explore** Is about exploring the existing system. It is crucial to investigate the root cause of problems, consider what ideas and resources exist already, and develop a bold and hopeful vision of how the future could look.
- **Reframe** Is about reframing the problem in different ways to act as a springboard for new ideas. It is done by bringing users together and synthesising insight, and by identifying opportunities and challenges.
- **Create** Moves towards the goal by creating a series of different actions and ideas. It is about thinking big and adopting a circular mindset.
- **Catalyse** Shows users what a new vision looks like and feels tangibly. Here the practitioner should think about the sustainability aspects and determine the environmental and social impact of what is being developed. A narrative should be created for others to join in with their ideas.
- **Continuing the Journey** Is about reflecting on the project and considering what needs to happen next. Work is never done, and other opportunities may arise. Therefore, the outcome must be open-ended and focus on creating and sharing knowledge for future work (Design Council, 2021).

The guideline will be tested by applying this framework to the case study of developing a sustainable product/service-system startup enabling a circular economy within the baby equipment and toys market. The test is conducted throughout the DS II phase, and the guideline is evaluated and improved based on the test.

Study Process

A guide to understand the study process through the combination of the *Design Research Methodology* (DRM) and the *Systemic Design Framework (*SDF) is seen in Figure 3. The figure explains the study process including overall steps. The model can be used as a guide for reading the report

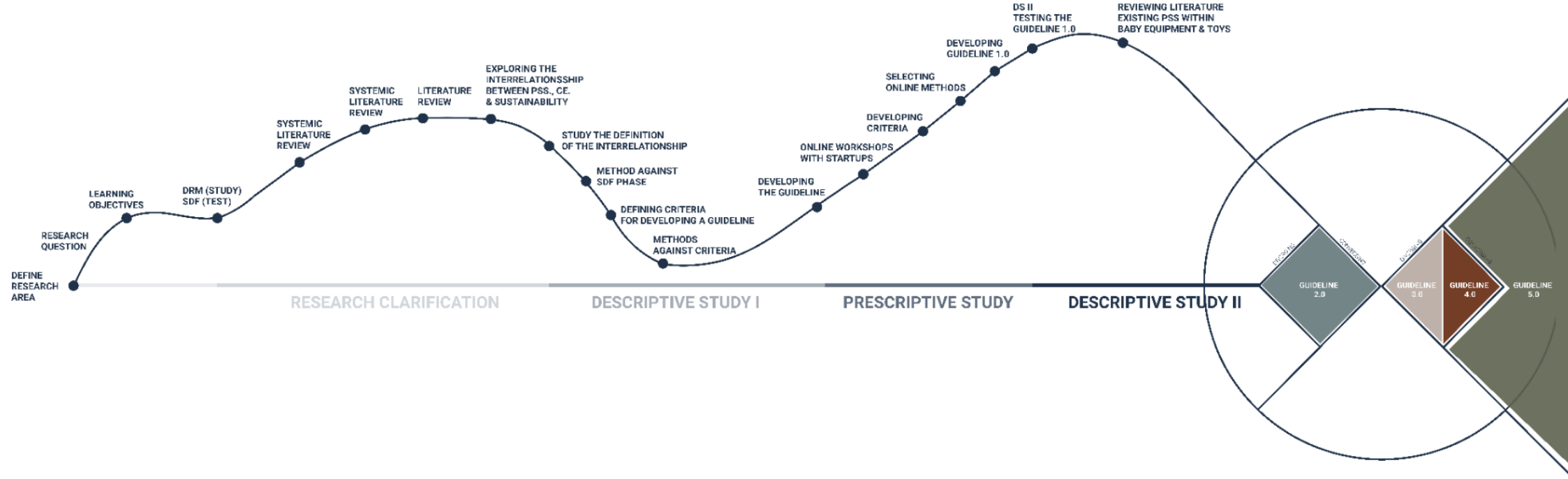

Figure 3: Study Process

Research Clarification

Preface

In the Research Clarification, a systematic literature review is performed to identify existing research related to the research question. A literature review is conducted to understand theories and methods in research associated with product/service-system, circular economy, and sustainability. Furthermore, the literature review identifies existing methods and guidelines related to product/service-system, circular economy, and sustainability aspects of a concept development process.We aim to answer these questions in the following section:

- What product/service-system, circular economy, and sustainability guidelines and methods exist in the literature, and how do they contribute to the development of a startup?
- What is the interrelationship between the concepts of product/service-system, circular economy, and sustainability defined in the literature?
- What notion of the relationship between product/service-system, circular economy, and sustainability should be followed throughout the project?

Systematic Literature Review

A systematic literature review was conducted to identify empirical evidence related to the research question: *What process and methods are needed to create a guideline that supports developing a sustainable product/service-system business model enabling a circular economy?*
The review followed three systematic literature review phases proposed by (Biolchini et al., 2005), covering the phases *Planning*, *Executing,* and *Analysis*. A systematic literature review following these phases was performed to enable replicability.

Planning Phase

In the *Planning* phase of the literature study, a list of associated search terms was developed for the areas of interest of the study. These were related to the area of a *guideline*, the area of a *startup*, and the areas of *PSS, circular economy,* and *sustainability*. The identified search terms are presented in Figure 4.

The literature study was conducted using several databases relevant to the area of study. These were *Scopus*, DTU *Findit*, and *AUB (Aalborg Library)*. The following search string was formulated:

("Guideline" OR "Guidance" OR "Framework") **AND** ("start*up" OR "SME" OR "Small and medium-sized enterprises") **AND** ("PSS" OR "Product Service System" OR "Product Service Systems" OR "Product Service Solutions" OR "Function-oriented business model" OR "Functional Sales") **AND** ("Circular Economy" OR "CE" OR "Circularity" OR "Closed loop economy") **AND** ("Sustainability" OR "Sustainable" OR "Social sustainab*" OR "Environmental sustainab*" OR "Economic sustainab*" OR "Nested sustainab*")

Execution Phase

In the execution phase of the literature study, the search string was applied to the chosen databases. The database search was performed in January 2021, and 5 articles were identified from DTU Findit, 723 articles were identified from AUB, and 432 articles were identified from Scopus.
Exclusion criteria were defined to be able to disqualify irrelevant studies. The exclusion criteria are seen in Figure 5.

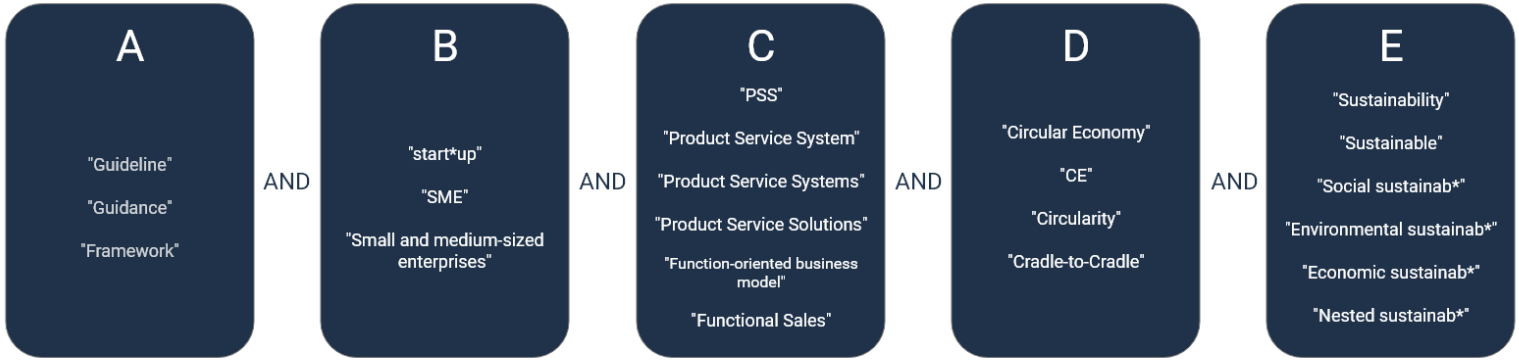

Figure 4: Search Blocks

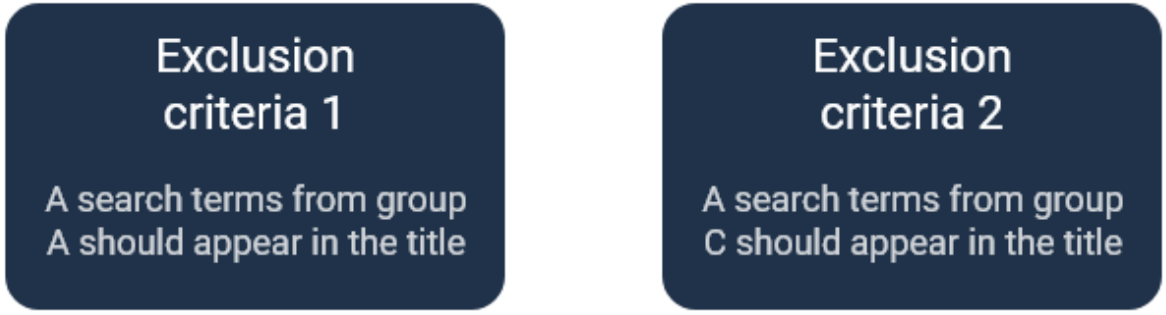

Figure 5: Exclusion criteria

As seen in Figure 6, the search string resulted in 1160 articles from the chosen databases. These articles were then screened through *selection procedure 1*. The articles that did not meet exclusion criteria 1 *'search terms from group A should appear in the title'* were excluded from the literature review. This criterion ensured that the articles identified for further study focus on developing a guideline/framework. This resulted in 67 identified articles relevant for additional screening. Exclusion criteria 2 *'search terms from group C should appear in the title'* was then applied in the screening phase. This criterion ensured that the articles identified for further study focus on developing a product/service-system. This screening resulted in 8 articles relevant for further investigation. The abstracts of the 8 identified articles were read through to assess if the eight identified articles were on the topic of guidelines for developing a sustainable product/service-system enabling a circular economy. None of the articles passed the abstract test as they lacked proposed sets of methods related to product/service-system, circular economy, and sustainability for developing a product/service-system business model targeting all phases of a development process. As a result of this, a total of 0 articles were identified in research developing a guideline for sustainable product/service-system startups enabling a circular economy.

Analysis Phase

As no research evidence was found relevant to the research question, the *analysis* phase proposed by (Biolchini et al., 2005) was not conducted.

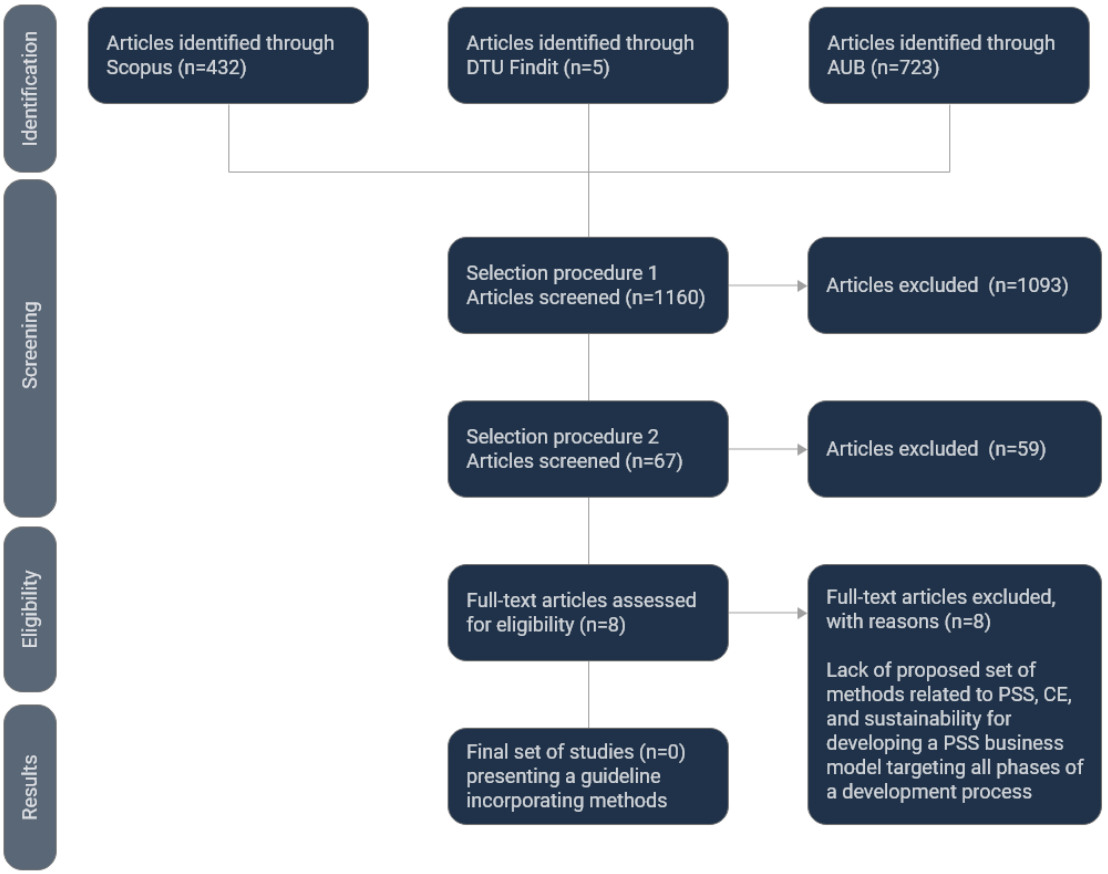

Figure 6: Literature research results at different phases.

Literature Review

A literature review was conducted to gain knowledge and summarise on research relevant to the study e.g. knowledge on theories and methods related to product/service-system, circular economy and sustainability. The collected articles provided insights to the topics from different authors point of view. Furthermore, the literature review was conducted to support the identification of a gap in the literature on guidelines for developing sustainable product/service-systems enabling a circular economy.
The literature review was not systemic in the identification of relevant literature nor in terms of how they were analysed and summarised.

To identify research relevant to the study, a protocol was developed. Headlines relevant to the study were defined in order to be able to identify search strings associated with the scope of the project. These were as followed:

1. Existing guidelines for developing product/service-system startups in the field of consumer goods
2. Strategies for developing a product/service-system
3. product/service-system, Sustainability, SDG & Rebound Effects
4. Circular economy as a concept in relation to product/service-system
5. Why consumers choose product/service-system / Consumer behavior towards product/service-system
6. Existing evaluation/validation methods for product/service-system
7. Research on baby equipment product/service-system

Associated search terms to each category were identified and a search was performed in the databases *Scopus, Findit, Springerlink, Google Scholar,* and *AUB* resulting in 74 articles potentially relevant to the study. These can be found in Appendix 1 where the *search string, the database, the result (title), a summary* and *the format* for each identified article is documented. Knowledge and theory from relevant articles identified were applied throughout the research clarification and more articles were continuously added as the appliance of relevant research has been an iterative process.

Existing Guidelines

Existing methods and guidelines

Through the literature review and sessions with supervisors and co-supervisors, different methods and guidelines supporting the development of product/service-system startups were identified. Furthermore, methods and guidelines proposed in relevant courses at DTU and AAU were applied to the overview of *Existing Methods and Guidelines. See* Table 1. 28 different methods and guidelines were identified and described with a short description to convey the potential relevance for the product/service-system startup guideline.

Table 1: Existing Methods and Guidelines

Existing Methods and Guidelines	Short Description
PSS development arena (McAloone 2011)	Six boundary conditions for a PSS development arena. Worth discussing when designing the characteristics of a PSS design and can help describe and discuss a PSS
PSS Characteristics Definition (Haase et al. 2017)	11 characteristics of PSS
Framework for analysing PSS (Mont 2004)	Analyze PSS through the elements of actor-networks and infrastructure
Hubka's Transformation Model (Matzen 2009)	Transformation system consisting of a technical process, transforming a certain operand, based upon influencing effects from different operators
Circular economy Business Model Canvas (Pieroni et al. 2019)	The Circular Economy Business Model Canvas is used to support the development of a PSS during the concept development phase. The use of the CE Business Model Canvas can be effective to summarize the main information regarding the proposed PSSs.
Standard for Social Return on Investment Analysis (SSROI) (Lingane and Olsen 2004)	Quality standard for social impact assessment based on 10 guidelines. These guidelines are relevant to any entity on which SROI analysis is performed (e.g., a business unit, project, or nonprofit organization).
Standards of Evidence for Impact Investing (Puttick and Ludlow 2012)	Approach to measuring and understanding the impact of early-stage social innovations in three different social areas based on 5 levels of progress
Sustainability Quick-Check model (SQC) (Halberstadt and Johnson 2014)	IT-supported tool for the preparation of sustainability assessments and reports
LCA clinic (Judl et al. 2015)	Approach for life cycle assessment and ecodesign in a day
SPI-Framework (Obst 2015)	Framework for identifying, measuring and reporting sustainability performance, using 15 Key SPIs. Each Key SPI indicates specific impacts, actions or efforts of an organization that allow measuring its sustainability performance on the BM level.
Triple-Bottom-Line Impact Analysis Framework of Fintech Companies (Varga 2018)	Framework for assessing the triple bottom line value creation of start-ups in the fintech industry based on three levels of progress
Lean Impact Measurement (Horne 2019)	Approach to measuring, comparing and forecasting the sustainability impact of new ventures at an early stage
Design Thinking and Business Analytics (Scherer et al. 2016)	A methodology that integrates Design Thinking and Business Analytics in the PSS design to build a profitable and lasting PSS
PSS lean design methodology (PSSLDM) (Pezzotta et al. 2018)	A structured methodology developed because of the lack of methodologies enabling the collaborative design of product and service features in an integrated way along its entire lifecycle

Cambridge Business Model Innovation Process (Geissdoerfer et al. 2017)	The Cambridge Business Model Innovation Process is a framework developed to guide organisations' business model innovation efforts and map the necessary activities and potential challenges.
DesignThinking and Sustainable Business Model Process (Geissdoerfer et al. 2016)	Bringing together 'design thinking' and 'sustainable business model innovation' to refine the creative process of developing sustainable value propositions and improve the overall business modelling process.
The Triple Layered Business Model Canvas (Joyce and Paquin 2016)	The Triple Layer Business Model Canvas (TLBMC) provides an integrative approach to support those seeking to understand existing business models and creatively explore potential sustainability-oriented business model innovations.
The Sustainable Business Model Pattern Taxonomy (Lüdeke-Freund et al. 2018)	Ten international experts participated in this process. They classified 45 SBM patterns, assigned these patterns to 11 groups along ecological, social, and economic dimensions of sustainability and evaluated their potential to contribute to value creation. The resulting taxonomy can serve as a basis for more unified and comparable studies of SBMs and for new business model tools that can be used in various disciplines and industries to analyse and develop sustainability-oriented business models in a consistent manner.
Sustainable Business Model Archetypes (Bocken et al. 2014)	Sustainable business model archetypes are introduced to describe groupings of mechanisms and solutions that may contribute to building up the business model for sustainability. The aim of these archetypes is to develop a common language that can be used to accelerate the development of sustainable business models in research and practice. The archetypes are: Maximise material and energy efficiency; Create value from 'waste'; Substitute with renewables and natural processes; Deliver functionality rather than ownership; Adopt a stewardship role; Encourage sufficiency; Re-purpose the business for society/environment; and Develop scale-up solutions.
A guide for evaluating the environmental performance of Product/Service-Systems (Kjaer et al. 2017)	This guide is intended to support the evaluation of the environmental performance of Product/Service-Systems through a six-step approach. The guide can be applied at different stages (pre- or post-implementation of the PSS) and by different stakeholders, e.g. as assistance during the design stage of a PSS or assisting decision-makers considering buying or promoting a PSS solution for environmental reasons.The purpose of the study should be to investigate improvement options from a PSS provider perspective and/or evaluate from a customer and/or societal perspective whether or not changing to a PSS will lead -or has led- to environmental improvements.
Sprint: How to Solve Big Problems and Test New Ideas in Just 5 Days (Knapp et al. 2016)	The sprint is a five-day process for answering critical business questions through design, prototyping, and testing ideas with customers.
The Doughnut Model (Raworth 2017)	New way of looking at the economy on an institutional level with a focus on social. economic and environmental sustainability. The Doughnut Model is a way to think about how to solve environmental and socio-economic challenges in a coherent and balanced way. It is a statement/communication tool.
SCRUM: The Art of Doing Twice the Work in Half the Time (Sutherland 2015)	Scrum is a framework used to address complex adaptive problems, while productively and creatively delivering products of the highest possible value.
The Field Guide to Human-Centered Design (IDEO.org 2015)	Human-centered design is about designing for people, generating ideas and creating innovative new solutions rooted in people's actual needs.
101 Design Methods (Kumar 2013)	Guidebook for successful innovation through design thinking. Approaches the practice of creating new products, services and customer experience.
Value Proposition Design (Osterwalder et al. 2014)	Value Proposition design dives into the value creating areas of the business model canvas and provides many exercises and schematics.
Decision Tree to Navigate Through PSS Typologies (McAloone and Pigosso 2018)	A decision tree to navigate through the PSS typologies defined by Tukker and Tischner.
Riskiest Assumption Canvas (McAloone and Pigosso 2020)	Identify assumptions of the PSS implementation planning.

The concepts of product/service-system, circular economy, and sustainability and their interrelationships as defined in the literature will be further investigated in the following section. This is done to understand the theoretical foundation for the guideline being developed and select a notion to follow throughout the project.

Product/Service-Systems

The Definition of Product/Service-Systems

Product/Service-Systems (PSS) is an emerging research field and practice in the industry, and through the past 15 years, the number of public articles on the subject has quadrupled (Haase et al., 2017). PSS consists of a product and a service that separately is defined as; a physical good (e.g., a computer) or a non-physical good (e.g., a piece of software) provided to the customer together with a service being an activity performed on behalf of the customer (Kjaer et al., 2017b).

As visualised by (Baines et al., 2007) in Figure 7, products have traditionally been considered separately from services, yet in recent years *servitisation* of products and the *productisation* of services have emerged. The convergence of these trends considers a product and a service as a single offering (Baines et al., 2007).

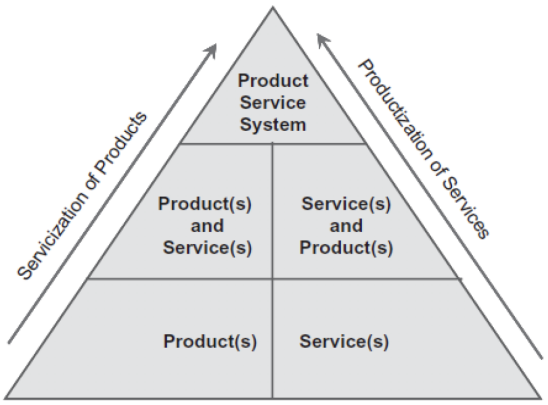

Figure 7: Evolution of the PSS concept (Baines et al., 2007)

Providing solutions to customers by integrating products and services is the root of a PSS. A PSS can, according to (Kjaer et al., 2017a) be defined as *'Product(s) and service(s) combined in a system to deliver required user functionality'*. (O. K. Mont, 2002) explains a PSS as *'a system of products, services, supporting networks and infrastructure that is designed to be: competitive, satisfy customer needs and have a lower environmental impact than traditional business models'*. (Goedkoop et al., 1999) defines a PSS as *'a marketable set of products and services capable of jointly fulfilling a user's need'*.

The Eight Types of Product/Service-Systems

It is essential to differentiate the different types of PSSs to be able to design and operate them. (Tukker & Tischner, 2017) define PSS in three overall categories encompassing eight types which can be seen in Figure 8 ((Tukker & Tischner, 2017) .

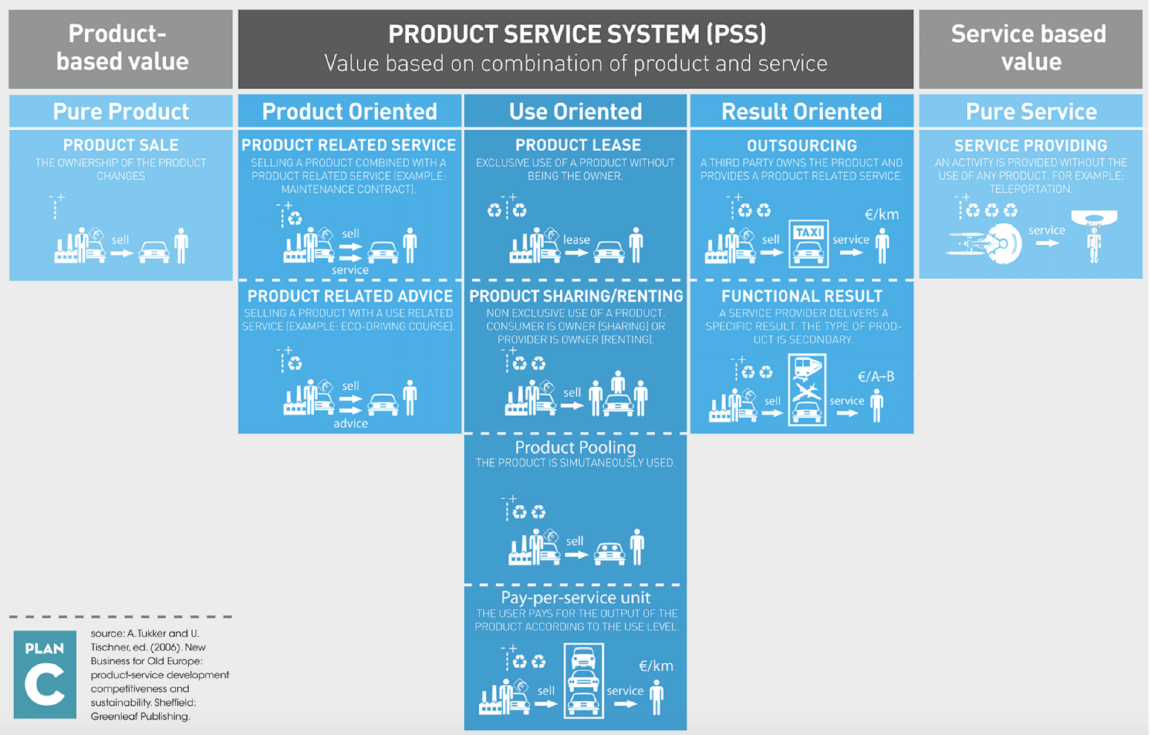

Figure 8: PSS types identified by (Tukker & Tischner, 2017)

The three types are described below.

- *A product-oriented PSS* is promoting/selling the product in a traditional manner and includes additional product-related services or advice. Examples of product-related services are after-sales services to guarantee the functionality and durability of the product, e.g. maintenance, repair, re-use, and recycling. An example of product-related *advice* could be co-driving courses offered when buying a car (Tukker & Tischner, 2017). Companies offering product-oriented PSSs want to minimise costs when using well-functioning and long-lasting products (Baines et al., 2007).

- *A use-oriented PSS* is selling the use or availability of a product that the customer does not own. Companies offering use-oriented PSSs want to extend the product life by optimising and prolonging the use of the product (Baines et al., 2007). According to (Tukker & Tischner, 2017) use-oriented PSSs can be categorised into four types. These are:
    - *Leasing* where the customer can experience an exclusive use without owning the actual product;
    - *Product sharing or renting* when the owner of the product is also the consumer, and thereby shares the product;
    - *Product pooling* where several users simultaneously use the product;
    - *Pay-per-service unit* where the customer pays according to the use.

- *Result-oriented* PSS is selling a result or capability instead of a product. There are two types of *Result Oriented* PSSs. The first type is *outsourcing* where a part of an activity of the PSS company is outsourced to a third-party and the third party owns the product and provides a product-related service. The second type is a *functional result* where the customer receives a specific outcome, and the type of product used is subordinate.

Applicability and Feasibility of Product/Service-Systems

(O. K. Mont, 2002) found three main uncertainties regarding the applicability and feasibility of PSSs. The first one is the *readiness to adopt the PSS into a company's strategic decisions*. The second one is the *readiness to accept the PSS by users*. The third one is the *environmental implications of PSSs*. The main finding from the study was that a successful PSS requires different *societal infrastructures*, *human structures,* and *organisational layouts* to function as a sustainable appearance (O. K. Mont, 2002). The challenge with PSS is developing a system solution where the pieces of the system fit together and a system solution that leads to people's satisfaction. It should be designed so that it provides a certain quality of life to the users and at the same time minimises the environmental impacts of the system (O. K. Mont, 2002).

Circular Economy

The Definition of Circular Economy

As circular economy (CE) as a concept has emerged, numerous definitions of the concept are defined in the literature. There is a lack of clarity on the meaning of *'circularity'* in practice (Kirchherr et al., 2017). The conceptual foundation of CE can be traced back to concepts like biomimicry, cradle-to-cradle, blue economy, and others (de Pádua Pieroni et al., 2018). The Ellen MacArthur Foundation is in literature seen as the author of the first prominent CE definition, which is defined as follows: *'[CE] an industrial system that is restorative or regenerative by intention and design.'* (Ellen MacArthur Foundation, 2013) cited in (Geissdoerfer, Savaget, Bocken, et al., 2017). The Ellen MacArthur Foundation depicts the definition in the Butterfly Diagram seen in Figure 9. Here components, products, and materials cycle through the economic system at their highest value at all times for as long as possible. The diagram distinguishes between a biological cycle representing products made from biodegradable materials and a technical cycle in which non-biodegradable materials are cycled. In the technical cycle, the value of products is preserved by maintaining or reusing products. In the biological cycle, the further value from materials is created by cascading them (Ellen MacArthur Foundation, 2013).

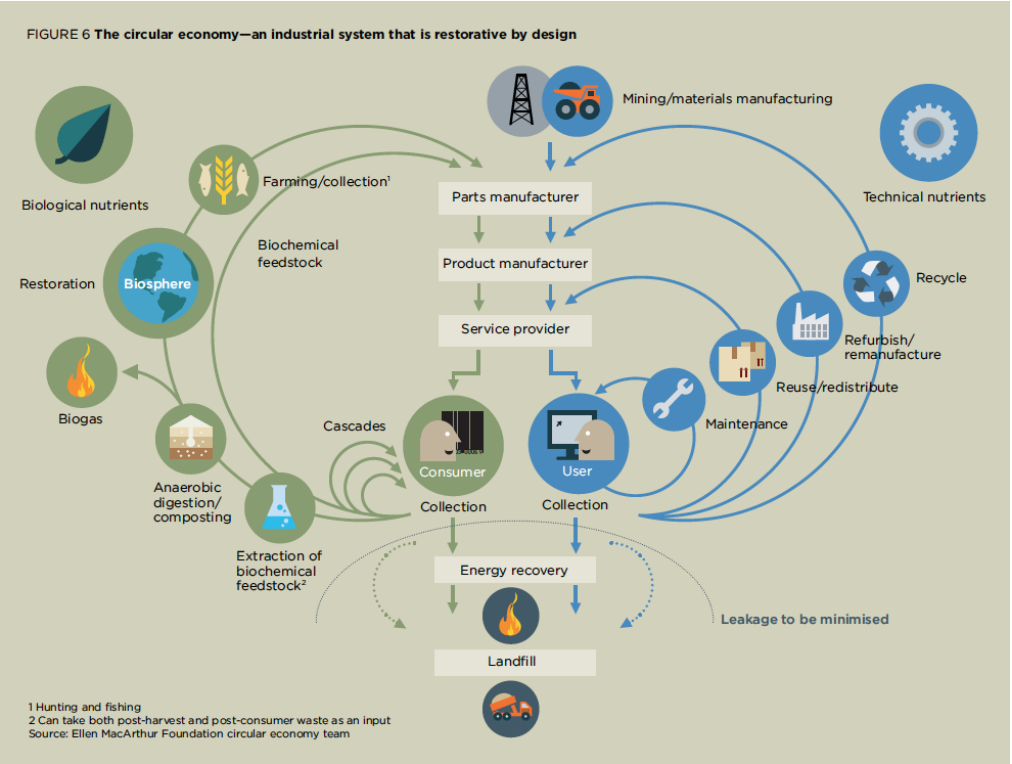

Figure 9: The Butterfly Diagram by Ellen MacArthur Foundation (Ellen MacArthur Foundation 2013)

(Blomsma & Brennan, 2017) state that the CE concept can be defined as an umbrella concept which is a '*broad concept used loosely to encompass and account for a set of diverse phenomena*' (Hirsch & Levin, 1999). CE has evolved into an umbrella concept due to the lack of a common theoretical framework since its emergence in the early 1990s (Hirsch & Levin, 1999). (Murray et al., 2017) argue that CE is a general term covering activities that embrace reducing, reusing, and recycling strategies into production, distribution, and consumption processes ((Murray et al., 2017). This definition leads to the *4R* and *3R framework* for CE, which were the most widespread definitions of CE before the year 2012. From here and after, the systems perspective on CE became the primary discourse on CE, most likely due to the definition proposed by Ellen MacArthur Foundation (Kirchherr et al., 2017). The *4R framework* stands for *reduce, reuse, recycle, and recover* where the *3R framework* encompasses *reducing, reusing, and recycling*. A more extensive R-framework is the *9Rs framework* which is depicted in Figure 10. The waste hierarchy starts from the top with the strategy with the highest circular benefit (Potting et al., 2017). Recycling is the most visible and expected component of the R-frameworks both in literature and by practitioners. Some companies are seen to merely focus on recycling which is a misunderstanding of being circular. Furthermore, it is seen that practitioners often leave out the *'reduce'* element when defining CE, most likely because reduction is viewed as hindering consumption and, thereby, economic growth. However, (Kirchherr et al., 2017) state that this can be prevented by shifting to a product-as-a-service business model.

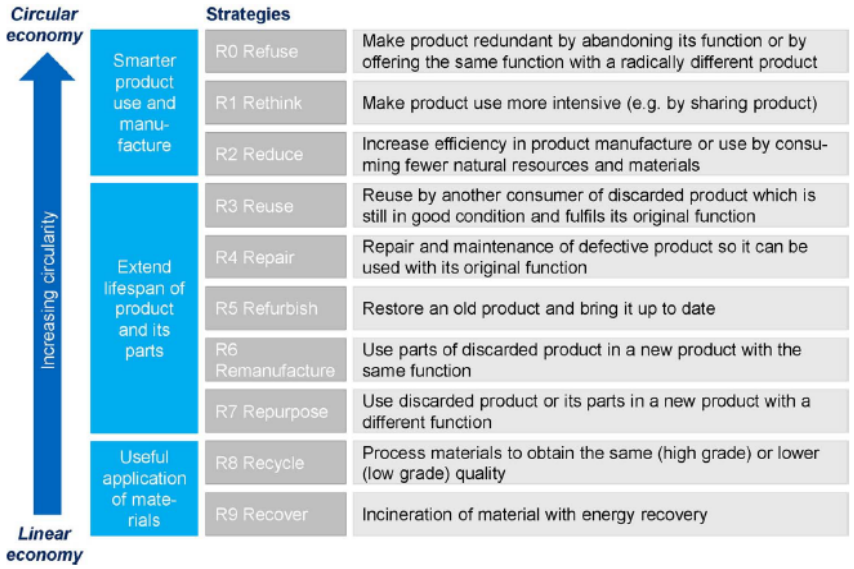

Figure 10: The 9R Framework (Potting et al. 2017)

Strategies for Achieving a Circular Economy

The concept of CE was popularised among businesses at the establishment of the Ellen MacArthur Foundation, speaking in favour of reducing the global sustainability pressure through the implementation of CE business strategies (Nancy M. P. Bocken et al., 2016).

An example of strategies for implementing CE approaches in businesses is proposed by (Nancy M. P. Bocken et al., 2016). Overall, they present two strategies for keeping resources in a loop; *slowing* resource loops and *closing* resource loops (Figure 11). Here *slowing* resource loops cover the reuse of goods while *closing* resource loops covers the recycling of materials. A third strategy, *narrowing* resource flows, urges businesses to adopt resource efficiency measures, e.g., designing products with less material use without compromising quality. This framework distinguishes between linear *'cradle-to-grave'* and circular *'cradle-to-cradle'* material flows (Nancy M. P. Bocken et al., 2016). Based on this framework, scholars propose product design and business model strategies to close or slow resource loops for designers and strategic decision-makers to use when moving towards a circular business, see Appendix 2 (Nancy M. P. Bocken et al., 2016).

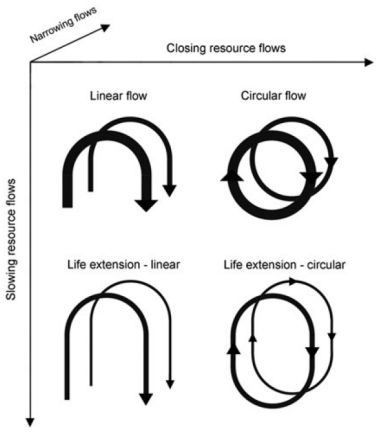

Figure 11: CE strategies for slowing, closing and narrowing resource flows (Bocken. et al. 2016)

Product/Service-Systems as Enablers of a Circular Economy

PSS business models establish a CE by applying circular strategies to one or several lifecycle stages of products and systems, Figure 12, (de Pádua Pieroni et al., 2018). (Tukker, 2015) supported this, who states that PSS business models are means of establishing *lease societies*, a *CE*, or a *resource revolution*.

Research conducted by (de Pádua Pieroni et al., 2018) discusses how different PSS business models contribute to the enabling of CE strategies considering both resource-efficient approaches (preventative) and resource-effective approaches (extending products/materials life). A trend for PSS companies is to combine resource-efficient and resource-effective CE strategies though it is seen to be competing for strategies in the literature. Result-oriented PSS solutions (especially the functional result type) are the PSS types with the highest decoupling potential as this PSS type creates the most significant incentive for companies to implement CE strategies as the resources used to deliver the result are cost factors for the companies.

The following section covers sustainability in literature to assess how it differs from a CE and how it contributes to sustainable PSSs. It is interesting to identify how the three concepts relate to each other in literature to determine any potential gaps in guidelines combining the concepts of PSSs, CE, and sustainability.

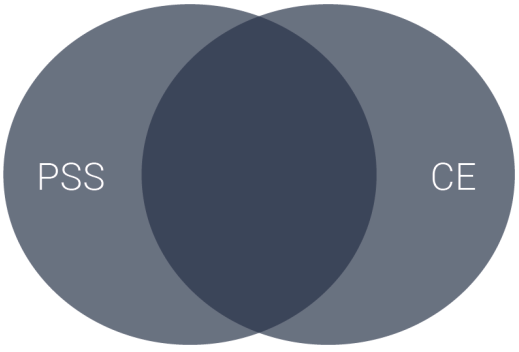

Figure 12: In literature, PSS is seen as an enabler of a CE

Sustainability

Sustainability as a Concept

The term sustainability has become prominent among politicians and practitioners in business development and organisations. Despite its increasing popularity, the notion is subjective, weakly defined, and often used to express what policies ought to achieve. It is recognised in the literature by scholars that the main inspiration of sustainability as a concept emerges from The World Commission on Environment and Development (Barnaby, 1987), commonly referred to as the *Brundtland Report*. The report implicated the conflicting aspects of human desires and eagerness in improving living standards with the limitations imposed by nature due to exploited resources. (Barnaby, 1987) defines four dimensions of sustainability namely preserving ecological long-term sustainability, fulfilling people's essential needs, and advocating equity within and across generations (Holden et al., 2014). Basic human needs are defined as *'(...) employment, food, energy, housing, water supply, sanitation, and healthcare(...)*'(Holden et al., 2014). Thus sustainability, according to the Brundtland Report, is about accommodating the essential needs of *all* human beings and enabling the opportunity to satisfy the desires for better life without compromising the long-term ecological sustainability (Barnaby, 1987). Satisfying the vital needs of a human being is viewed as the primary dimension, and the eagerness for a better life and meeting individual aspirations is considered a secondary dimension. However, desires such as striving for continuous economic growth can consequently resolve aspirational attempts besides what has been perceived as ecologically sustainable and intransigent future generations (Holden et al., 2014)

Social, Environmental, and Economic Sustainability

The three pillars have been interpreted in various ways but originally, the **people** dimension is supposed to reflect the positive and negative impacts on the well-being of humans imposed by an organisation. **Planet** concerns the impact on the environment and climate caused by an organisation. The result considered encompasses both the positive and negative impact as waste removal, restoration of the impact caused by the people, contributions to reforestation, reduction of carbon footprint, and assessment of eutrophication based on materials and measuring and governing the use of natural resources. **Profit** is about an organisation's economy and its impact on a local, national and international level. Most important is the economy's ability to create wealth, generate and cultivate innovation, and secure employment (Elkington, 1998; Kraaijenbrink, 2019). The famous 'triple bottom line' argues that sustainability is at the center of all three aspects. Therefore, the focus should rest on balancing the social, environmental, and economic aspects (Elkington, 1998; Holden, 2007). In line with this argument, the UN's agenda for Development stated that '*economic development, social development, and environmental protection are interdependent and mutually reinforcing components of sustainable development*' (United Nations, 1997).

The Triple Bottom Line concept resonated with many business people due to Elkington's presence as an entrepreneur, and it, therefore, gained success within businesses and among practitioners. What was meant as a concept for sustainable development turned into a concept of 'sustainable' businesses (Holden, 2007). Thus, the concept in modern days has been criticised by researchers. (Holden, 2007) argues that a solid economic bottom line is of significance in business. Still, economic growth in itself,

as to how the profit aspect of the three pillars is popularly interpreted today, is misleading and not considered sustainable development (Holden, 2007). (Kuhlman & Farrington, 2010) state that dividing sustainability into three dimensions contradicts the original intent of environmental safeguarding and well-being for all human beings. The importance of the environmental aspect could consequently be jeopardised and down prioritised and finally detach the social part from the economic factors by only focusing on economic activity rather than welfare. In other words, although (Elkington, 1998) brought good intentions with the concept, the practitioners who 'consumed it' by cherry-picking rather than making it a balance between the three dimensions transformed the concept into a *'(...)blanket concept to assure stakeholders of the policy's good intentions'* (Kuhlman & Farrington, 2010). The scholar behind the Triple Bottom Line concept, (Elkington, 1998) himself, agrees to much of the criticism due to misinterpretations and misuse of the concept. For those reasons, he decided to recall it in the Harvard Business Review on its 25th anniversary. He proclaimed the Triple Bottom Line was designed to provoke our capitalistic paradigm and transition into a new tomorrow with disruption and breakthrough change. According to (Elkington, 2018) the Triple Bottom Line is not an accounting tool, and the economic dimension is not just financial. Existing sustainable frameworks are only as good as the pace and scale and what is really needed is '(...) to stop us all overshooting our planetary boundaries' ((Elkington, 1998).

Returning to 'Old' Thoughts of Sustainability

Instead of applying the misleading interpretations of the Triple Bottom Line framework, scholars suggest that we should return to the original meaning of sustainability. This covers practicing and governing sustainable development by meeting the four dimensions defined by the Brundtland Report in 1987 as *'(...) safeguarding long-term ecological sustainability, satisfying basic needs, and promoting intragenerational and intergenerational equity'* ((Barnaby, 1987). According to (Kuhlman & Farrington, 2010) is *'(...)where sustainability is concerned with the well-being of future generations and in particular with irreplaceable natural resources—as opposed to the gratification of present needs, which we call well-being.'* To accomplish such, (Holden et al., 2014) propose to keep the countries responsible for their actions and have them assessed by a designed assessment tool and in that way keep institutions and organisations accountable for meeting the four primary dimensions of sustainability (Holden et al., 2014). The sustainability challenges then remain *'(...) how to reconcile one goal, 'development' with another 'sustainability'. The two goals are often in tension*' ((Barnaby, 1987) cited in (Kuhlman & Farrington, 2010)).

(Giddings et al., 2002) argue that the intersection between environment, society, and economy is conceived of as separate, although connected entities are not unified entities. The environment, society, and economy are instead interconnected with the economy dependent on society and the environment while human existence and society are dependent on and within the environment (Giddings et al., 2002). The *Nested Model*, Figure 13, rather than the three-ring model, encourages a conceptual outlook sympathetic to integration (Giddings et al., 2002).

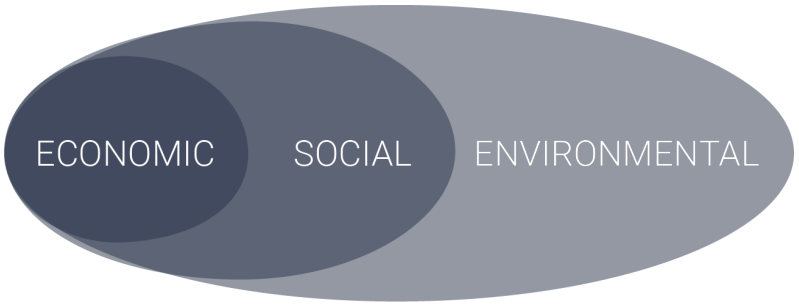

Figure 13: Nested sustainable development - the economy dependent on both societal and environmental sustainability

The Relation Between Sustainability and Circular Economy in Literature

CE is a way of achieving sustainability and sustainable development in companies and organisations. However, the definition of sustainability is not clearly described in CE-related literature (Geissdoerfer, Savaget, Bocken, et al., 2017). A holistic view approach to sustainability often lacks in literature, meaning that one or more of the three sustainability dimensions is often excluded from the definition. Economic prosperity is the most prominent sustainability dimension in CE, followed by environmental quality (Elkington, 1998). The impact of CE on social equity is greatly missing in the research field (Kirchherr et al., 2017); (Ellen MacArthur Foundation, 2015). This tendency found in the literature on the relation between CE and sustainability is visualised in Figure 14. Here it is seen that CE most often focuses on the economic and environmental sustainability aspects while the focus on social sustainability is missing in the literature.

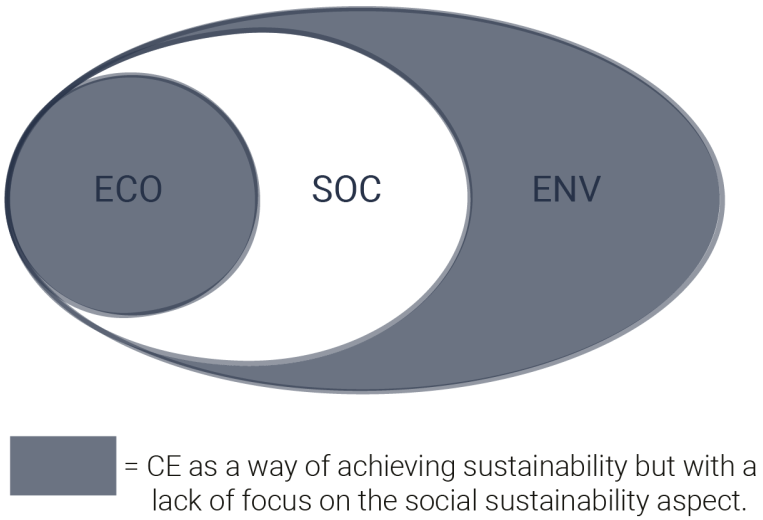

Figure 14: The relation between CE and sustainability in literature

(Geissdoerfer, Savaget, Bocken, et al., 2017) have conducted a literature review highlighting CE and sustainability differences and similarities. Selected main differences are seen in Table 2 (Geissdoerfer, Savaget, Bocken, et al., 2017). An example is the motivation behind CE and sustainability. In contrast, sustainability aspires to meet the three dimensions of sustainability equally holistically. The primary motivation of CE depends on the economic stakeholder responsible for the implementation of a CE system (Elkington, 1998; Geissdoerfer, Savaget, Bocken, et al., 2017).

Table 2: Selected differences between sustainability and circular economy (Geissdoerfer et al. 2017)

Selected differences between sustainability and the Circular Economy.

	Sustainability	Circular Economy
Origins of the term	Environmental movements, NGOs, non-profit and intergovernmental agencies, principles in silviculture and cooperative systems	Different schools of thought like cradle-to-cradle, regulatory implementation by governments, lobbying by NGOs like the EMF, inclusion in political agendas, e.g. European Horizon 2020
Goals	Open-ended, multitude of goals depending on the considered agent and her interests	Closed loop, ideally eliminating all resource input into and leakage out of the system
Main motivation	Diffused and diverse reflexivity and adaptive→ past trajectories	Better use of resources, waste, leakage (from linear to circular)
What system is prioritised?	Triple bottom line (horizontal)	The economic system (hierarchical)
To whose benefit?	The environment, the economy, and society at large.	Economic actors are at the core, benefitting the economy and the environment. Society benefits from environmental improvements and certain add-ons and assumptions, like more manual labour or fairer taxation
How did they institutionalise (wide diffusion)?	Providing vague framing that can be adapted to different contexts and aspirations.	Emphasising economic and environmental benefits
Agency (Who influences? Who should influence?)	Diffused (priorities should be defined by all stakeholders)	Governments, companies, NGOs
Timeframe of changes	Open-ended, sustain current status “indefinitely”	Theoretical limits to optimisation and practical ones to implementation could set input and leakage thresholds for the successful conclusion of the implementation of a Circular Economy
Perceptions of responsibilities	Responsibilities are shared, but not clearly defined	Private business and regulators/policymakers
Commitments, goals, and interests behind the use of the term	Interest alignment between stakeholders, e.g. less waste is good for the environment, organisational profits, and consumer prices	Economic/financial advantages for companies, and less resource consumption and pollution for the environment

The Relation Between Sustainability and Product/Service-System in the Literature

Throughout the establishment of PSSs, it was assumed that by shifting from selling products to offering integrated solutions, PSSs could reduce the environmental impact. At the same time, it maintains economic competitiveness and contributes to a positive social sustainability development (de Jesus Pacheco et al., 2019). However, it is seen that research within the field of development and implementation of PSSs often takes for granted that PSSs have the potential to embed all three sustainability dimensions into PSS business models (Barquet et al., 2016). Additionally, several leading researchers within the field of sustainable PSSs have recently concluded that PSSs are not necessarily more environmentally sustainable compared to traditional product offers (Medini & Boucher, 2016; Pigosso & McAloone, 2016). PSSs can even have a worse environmental impact and only encompass economic benefits (Barquet et al., 2016; de Jesus Pacheco et al., 2019; Tukker, 2015) .
As a response to this discourse, the term sustainable Product/Service-Systems (SPSS) has gained more interest from scholars (de Jesus Pacheco et al., 2019). SPSS is defined as '*an offer model providing an integrated mix of products and services...where the economic and competitive interest of the providers continuously seeks environmentally and socio-ethically beneficial new solutions' (Bacchetti et al., 2016)*. Based on this definition the SPSS business model has the potential to include benefits related to all sustainability dimensions of the Nested *Model* sustainability perspective as visualised in Figure 15 (Giddings et al., 2002).

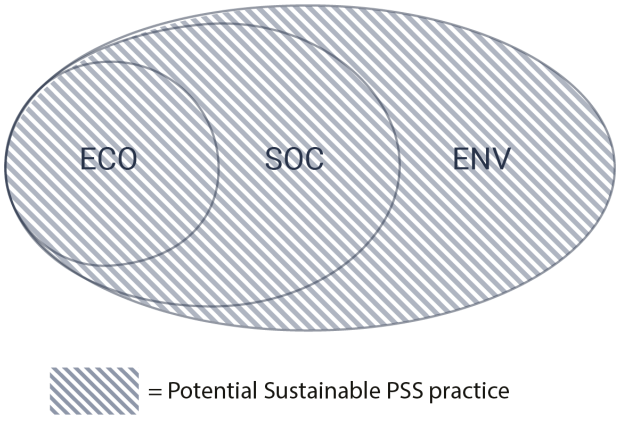

Figure 15: The relation between sustainability and PSSs in literature

Environmental Sustainability and Product/Service-Systems

PSSs are in literature seen as business models that can be more environmentally sustainable than traditional business models (Tukker & Tischner, 2006). However, the environmental performance depends on the type of PSS (Tukker, 2004). (Tukker, 2004) has evaluated the environmental potential of the eight different types of PSSs. They divide the environmental performance of PSSs into three impact categories; (i) incremental reductions (10-20%), (ii) considerable reductions (up to 50% or factor 2), and (iii) radical reductions (up to 90% or factor 10). The potential environmental characteristics of each PSS type are listed in the table below (Table 3).

Table 3: Environmental characteristics of sustainability of the eight types of PSS (Tukker 2004)

Product Oriented	Use Oriented	Result oriented
Product-related service ● It does not lead to change in the technological system or change the use behaviour of customers. ● Providers do not have an incentive to optimise the life cycle costs of products. ● Improved maintenance or established take-back systems can potentially lead to incremental impact reductions.	**Product lease** ● The provider is responsible for maintenance and repair potentially leading to longer product life and more efficient energy use. ● If the provider produces the product, the provider may have an incentive to design the products for longer product life. ● There is no economic incentive for the provider or the user to minimise the product's energy use throughout the use phase. ● Risk of careless use of products.	**Outsourcing** ● In outsourcing PSS, the product or the service includes a third party. ● There might be more providers, but the result received remains more or less the same. ● Outsourcing products and services usually lead to incremental environmental improvements.
Product related advice ● Similar to that for product-related service ● Advice on optimised use of products can result in incremental impact reductions.	**Product sharing/renting** ● Potential for high impact reductions as products is more intensively used. ● This PSS can lead to less-use situations and the use of more environmentally friendly alternatives. ● Risk of careless use of products.	**Functional result** ● PSS has the most significant potential for a radical impact reduction as the provider controls the means to meet the user needs. The PSS provider can choose to develop and offer systems with low impact.
	Product pooling ● Similar to that for product sharing/renting ● Potential for more impact reductions if the emissions are related to the use phase as products are being used simultaneously by several users.	
	Pay-per-service unit ● Providers of this type of PSS has a big incentive to optimise the design and use of the product throughout the entire product life cycle (e.g., reuse of components/products) ● Users might be prone to use the product/service more consciously as they pay per unit use.	

The differences in environmental performance are translated into a tentative assessment of the environmental sustainability potential for each of the eight types of PSSs (Figure 16). The different PSS types are compared to their reference situation and assessed on a scale from 'worse' to 'radical reduction (<90%)' (Tukker, 2004).

PSS type	Impacts compared to reference situation (product)				
	Worse	Equal	Incremental reduction (<20%)	Considerable reduction (<50%)	Radical reduction (<90%)
1. Product-related service		←----------→			
2. Advice and consultancy		←----------→			
3. Product lease	←----------→				
4. Product renting and sharing		←----------→			
5. Product pooling		←----------→			
6. Activity management		←----------→			
7. Pay per unit use		←----------→			
8. Functional result		←----------→			

Notes:
- Renting, sharing: radically better if impact related to product production.
- Pooling: additional reductions compared with sharing/renting if impacts related to the use phase.
- Renting, sharing, pooling: even higher if the system leads to no-use behaviour.

Figure 16: Tentative assessment of the environmental sustainability characteristics of the eight types of PSS

Tukker, (2004) concluded that the PSS types *product renting and sharing*, *product pooling*, and *functional results* are the business models with the highest potential for improving environmental sustainability compared to the reference situation.

Rebound Effects

When assessing the environmental impact of a PSS, it is essential to address the effects to the system caused by rebound effects. Rebound effects occur when improved efficiency causes increased consumption of products and services despite sustainable efforts. Rebound effects can have both a negative and positive impact on the environment but are mostly seen as unwanted effects on a system (Kjaer et al., 2019).

Rebound effects occur when scarce resources are released or bound due to the implementation of a PSS (Bo et al., 2008). Scarce resource factors are:

- Time: When the PSS is more or less time-consuming than the current technology.
- Money: When the PSS is more or less costly than the current technology.
- Space: When the PSS takes up more or less space than the current technology.
- Technology: When the PSS influences the availability of specific technologies or raw materials.

There are three types of rebound effects that can occur in a PSS. These are direct rebounds, indirect rebounds, and economy-wide rebounds (Sorrell, 2007). Direct rebound effects arise when a system implementation aims to improve energy or material efficiency, but the energy or material consumption is not reduced. Indirect rebound effects occur when users spend economic resources saved due to the use of PSSs offered on other energy-intensive products and services. Economic-wide rebound effects occur when resource efficiency results in cheaper goods throughout the economy, leading to increased use of goods and resources for the economy (Sorrell, 2007).

The Relationship Between Product/Service-Systems, Circular Economy and Sustainability in Literature

Several gaps in the bridging between these concepts were identified in the literature through the literature research on the relationships between *PSS & sustainability* and *CE & sustainability*.
The exploration of the relationship between PSS and sustainability showed that research within the field of development and implementation of PSSs often takes for granted that PSSs have the potential to cover all aspects of sustainability and that there is a lack of focus on the three sustainability aspects as interconnected as seen in the *Nested Model* (Barquet et al., 2016; Giddings et al., 2002).
The research in the literature on the relationship between CE and sustainability showed that sustainability is vaguely defined in CE related literature and that CE in literature often lacks a focus on the social sustainability aspect (Elkington, 1998; Ellen MacArthur Foundation, 2015; Geissdoerfer, Savaget, Bocken, et al., 2017; Kirchherr et al., 2017).
Figure 17 visually depicts the understanding mentioned above of the relationships between PSS & sustainability and between CE & sustainability in the literature in one combined model.

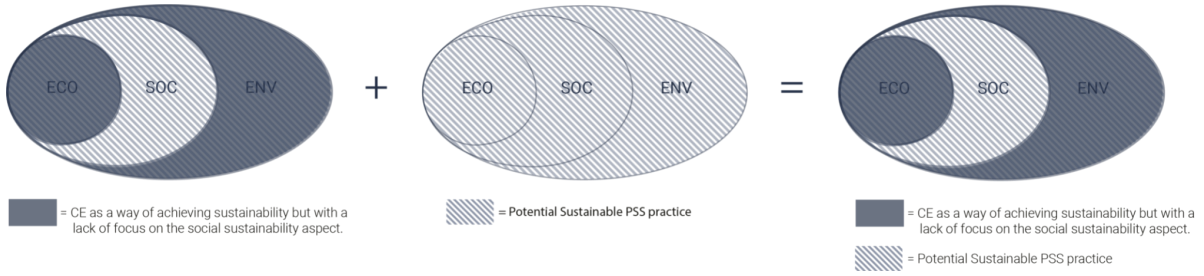

Figure 17: There is a lack of focus on social sustainability in CE and PSSs, covering all aspects of sustainability for granted. This shows a gap in the literature on research combining the concepts of PSSs, CE, and sustainability

(Blüher et al., 2020) support these statements on missing links between PSS & sustainability and CE & sustainability. They argue that PSSs are often incorrectly presented as inherently sustainable business models in practice based on the argument that PSSs are enablers of a CE by implementing CE characteristics to PSS business models.
Furthermore, they conclude based on an analysis of 62 papers that reported sustainability impacts caused by the implementation of PSSs are mainly assessed as positive impacts to the system in the literature. These were particularly ecological benefits and cost-saving benefits, thus positive impacts related to environmental and economic sustainability. Based on this analysis, they conclude that there is a lack of focus and assessment of social impacts on the system.
Finally, (Blüher et al., 2020)) conclude that sustainability effects to PSSs should be considered from a holistic point of view by considering both economic, social, and environmental impacts to the system when developing a PSS that enables a CE.

Development of a Guideline Closing the Gap in Literature

An investigation on the definitions of the interrelationship between the concepts PSS, CE, and sustainability in the literature was conducted. Here, one or more aspects of sustainability are often neglected in the literature on PSSs and CE. There is an apparent lack of a generic definition of the interrelationship between the three concepts. The definition of the interrelationship between the concepts *PSS*, *CE,* and *sustainability* followed throughout this project is defined as:

> *A PSS should enable a CE and be both economic, social, and environmental sustainable - economic, social, and environmental sustainability should be perceived as co-dependent in terms of the economic sustainability being a subset of the social sustainability and the social sustainability being a subset of environmental sustainability.*

Figure 18 illustrates the interrelationship between PSS, CE, and sustainability that the guideline being developed throughout this study should follow. The guideline will close the identified gap in the literature on lacking guidelines that support the development of a sustainable PSS startup enabling a CE.

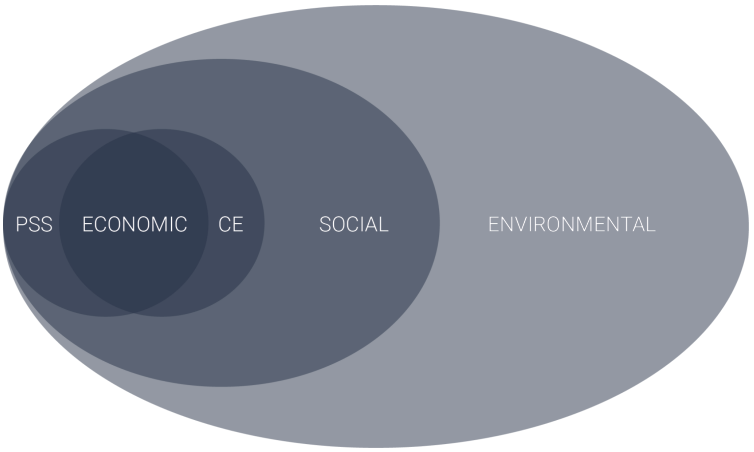

Figure 18: PSS startups following the guideline will be enablers of a CE and incorporate social, environmental and economic sustainability practice

Concluding notes on the Research Clarification

- *What product/service-system, circular economy, and sustainability guidelines and methods exist in the literature, and how do they contribute to the development of a startup?*

Throughout the research clarification, it was found that a PSS startup's success in the market and its competitive advantages are highly dependent on the environmental and social strategies decided on in the early phases of the startup development (Sassanelli et al., 2015); (Barquet et al., 2016; Scherer et al., 2016) Despite this, ((Scherer et al., 2016); (Barquet et al., 2016; de Jesus Pacheco et al., 2019) argue that there are few guidelines in the literature gathering methods for developing economic, social, and environmentally sustainable PSS startups that enable a CE.
A literature search was conducted on existing guidelines and methods in literature contributing to the development of a sustainable PSS enabling a CE. 28 relevant methods were identified, and the potential contribution of each method to the topic was formulated.

- *How is the interrelationship between the concepts of product/service-system, circular economy, and sustainability defined in the literature?*

An exploration of the definitions of PSS, CE, and sustainability and their interrelationship in literature was carried out. This showed that PSSs are clearly defined as means of establishing a CE by applying circular strategies to PSS life cycle stages of products and systems (de Pádua Pieroni et al., 2018; Tukker, 2015). Furthermore, it was uncovered that the social sustainability aspect is greatly missing in the research field of CE (Ellen MacArthur Foundation, 2015; Geissdoerfer, Savaget, Bocken, et al., 2017; Kirchherr et al., 2017). Finally, it showed that PSSs have the potential to reduce impacts across all three sustainability aspects. Thus, this potential is often taken for granted in research within the field of PSS development and implementation (Barquet et al., 2016; de Jesus Pacheco et al., 2019).

- *What notion of the relationship between product/service-system concepts, circular economy, and sustainability should be followed throughout the project?*

Based on the research clarification, a definition of the interrelationship between the concepts PSS, CE, and sustainability followed throughout this project was defined;

A PSS should contribute to enable a CE and be both economic, social, and environmental sustainable - economic, social, and environmental sustainability should be perceived as co-dependent in terms of the economic sustainability being a subset of the social sustainability and the social sustainability being a subset of environmental sustainability.

Descriptive Study I

Preface

A review of the literature was conducted on existing guidelines and methods for developing *sustainable business models* and guidelines and methods for incorporating *CE strategies.* In the DS I, the aim is to increase the understanding of the findings from the research clarification which will be achieved through a comparative analysis of existing guidelines.

As written in the methodology section, the startup guideline will be created around the SDF and, more specifically, the four phases *explore & reframe, create, catalyse,* and *continuing the journey*. The comparative analysis will be of the 28 different methods and guidelines identified and reviewed in the research clarification. The results of the DS I will be an analysis of each of the methods and guidelines assessing how and if they bring value to the SDF phases (Design Council, 2021).

Additionally, the 28 different methods and guidelines will be evaluated against defined criteria for developing a guideline. Startups following the guideline should meet the criteria of developing a **sustainable PSS startup** that **focuses on all three sustainability dimensions** and **incorporates several CE strategies**. To build on research from other scholars, the criteria were used to assess whether the 28 identified methods and guidelines could potentially contribute to developing a guideline for PSS startups.

We aim to answer these questions in the following section:

- *How do PSS, CE, and sustainability guidelines and methods in literature contribute to the different phases of the revised double diamond from the Systemic Design Framework?*
- *What are the criteria for developing a guideline for startups and which of these do the guidelines and methods identified in the literature meet?*

The Systemic Design Framework

Each method and guideline were analysed and each step of a method was described with a short description and key takeaways and placed within the phase of the SDF of which it served the most value, see Appendix 3 (Design Council, 2021). The description of the steps of each method is marked with an 'x' to give a quick overview of the phases they contribute to in Table 4. The marked 'x' in the table illustrates that it contributes to a SDF phase but it is not necessarily sufficient enough for the entire phase.

The two phases *Explore & Reframe* could be conducted separately but are combined into one phase in this project to converge and diverge the problem space in an iterative process. As seen in Table 4 , only a few guidelines from the literature cover all phases of the process of the SDF. Moreover, the ones covering all phases often lack clear and detailed descriptions of each method guiding the startup practitioner in applying the method, e.g., no template provided or vaguely defined. For example, it is seen that methods often state that the practitioner should 'measure the unsustainable impact of the project', but it is not clearly defined *how* to measure the impact or *how* the authors *define sustainability*. Furthermore, the method or guideline might bring some value to a phase of the SDF but might not be adequate to meet the aims of the specific phase. Additionally, the identified methods often only focus on one aspect of the design development process e.g., sustainability, user insights.
This analysis of existing methods and guidelines support that there is a lack of support for developing sustainable PSSs that enable a CE.

Table 4: How the existing methods and guidelines contribute to the SDF phases

Existing methods/guidelines for developing PSS Startup	Explore & Reframe	Create	Catalyse	Continuing the Journey
	SDF phases supported by the method/guideline			
PSS development arena (McAloone 2011)		x		
PSS Characteristics Definition (Haase et al. 2017)		x		
Framework for analysing PSS (Mont 2004)		x		
Hubka's Transformation Model (Matzen 2009)		x		
Circular economy Business Model Canvas (Pieroni et al. 2019)		x		
Standard for Social Return on Investment Analysis (SSROI) (Lingane and Olsen 2004)				x
Standards of Evidence for Impact Investing (Puttick and Ludlow 2012)	x	x		x
Sustainability Quick-Check model (SQC) (Halberstadt and Johnson 2014)		x		
LCA clinic (Judl et al. 2015)	x	x		x
SPI-Framework (Obst 2015)		x		
Triple-Bottom-Line Impact Analysis Framework of Fintech Companies (Varga 2018)		x		
Lean Impact Measurement (Horne 2019)		x		
Design Thinking and Business Analytics (Scherer et al. 2016)	x	x	x	x
PSS lean design methodology (PSSLDM) (Pezzotta et al. 2018)	x	x	x	x
Cambridge Business Model Innovation Process (Geissdoerfer et al. 2017)	x	x	x	x
DesignThinking and Sustainable Business Model Process (Geissdoerfer et al. 2016)	x	x	x	x
The Triple Layered Business Model Canvas (Joyce and Paquin 2016)		x		
The Sustainable Business Model Pattern Taxonomy (Lüdeke-Freund et al. 2018)		x		
Sustainable Business Model Archetypes (Bocken et al. 2014)		x		
A guide for evaluating the environmental performance of Product/Service-Systems (Kjaer et al. 2017)		x		x
Sprint: How to Solve Big Problems and Test New Ideas in Just 5 Days (Knapp et al. 2016)	x	x	x	x
The Doughnut Model (Raworth 2017)		x		
SCRUM: The Art of Doing Twice the Work in Half the Time (Sutherland 2015)	x	x	x	x
The Field Guide to Human-Centered Design (IDEO.org 2015)	x	x	x	x
101 Design Methods (Kumar 2013)	x	x	x	x
Value Proposition Design (Osterwalder et al. 2014)	x	x	x	x
Decision Tree to Navigate Through PSS Typologies (McAloone and Pigosso 2018)		x	x	
Riskiest Assumption Canvas (McAloone and Pigosso 2020)				x

Criteria for Developing a Guideline

Criteria were defined to ensure that practitioners applying the guideline can develop a sustainable PSS enabling a CE. The guideline criteria ensure that the individual practitioner is not responsible for navigating between the various methods and guidelines within the field of sustainability, CE, and PSS development. These are called '**Criteria for Developing a Guideline**' and were defined as follows:

1) The guideline should be applicable by startups/SMEs.
2) The guideline should be applicable by large companies.
3) The guideline tools should cover the entire process of developing a startup.
4) The guideline tools should cover the entire process of developing a PSS.
5) The guideline should support the development of economically sustainable PSSs.
6) The guideline should support the development of socially sustainable PSSs.
7) The guideline should support the development of environmentally sustainable PSSs.
8) The guideline should be a framework for developing PSSs enabling a circular economy.

The methods and guidelines from the 'Existing Methods and Guidelines' overview (Appendix 3) were then evaluated against the **Criteria for Developing a Guideline**, see Table 5. This was done to support the statement that there is 'a clear gap in the literature on a guideline supporting the development of an economic, social, and environmental sustainable PSS startup that enables a CE' (Barquet et al., 2016; de Jesus Pacheco et al., 2019; Scherer et al., 2016) and to support the statement that 'existing guidelines for developing a PSS are often relevant to large companies and not applicable by startups/SMEs (de Jesus Pacheco et al., 2019). If a method/guideline meets the criteria, the cell is marked with an 'x'.

Table 5: Evaluation of existing methods and guidelines against the criteria for developing a guideline.

Guidelines/methods for developing PSS Startup	Methods applicable for start-ups/SME's	Methods applicable for large companies	Guideline tool for developing a start-up	Guideline tool for a developing a PSS	Focus on sustainability			Focus on circular economy
					Economic	Social	Environmental	
PSS development arena (McAloone 2011)	x	x						
PSS Characteristics Definition (Haase et al. 2017)	x	x					x	
Framework for analysing PSS (Mont 2004)	x	x					x	
Hubka's Transformation Model (Matzen 2009)	x	x						
Circular economy Business Model Canvas (Pieroni et al. 2019)	x	x			x		x	x
Standard for Social Return on Investment Analysis (SSROI) (Lingane and Olsen 2004)	x				x	x		
Standards of Evidence for Impact Investing (Puttick	x	x			x	x		

and Ludlow 2012)								
Sustainability Quick-Check model (SQC) (Halberstadt and Johnson 2014)	x	x				x	x	
LCA clinic (Judl et al. 2015)	x	x				x	x	
SPI-Framework (Obst 2015)	x				x	x	x	
Triple-Bottom-Line Impact Analysis Framework of Fintech Companies (Varga 2018)	x				x		x	
Lean Impact Measurement (Horne 2019)	x				x	x	x	
Design Thinking and Business Analytics (Scherer et al. 2016)	x	x		x				
PSS lean design methodology (PSSLDM) (Pezzotta et al. 2018)	x	x	x	x			x	
Cambridge Business Model Innovation Process (Geissdoerfer et al. 2017)	x	x	x					
DesignThinking and Sustainable Business Model Process (Geissdoerfer et al. 2016)	x	x	x					
The Triple Layered Business Model Canvas (Joyce and Paquin 2016)	x	x			x	x	x	
The Sustainable Business Model Pattern Taxonomy (Lüdeke-Freund et al. 2018)	x	x			x	x	x	x
Sustainable Business Model Archetypes (Bocken et al. 2014)	x	x		x	x	x	x	
A guide for evaluating the environmental performance of Product/Service-Systems (Kjaer et al. 2017)	x	x		x			x	
Sprint: How to Solve Big Problems and Test New Ideas in Just 5 Days (Knapp et al. 2016)	x	x						
The Doughnut Model (Raworth 2017)	x	x			x	x	x	

SCRUM: The Art of Doing Twice the Work in Half the Time (Sutherland 2015)	x	x						
The Field Guide to Human-Centered Design (IDEO.org 2015)	x	x				x		
101 Design Methods (Kumar 2013)	x	x						
Value Proposition Design (Osterwalder et al. 2014)	x	x	x		x			
Decision Tree to Navigate Through PSS Typologies (McAloone and Pigosso 2018)	x	x		x				
Riskiest Assumption Canvas (McAloone and Pigosso 2020)	x	x		x				

Only five guidelines meet the criteria of being a guideline tool for developing a startup. Only four guidelines meet the criteria of being a guideline tool for developing a PSS. The assessment also shows that most guidelines/methods focus on either social, economic, or environmental sustainability and therefore only a few guidelines/methods incorporate all three sustainability aspects. Additionally, when looking into each method and guideline comprising sustainability aspects it is seen that the sustainability term tends to be vaguely defined. The same tendency is found for the CE term making it difficult for practitioners with a non-design and/or engineering background to apply sustainability and CE methods throughout the development of a startup.
Based on this evaluation of the existing methods and guidelines against criteria, it is concluded that there is a clear need for a guideline for developing sustainable PSS startups enabling a CE as none of the methods or guidelines meet all criteria.

Concluding notes on the Descriptive Study I

- *How do product/service-system, circular economy, and sustainability guidelines and methods in literature contribute to the different phases of the revised double diamond from the Systemic Design Framework?*

A table was made to assess whether the identified methods and guidelines contribute to the different phases of the SDF (Design Council, 2021). The evaluation clearly showed that few guidelines from the literature covered all the phases. However, the screening of existing methods and guidelines showed that there are elements that potentially could add value to each phase of the development process of a PSS startup. Finally, it was found that although the many existing methods could potentially add value, it is difficult for practitioners to navigate between these as they are not combined in one framework. This leaves the practitioner to assess the relevance of methods in the areas of PSS, CE, and sustainability.

- *What are the criteria for developing a guideline for startups and which of these do the guidelines and methods identified in the literature meet?*

Criteria were formulated to ensure that the guideline developed throughout this project would close the identified gap in the literature on sustainable PSS startups enabling a CE (Barquet et al., 2016; de Jesus Pacheco et al., 2019; Scherer et al., 2016). The identified guidelines and methods from the literature were evaluated against the defined criteria. The evaluation demonstrated the gap in the literature as no methods or guidelines meet all criteria. Additionally, few methods and guidelines proved to support the development of a startup and the development of a PSS, and few methods and guidelines focus on economic, social, and environmental sustainability. Finally, it showed a tendency of the term sustainability and the term CE being vaguely defined in the methods/guidelines.

Prescriptive Study I

Preface

In the DS I, the identified guidelines from the RC are analysed compared to the *Systematic Design Framework* and evaluated against the defined criteria ensuring that the guideline will contribute to creating a PSS startup enabling a CE. This PS elaborates on the two phases as there is now a clear understanding of the diagnosed problem (Blessing & Chakrabarti, 2009).

The PS is about developing a final guideline to be tested in the DS II. Online guidelines have been investigated to develop a more extensive guideline 1.0. Criteria ensuring applicability of the selected methods were added as criteria identified in the DS I phase. The deliverables for this phase include a description of the final guideline 1.0.

We aim to answer these questions in the following section:

- *What criteria should be met by methods and guidelines to be applicable in Guideline 1.0?*
- *What methods from literature and online guidelines meet these criteria and contribute to Guideline 1.0?*

Online Workshop with Startups

The three startups *RaskRask*, *Søuld*, and *MoonBoon* were invited to participate in online workshops, for the team to gain an understanding of potential PSS, CE, and sustainability opportunities and related challenges when developing and implementing startups. The workshops were facilitated through a MiroBoard, see Appendix 4. Some of the methods identified in the RC were tested and assessed with the startups through the online workshops to clarify if elements of these could bring value to the developed guideline. These online workshops were essential to develop the guideline by building relationships, building empathy, and bringing in stakeholders by co-designing and learning from their skills (Design Council, 2021).

- **RaskRask** saw a need to modernise the industries of masseurs, personal trainers, and yoga teachers. They have interpreted the physical clinics and centers. Instead of having physical locations, they have developed a platform where selected masseurs, personal trainers, and yoga teachers are present for users to book a service provided at the user's home (RaskRask, 2021).
- **Søuld** is a provider of acoustic products made of upcycled natural waste eelgrass into new healthy acoustic products designed for a CE as the products are designed for disassembly. Furthermore, Søuld is working towards the goal of developing acoustic components that are recyclable (Søuld, 2021).
- **Moonboon Baby Studio** produces equipment for babies and children in organic and sustainable materials. They are the only ones on the market producing organic sways with kapok mattresses and sway motors in biodegradable plastics (Moonboon Baby Studio, 2021).

All three startups shared knowledge on their startup process by identifying challenges and opportunities met through the startup journey. Furthermore, the activities of the startups in the initial development phases were discussed to understand the timeline of the implementation of different strategies. In relation to this their sustainability and circular strategies were mapped according to their journey and the potential of future sustainable and circular strategies were discussed. Insightful learnings were gained through the discussion around the startups activities, strategies, challenges and opportunities.

RaskRask, Søuld and Moonboon Baby Studio both implemented an initial concept to their respective markets and gained direct feedback from users. Through the feedback from users the startups found strengths and weaknesses in their business strategies. **RaskRask** focused on the economic aspect when implementing the business concept to the market and later realised that environmental and social strategies would have been beneficial to incorporate in the initial phases of the startup development. This has led to their attempts on being more environmentally sustainable are focused on strategies with incremental improvements rather than improvements targeting the entire concept of RaskRask.
On the contrary, **Søuld** focused on implementing environmental sustainability strategies to their product development in the early phases of the startup development. The intense focus on developing sustainable product strategies resulted in the startup focusing less on the economically viability aspects of the business model.

Finally, **Moonboon Baby Studio** focused on the social aspect of sustainability, by understanding the needs of parents, and in trying to solve their problem of lack of sleep. Additionally, the product itself was designed for disassembly and with a long product life in the initial phases of the startup journey (environmental sustainability and CE strategies). This resulted in less energy and resources used for exploring other economic business model opportunities eg. rental strategies. This has later become a challenge for Moonboon Baby Studio as competitors are entering the rental market targeting the same types of products.
The online workshop emphasised the need of a guideline supporting startups in decision making processes in the initial phases of a startup development.

Criteria for the Methods Selected to the Guideline

Three different types of criteria for selecting methods for the guideline have been defined to ensure that it will cover the identified gaps in the literature, see Table 6. The selected methods do not necessarily need to meet *all* criteria. For instance some of the methods do not meet the criteria for *applicability* but have been selected as they have the potential for the team to develop intuitive templates for further elaborations.

The first type of criteria are extracted from the SDF that follows the phases *Explore & Reframe*, *Create, Catalyse* and *Continuing the Journey*. These steps are translated into criteria to make sure that the guideline fits into the design phases of the SDF.

The second type of criteria are defined to make sure that the guideline closes the gap in literature on lack of guidelines and methods for developing a **sustainable PSS startup enabling a CE.** These are the criteria defined in the DS I.

The third and final type of criteria are based on an analysis of existing methods and guidelines earlier identified in the literature search. Here it was found that the methods and guidelines often lack descriptions guiding the practitioner and that they were not self-explanatory. Not all methods had templates and the templates identified seemed to be developed for designers, engineers and/or anthropologists and not all potential entrepreneurs and practitioners. Therefore, the guideline must have a sufficient *description*, providing a *template* and be *applicable for non designers, engineers and/or anthropologists*.

Table 6: Criteria for selecting methods to the guideline (some added from Design Council (2021)

The Design Process	The Methods			Applicability
Should contribute to the goals of the SDF phase *explore & reframe*	Should be applicable for startups/SMEs			Should be descriptive/self explanatory
Should contribute to the goals of the SDF phase *create*	Should be applicable for large companies			Should have templates
Should contribute to the goals of the SDF phase *catalyse*	Should contribute to a guideline for developing a startup			Should be applicable by users with different professional backgrounds
Should contribute to the goals of the SDF phase *continuing the journey*	Should contribute to a guideline for developing a PSS			
	Should focus on sustainability			
	Eco.	Soc.	Env.	
	Should focus on circular economy			

Online Methods and Guidelines

Besides methods identified in the RC, methods and guidelines available in online tool kits were identified and reviewed. There are potentially many more to be explored but these are some of many tool kits that target PSS, CE and/or sustainability. Identified methods from online tool kits were evaluated against the criteria and later selected for the guideline if they were identified to bring value to a PSS startup design process. These can be seen in Table 7.

Table 7: Online Methods and Guidelines

Online Methods and Guidelines	Area of knowledge	Short description
Proteus tools - PSS Tool Book Workbook 4 (Finken et al., 2013)	PSS	A catalogue of tried-and-tested tools and methods towards PSS development A successful product/service-system concept needs to address and incorporate four fundamental dimensions: Value Proposition, User Activity Cycle, Offering Life Cycle, Ecosystem
The Market Opportunity Navigator (The Market Opportunity Navigator, 2020)	Market Opportunities	The Market Opportunity Navigator helps entrepreneurs and business managers to systematically discover their best market opportunities
Circular Design Guide, Ellen MacArthur (Ellen MacArthur Foundation, 2018)	CE	The toolkit is designed to guide people through a selection of resources to learn, apply, and contribute to bringing circular design to life. The toolkit provides a selection of curated resources to support people in their exploration and application of circular design.
Gartner Marketing Maturity Assessment Tool (Gartner, 2021)	Market Opportunities	Assess and evaluate your organisation's marketing maturity to reveal gaps between where you are and where you want to go. See how you stack up across nine digital competencies.
Circit Workbook 1 (Kravchenko et al., 2020)	CE	The workbook provides guidance on how to perform a sustainability screening of CE initiatives.
Circit Workbook 2 (M. de P. Pieroni et al., 2020)	CE	The workbook provides an overview of how to plan for changing business models towards CE. The workbook provides a three-stage process for rethinking and reconfiguring business models for CE.
Circit Workbook 3 (Shahbazi et al., 2020)	CE	The workbook provides insights into how to integrate CE into product design and development, supporting decision-making and enhancing the circularity of products, by means of circular design guidelines and a product circularity assessment tool.
Circit Workbook 4 (Kristoffersen et al., 2020)	CE	The workbook provides insights into which technologies to focus on, depending on the level of organisational readiness and CE strategies to be adopted.
Circit Workbook 5 (Hildenbrand et al., 2020)	CE	The workbook helps to identify and evaluate options for closing the loop of products and parts that are already out on the market.
Circit Workbook 6 (Blomsma et al., 2020)	CE	The workbook provides the reader with the means to conduct a three-phase process for the design and development of circular value chains. The process is aimed at clarifying what stakeholders to work with, at what time, and in what capacity, in order to create circular value chains.
Dansk Design Center (Dansk Design Center, 2021)	Design Thinking	Danish Design Center's toolbox. The tools are divided into three categories that help you and your team to 1) develop new ideas, 2) involve users in your idea development and 3) make the solutions concrete.
MATChE (MATChE, 2021)	CE	Number of state-of-the-art tools and methods that are helpful to the development of circular economy businesses and initiatives.

Guideline 1.0

The now 28 methods and guidelines uncovered in the RC, and the 11 ones uncovered online - making it 39 all together - were gathered as the foundation for the guideline 1.0. All methods from the guidelines were reviewed one by one and evaluated against the criteria from Table 6. Doing this we ended up with the final Guideline 1.0 to be tested in the Descriptive Study II with methods supporting the different phases of the *Systematic Design Framework* Table 8, Appendix 5 *Guideline 1.*

Table 8: Guideline 1

Orientation & Vision Setting	Explore & Reframe			Create		Catalyse	Continuing the Journey
Agree to a long-term goal (Knapp et al. 2016)	Learn from Nature - Ask "how might nature solve this problem? (Ellen MacArthur Foundation 2018)	TCO Chart (Finken et al. 2013)	SWOT Matrix (Pieroni et al., 2020)	Create Persona (Kumar 2013)	Product Journey Mapping (Ellen MacArthur Foundation 2018)	LCA Clinic - Life Cycle Assessment and Ecodesign in a Day (Judl et al. 2015)	Service Blueprinting (Pezzotta et al. 2018)
Define the right challenge (Knapp et al. 2016)	Workshop with Stakeholders - Field Guide to Human Centered Design (IDEO.org 2015)	Extremes and Mainstreams - Field Guide to Human Centered Design (IDEO.org 2015)	Cluster analysis for customer segmentation (Scherer et al. 2016)	Brainwriting (IDEO.org 2015)	Circular Opportunities (Ellen MacArthur Foundation 2018)	Rebound effects (Kjaer et al. 2017)	Brand Promise (Ellen MacArthur Foundation 2018)
Define the right team (Knapp et al. 2016)	Group workshop - Field Guide to Human Centered Design (IDEO.org 2015)	Guided Tour - Field Guide to Human Centered Design (IDEO.org 2015)	Prioritising Opportunity Clusters (MATChE 2021)	Brainstorming (MATChE 2021)	Learn from Nature (Ellen MacArthur Foundation 2018)	Choosing recirculation strategy (Pieroni et al. 2020)	Prototype testing (Wizard of Oz) (Pezzotta et al. 2018)
Building Teams (Ellen MacArthur Foundation 2018)	Expert workshop - Field Guide to Human Centered Design (IDEO.org 2015)	Brainstorm - Field Guide to Human Centered Design (IDEO.org 2015)	Stakeholder Opportunity Cluster (MATChE 2021)	Circular Strategy Scanner (MATChE 2021)	Economic, Social and Environmental Layer - 3 business model canvasses (Joyce and Paquin 2016)	Ecosystem mapping (Finken et al. 2013)	KPI Modelling (Pezzotta et al. 2018)
Set the time and space to conduct your sprint (Knapp et al. 2016)	Reach out to experts - inspired by (Knapp et al. 2016)	MECO Analysis (MATChE 2021)	Value Mapping (Scherer et al. 2016)	Sustainable business model archetypes (Bocken et al. 2014)	Decision Tree to Navigate through PSS Typologies (McAloone and Pigosso 2018)	Attractiveness Map (The Market Opportunity Navigator 2020)	Imagine New Partnerships (Ellen MacArthur Foundation 2018)
	User Activity Cycle (Finken et al. 2013)	Material Flow Analysis (MATChE 2021)	Readiness workshop toolkit (MATChE 2021)	PSS Morphology (Finken et al. 2013)	11 characteristics of PSS (Haase et al. 2017)	PSS Concept Evaluator (Finken et al. 2013)	Create Your Narrative (Ellen MacArthur Foundation 2018)
	Ecosystem mapping (Finken et al. 2013)	Insides Out (Ellen MacArthur Foundation 2018)	PESTEL analysis (MATChE 2021)	Circular Economy Business Model Pattern Cards (MATChE 2021)	Circular Economy Business Model Canvas (Pieroni et al. 2019)	SWOT (Pieroni et al. 2020)	Riskiest Assumption Canvas (McAloone and Pigosso 2020)
	Service Flip (Ellen MacArthur Foundation 2018)	Stakeholder Value Mapping (MATChE 2021)	Customer Profile (Osterwalder et al. 2014)	PSS development arena with focus on 6 boundary conditions (McAloone 2011)	Checklist of Sustainability Qualifying Criteria (Pieroni et al. 2020)		
	Rebound effects (Kjaer et al. 2017)	Stakeholder Definition - inspired by Cambridge Business Model Innovation Process (Geissdoerfer et al. 2017)	Inspiration: Digital Systems (Ellen MacArthur Foundation 2018)	Napkin pitch (Scherer et al. 2016)			
	Map the product life cycle (Pieroni et al. 2020)	Trends Matrix - inspired by (Kumar 2013)	Inspiration: Digital Systems (Ellen MacArthur Foundation, 2018)	Identify PSS solutions capable of fulfilling customers' needs (Pezzotta et al. 2018)			
	Quick LCA study - inspired by LCA Clinic (Judl et al. 2015)	Offering Activity Culture Map (Kumar 2013)		Embed Feedback Mechanisms (Ellen MacArthur Foundation 2018)			

Concluding notes on the Prescriptive Study

- *What criteria should be met by methods and guidelines to be applicable in Guideline 1.0?*

Three different types of criteria were identified to ensure that selected methods would cover the gap in the literature. The first type of criteria ensured that the methods would contribute to phases of the SDF. The second type of criteria were extracted from the *Criteria for developing a guideline* from the DS I ensuring that the PSS startup will focus on all three sustainability dimensions and incorporate CE strategies. The third type of criteria were created based on limitations discovered in existing methods and guidelines from the literature ensuring that the guideline would incorporate descriptions, templates and be applicable for practitioners with different professional backgrounds.

- *What methods from literature and online guidelines meet these criteria and contribute to Guideline 1.0?*

The 31 identified methods and guidelines from literature and online tool kits were evaluated against the three different types of criteria to ensure that the methods would cover the gap in the literature. The evaluation led to the deliverable of an initial Guideline 1.0 to be tested in the DS II.

Descriptive Study II

Preface

The DS II aims at testing and evaluating the Guideline 1.0 developed in the PS. The test is conducted by applying the Guideline 1.0 to a startup case study of developing a PSS startup enabling a CE. The development process of the PSS startup follows the phases *Explore & Reframe, Create, Catalyse,* and *Continuing the Journey* from identifying user needs and problems to creating and exploring final concepts.
The goal is to develop PSS concept(s) that provide sustainable solutions for purchasing baby equipment and toys and that contributes to a CE.
The applicability of the methods of the Guideline 1.0 are evaluated based on an assessment of the value of insights to the areas of PSS, CE, and sustainability and attributed a rating in a scale from 1-5. Throughout the test of the Guideline 1.0, methods are applied if a lack of insights to the design phase is identified. The DS II results in a revised version of the guideline.

We aim to answer these questions in the following section:

- *How can the methods of the guideline be tested and evaluated through a startup case study and how can the SDF contribute to it?*

Preface

The DS II aims at testing and evaluating the Guideline 1.0 developed in the PS. The test is conducted by applying the Guideline 1.0 to a startup case study of developing a PSS startup enabling a CE. The development process of the PSS startup follows the phases *Explore & Reframe, Create, Catalyse,* and *Continuing the Journey* from identifying user needs and problems to creating and exploring final concepts.
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We aim to answer these questions in the following section:

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The Test Process

The Guideline 1.0 developed throughout the PS gathers methods from the literature and from guidelines available online that meets the criteria for developing a sustainable PSS startup enabling a CE. Throughout the DS II phase, the guideline was applied as a framework for developing a sustainable PSS enabling a CE within the baby equipment and toys market in order to test and evaluate if the selected methods meet the criteria in practice. The development process of the PSS startup followed the SDF design process suggested by the (Design Council, 2021) through the phases *Explore & Reframe, Create, Catalyse,* and *Continuing the Journey.*
Participatory design has been a general approach throughout the SDF process in order to build relationships with and learn from the stakeholders of the ecosystem. During the *Explore & Reframe* phase insights to the market were gained through workshops with users, existing startups and established companies in the market of baby equipment and toys. Furthermore, a survey with 1.093 respondents from Denmark and 150 respondents outside Denmark was conducted to gain knowledge about users and the market. During the *Create* phase, users were involved in co-creating the concepts through brainstorming and eight users helped in creating concepts from the developed morphology. Finally, users were engaged in evaluating the developed concepts during the *Catalyse* phase involving 269 respondents on a survey investigating the three developed concepts.

The first step of the DS II phase was to conduct a literature search on existing PSSs within the baby equipment and toys market to explore researched successful or unsuccessful implementations of PSS strategies. Hereafter, the PSS startup guideline was developed, reevaluated and updated in the PS phase and tested in the DS II phase through an iterative process as seen in Figure 19.

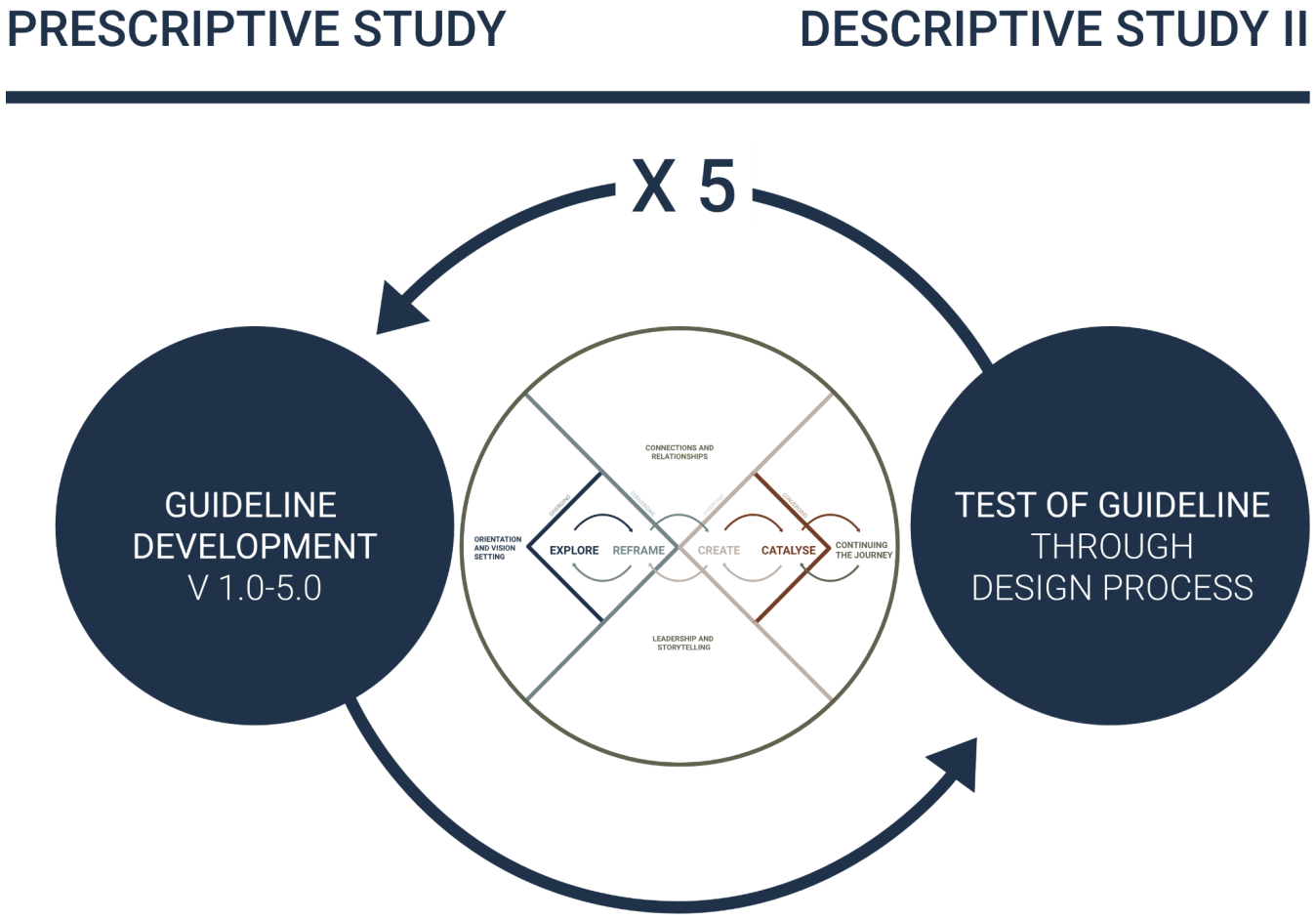


Figure 19: The iterative process of developing the guideline in the PS and testing the guideline in the DS I

Methods were continuously added during the test of the guideline if the identified methods did not fulfill the aim of each SDF phase and/or did not contribute to adequate knowledge within the areas of PSS, CE and/or sustainability.
The aims are related to the elements of the different SDF phases described in the methodology section and are generically described to be applicable by PSS startups targeting different markets. These aims are as follows:

1. *Explore & Reframe*: To analyse the needs and problems of the stakeholders of the existing market and to get a deep understanding of the interrelationships and flows between stakeholders in order to identify *Design Concept* criteria for developing a sustainable PSS startup enabling a CE.
2. *Create*: To ideate and brainstorm on business models within the startup team and through co-creation with users to narrow down ideas to concepts contributing to a sustainable and circular development.
3. *Catalyse*: To make the PSS concepts tangible by depicting the changes of flows between stakeholders of each concept to the ecosystem, to determine the sustainability impact of the concepts and to evaluate concepts against criteria. A final concept may be selected in the *Catalyse* phase if the practitioner has enough knowledge and support to select the most feasible concept.
4. *Continuing the Journey*: To define the final concept(s) and to reflect on what needs to be done through further work as the project is open-ended.

The methods attributed to each SDF phase from Guideline 1.0 are tested throughout the DS II. The structure of the test is as followed:

1. Initially, the **aim of each method** and the **area of knowledge** of which they contribute to is presented.
2. The **Guideline 1.0 methods are tested** through the startup case study and **additional methods are added** if there is a lack of knowledge on PSS, CE, and/or sustainability aspects or if the goal of the SDF phase is not fully met. This leads to a revised and updated guideline.
3. After each method has been tested it has been **evaluated** on a scale from **1-5 based on the degree of insights to the market** (Appendix 6)
4. **Insights from selected methods** with a high rating are presented to convey insights to the startup case study.
5. **Conclusion** on the tested methods and on the insights from the test of methods through the startup case study.

A template can be found for each created method in the Guideline for *Developing a Sustainable and Circular PSS startup* (Appendix 7) including an example of the method done through this startup case study, see Appendix 8.

Literature Review on Product/Service-Systems Within the Baby Equipment and Toys Market

To support the understanding of the existing market a literature review was conducted to gain knowledge on existing PSSs and startups within the baby equipment and toys market.

In a study by (O. Mont et al., 2006) it is stated that not many, if any, examples of PSSs could be found in the area of baby products. Most were found in sharing systems organised by customers themselves. The initiatives within the PSS field are limited to designing safe and high-quality children products and focus on reducing health hazards, rather than the environmental improvements to be achieved when designing products for their impact in the use phase (O. Mont et al., 2006).

In two case studies by (Catulli, 2012; Catulli et al., 2013) parents seemed positive towards the PSS concept of a lease or rent of baby prams and baby car seats (Catulli, 2012; Catulli et al., 2013). Mentioned in the case studies are associated benefits such as possible savings as these products are only used for a short period of time. By only paying for the usage of the products it would lead to financial savings (Catulli, 2012). Yet some parents liked the expensive strollers like Bugaboo and did not want to be associated with renters or leasing of a pre-used pram. They wanted to be seen as the 'best parents', who gave their babies the best but at the same time they would feel good about saving money (Catulli et al., 2013). Prams are seen as fashion items and self-image is a very important satisfaction factor and therefore the users care about brand images and want to be seen by their peers in the best light (Catulli et al., 2013). Thus, it is important for a PSS provider to choose a high class and quality brand name in order to add credibility to a PSS within baby equipment (Catulli, 2012). Today's parents look at peers in their environment and social networks for advice and information even more than their own parents. Therefore, these sources could have an influence on how to promote the PSS (Catulli et al., 2013)..

The used market developed by private users dominates the total market for prams and are in Sweden estimated to represent 65-75% of total sales. The depreciation of the prams after the first user is 35-50% depending on the model, use and maintenance. This makes the prams very attractive on the used market. Such a large used market means that the producers only make a profit from the first customer. Thereafter the private actors make all the consequent payments and by selling prams privately the transaction costs are entailed to the private sellers. Having such a large used market for baby and children products shows that parents have a positive attitude towards used products and shows that producers lose the opportunity to profit from reselling their goods. This implies that there is a need for a new business model based on selling the function that baby prams provide (O. Mont et al., 2006).
As a pram company (O. Mont et al., 2006) argue that they could gain control over the used market through a leasing scheme. The goal of the system would be to re-introduce used products in a 'like new' condition. Their study indicated technical and economic potential for leasing prams. For the logistic costs not to be too high, a possible solution could be to involve retailers, who would remanufacture and administrate the pram leasing (O. Mont et al., 2006). Figure 20 shows how the new product service system would look.

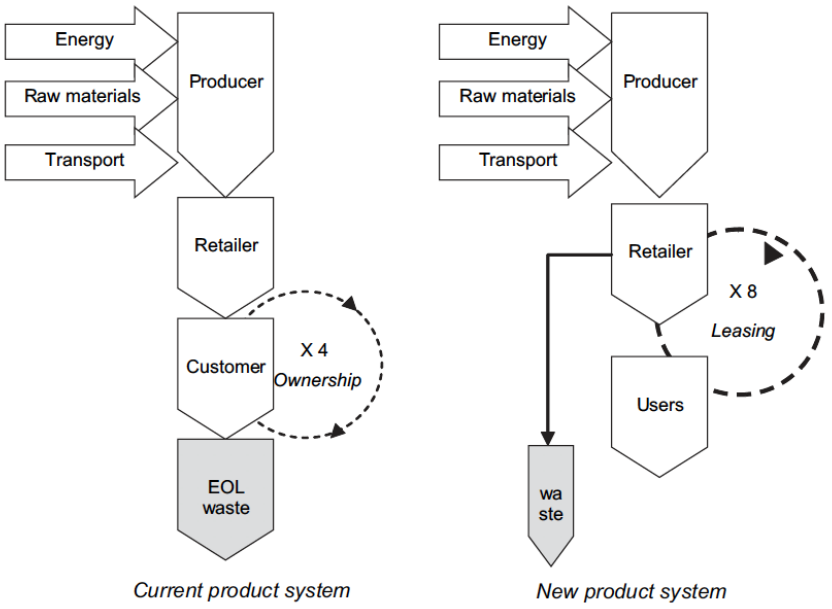


Figure 20: A new system (Mont et al. 2006)

(Waight, 2013) argues that a parent is responsible for their own and the child's ecological footprint as they make consumption decisions on behalf of the child. Parents are engaged in sustainable consumption practices and one in five have acquired a greater number of used items for their child. In the study by (Waight, 2013), it was found that parents proceed to buy more used items as the child grows or when they have more children. This was due to:

1. Financial motivations; often finances had to be shared across a larger family.
2. Motherly protection; new mothers were more concerned about hygiene and safety but once they settled into their role and responsibilities, mothers relaxed and became less protective.
3. The desire for more products; more used products were bought as a part of the process of preparing to be a mother.

Pilot Project with Bugaboo

A pilot project was conducted by Bugaboo to lease and to refurbish their prams. They had a pilot with 50 customers over three years. Their value proposition said: *Customers could change their stroller according to their changing needs (get 2 for the price of 1) (Bakker, 2018)*. Many challenges were found, as Bugaboo is not optimised for acting as a service provider. They had no experience with reverse logistics, they were new to refurbishment and customer treated leased strollers with less care (Bakker, 2018). It was observed that there was a high demand for swapping Bugaboo accessories and that strollers were highly damaged after one use-cycle leading to two unsustainable behaviors; overconsumption of PSS offering and treating products in PSS carelessly (Bakker, 2018; Gustafsson & Harild, 2021).

PramShare and PramWash

PramShare and PramWash companies founded in Singapore and addressed the challenge of stranded prams, wasted materials, expensive baby gear, frequent equipment replacement and maintenance. Furthermore, they wanted to enhance the user experience (Itkin, 2021).

PramShare offers long-term and one-time rentals of high-quality prams, strollers and car seats. PramWash specialises in the cleaning of prams, strollers, baby carriers, car seats and toys. This is a PSS business model that provides parents with high-quality prams and mitigates the hassle of buying new gear and at the same time reduces waste and keeps materials in the value chain for as long as possible. PramShare applies CE strategies to create value from underused products by reusing and upcycling used prams to an as-good-as-new condition (Itkin, 2021).

PramShare has grown 15% year-over-year between 2017 and 2018 while PramWash has grown 250% year-over-year between 2017 and 2018. In 2018, PramShare had 300+ customers while PramWash had 1000+ customers. For subscription customers, they are entitled to a complimentary model swap when their child outgrows it and cleaning. They are currently working on addressing two key challenges to further scale-up. The first is parents' perceptions of rented products as a common perception among parents is that buying a new pram is cleaner than renting a used one. The second one is sourcing replacement components since finding spare parts can be difficult (Itkin, 2021).

Exploring the Existing Market

To get an overview of competitors on the market in Denmark, existing PSS solutions were mapped. This includes a mapping of existing PSSs within the baby equipment and toys market, existing PSSs within the baby clothes and food markets for inspiration, and existing PSSs within other markets for inspiration. The method applied to the case study can be found in Appendix 8 under the method *Mapping of Existing PSS's*. The mapping shows that there are some but not many existing PSSs targeting the baby equipment and toys market. Hereby the market is a new market space for PSS startups.

Furthermore, an investigation of parents' must-have-lists available online was conducted, to get an overview of possible market influencers, identify and understand the expense of the frequently mentioned products and provide a foundation for understanding environmental impact. In total it was found that a parent is recommended to buy a minimum 44 products when expecting a child, See Appendix 9 under the method

Reflection

The literature review on existing PSSs within the baby equipment and toys market supports the assumption that this is a market with great potential for implementing PSSs. The study by (Waight, 2013) and (Itkin, 2021) is interesting to look into as this highlights that PSS startups targeting the baby equipment and toys market should not necessarily target first time parents as (Waight, 2013) states that the more children parents have, the more they are prone to buy from used. Furthermore, it shows that the PSS provider should consider how to mitigate the challenge of changing parents' perception of hygiene of used products into the PSS business model development.

The literature review exploring existing PSS providers within the baby equipment and toys market indicates that parents seem positive towards PSS offerings and that there is a great potential for implementing successful sustainable PSS startups in the market. Thus, insights from the Bugaboo case study highlights that a PSS startup should consider how to mitigate implementation challenges throughout the initial phases of the PSS development (Bakker, 2018).

The many must-have products show an enormous consumption related to having a child but also indicate a great potential in circulating products through renting or leasing. Additionally, the mapping of competitors within the existing baby equipment and toys market indicates that this market has a great potential for implementing PSS businesses.

Insights from the literature review on existing PSSs within the baby equipment and toys market will be used in the *Explore & Reframe* phase.

Selected Methods to be Tested from Guideline 1.0

The selected methods from the literature and from online guidelines can be found in Guideline 1.0 Appendix 5 *Guideline 1.0*. The methods are generic and therefore applicable to all types of markets. It is recommended to follow the guideline from start to finish to ensure that all aspects (CE, PSS, sustainability) are sufficiently covered. Though, depending on the phase of the journey that the startup is in, they can also use selected methods to gain insights to areas of which they are lacking knowledge on.
7 out of 27 methods from the *Explore & Reframe* phase, 9 out of 19 methods from the *Create* phase, 4 out of 7 methods from the *Catalyse* phase and 2 out of 7 methods from the *Continuing the Journey* phase were chosen to be tested with the startup case study of developing a PSS startup enabling a CE within the baby equipment and toys market see Table 9-12 .
The aim of each method is described in Appendix 6 together with the area of knowledge of which each method contributes to (PSS, CE, and/or sustainability). The reasons for adding each method are defined in the table. Furthermore, a more detailed description of the aim of the methods can be found in Appendix 6.
The remaining methods suggested for each phase in Guideline 1.0 were opted out either due to being less relevant for the analysis of the baby equipment and toys market (but still applicable by other startups) or due to the methods giving insights similar to the selected methods to be tested - these would be valuable to apply to the project to support the findings or to give a deeper understanding of the market, but were not applied due to the scope of the project. These methods can be found under *Suggestions for Further Work* in the final proposed guideline, see Appendix 5 *Guideline 5.0*.
The test and revision of methods will be presented in the following sections.

EXPLORE & REFRAME

N	Method	Reference	Aim	Insights to
7	Methods used in order to both diverge and converge in the Explore & Reframe phase	Full references will be shown in the tables below.	The aim of the retrieved methods is to explore the market, gain insights to user needs and problems and later reframe the exploration in defining criteria for the following phase.	PSS / SUS. all aspects / CE

Table 9: Selected methods to be tested through the *Explore & Reframe* phase

CREATE

N	Method	Reference	Aim	Insights to
9	Methods used to diverge in the Create phase	Full references will be shown in the tables below.	The aim of the retrieved methods is to diverge the solution space and create concepts that solve the identified problems and accommodate the user's needs.	PSS / SUS. all aspects / CE

Table 10: Selected methods to be tested through the *Create* phase

CATALYSE

N	Method	Reference	Aim	Insights to
4	Methods used to converge in the Catalyse phase	Full references will be shown in the tables below.	The aim of the retrieved methods is to converge the solution space and assess, elaborate and evaluate the proposed concepts.	PSS / SUS. all aspects / CE

Table 11: Selected methods to be tested through the *Catalyse* phase

CONTINUING THE JOURNEY

N	Method	Reference	Aim	Insights to
2	Methods used to diverge when Continuing the Journey	Full references will be shown in the tables below.	The aim of the retrieved methods is to continue the journey and once more diverge the solution space and plan how to evolve and elaborate the proposed concepts.	PSS / SUS. all aspects / CE

Table 12: Selected methods to be tested through the *Continuing the Journey* phase

Explore & Reframe

Explore & Reframe

The first phase of developing a PSS startup is called *Explore & Reframe* and incorporates methods making it possible for startup teams to go from having no or limited knowledge of the needs or problems of the different stakeholders to having a deep understanding of the flows and interrelationships between stakeholders. Furthermore, empathy for the users in the market is built in the *Explore & Reframe* phase. The practitioner will obtain an understanding of what products and services are attractive to the users to incorporate in potential PSS and CE strategies. Additionally, the practitioner will understand economic, social, and environmental sustainability challenges seen from a user's and a provider's perspective.
The aim of the *Explore & Reframe* phase is:

> *To analyse the **needs** and **problems** of the stakeholders of the existing market and to get a deep understanding of the **interrelationships** and **flows** between stakeholders in order to identify **Design Concept Criteria** for developing a sustainable PSS startup enabling a CE within the market being analysed.*

Test and Revision of Methods for the Explore & Reframe Phase

The seven methods proposed in this phase were performed to gain insights to the market for baby equipment and toys. The data was collected through a survey targeting the users and through the literature search on existing PSS within the market. Additionally, data was collected through workshops with users and through workshops with product-, service- and PSS-oriented startups and larger companies.

During testing of the methods it was found that there was a lack of methods to be added to the guideline in order to diverge the problem space even more and to gain more knowledge on the stakeholders and their interrelationships. Furthermore, a deeper understanding of the PSS, CE, and sustainability aspects of the baby equipment and toys market was needed to later develop a concept meeting all criteria for the PSS startup. This acknowledgement led to new methods being applied to the guideline resulting in the Guideline 2.0, see Appendix 5 *Guideline 2.0*. The methods were found in online guidelines or were inspired by learnings throughout the studies of the team members at the Technical University of Denmark and at Aalborg University. The aim of each of the new methods applied and the methods applied to Guideline 1.0 for the *Explore & Reframe* phase is described in Table 13 together with the area of knowledge of which each method contributes to (PSS, CE, and/or sustainability). A more detailed description of the aim of each of the newly added methods can be found in Appendix 6.

10 out of 15 of the new methods added did not meet one or more of the requirements for the methods added to the guideline being; 1) *it should be descriptive/self explanatory*, 2) *it should have a template*, and 3) *it should be applicable by users with different professional backgrounds*. Moreover, changes and improvements were made to the templates of the remaining 11 methods proposed by the authors to ensure streamlining of the components and design of the templates throughout the guideline. The templates for all the methods can be found in the final guideline, see *Developing a Sustainable and Circular PSS startup* (Appendix 7).

The methods *Identified Problems, Identified User Needs,* and *Defining Criteria* were added to the *Explore & Reframe* phase as methods supporting the converging of the problem space. In the templates of the three methods it can be seen that the methods *Identified Problems* and *Identified User Needs* should be understood as methods that are applied to all other methods in the *Explore & Reframe* phase to identify problems and needs of the users discovered by applying each of the other methods. The identified problems and needs within the analysed markets were hereafter translated into final criteria named *Design Concept Criteria*. The criteria ensured that the developed PSS startup concepts close the gap found in literature as the needs and problems are detected through all methods applied and as these give insights to both the PSS, CE and sustainability aspects of the market.

Table 13: Table with applied methods to the *Explore & Reframe* phase.

N	Method	Reference	Aim	Insights to	Added as it supports:	Rating 1-5
1	User Activity Cycle	Finken et al., 2013	To identify user activities and associated needs and to identify business opportunities based on market gaps and market shares with competitors.	SUS. all aspects	The understanding of user activities and to identify market opportunities.	5
2	Ecosystem Map	Finken et al., 2013	To understand the interactions between important stakeholders of the market you are looking into by mapping the flows and interactions between stakeholders, and to identify missing interrelations between stakeholders showing potential improvement areas for the developed PSS.	PSS	The understanding of flows and interactions between stakeholders of the ecosystem being analysed.	5
3	Service Flip	Ellen MacArthur Foundation, 2018	To understand the underlying user needs of products and think creatively about how to flip these from products into services.	PSS	The understanding of possible services related to analysed products.	4
4	Rebound Effects	Kjaer et al., 2017a	To gain insight to the social, economic and environmental impacts to the system caused by unwanted user behavior or caused by the implementation of product, services, or PSSs within the existing market.	SUS. all aspects	The understanding of potential or existing environmental, social and economic impacts to the system being analysed.	4
5	Map the Product Life Cycle	M. de P. Pieroni et al., 2020	To gain insight to the phases of the product life cycle and hereby to gain insight to potential environmental effects and circularity aspects in each stage of the life cycle.	PSS / CE	The understanding of the product life cycle of selected analysed products within the existing market being analysed.	3
6	Quick LCA Study (inspired by LCA Clinic)	Judl et al., 2015	To conduct an LCA or to analyse the results of an existing LCA study and hereby evaluate the environmental performance of a product, a service or an existing PSS within the market you are analysing.	SUS. environment	The knowledge on environmental impacts of PSS strategies implemented in the current market.	5
7	Total Cost of Ownership Chart	Finken et al., 2013	To consider all direct and indirect costs associated with owning and using a product throughout the entire product life cycle taking both the product and the services into account.	SUS. economic	The understanding of direct and indirect costs associated with products in the market being	5

					analysed.	
Added methods						
8	Stakeholder Exploration	MATChE, 2021	To gain insights to the possibilities and values of working with or interviewing new stakeholders within the existing market being analysed.	PSS	The definition of relevant stakeholders and as it supports the planning of stakeholder workshops.	4
9	Circular Buy-In	Ellen MacArthur Foundation, 2018	To identify key stakeholders and to assess the power and interest of these stakeholders from the PSS startup perspective or from an stakeholders perspective.	PSS	The understanding of the power/interest of stakeholders seen from an workshopees perspective.	3
10	Empathy Map	Gibbons, 2018a	To map user attitudes, feelings and behavior in order to align on a deeper understanding of the end users.	SUS. social	The understanding of the users feelings and behavior when interacting with products and services of the market being analysed.	5
11	Experience Map	Gibbons, 2018b	To gain an understanding of the user experience being investigated and to understand physical and emotional factors from a users' point of view.	SUS. social	The understanding of the users feelings and behavior when interacting with products and services of the market being analysed.	4
12	Challenges & Opportunities	*Method template developed in this project*	To identify challenges and opportunities of implementing products, services, and/or PSSs within the existing market being analysed, seen from a user's, competitor's, or expert's point of view.	PSS	The understanding of challenges and opportunities regarding the implementation of products, services, and/or PSS strategies to the analysed market.	5
13	Affinity Diagram	Beyer & Holtzblatt, 1997	To gather ideas, opinions and issues in relation to the market being investigated. The Affinity Diagram can be based on insights from surveys, user comments, workshops/workshops with relevant users and stakeholders and from insights from the literature.	PSS / SUS. all aspects	The collection and common understanding of the knowledge gained through the empirical study. Not all knowledge is not necessarily anchored in other methods applied.	5

14	Identifying Strategies	*Method template developed in this project* Inspired by Giddings et al. 2002	To gain insights to potential economic, social, and environmental sustainability strategies and circular strategies incorporable in a PSS business model.	PSS / SUS. all aspects / CE	The collection of knowledge on potential CE and sustainability strategies incorporable in future PSS concepts.	5
15	Mapping of Existing Product/Service -systems	*Method template developed in this project* Inspired by Tukker and Tischner 2017	To map existing or closed PSS competitors within the market being analysed and to map existing product/service/PSS companies inspiring the startup development team. The mapping can function as inspiration for potential companies to contact and workshop.	PSS	The understanding of the current PSSs within the market being analysed.	2
16	Survey Analysis (Denmark, Outside of Denmark & Cross-analysis)	*Method template developed in this project*	To get respondents that are engaged in products and services within your market in order to gain insights to demographic characteristics (like age, gender, employment, income etc), psychographic characteristics (like values, attitudes, interests, lifestyles etc) and to behavioral characteristics (like motivations, intelligence, emotions etc) of the users within the market you are analysing.	PSS / SUS. all aspects	The collection of empirical data.	5
17	User's Must-Have Lists	*Method template developed in this project*	This method lists the number of products owned by different workshoped users and confirms what products are popular and what products are generally bought from new, from used or received as gifts.	SUS. economic	The understanding of the economic aspects of products, services or PSS offerings in the market being analysed.	2
18	Comparing product prices	*Method template developed in this project*	To compare prices on existing products on the market being analysed. The method can advantageously be used to assess the differences in price between product types (e.g. new/used product or high class brands/cheap brands).	SUS. economic	The understanding of economic aspects of different types of products on the market being analysed.	5
19	Interviews & Workshops	*Method template developed in this project*	To understand the users and the stakeholders within the existing market through participatory design in workshops.	PSS / SUS. all aspects / CE	The collection of empirical data through participatory design.	5
20	Identified Problems	*Method template developed in this project*	To identify problems faced by the users when purchasing products and services within a certain market and to identify problems faced by providers when implementing PSS, CE and sustainability strategies within a certain market.	PSS / SUS. all aspects / CE	The analysis of the knowledge and data collected through all other methods in the explore & reframe phase.	5

21	Identified User Needs	*Method template developed in this project*	To identify user needs regarding purchasing of products and services within a certain market and to identify needs of the providers when implementing PSS, CE and sustainability strategies within a certain market.	PSS / SUS. all aspects / CE	The analysis of the knowledge and data collected through all other methods in the explore & reframe phase.	5
22	Defining criteria	*Method template developed in this project*	To create criteria based on problems and needs identified throughout the methods applied in the 'Explore & Reframe' phase to define need-to-have and nice-to-have criteria for the PSS solution.	PSS / SUS. all aspects / CE	The development of a startup being sustainable and enabling a CE within the specific market being analysed as the criteria are based on problems and needs uncovered in that specific market.	5

Learnings from the Explore & Reframe Phase

The development of a sustainable PSS startup enabling a CE within the baby equipment and toys market has been the case study for testing the Guideline 1.0. The Guideline 2.0 is based on the learnings gained through the use of methods from the *Explore & Reframe* phase.

Understanding the Ecosystem of Baby Equipment and Toys

The large size of the baby equipment and toys market means that there are numerous stakeholders competing to get a share of the market. These are important stakeholders to identify and understand when designing a PSS startup to develop an economically feasible business model competitive in the global marketplace of baby equipment and toys. Methods supporting the mapping and understanding of the stakeholders and their interrelationships (e.g. the *Ecosystem Map*) and methods supporting the collection and analysis of knowledge on the market from these stakeholders (e.g. *workshop Guideline* and *Survey Analysis*) were therefore added to the guideline and tested, see Appendix 8 *Explore & Reframe*. By applying the met*hods Mapping of Existing PSSs* and *Stakeholder Exploration*, several interesting product-, service- and PSS startups and larger companies within the market were identified. Two of the identified stakeholders were **Moonboon Baby Studio**, which is a product oriented startup selling sways and motors for sways, and **BabySam**, which is a large reseller of baby equipment and toys that also rents out equipment. Both companies accepted the invitation to participate in co-creation online workshops facilitated by the startup team. The goal of the workshops was to understand the product-, service-, and PSS strategies and to understand the sustainability and CE strategies of the two companies. Furthermore, the goal was to gain an understanding of the stakeholders of the ecosystem and the flows of products, services, money and information between these.

The workshops were facilitated with the use of interactive Miro boards allowing the workshops to co-create on the analysis of the market and on the analysis of the stakeholder interrelationships. The workshops were structured around the *Interviews & Workshops* template and selected methods from the *Explore & Reframe* phase were applied to the workshop Miro boards, see Appendix 10. The CEO of Moonboon Baby Studio, Marie Grew, contributed with valuable insights through the methods' *Identifying Strategies', 'Challenges & Opportunities'*, and *'Service Flip'* and the CEO of BabySam, Kenneth Willenbrack

Nørgaard, contributed with insights through the methods *'Identifying Strategies', 'Challenges & Opportunities', 'Map the Product Life Cycle', 'Circular Buy-in',* and *'Total Cost of Ownership Chart'*.
Selected needs and problems identified through an analysis of the insights gained through the above mentioned methods are highlighted to convey important user and market insights.

Moonboon Baby Studio

One of the methods conducted with the Moonboon Baby Studio was the method *Identifying Strategies* applied to get an understanding of possible circular strategies to incorporate in the business model of a PSS startup. The needs related to circular strategies of the MoonBoon Baby Studio were mapped to understand MoonBoon Baby Studio's requirements to the products to run an environmental and economic sustainable business. The identified needs were possible criteria for the PSS startup business model later to be developed and would furthermore function as inspiration for possible circular strategies, see Figure 21 or Appendix 8 *Identifying Strategies*.
An example of a need depicted was the need of *designing products for ease of maintenance and repair*. Moonboon Baby Studio meets this need by designing products for easy disassembly and hereby for ease of maintenance and repair. Additionally, Moonboon Baby Studio has its own production site in Denmark making it possible to provide a fast maintenance and repair service of products to the users. This identified need was translated into the criterion *the solution should accommodate products designed for disassembly to the extent possible*.
Another example of a need of the Moonboon Baby Studio users was the need for *extending the product value*. Moonboon Baby Studio meets this need by exploiting residual value of products by remanufacturing parts of the motors. Furthermore, Marie Grew pointed out that Moonboon Baby Studio has a vision for selling defective but functional products cheaper in the near future. As of now, 30 out of 1000 produced sways are defective but functional. This is a circular business model strategy that slows the material loop of products and that enables economic and social benefits for the provider and the user. This need was translated into the criterion *products that are defective/damaged should be downgraded or repurposed.*
Finally, the team, together with Marie Grew, identified several problems related to the implementation of circular strategies to the business model of Moonboon Baby Studio. The first sway motor designed and produced by the Moonboon Baby Studio was made of biodegradable plastics with the intention of developing products made of environmentally friendly materials. Thus, the products were sent back by the users as the motors had become deform due to exposure to high temperatures. The batch of motors of this material was therefore discarded leading to unexpected negative economic and environmental impacts. This identified problem was translated into the criteria that the *solution should accommodate products of materials as environmentally sustainable as possible* and *the solution should accommodate products designed for durability and longevity.*

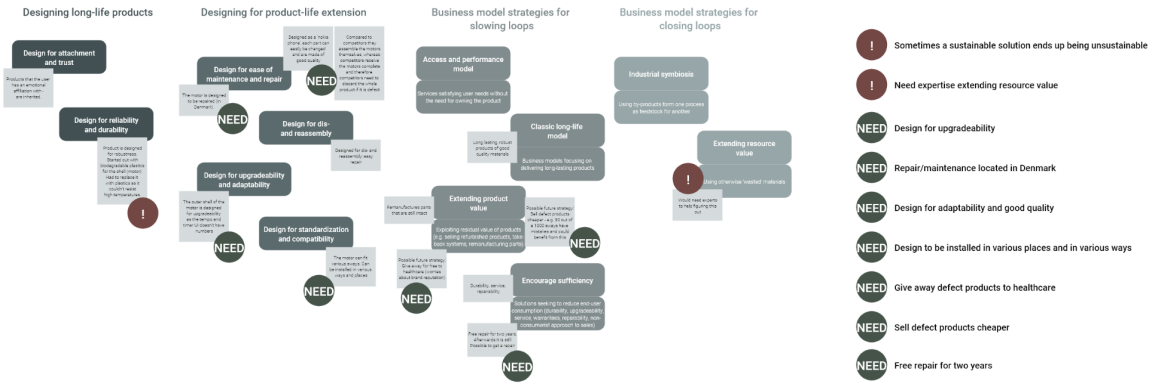


Figure 21: The *Identified Strategies* method conducted with Marie Grew from Moonboon Baby Studio

BabySam

One of the methods conducted with Kenneth Willenbrack Nørgaard was the method *Challenges & Opportunities* which is a method developed in this project applied to get an understanding of potential challenges & opportunities occurring when implementing PSS strategies. The opportunities (needs) are depicted in the inner circle while the challenges (problems) are depicted in the outer circle as seen in Figure 22. An example of a problem identified by Kenneth is that users *say* that they want to rent products and that the sustainability intentions of the users are good, but that the willingness to pay for using products without owning them is low in reality due to lack of added value through services in current solutions for the user. Furthermore, he stated that products within the baby equipment and toys market are under a high price pressure as new competitors are constantly entering the market. The criterion *the solution should compete with competitors prices on intangible values (services)* is therefore formulated to overcome these identified problems. The services provided to the user would replace the need for owning the products. Furthermore, the criterion would ensure that the added value through services would compensate for the higher price on rented products compared to low-price products on the market.

An example of a need that K. Nørgaard identified, is the demand for more focus on environmental and social sustainability for purchasing solutions of baby equipment and toys. This is a need that is characteristic for the core users of BabySam's products which are young females in the age 27-32. Furthermore, he stated that there is a huge potential in rental business model strategies of baby equipment of high quality as he stated that:

> *"It is more profitable for us to rent out high quality products than to sell products. For example BabySam earns 200 DKK per rental period of a breast pump that can be rented out 200-300 times"*

Thus, BabySam has not implemented large-scale rental purchasing solutions for users due to several challenges faced by BabySam. One challenge identified by Kenneth is that it is costly and resource consuming to transition from being mainly a pure product oriented company to being a PSS oriented company. Furthermore, BabySam is branded as a product selling reseller and finally, BabySam do not wish to be the first movers of implementing large-scale rental strategies as users need more education on prices of sustainability and quality of products and as users should be more familiar with PSS rental solutions.

Figure 22: The *Challenges & Opportunities* method conducted with Kenneth Nørgaard from BabySam

Through the workshops, the team gained a deep understanding of the market by getting direct inputs to the methods from companies that deliver both products, services and PSSs. Insights to the market from the workshop with Marie Grew and Kenneth Willenbrack Nørgaard led to the team being able to understand who the most important stakeholders are when developing a startup competing in the baby equipment and toys market. These stakeholders were mapped in an *Ecosystem Map*, see Figure 23, Appendix 11 *Ecosystem Map 1.0*.

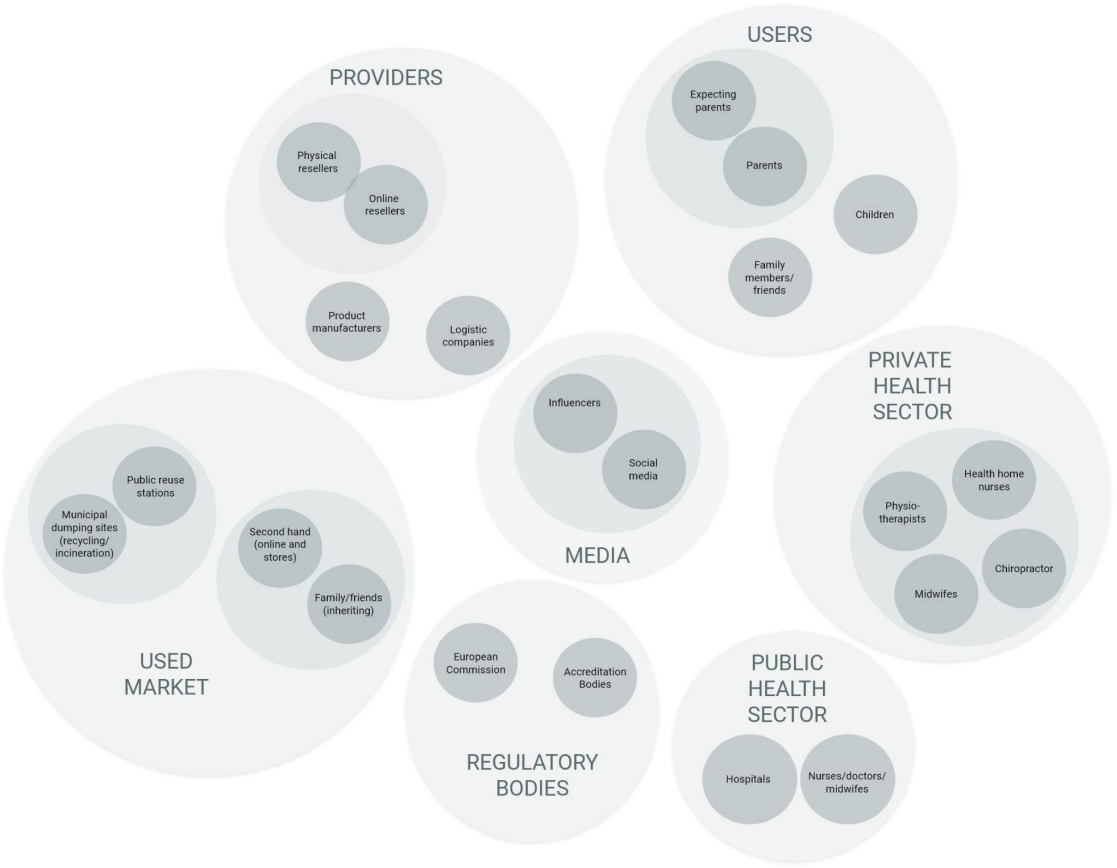


Figure 23: Mapping of the important stakeholders within the baby equipment and toys market

A deeper understanding of the user stakeholders were needed to understand the relationships and flows between stakeholders from the PSS startup's point of view before mapping flows and interrelationships in the ecosystem map.

Understanding the Users

To gather quantitative and qualitative data on users, a survey was developed exploring the purchasing patterns of users and the feelings and concerns related to buying baby equipment and toys. A target plan of places to share the survey online was defined to be sure that the team would reach all possible users within the baby equipment and toys market. The survey was sent out to users through Facebook groups for parents, through Instagram via accounts with a large number of followers, and via friends and family of the team members. The survey attracted 1.093 Danish respondents and 150 foreign respondents. The respondents contributed with additional comments throughout the surveys. The Danish survey results can be found in Appendix 12 *Survey Results Denmark* and the foreign survey results can be found in Appendix *12 Survey Results Foreign*. The large number of respondents show that there is a great interest in the project from the users which further indicates that there is a lack of sustainable purchasing solutions for baby equipment and toys. The surveys gave valuable insights to **demographic** characteristics, like age, gender, employment, and income, **psychographic** characteristics for instance values, attitudes, interests, and lifestyles, and to **behavioral** characteristics such as motivations and emotions. These insights were analysed through a Google Analyse analysis and through a cross-analysis of the survey data.

Amongst other areas of insights, the team was interested in knowing more about the users incentives for renting recirculated products or buying used baby equipment and toys. Moreover, the team was interested in exploring the users behavior around circulated and used products.
Through the initial analysis of the survey data it was found that a large percentage - 35,4% - of the 1.093 respondents stated that they would rent/lease baby equipment and toys products in order to be more environmentally friendly (Figure 24, Appendix 8 *Conducting a Survey*). Hereby a need for more sustainable purchasing solutions, like rental models, is seen amongst the users. This trend discovered in the empirical data was supported by the CEO of BabySam, K. Nørgaard, who said:

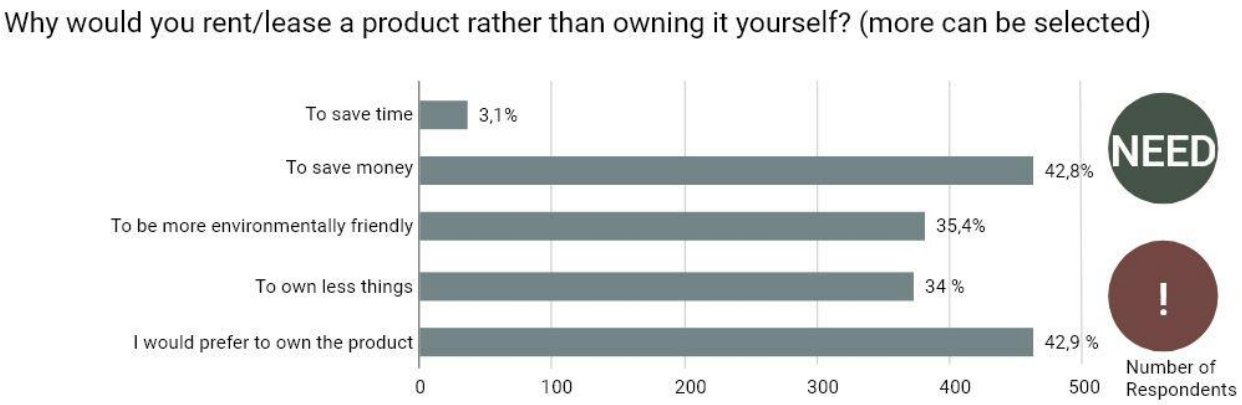
> '*there is a new green generation on its way who is more focused on environmental sustainability - I predict that the generation Z will be the front runners of choosing more sustainable purchasing solutions for baby equipment and toys*'

The need for more sustainable purchasing solutions through the implementation of PSS business models was also supported by the literature stating that:

> *'PSS providers should target environmentally friendly users as studies show that a large group of users choose PSSs due to its lower impact on the environment' - (Akbar & Hoffmann, 2018)*

In the survey analysis it is also seen that a large number of users - 42,8% - respond that they would rent/lease baby equipment and toys to save money (Figure 24). This supports the statement by K. Nørgaard, CEO of BabySam, that users want to be more sustainable, but do not necessarily want to pay more money for it. The survey data therefore further support that the implementation of services providing intangible values to rented/leased products are important to incorporate in the PSS business model.

Figure 24: User incentives for renting/leasing baby equipment and toys



In Figure 25 it is seen that the products that users are prone to rent are types of products that are already available for rental on the market. These are the baby sway motor, that 33.1% could be interested in renting, and a car safety seat that 20.9% could be interested in renting. 27.2% replied that they could be interested in renting the baby sway which cannot be rented by any providers now. The baby sway presumably scores high as this product is closely related to the baby sway motor. This data analysis indicates that users need to be familiarised with rental purchasing opportunities for specific

types of baby equipment and toy products before being interested in taking advantage of rental offerings. This implies that the market for rental solutions is still an unexploited market with large potentials. Furthermore, first movers of implementing rental purchasing solutions are needed as stated by K. Nørgaard.

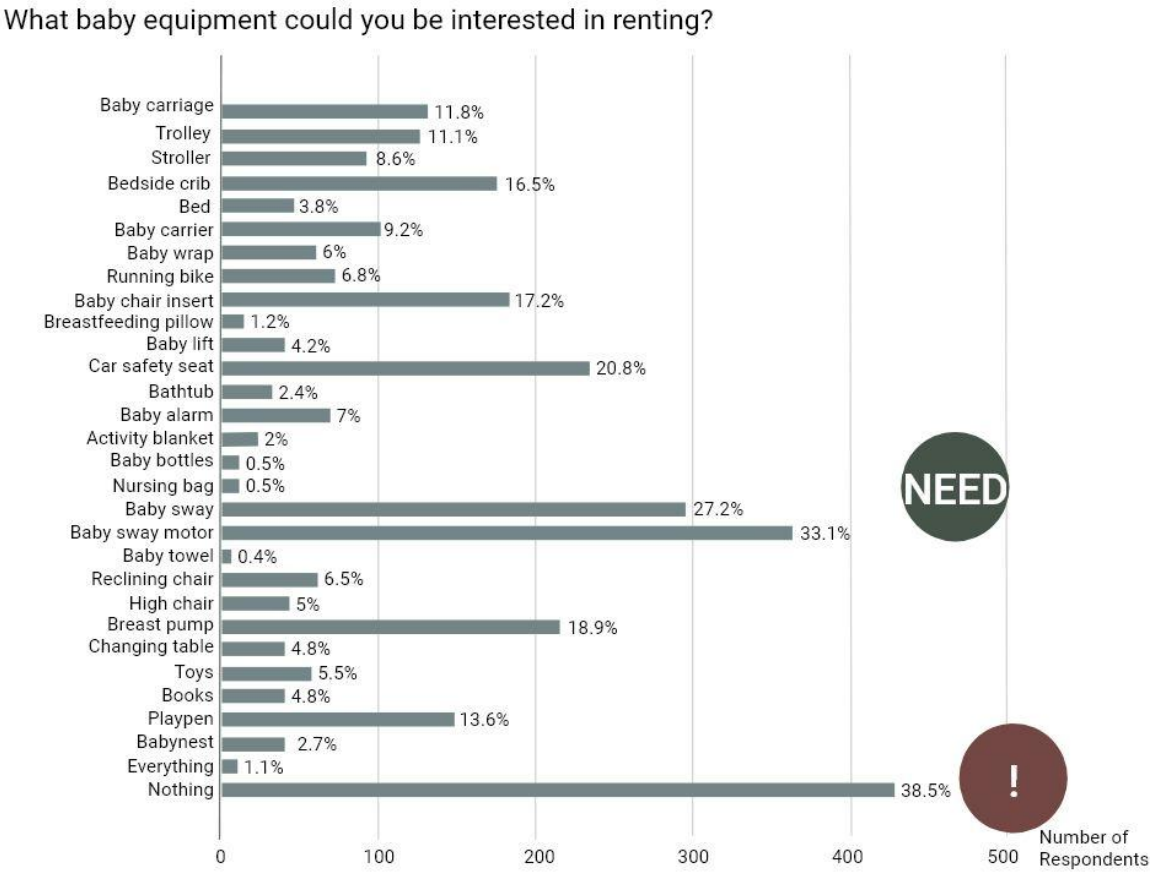


Figure 25: Chart on what baby equipment and toys could be interesting to rent from a user perspective

The results from the cross-analysis of the survey data was conducted to analyse the relationship between variables in two or more of the questions for the users - all analyses can be found in Appendix 8 *Cross-analysis of the Survey*. In Figure 26, an example from the cross-analysis is indicating that the older the user, the more prone he/she is to have resold used baby equipment and toys.

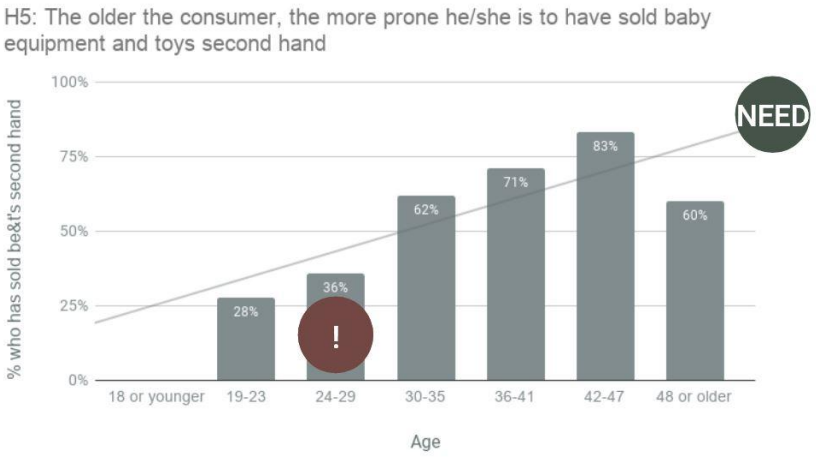


Figure 26: Cross Analysis from survey

More insights to the users practice around purchasing baby equipment and toys were identified through comments to the survey, through user workshops, and through comments on Facebook mapped in the *Affinity Diagram,* Appendix 8 *Affinity Diagram*;

> *'I spent way too much money on my first child, not the second and the third, as I didn't know what I would be needing and therefore bought way too much equipment and toys'* - Survey respondent

> *'I have used everything that I bought, but there were items that were only used a handful of times before being thrown out - these were products that I should have bought at a cheaper price than I did'* - User participating in the user workshop

> *'Parents are prone to buy more (and expensive) products than needed for their first child to be sure that they have what is needed in regards to safety, well-being etc.'* - User commenting on the survey post on Facebook

These insights indicate that the older the user is and hereby the more children the user have, the more prone he/she is to have resold baby equipment and toys. Furthermore, it indicates that first time parents spend much more money on baby equipment and toys than experienced parents due to lack of knowledge on products that are needed. Hereby, the large amount of equipment and toys take up space leading to the parents attempting to sell unused products on used market platforms.

To gather further qualitative data, a workshop with seven users was performed to support a further exploration of the user practice around purchasing of baby equipment and toys. The workshop was performed in an interactive *MiroBoard*. The methods *User Activity Cycle, User's Must-Have Lists, Comparing Product Prices,* and *Challenges & Opportunities* were reviewed and completed together with the users, see the Workshop *MiroBoards* in Appendix 13. These methods started an insightful discussion and conversation on the users attitudes, principles and feelings around existing purchasing solutions for baby equipment and toys. An example of a method applied is found in the *User Activity Cycle* seen in Figure 27. Here a part of the activity cycle is shown where activities from the *during* phase are highlighted - the two other phases of the *User Activity Cycle* (pre phase and post phase) can be found in Appendix 8 *User Activity Cycle*. The method helped the team identify user activities, potential market gaps and to identify where there is a market share with competitors. A problem identified

through the *User Activity Cycle* is that users spend large amounts of money on new equipment and toys when having their first child and then later find out that the large amount of products could as well have been bought used and at a cheaper price. This supports the finding from the cross-analysis and the *Affinity Diagram* indicating that the older users are, and the more children they therefore might have, the more prone they are to buy and sell baby equipment and toys used.

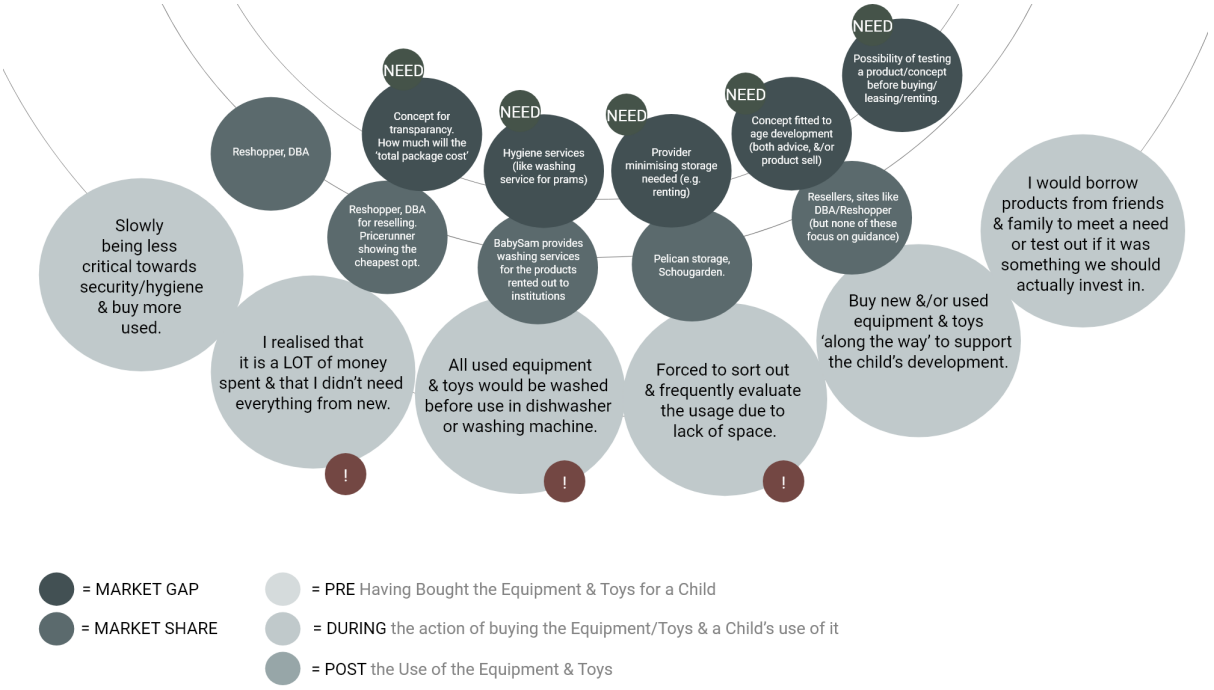


Figure 27: Segmentat of the *User Activity Cycle* co-developed through the workshop with parents

Another problem identified through the workshop with users is that parents tend to be more concerned about the hygiene of used baby equipment and toys than with products for themselves or with products bought from new. This is also seen in the *User Activity Cycle* where an activity identified, related to the use of baby equipment and toys, is to wash equipment and toys in a dishwasher or washing machine before use. This activity leads to the identification of a market gap of providing hygiene services when buying used (e.g. cleaning services of equipment) and a lack of transparency on the actual hygiene standard of products. These hygiene concerns and used product hygiene benefits are expressed by the survey respondents. Users states:

> '*I mostly buy baby equipment and toys from new due to hygiene concerns - especially if it is products that my child will bite in or have close to its body*' - Survey respondent

> *'I mostly buy second hand as toxins from dyeing, painting or other surface treatment have evaporated*' - Survey respondent

These findings indicate that PSS providers including recirculated or used products in their business model strategies should consider how to meet the hygiene standards and consider how to communicate the hygiene standards to users. To ensure that the developed PSS concepts meet this need several criteria were formulated;

1) Used products should be clean; no harming bacteria, no visible stains on contact surface areas, cleaned with environmentally friendly detergent.
2) There should be a hygiene guarantee on products (e.g. products can be send back if they do not meet the hygiene standards of user)
3) The hygiene (cleaning) history of products should be transparent to the user.

Workshop and Survey Insights Applied to other Methods

Additional methods were applied besides the methods co-developed through workshops with Moonboon Baby Studio, BabySam, and seven users. These were added as analysis tools to get more knowledge on possible CE strategies, and on the economic, social, and environmental impacts to the current market. The insights to the market and the users gained through the survey analyses and through the workshops were the basis for the methods added. Examples of added methods are *Quick Life Cycle Assessment Study, Total Cost of Ownership, Rebound Effects,* and *Experience Map.* Selected important insights are highlighted in the section below.

Insights from Total Cost of Ownership, Rebound Effects and LCA

By calculating the total cost of ownership of a pram from a user's perspective, the team gained valuable insights to the direct and indirect costs associated with owning and using baby equipment or toys, see Figure 28. The TCO of a pram highlights the actual cost of different types of prams throughout the entire product life cycle. The cost patterns identified can be applied to other baby equipment and toys as well.

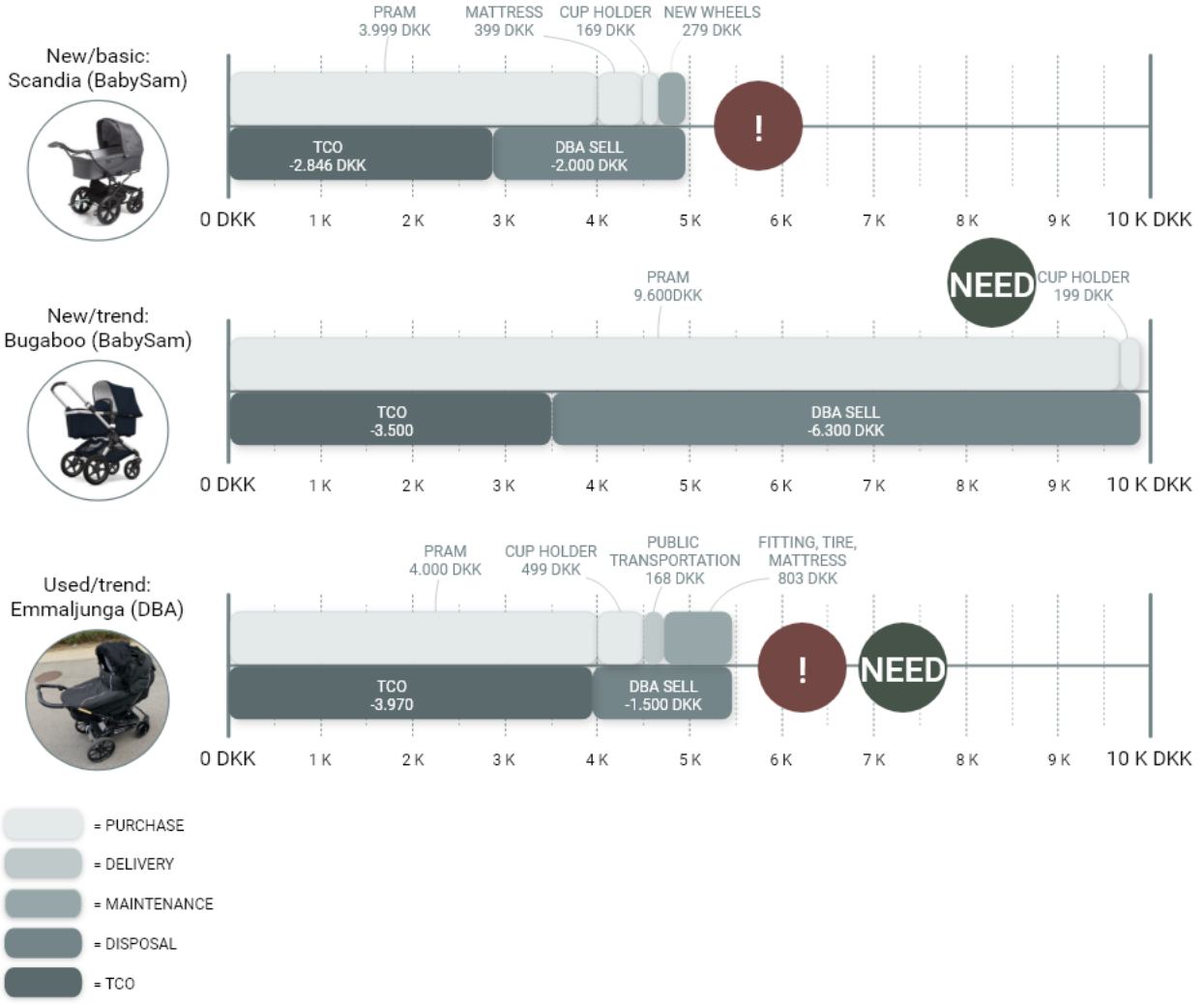


Figure 28: Total cost of ownership of three types of prams

The costs associated with the user activities of *purchasing, delivery, maintenance,* and *disposal* of a pram are based on the product life cycles of prams of the users that participated in the user workshop. Three types of prams are analysed in the TCO being a *basic middle priced pram bought from new*, a *trendy high price pram bought from new*, and a *trendy high price pram bought from used*. Surprisingly, the pram bought from used is the product with the highest TCO. Furthermore, the TCO analysis shows that the trendy pram only costs 654 DKK more than the basic, middle priced pram. Thus, it could be argued that the trendy pram bought from new is the most economically viable product to buy as the user gets a higher quality and more functionalities for the money and can resell the pram at a high price at the end of use. Furthermore, the TCO indicated that the pram is not necessarily an economically

viable product to potentially rent out as prams can be resold at a relatively high price compared to the direct cost. Finally, it is found that used prams are resold at a too high price making it economically unsustainable for the user to invest in a used pram. This is supported by statements from users:

> *'I mostly buy equipment and toys from new as it has been difficult to find the energy for negotiating prices on used products at the end of the pregnancy - it is easier to just buy from new as people set the prices of used products high and close to the sales prices'* - User comment from survey.

> '*Prices on used equipment and toys are set way too high and it is often difficult to evaluate if the prices correspond to the quality of the product'* - User comment from Facebook.

Economically viable purchasing solutions of used equipment and toys are therefore demanded by users as it is seen that the used market prices are too high to be profitable for the users. This leads to more users buying products from new. In Figure 29, a segment of the method *Rebound Effects* can be seen where this consumption pattern is mapped as an indirect rebound effect of users buying too expensive equipment and toys and reselling it at a high price. This causes the indirect rebound effect of users buying equipment and toys from new to occur leading to environmental and economic impacts to the system. All direct, indirect, and economy-wide rebound effects identified from the consumption patterns of the users can be found in Appendix 8 *Rebound Effects*.

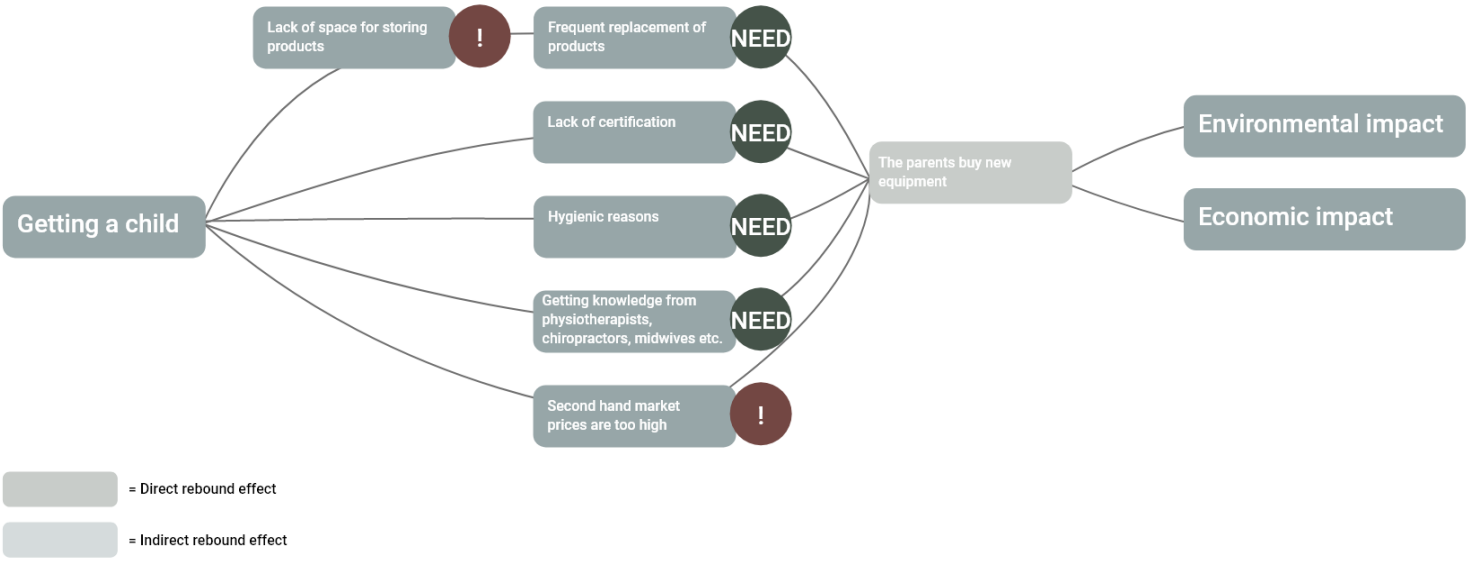


Figure 29: Segment of the *Rebound Effects* methods based on insights from the workshops, the surveys, and the literature study

Another method giving valuable insights to environmental sustainability aspects of the baby equipment and toys market is the *Quick LCA Study* method, see Appendix 8 *Quik LCA Study*. Here a review was performed on a cradle-to-grave LCA of a pram comparing the environmental impacts of a rental and a traditional ownership business model serving all children born in Singapore over five years (Kerdlap et al., 2021). The key takeaways from the LCA review were:

1. Life cycle environmental impacts of renting prams are potentially 29-46% lower compared to the traditional ownership business model if the environmental impacts from the heavy cleaning in the rental model are reduced by;
    a. Reducing the use of electricity based processes
    b. Reducing the use of wet wipes (minimise water consumption)
    c. Reducing the use of materials for cleaning
    d. Reducing the transportation of products for cleaning
2. Users should rent prams if the alternative option is to own a pram and use it for only three years before it is sent for disposal.
3. Rental pram companies should reduce the amount of heavy cleaning cycles to 4–5 times a year (once every 3 months) to have a better environmental performance, compared to scenario ownership 2 where 50% of the prams are passed onto other users.
4. Scenario 1 and 2 (all prams are disposed after use and 50% are passed on to a new user after use) always starts off with higher impacts compared to the rental scenarios.

This LCA study highlights that the main environmental impacts of rented prams occur in the *maintenance* life cycle stage. For PSS providers to decrease the environmental impact of a pram (and presumably other baby equipment and toys products as well) compared to owning the product, the provider needs to reduce the impacts from the heavy cleaning.

The Ecosystem Map

The workshop combined with the insights from the analysed survey data gave a thorough understanding on product-, service, information-, and money flows from the users to other stakeholders allowing for the startup team to map the flows within the ecosystem of the baby equipment and toys market, see Figure 30, Appendix 11 *Ecosystem Map 2.0*.

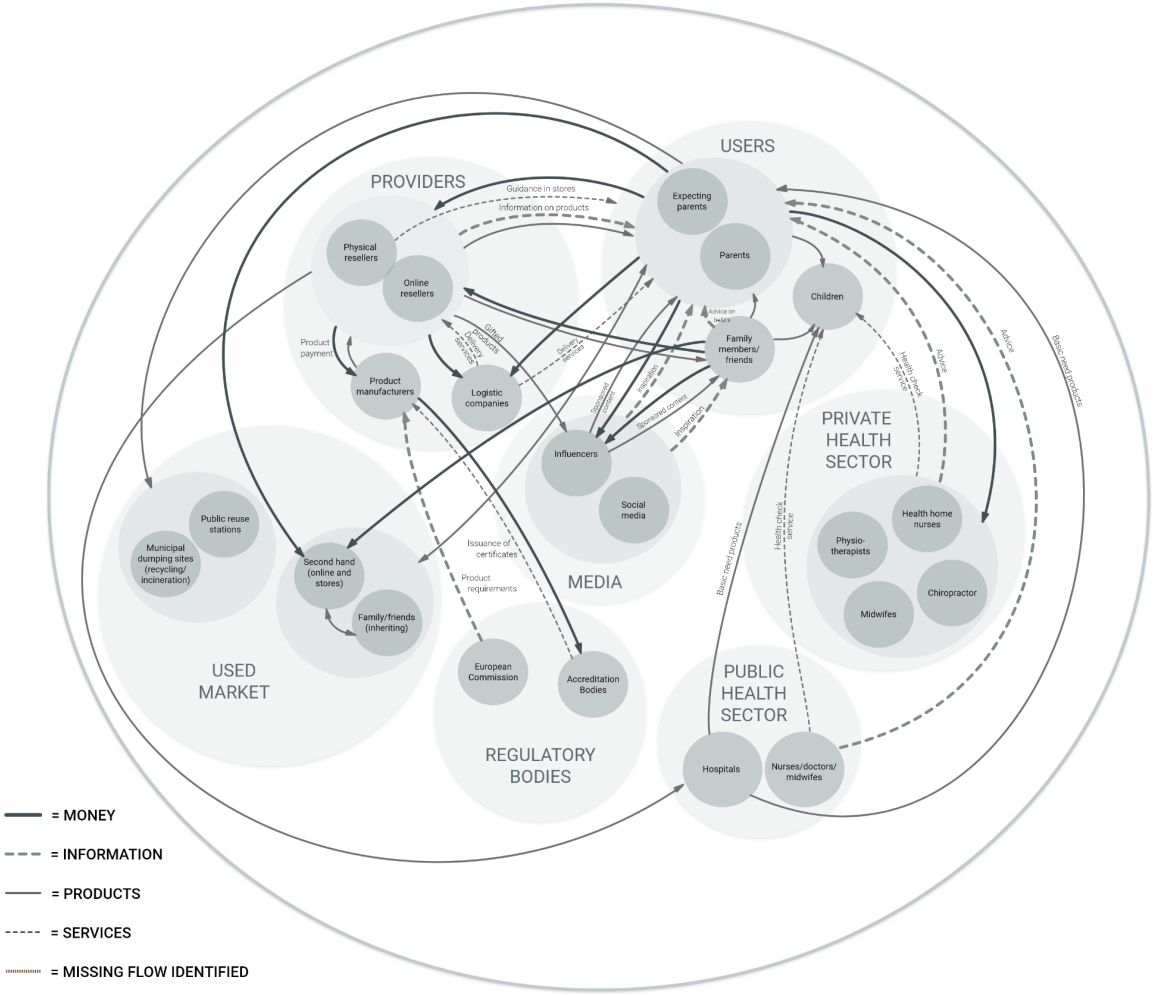


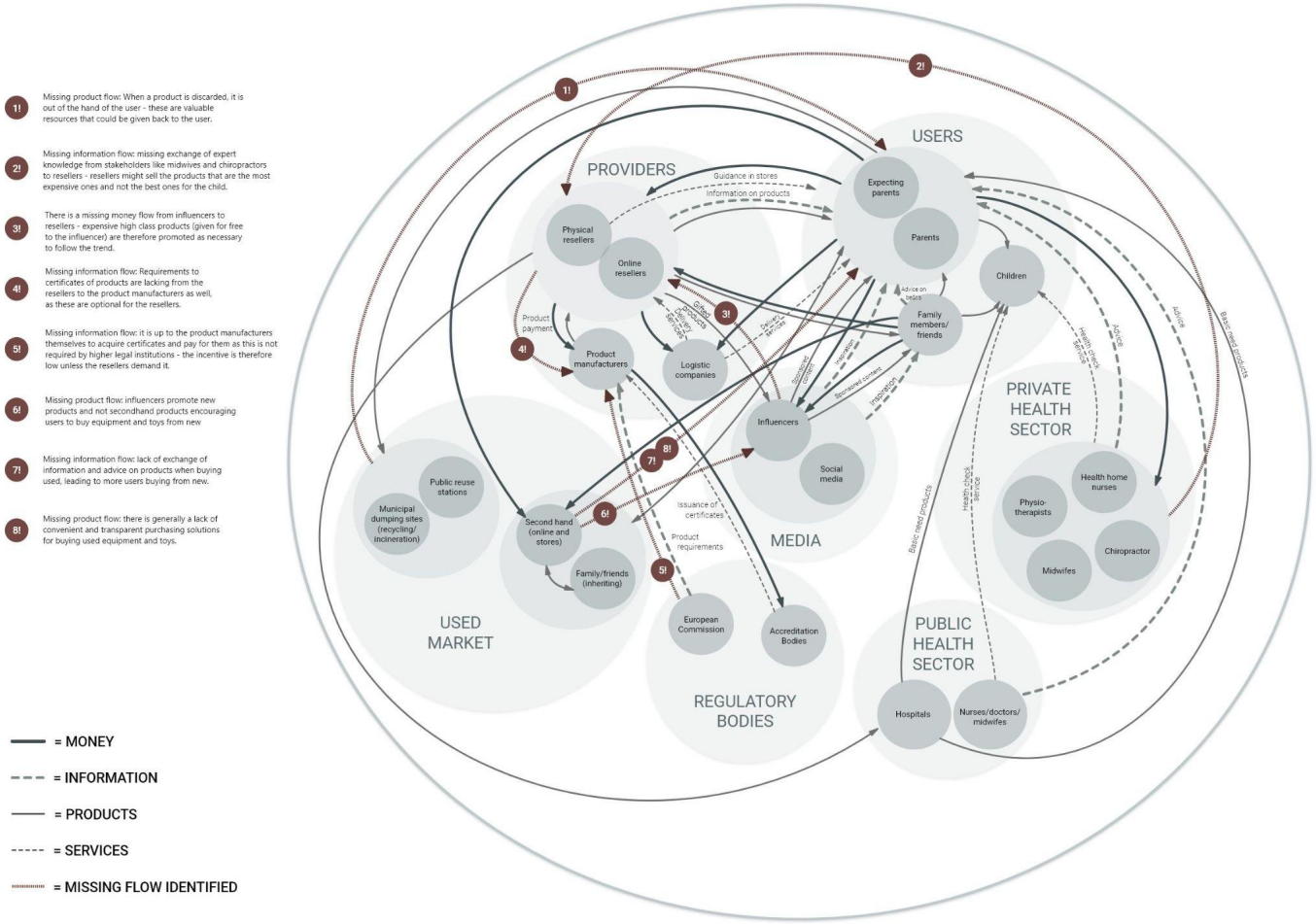
Figure 30: Mapping of the flows between stakeholders within the baby equipment and toys market

Through a divergent approach to the problem space, a deep understanding of the relationship and flows between stakeholders was now obtained via workshops with MoonBoon Baby Studio, BabySam, and several users and through the collection of quantitative and qualitative data through the survey.
To converge the problem space and bring back a focus on identifying the main problems related to purchasing baby equipment and toys, the team identified needs and problems in all methods applied in the *Explore & Reframe* phase. These methods and their respective templates were developed in this project, as knowledge on important needs and problems of the different stakeholders often get lost during a comprehensive exploration of a problem space and as the team members found that there

were no sufficient methods in the literature to apply to gather loose knowledge. The needs and problems identified were depicted as seen in Figure 31 throughout the *Explore & Reframe* phase.

Figure 31: Mapping of needs and problems

Needs and problems from all methods applied during the *Explore & Reframe* phase tapped into missing flows in the ecosystem of the baby equipment and toys market. The ecosystem map hereby summarised the lack of purchasing solutions in the baby equipment and toys market communicated and visualised through missing flows in the ecosystem map. These missing flows of products, services, information, and/or money are highlighted in Figure 32 with dotted red lines. The arrows indicate the



direction of the flows.

Figure 32: Mapping of the missing flows between stakeholders within the baby equipment and toys market

From the missing flows mapped in the ecosystem of baby equipment and toys in Figure 32, it shows that when a product is discarded, it is out of the hands of the user - these are valuable resources that could be given back to the user. The map also shows that there is a missing money flow from influencers to resellers - expensive high class products (given for free to the influencer) are therefore promoted as necessary to follow the trend. Additionally, influencers promote new products and not secondhand products encouraging users to buy equipment and toys from new.
The map shows that there is a missing exchange of expert knowledge from stakeholders like midwives and chiropractors to resellers - resellers might sell the products that are the most expensive and not the best ones for the child. Furthermore, there is a lack of exchange of information and advice on products when buying used leading to more users buying from new. Finally, it is seen that it is up to the product manufacturers themselves to acquire certificates and pay for them as this is not required by higher legal institutions - the incentive is therefore low unless the users demand it. Requirements to certificates of products are also lacking from the resellers to the product manufacturers, as these are optional for the resellers. Hereby it is seen from the missing flow analysis of the ecosystem map that there is a huge potential for closing flows and hereby market gaps through the development of more sustainable purchasing solutions of baby equipment and toys.

The goal of the *Explore & Reframe* phase of understanding the relationships and flows between stakeholders and of understanding needs and problems occurring was met. The next step was now to translate the problems and needs into need-to-have and nice-to-have criteria named *Design Concept Criteria*. By doing this, the PSS startup team ensured that the final concept(s) would meet the user needs and the problems identified by meeting the criteria. Problems and needs were grouped by applying the methods Identified Problems and Identified User Needs and hereafter translated into criteria. Hereafter a grouping of criteria based on the area of which it influences was conducted (e.g. hygiene, convenience, adaptability, identity shaping) and criteria similar to each other were combined into one. This led to a total of 47 need-to-have and nice-to-have criteria that the developed PSS concepts should meet allocated under the titles *product*, *product & service*, and *service* (Figure 33, Appendix 14.

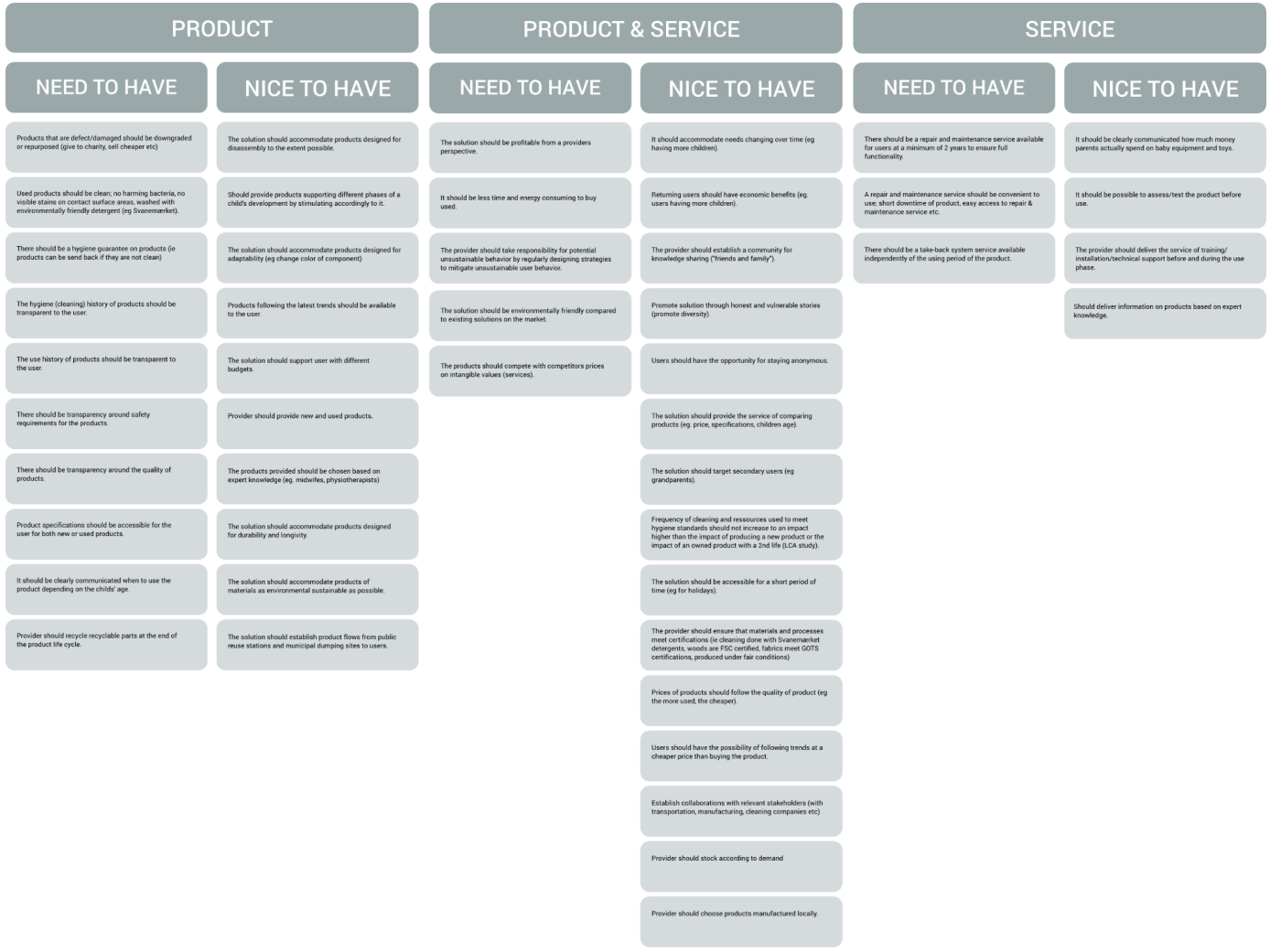


Figure 33: Design Concept Criteria for the PSS concept developed for the baby equipment and toys market.

Summarise of the Explore & Reframe Phase

Through the test of the methods for the *Explore & Reframe* phase it was found that the methods identified from the literature study and selected for this phase were not sufficient to be able to diverge and converge the solution space. Therefore 15 methods were added of which method templates were developed for 10 of these as they did not meet the requirements for the methods added to the guideline.

The solution space for developing innovative purchasing solutions for the baby equipment and toys market was diverged through knowledge gained through workshops with BabySam, Moonboon Baby Studio and seven users and through surveys and a literature study. This knowledge was anchored in methods applied in the phase and by analysing *needs* and *problems* of the stakeholders of the ecosystem the problem space was converged resulting in final *Design Concept Criteria* for the sustainable PSS startup developed with the startup case study. Through the *Explore & Reframe* Phase the Guideline 1.0 have now been tested which have resulted in the revised version 2.0

Create

Create

From the first phase *Explore & Reframe* startups obtained an understanding of the interrelationships between stakeholders and built empathy for users of the market. The startup gained knowledge on PSS and CE strategies and understanding on economic, social and environmental sustainable challenges. The deliverable of the phase was identified *Design Concept Criteria* for developing the sustainable PSS startup enabling a CE. The second phase of developing a PSS startup is called *Create* and incorporates methods for startup teams to go from the developed criteria to creating personas and ending up with different created concepts for the PSS. Through the *Create* phase, the practitioner will develop several concepts co-created with users and the practitioner will narrow down the ideas to concepts. The practitioner will explore the created PSS concepts and define how they engage with all three aspects of sustainability.
The aim of the *Create* phase is:

> *To ideate and brainstorm on **business models** within the startup team and through **co-creation** with users to narrow down **ideas to concepts** contributing to a sustainable and circular development.*

Test and Revision of Methods for the Create Phase

The methods applied in the *Create* phase were based on the collected data from the *Explore & Reframe* phase. During the test of the methods it was found that from the identified methods to the guideline, 3 methods needed to be added to diverge the solution space. The method *Morphology* was added to create ideas with users from identified problem characteristics and the method *Storyboards* was added to gain a common understanding of the selected concepts and to collect feedback to the concepts The *Personas x Concepts* method was added to investigate the concepts against the created personas. This acknowledgement led to the three new methods being applied to the guideline resulting in the Guideline 3.0, see Appendix 5 *Guideline 3.0*.

The aim of the methods is described in Table 14 together with the area of knowledge that the methods contribute to (PSS, CE, and/or sustainability). A more detailed description of the aim of the methods can be found in Appendix 6.

2 out of 3 of the new methods added did not meet one or more of the requirements for the methods added to the guideline being; 1) *it should be descriptive/self explanatory*, 2) *it should have a template*, and 3) *it should be applicable by users with different professional backgrounds*. Method templates were therefore designed by the team, see *Developing a Sustainable and Circular PSS startup* (Appendix 7). Changes were made to the remaining methods for the *Create* phase to streamline the components and design of the templates.

Table 14: Table with applied methods to the *Create* phase.

N	Method	Reference	Aim	Insights to	Added as it supports:	Rating 1-5
1	Create Persona	Kumar, 2013	To define user personalities (personas) representing the types of users of the analysed market and hereby of the future developed concepts. Concepts should address the needs of the identified personas and fit with their context.	PSS / SUS. all aspects / CE	The understanding of what users the concepts should be designed for.	5
2	Brainwriting	IDEO.org, 2015	To facilitate a common brainstorming session of concept ideas or concept features.	PSS / SUS. all aspects / CE	A unified consensus around concept ideas and features.	4
3	Sustainable business model archetypes	N M P Bocken et al., 2014	To be used as inspiration for adding criteria ensuring that the brainstormed solution will contribute to building up a business model for sustainability.	SUS. all aspects	Brainstorming for sustainability.	3
4	PSS Morphology	Finken et al., 2013	To support the development of new concepts or to support the combination of PSS characteristics systematically to describe already identified concepts.	PSS / SUS. all aspects / CE	The development of different concepts with users.	5
5	Circular Economy Business Model Pattern Cards	MATChE, 2021	To support the ideation and brainstorming session through inspiration on potential Circular Economy busineFcircularss model strategies for your startup concepts.	CE	Brainstorming for circular economy.	5

6	Napkin pitch	Scherer et al., 2016	To provide a simple and consistent format to summarize and communicate new concepts brainstormed.	PSS / SUS. all aspects / CE	Communication of new concepts.	4
7	Economic, Social and Environmental Layer - 3 business model canvasses	Joyce & Paquin, 2016	To explore and define sustainability-oriented business model innovation focusing on all three aspects of sustainability.	PSS / SUS. all aspects / CE	The three concepts focus on all three aspects of sustainability.	5
8	Decision Tree to Navigate through PSS Typologies	T. McAloone & Pigosso, 2018	To navigate through PSS typologies to find out if concepts are product oriented, use oriented or result oriented PSSs.	PSS	The concept being a PSS.	5
9	11 characteristics of PSS	Haase et al., 2017	To support a common understanding of developed concepts by identifying PSS characteristics of each concept.	PSS	An understanding of the PSS characteristics for each concept.	5
Added methods						
10	Morphology	Cross, 2005	To support creating a sustainable PSS startup enabling a CE by combining problem characteristics systematically and creating new and suitable combinations.	PSS / SUS. all aspects / CE	Creation of new and suitable combinations from the identified problem characteristics.	5
11	Personas x Concepts	*Method template developed in this project*	To investigate the generated concepts for the concepts against the created personas.	PSS / SUS. all aspects / CE	To ensure that the concepts are fitted for the created personas.	4
12	Storyboards	IDEO.org, 2015	To support a common understanding of selected concepts and to support the communication of the concepts to users when collecting feedback to the concepts.	PSS / SUS. all aspects / CE	To have a common understanding of the selected concepts and to collect feedback.	5

Learnings from the Create Phase

During the *Explore & Reframe* the Guideline 1.0 was tested and revised resulting in the Guideline 2.0. Through the *Create* phase the Guideline 2.0 is tested and revised resulting in the Guideline 3.0, see Appendix 5 *Guideline 1.0-3.0*. The Guideline 3.0 is based on the learnings gained through the use of methods through the *Create* phase.

Personas

Potential users of the PSS were generated based on insights, design principles, values and findings from research. Through a generation of user attributes both demographic and behavioral it was possible to analyse the types of potential users and organise them according to sets of shared

attributes. Four personas were created being true to the findings of the research. A visual profile for each persona was generated to be able to communicate these. The concepts generated later built on the needs of the personas to fit with their context. The four personas were *The Environmentalist*, *The Trend-Follower*, *The Practicalist* and *The Economist*. All personas are described with a bio, personality spectrum, their needs, motivations and frustrations and an explanation of what their favorite brands and websites are. The four personas can be found in Appendix 8 *Personas*. In Figure 34 the example of *The Environmentalist* can be seen.

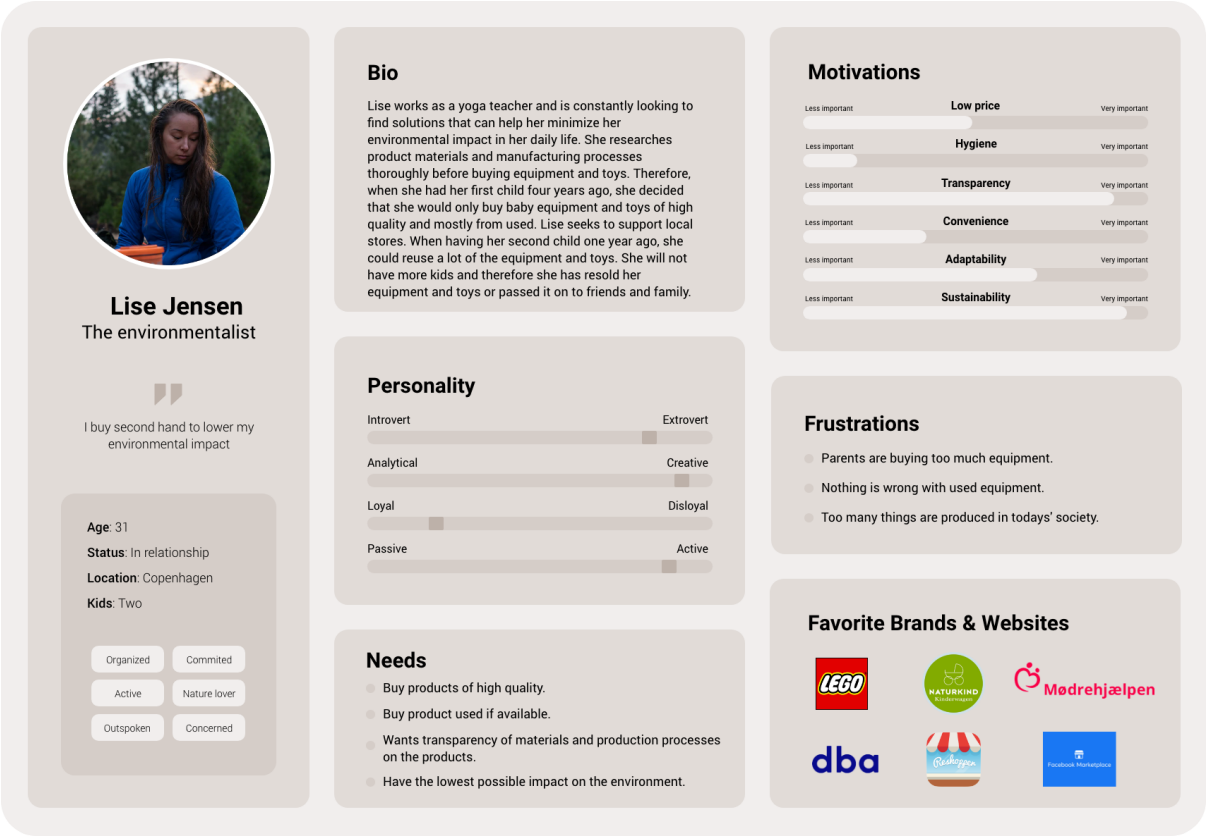


Figure 34: *The Environmentalist* Persona

Brainstorming Ideas and Concepts

The personas developed from the findings from the research in the *Explore & Reframe* phase, helped identify user types and functioned as a starting point for developing ideas and concepts. The methods *The Circular Economy Business Model Pattern Cards* and *Sustainable Business Model Archetypes* supported in sensing opportunities and generating ideas about potential CE business models for the startup development and in describing solutions that can contribute to build up business models for sustainability Appendix 8 *The Circular Economy Business Model Pattern Cards & Sustainable Business Model Archetypes*. The methods were used as inspiration tools for the brainstorming sessions. In the brainstorming session the two methods *Napkin Pitch* and *Brainwriting* were used. *Napkin Pitch* provided a simple method to summarise and communicate concepts and *Brainwriting* allowed for building upon existing suggestions and elaborating on ideas, see Appendix 8 *Brainwriting & Napkin Pitch*. Through these brainstorming sessions 38 ideas were generated, see Appendix 15 *38 Ideas*.

Generating ideas with users through Morphology

Through the generated 38 ideas the different problem characteristics were identified and evolved into a morphology. Creating the morphology revealed the different characteristics for the PSS system and supported how new solutions could be created. The different characteristics generated were: *product, service* (type of activity, price transparency, repair maintenance cleaning services, advice on product, environmental impact transparency), *product condition*, *product quality, brand, platform, location, payment (buy), payment (sell), comments, end-of-life, responsibility, PSS,* and *CE strategies*.

Systematically it was possible to identify new and suitable combinations for different PSS concepts. The generated ideas by the team members had all been based on the findings from the *Explore & Reframe* phase. To keep building empathy with the users, eight users were invited to help generate ideas through the identified characteristics in the Morphology. Co-designing different PSS concepts allowed for ideas generated by potential users.

Users were fond of the renting/leasing opportunities with toys and short term use products, but wanted to be able to pick the products themselves:

> '*that is why I do not want the try-these-wine packages, because they always put in something you do not want'* - User 1
>
> *'I do not want to receive a box with a lot of unuseful equipment or toys. This would result in me buying extra products beside what I rent'*- User 7

The generated concepts can be seen in Figure 35 and in Appendix 8 *Morphology* with comments.

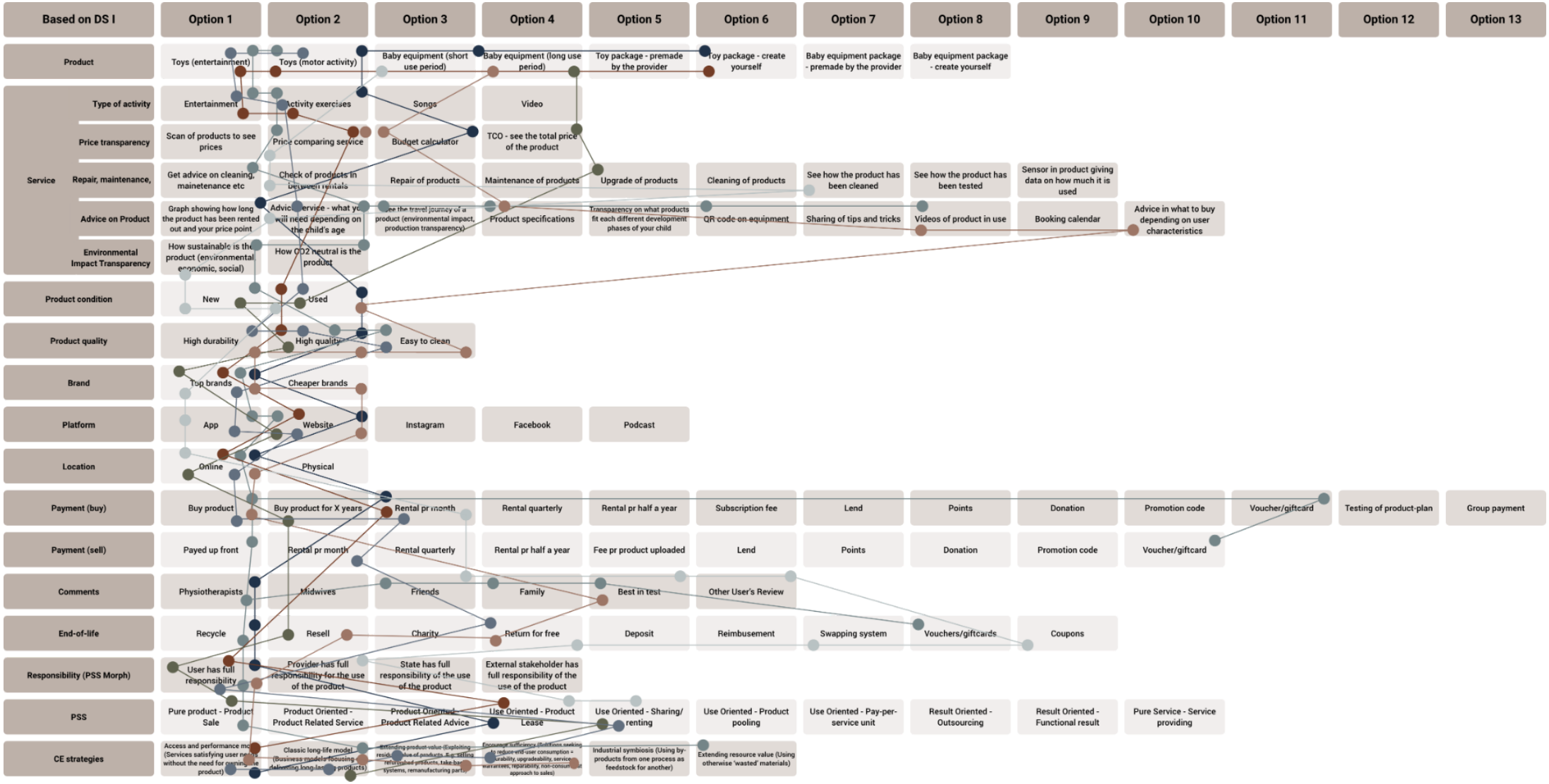


Figure 35: Morphology created with eight use

The brainstorming sessions and the co-created morphology concepts with users turned into 45 ideas in total. By combining brainstormed features and ideas for concept components, the 45 ideas were combined into 17 concepts. The 17 concepts were narrowed down to three concepts based on the insights on the market and on the knowledge on user needs and problems identified in the *Explore and Reframe* phase and based on the user input collected through the co-creation of concept ideas with eight users. The three concepts were named *PlayCase*, *PaRENT* and *MiniStream*.

Investigation of the three concepts

To investigate the value proposition of the PSS concepts the method *The Triple Layered Business Model Canvas* was chosen to support innovation towards more sustainable business models. This method extends the original business model canvas by adding two layers - an environmental layer based on a lifecycle perspective and a social layer based on a stakeholder perspective. By using this method more knowledge was gained about the objectives of the environmental and social aspects of the startup and it was identified where the biggest environmental impacts and benefits laid within the three concepts. The method ensured a focus on all three aspects of sustainability. To investigate the three created PSS concepts the methods *PSS Morphology, 11 PSS Characteristics* and *Decision Tree to Navigate through PSS Typologies* were conducted. *PlayCase* and *PaRENT* scored yes on all the *11 PSS Characteristics*, whereas *MiniStream* did not have a physical product and therefore not a product life cycle either. It was revealed through the methods that *PlayCase* and *PaRENT* were much alike just focusing on circulating different types of products.

The three different concepts were investigated through the *Personas x Concepts* method to ensure that the concepts would fit the personas and to investigate user patterns, see Figure 36.

Figure 36: Personas x Concepts

Storyboards

Finally, storyboards were created for *MiniStream*, *MiniPlay* and *PaRENT* to have a quick, low-resolution prototype as well as a short text describing the concepts. The storyboards were chosen to be black and white to not influence the users. Creating the storyboards allowed for a common understanding of the selected concepts and it supported the communication of the concepts to users when collecting feedback. The three concepts are described as follows:

MiniStream

MiniStream is an app-based platform with games and activities for children aged 0-3 years. MiniStream is a concept that encourages parents to minimise large amount of purchased new toys by offering activities that are built around existing products available in their homes (e.g. kitchen utensils, cardboard boxes and pencils). MiniStream guides users through tailor-made games for their child's needs and offers games within motor and cognitive development which at the same time are entertaining. As a parent, they get access to weekly new games suggested specifically for them. MiniStream gives users the opportunity to entertain their child at any time and anywhere without having to invest a lot of money in the latest toy.

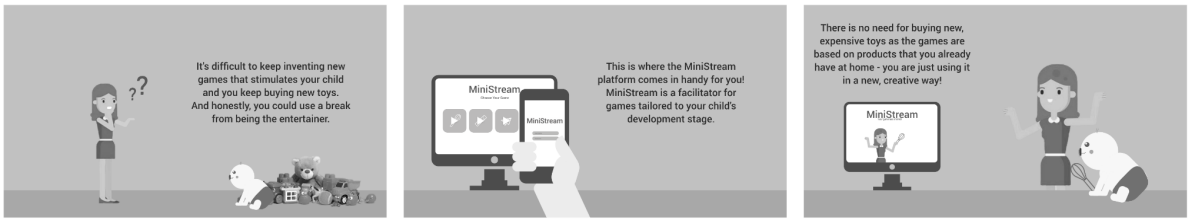


Figure 37: MiniStream

PlayCase

PlayCase is a suitcase with pre-defined or personally selected toys that parents get delivered according to the child's needs. As a subscriber to PlayCase, parents should not think about having to buy the latest toy for their child, and should not familiarise themselves with what toys are needed for the child in terms of their age. The toys are carefully selected to be sustainable and circular and the toys are of high quality brands. As PlayCase subscribers, users can choose whether they want a package sent every month, every other month or every three months. If their child is particularly fond of a specific toy they can choose to extend the rental period. PlayCase circulates the products which are thoroughly cleaned before they are given a new life. With PlayCase, users avoid toys piling up in the home, and they will always have the right toys for their child's developmental stage.

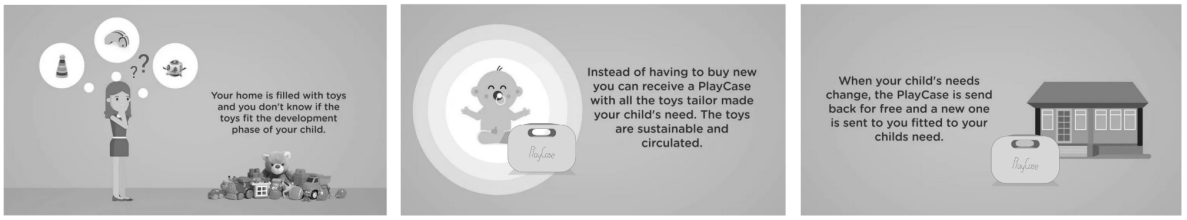


Figure 38: PlayCase

PaRENT

PaRENT is a package of pre-defined or personally selected products that parents should have for their child for the first 12 months. By renting quality equipment through PaRENT users avoid spending large sums on equipment and do not have to worry about the disposal of the products after use. PaRENT delivers the packages to their homes and takes the products back again for free. All products are selected on the basis of sustainability and circular principles. The products are carefully quality assured and cleaned between periods of use. PaRENT packages can easily be ordered online or through the PaRENT app which also guides users with notifications for the equipment they need depending on their needs at a certain time (inspired by pregnancy apps).

As a user, they have the option to extend the rental period of certain products or send a product back ahead of time against a refund if the need for the specific product was not there anyway. Through the app users can also see product specifications, see conditions for the manufacturing staff as well as information about the transport. Additionally, users can see best-in-test reviews and comments from other users. With a PaRENT subscription, users avoid having to buy and store products that they use for a very short time - and they get high-quality products and good design.

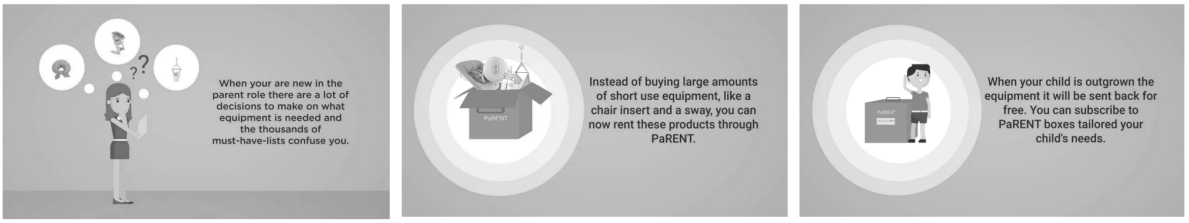


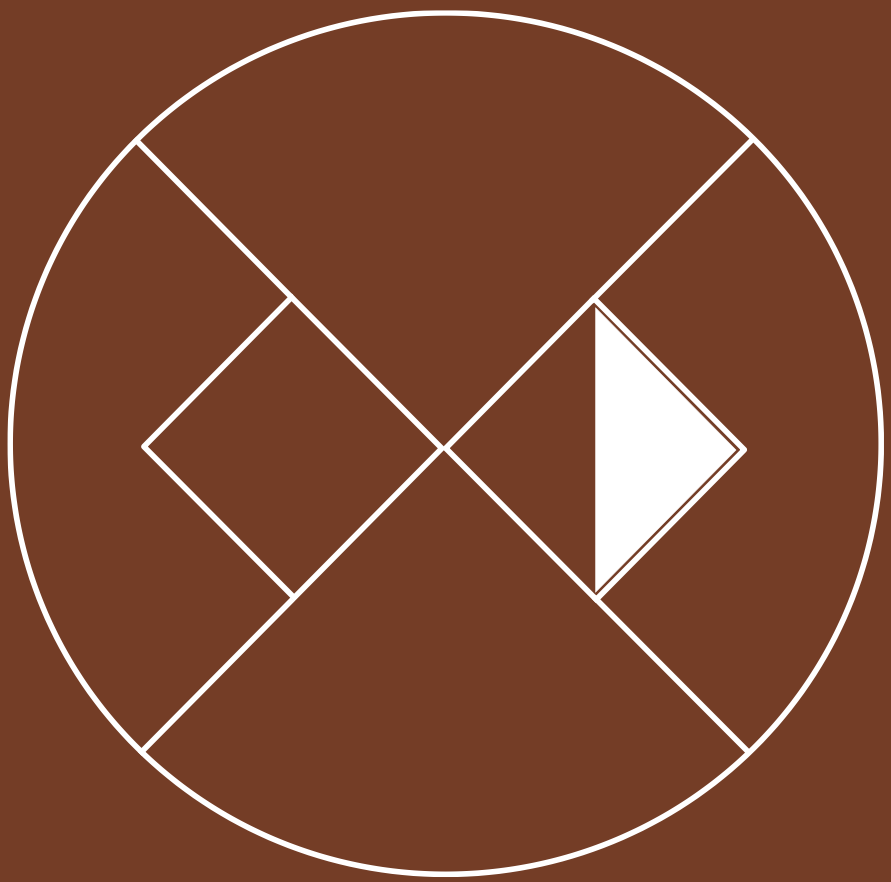
Figure 39: PaRENT

The storyboards supported the understanding of the concepts and was helpful in communicating the concepts to the users when generating user feedback.

Summarise of the *Create* Phase

During the test of the methods it was found that the identified methods for the guideline were insufficient in order to diverge the solution space and challenge the brief. Three methods were added to involve users through co-creation of concepts and to visualise the generated concepts further.

The phase *Create* incorporates methods for startups to move from the developed criteria to ending up with different concepts co-created with users. By developing personas it was possible to create concepts. Ideas were created through different ideation and brainstorming methods which ended in several problem characteristics gathered in a morphology that users could create ideas and concepts from. The three generated concepts were analysed through PSS and sustainability methods to ensure that a sustainable PSS contributing to circular development will be created through sustainable business models. Through the *Create* Phase the Guideline 2.0 have now been tested which have resulted in the revised version 3.0



Catalyse

Catalyse

Ideas for PSS features and aspects of PSS concepts had now been brainstormed and combined into final concepts through the *Create* phase. This led the team on to the next phase called *Catalyse.* This phase incorporated methods making it possible for startup teams to converge the solution space by going from having potential sustainable and valuable PSS concepts to having concepts that are assessed and evaluated against sustainability aspects and evaluated by the users. Through the *Catalyse* phase, the practitioner additionally gained an understanding of the change in product-, service-, money- and information flows between stakeholders within the ecosystem. By the end of the *Catalyse* phase the startup team was able to decide on the concept with the highest sustainability potential, but could choose to move on with several concepts in the *Continuing the Journey* phase e.g. if the team wishes to prototype and test several concepts.
The aim of the *Catalyse* phase is:

> *To make the **PSS concepts tangible** by depicting the changes of flows between stakeholders of each concept to the ecosystem, to **determine the sustainability impact** of the concepts and to **evaluate concepts against criteria**. A final concept may be selected in the catalyse phase if the practitioner has enough knowledge and support to select the most feasible concept.*

Test and Revision of Methods for the Catalyse Phase

Through the testing of the methods found in the literature study and in online guidelines for the *Catalyse* phase, it was discovered that few more methods needed to be added to the guideline to converge the solutions space.
The methods from the *Catalyse* phase in the Guideline 3.0 were tested and gave valuable insights to all aspects of sustainability (*LCA Clinic* and *Rebound Effects*) and to the opportunities for changing the current market being analysed by implementing proposed concepts (*Ecosystem Map* and *Attractiveness Map*). It was found that there was a need for including the users when assessing and evaluating the concepts before being able to move on to the *Continuing the Journey* phase. Therefore the method *User Feedback Survey* was added to the guideline to gather user feedback, and the method *Affinity Diagram* was added to gather and group additional user insights gained through the survey.
Through the testing of the methods for the *Catalyse* phase it was also discovered that the *Design Concept Criteria* developed in the *Explore & Reframe* phase needed to be incorporated as an evaluation tool. This method should be incorporated as it is crucial for the developed concepts to meet the defined criteria if the final concept should be a successful sustainable PSS startup enabling a CE within the specific targeted market. This led to the Guideline 3.0 being revised resulting in the Guideline 4.0. Appendix 5 *Guideline 4.0*.

The aim of each of the new methods applied is described in Table 15 together with the area of knowledge of which each method contributes to (PSS, CE, and/or sustainability). Furthermore, the argumentation for adding the three new methods to the guideline can be found in Table 15. A more detailed description of the aim of each of the newly added methods can be found in Appendix 6.

Table 15: Table with applied methods to the *Catalyse* phase.

N	Method	Reference	Aim	Insights to	Added as it supports:	Rating 1-5
1	LCA Clinic - Life Cycle Assessment and Ecodesign in a Day	Judl et al., 2015	To analyse the assumptions of improved environmental impacts of developed concepts against a reference (eg. existing market solutions) and to compare the environmental impact of selected concepts.	SUS. environment	The analysis of environmental impacts caused by the different developed concepts.	5
2	Rebound Effects	Kjaer et al., 2017	To provide insights to potential increased social, economic, and environmental impacts caused by a change in user behavior due to the implementation of a PSS concept.	SUS. all aspects	The understanding of potential environmental, social and economic impacts to the system caused by the implementation of the concepts developed.	4
3	Ecosystem mapping	Finken et al., 2013	To understand and visualise the change to the ecosystem caused by the implementation of concepts by mapping new established flows and interactions between stakeholders.	PSS	The understanding of change in flows and interactions between stakeholders of the ecosystem of each developed concept.	5
4	Attractiveness Map	The Market Opportunity Navigator, 2020	To evaluate the market opportunity of each concept and to map the level of potential and the level of challenge for the different concepts.	PSS	The evaluation of the most attractive concept(s) out of selected concepts.	3
Added Methods						
5	Affinity Diagram	Beyer & Holtzblatt, 1997	To systemise ideas, opinions and issues collected from a feedback survey.	PSS / SUS. all aspects / CE	The collection of feedback from users that are not anchored in other methods.	5
6	User Feedback Survey	*Method template developed in this project*	To collect feedback to different generated PSS concepts used for assessing and evaluating the concepts. By applying this method, valuable user feedback is gained ensuring that the concept is designed for users and evaluated by users.	PSS	The gathering of user feedback on developed concepts.	5
7	Evaluation of Concepts Against Criteria	*Method template developed in this project*	To evaluate if the previously generated 'need to have' and 'nice to have' are met by the developed PSS concepts in order to assess the different concepts.	PSS / SUS. all aspects / CE	The evaluation of selected concepts - do they meet the criteria developed in the *explore & reframe* phase?	5

Learnings from the *Catalyse* Phase

The team had now gotten a common understanding of the three chosen PSS concepts through the diverging *Create* phase. To reach the goal, several methods supporting an evaluation of the economic, social, and environmental feasibility of the concepts were applied to the startup case study in the *Catalyse* phase. First, a revised *Ecosystem Map* for all three concepts was depicted supporting the understanding of the changes in flows and the changes to interactions between stakeholders. Furthermore, the *Ecosystem Map* should support the selection of concepts (or elements of concepts) to move on with in the next phase of the design process.
As seen in Figure 40, the MiniStream PSS concept closed five out of eight flows identified in the *Explore & Reframe* phase. The identified flows and how they are closed are presented below;

- Flow number 2: MiniStream closes the missing **information** flow from the *private health sector* to product/service *providers* as the MiniStream games are based on knowledge e.g. from midwives, chiropractors, and physiotherapists.
- Flow number 6: MiniStream closes the missing **information flow** from *influencers* to *users* as MiniStream targets promotion of dematerialising toys through social media.
- Flow number 7: MiniStream closes the missing **information flow** from *provider* to *user* as information and advice on the games is provided when purchasing immaterial products through the platform.

The ecosystems of the PlayCase and PaRENT concepts close the same missing flows as described for the MiniStream concept above. They also close the flows number 4 and number 8 as they incorporate recirculated toys or baby equipment in their business model. These can be seen in Figure 41 and Figure 42. All Ecosystem Maps can be found in Appendix 11 *MiniStream, PlayCase, & PaRENT*.

MiniStream

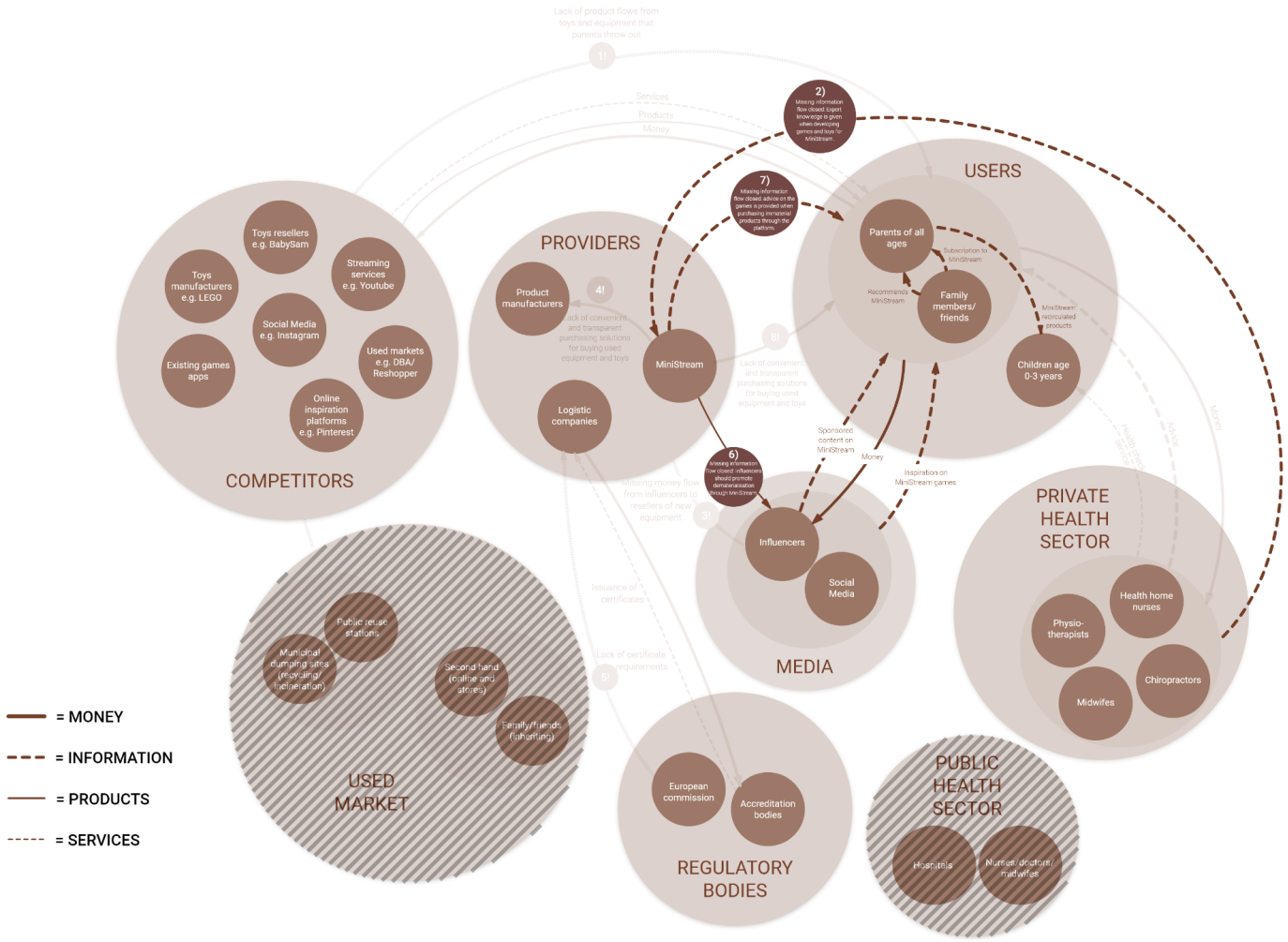


Figure 40: Revised ecosystem map of the MiniStream concept

PlayCase

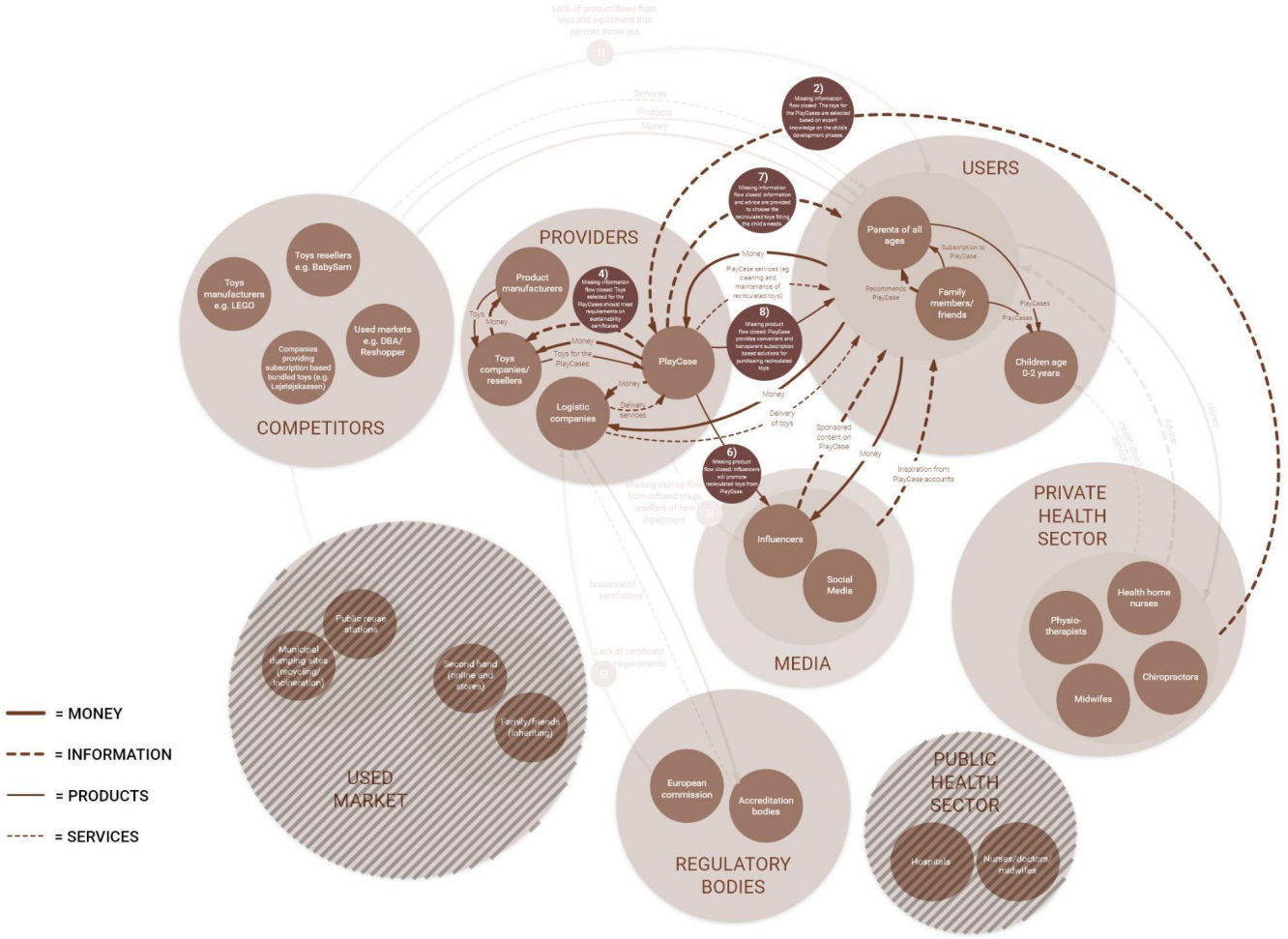


Figure 41: Revised ecosystem map of the PlayCase concept

PaRENT

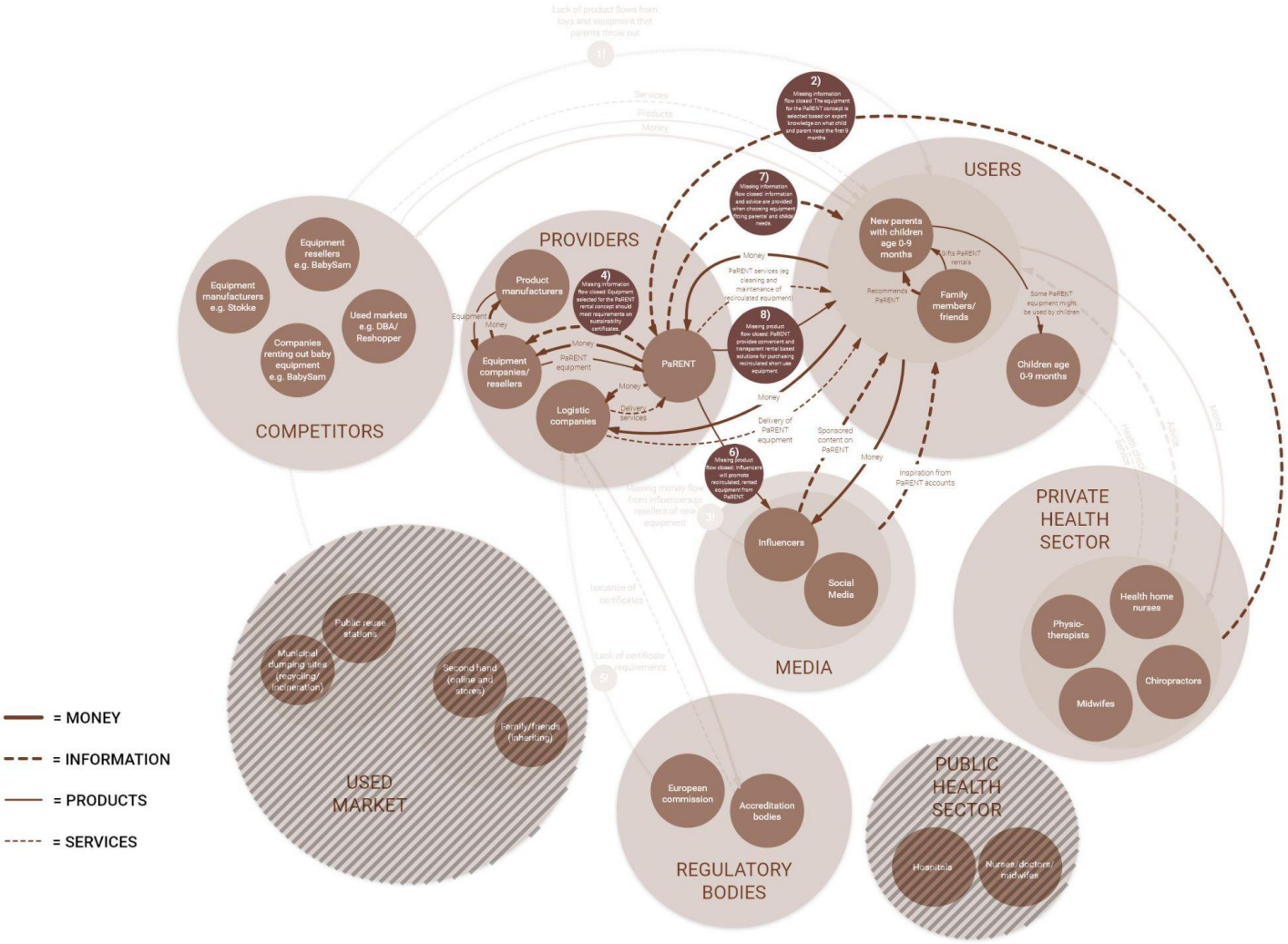


Figure 42: Revised ecosystem map of the PaRENT concept

It can be seen from the ecosystems of the three concepts that the *user* stakeholders and the interaction between these differ from concept to concept. For the MiniStream concept, the targeted users are *parents of all ages* and *family members/friends* while the end users are *children aged 0-3 years*. For the PlayCase concept, the targeted users are *parents of all ages* and *family members/friends* while the end users are *children aged 0-2 years*. Finally, the targeted users for the PaRENT concept are *new parents with children aged 0-9 months* and *family members/friends*. The end users of the PaRENT concept are both the parents and the their children as some equipment (eg. a breast pump) is used by the parents and some (eg. a bedside crib) is used by the child.
As well as a difference in *user* stakeholders between the concepts, a difference in competitors are also seen in the ecosystem maps. The competitors to the MiniStream concept encompasses both resellers, manufacturers, and used market platforms selling toys as well as online platforms providing inspiration for games, Figure 40. Competitors to the PlayCase and PaRENT concepts are found to be manufacturers, resellers, used markets and rental companies selling/renting out respectively toys and equipment.
As seen in the *Ecosystem Maps*, the MiniStream concept has fewer relationships and flows between stakeholders as this concept does not incorporate a physical product. Therefore, the infrastructure is significantly less complex than for the PlayCase and PaRENT concept.

The ecosystem maps of the three concepts show that several flows missing in the ecosystem of the current market will be closed by implementing both the MiniStream, the PlayCase and the PaRENT concepts. The PlayCase and the PaRENT concept showed to close two more flows than the MiniStream concept as these incorporate a physical product element.
To further support a selection of the three concepts, the methods *Life Cycle Assessment and Ecodesign in a Day*, *Rebound Effects, Attractiveness Map, User Feedback Survey, Choosing Recirculation Strategy* and *Evaluation of Concepts Against Criteria* were applied in the *Catalyse* phase, see Appendix 8. These methods supported the understanding of the feasibility of each concept taking possible economic, environmental, and social sustainability aspects into account as well as user feedback from 267 users and possible CE strategies into account. Selected insights from these methods are highlighted in the sections below.

Life Cycle Assessment and Ecodesign in One Day

The method *Life Cycle Assessment and Ecodesign in One Day* was applied to get an estimated quantification of the environmental impact of each of the three concepts. The method template is inspired by the *Life Cycle Clinic for startups* template developed by (Judl et al., 2015). The test of the methods *functional unit, the revenue, the system boundaries* and *the LCA results* can be found in Appendix 8. The concepts were compared to a reference product which is the alternative concept scenario in the existing market. Six scenarios were hereby mapped in the LCA, see Table 16.

Table 16: The different concept scenarios with the reference products and the

Reference product (products within the existing market)	Analyzed product (the concepts)
5 pieces of **toys** are bought from new	PlayCase - 5 pieces of toys are rented (results from the LCA of a rented pram from the *Explore and Reframe* phase is applied here*)
5 pieces of **short use equipment** are bought from new	PaRENT - 5 pieces of equipment are rented (results from the LCA of a rented pram from the *Explore and Reframe* phase is applied here*)
4 pieces of newly bought toys are used for playing games for one hour every day for half a year	MiniStream - videos streamed from app/ website 1 hour every day for half a year

**Lifecycle environmental impacts of renting prams are potentially 29-46% lower compared to the traditional ownership business model.*

The scenarios were modelled and the characterised impact profile at midpoint level and the weighted impact profile at endpoint level were calculated in SimaPro. In Figure 41, the weighted impact profiles can be seen. A key takeaway from this chart is that the *PaRENT* (existing alternative) has the highest impact to all three endpoint impact categories. This indicates that the biggest potential for minimising the impact of the user is by choosing the *PaRENT* concept. This is due to the team assuming that the impact of renting short use equipment would potentially be 29-46% lower compared to owning the products as seen in the pram LCA study (Kerdlap et al., 2021). Another key takeaway is that the *MiniStream* concept has a higher impact to Ecosystems and Human health compared to the existing alternative - this indicates that the *PlayCase* and *PaRENT* concepts have larger potentials for minimising the environmental impact than the *MiniStream* concept.

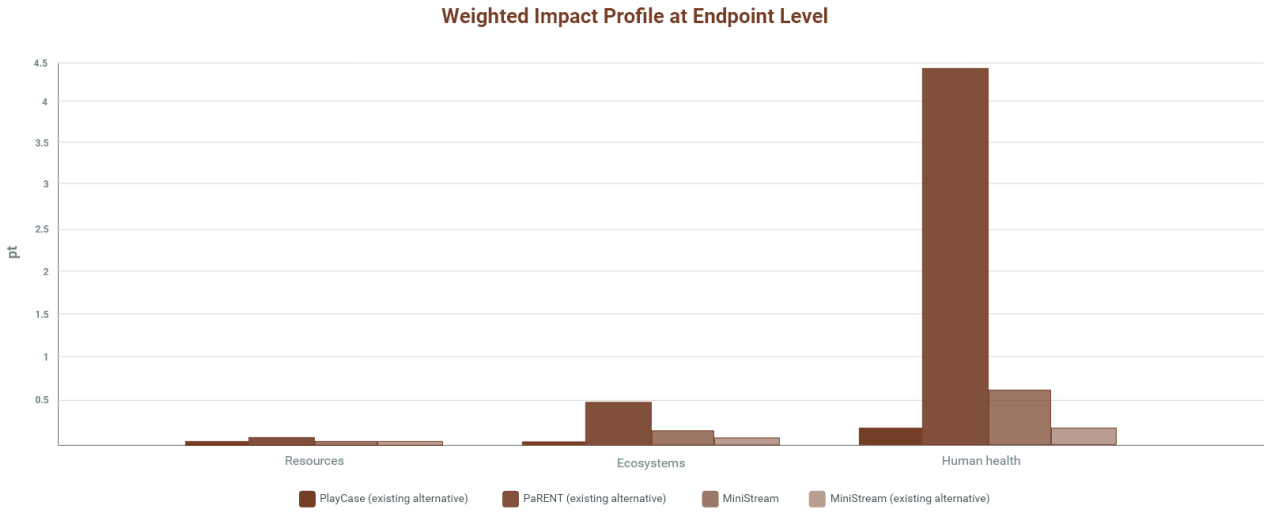


Figure 41: The weighted impact profile of the modelled scenarios at endpoint level

Survey Analysis - Feedback on the Three Concepts

The users were involved in evaluating and selecting concepts through a user survey gathering feedback on the three concepts, see Appendix 12 *Concept User Feedback*. In just one day, 267 users responded to the survey. The large number of respondents once again indicate that there is a need for developing innovative and sustainable purchasing solutions for buying baby equipment and toys.
The test and the results of the survey analysis method can be seen in Appendix 8 *Analysis Survey Analysis - Feedback*. The distribution of favorite concepts amongst the users can be seen in Figure 44. Here the *MiniStream* concept takes first place with 50.5% of the users vote followed by the *PaRENT* concept with 28.7% and the *PlayCase* concept with 20.8%.

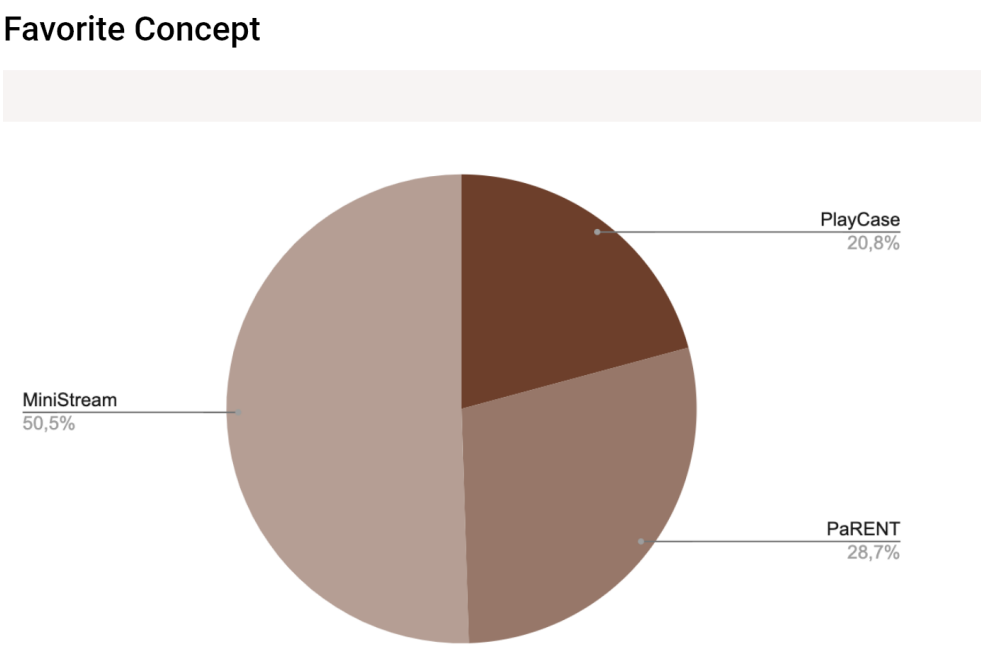


Figure 44: Users' attitude towards the three concepts

The survey allowed for the respondents to further elaborate on their selection of favorite concepts. These are grouped in the *Affinity Diagram* method and can be found in Appendix 8 *Affinity Diagram*. Selected quotes that present consistent attitudes and arguments for choosing the three concepts are extracted from the affinity diagram and presented below.

> ***'MiniStream*** *is my favorite concept as it could help me to be more creative with the things that I have at home and at the same time same money on toys - I have experienced that my children are most fond of things that are not necessarily designed to be toys like spoons and tupperware.'* - user

> *'I like the* ***PaRENT*** *concept the most as it would be great to be able to borrow equipment that you do not use for a long period of time - before having a child, you have no idea of what equipment is necessary.'* - user

*'**PaRENT** is a really great idea for those who want products of high quality but may not be able to afford it themselves - or for those who do not have a lot of space.'* - user

*'**PlayCase** is my favorite concept as I am in favor of reuse and recycling of products - The toys I buy pile up at home but at the same time I want the best toys for my child. Therefore a rental purchasing solution for toys would fit me'* - User

A cross-analysis of the *User Feedback Survey* data was performed to further understand the selection of favorite concepts based on the profile of the user. An example of a cross-analysis chart can be seen in Figure 45. This demonstrates that there is the highest percentage of users within each 'number of children'-category that votes that the *MiniStream* concept is their favorite concept. Additionally, it is seen that the *PlayCase* concept scores lowest for users with one child (waiting second) and for users with two or more children. This indicates that the *PlayCase* concept is not needed when there are two or more children to entertain each other.

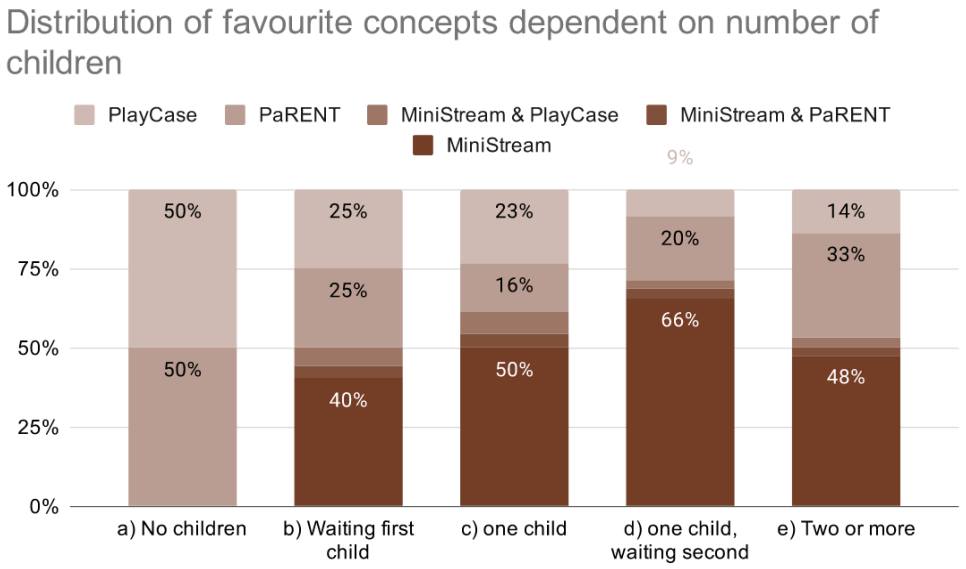


Figure 45: User distribution of favourite concepts depending on number of children

Evaluation of Concepts Against Criteria

By evaluating the concepts against the *Concept Design Criteria* defined in the *Explore & Reframe* phase, the team explored to what degree the concepts would be sustainable PSS startup business models enabling a CE. Hereby, the method *Evaluation of Concepts Against Criteria* can be used to select a concept or opt out concept ideas if they do not meet the criteria sufficiently see Figure 46. As seen in Appendix 8 *Concepts Against Criteria*, all three concepts meet all need-to-have criteria. Thus, four product-oriented criteria have been nullified for the *MiniStream* concept as this concept does not incorporate a physical product.

Evaluation of Concepts Against Criteria

- Not a physical product
- X Solution fulfills criteria
- 0 Solution does not fulfill criteria

NEED TO HAVE

PRODUCT	MiniStream	PlayCase	PaRENT
Products that are defect/damaged should be downgraded or repurposed (give to charity, sell cheaper etc)	-	X	X
Used products should be clean; no harming bacteria, no visible stains on contact surface areas, washed with environmentally friendly	-	X	X
There should be a hygiene guarantee on products (ie products can be send back if they are not clean)	-	X	X
The hygiene (cleaning) history, the use history, safety requirements and the quality of products should be transparent to the user.	-	X	X
Product specifications should be accessible for the user for both new or used products.	X	X	X
It should be clearly communicated when to use the product depending on the childs' age.	X	X	X
PRODUCT & SERVICE			
The solution should be profitable from a providers perspective.	X	X	X
It should be less time and energy consuming to buy/use used equipment.	X	X	X
The provider should take responsibility for potential unsustainable behavior by regularly designing strategies to mitigate unsustainable user behavior.	X	X	X
The solution should be environmentally friendly compared to existing solutions on the market.	X	X	X
The products should compete with competitors prices on intangible values (services).	X	X	X
SERVICE			
There should be a repair and maintenance service available for users at a minimum of 2 years to ensure full functionality.	-	X	X
A repair and maintenance service should be convenient to use; short downtime of product, easy access to repair & maintenance service	-	X	X
There should be a take-back system service available independently of the using period of the product.	-	X	X
SUM	7/7 = 100%	14/14 = 100%	14/14 = 100%

Figure 46: Concepts Against Criteria.

Final Concepts

The evaluation methods led to arguments for choosing different concepts to move on with depending on the type of evaluation method. Hereby there is no unambiguous answer to what concept is the most feasible concept to move on with in relation to CE and sustainability.

As found in the method *11 PSS Characteristics* in the *Create* phase, the *MiniStream* concept was missing a physical product. As one could argue, the MiniStream concept would therefore be a service and not a PSS. Thus, as the users favorite concept was the *MiniStream* concept, it was decided to merge the concepts *MiniStream* and *PlayCase* and hereby apply *MiniStream* business model aspects to the PlayCase concept. This resulted in a PSS business model where recirculated, rented toys are supported by different exercises to the toys through a web and mobile application. The combined concept was named *'MiniPlay'* resulting in the concepts *MiniPlay* and *PaRENT* to be further developed in the *Continuing the Journey* phase.

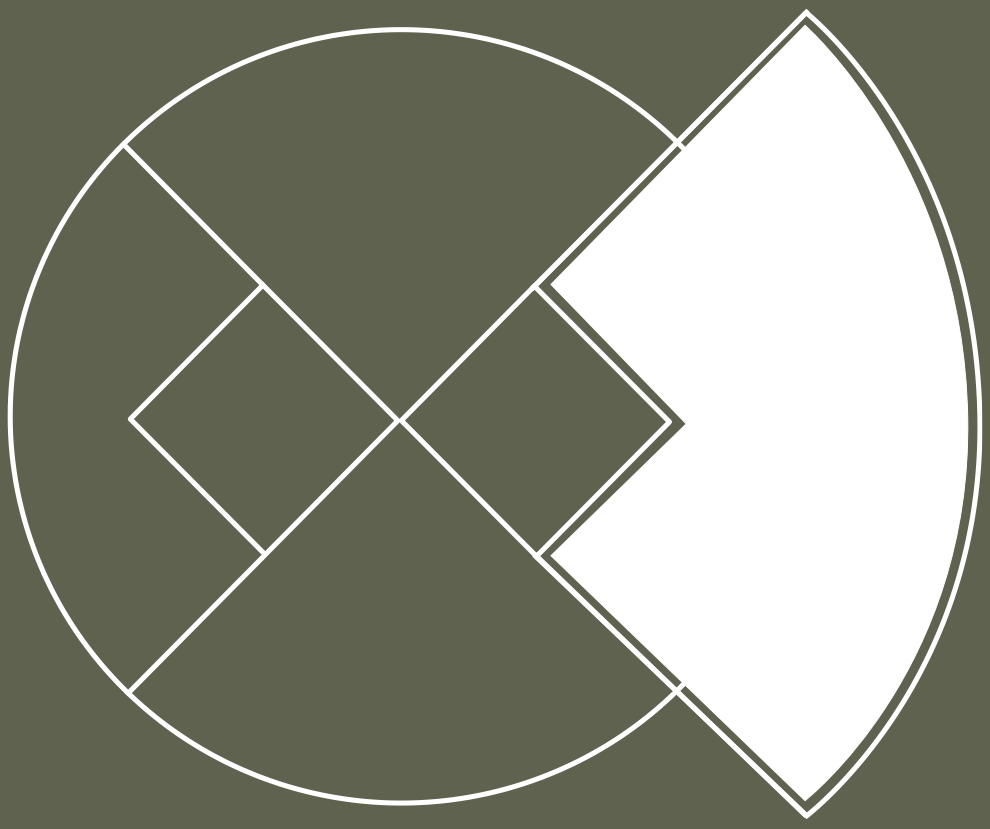
Other practitioners using the guideline as a framework for developing a sustainable PSS startup could choose one concept to move on within the *Continuing the Journey* phase. Thus, it was decided to move on with two concepts in this startup case study as more user feedback was needed to select one of the concepts.

Summarise of the Catalyse Phase

Through the converging *Catalyse* phase it was found that few more methods needed to be added to the original Guideline 3.0 to converge the solution space. The added methods were methods supporting the collection of user feedback on proposed concepts and supporting the evaluation of concepts against the criteria defined in the *explore & reframe* phase. This led to a Guideline 4.0, see Appendix 5 *Guideline 4.0*.

The revised ecosystem based on the changes in flows and interactions between stakeholders caused by the implementation of the three concepts, gave great insights to possible changes to the ecosystem of the current way of purchasing baby equipment and toys. All three concepts established product-, service-, money- or information flows that do not exist between stakeholders of the current baby equipment and toys market today.

A decision on combining the concepts *MiniStream* and *PlayCase* was taken based on the understanding of the feasibility of each concept taking both economic, environmental, and social sustainability aspects into account as well as user feedback from 267 users and possible CE strategies into account. Hereby the concepts *MiniPlay* and *PaRENT* were chosen to be further explored in the *Continuing the Journey* phase.



Continuing the Journey

Continuing the Journey

In the *Catalyse* phase methods had been incorporated to make it possible for startups to converge the solution space to end up having concepts evaluated against sustainability aspects and evaluated by users. It was chosen to move forward with the two concepts MiniPlay and PaRENT.
Through *Continuing the Journey* the startup will reflect on the concept(s) and create and share knowledge for the future work of the outcome. The practitioner will gain knowledge around the services delivered for each concept and gain knowledge on how to build the brand around the circular innovation and finally a visualisation and strategic plan for the future will be developed.
The aim of the *Continuing the Journey* phase is:

> To define the **final concept(s)** and to **reflect** on what needs to be done through **further work** as the project is **open-ended** and more development and knowledge therefore might be needed to proceed with a concept.

Test and Revision of Methods for the Continuing the Journey Phase

Three methods were tested in the *Continuing the Journey* phase through the case study of developing a concept within the market for baby equipment and toys. The aim of the methods is described in Table 17 together with the area of knowledge that the methods contribute to (PSS, CE, and/or sustainability). A more detailed description of the aim of the added methods can be found in Appendix 6.

Through the phase *Continuing the Journey* it was found that the startup was not ready to move forward with only one idea as the concepts would need to be explored further. Through the *Continuing the Journey* phase it should be ensured that the final Guideline 5.0 had goals and a plan to develop the startup further in the future. Therefore, the method *Roadmap* was added to the guideline. The final business model for the concepts will be developed in the *Continuing the Journey* phase, a method used in the *Create* phase.

Table 17: Table with applied methods to the *Continuing the Journey* phase.

N	Method	Reference	Aim	Insights to	Added as it supports:	Rating 1-5
1	Service Blueprinting	(Pezzotta et al., 2018)	To map the user journey and the company's processes happening simultaneously and to support a common understanding of the services delivered.	PSS / CE	The understanding of the services delivered for each concept.	5
2	Brand Promise	Ellen MacArthur Foundation, 2018	To describe your brand purpose and hereby your message to your customers and to build the brand around your circular innovation.	PSS / CE	The understanding of the message of each concept.	4
Added Method						
3	Roadmap	Roadmunk, 2021	To visualise and map the strategic plan that defines the goal or the desired outcome of your startup and includes the major steps and milestones needed to reach it.	PSS / SUS. all aspects / CE	Building a strategic plan that defines the future goals of the startup and/or concept.	5

Learnings from the Continuing the Journey Phase

Elaborating on MiniPlay and PaRENT

From the *Catalyse* phase the concepts went from three to two. The method *Brand Promise* was performed for the two concepts *MiniPlay* and *PaRENT* to build the brands around the circular innovation, see Appendix 8 *Brand Promise*. The two concepts focus on recirculation of products and should be reused by several users. When not functioning the products should be either upgraded or fixed through repair and maintenance. When the product reaches the end of life it should be either refurbished, remanufactured or repurposed.

The method *Service Blueprint* represents the service delivery process for the two concepts. It facilitates the description of the relationship between the user and the organisation and describes the user journey and the company's process simultaneously. By mapping the service delivery process it can help improve the employee experience and indirectly the user's experience, see Appendix 8 *Service Blueprint*. This method should be elaborated further when the startup chooses one concept.

As it was chosen not to choose between the two concepts *MiniPlay* and *PaRENT* as the startup assessed that the concepts needed further investigation a roadmap was conducted. The roadmap serves as a strategic plan for the future. Through the roadmap a development plan was created from 2021-2023, see Appendix 8 *Roadmap* and Figure 47.

Regarding the development of the two concepts an evolving phase of the concepts is planned for the Q3 in 2021. Here users will be involved through tests of the concepts by creating a survey and through focus groups and workshops. It is still very important for the startup to engage with users to make sure that the final PSS concept will be accepted by users. The business model will be further elaborated for the final concept both in terms of the economic, social and environmental aspect. The startup will apply for funding and accelerator programs throughout the rest of 2021 to ensure it is economically possible to establish the PSS. The PSS concept is reliant on engaging with experts, therefore an establishment with pediatricians, pedagogues, physiotherapists, health nurses and midwives will be created and maintained throughout the life of the PSS.

In Q4 2021 a selection of the concepts between *MiniPlay* and *PaRENT* will happen. A prototype of the concept will afterwards be created. Users will be involved in the testing of the prototype to ensure the successfulness of the PSS for both the app and the chosen products. Through 2022 the startup will establish themselves as a company and the PSS will kick-off. Instagram will be targeted following a product release campaign created in collaborations with marketing companies who will also help with focused advertising. Other potential partnerships will be established e.g. with Lego or BabySam and in 2023 influencers will be targeted to advertise for the PSS. In 2023 the first recirculation of products will happen which will include maintenance and cleaning as services.
The roadmap has served as a communication tool to help articulate the strategic thinking behind both the goal and the plan for getting there and therefore the roadmap will also be elaborated on in the future.

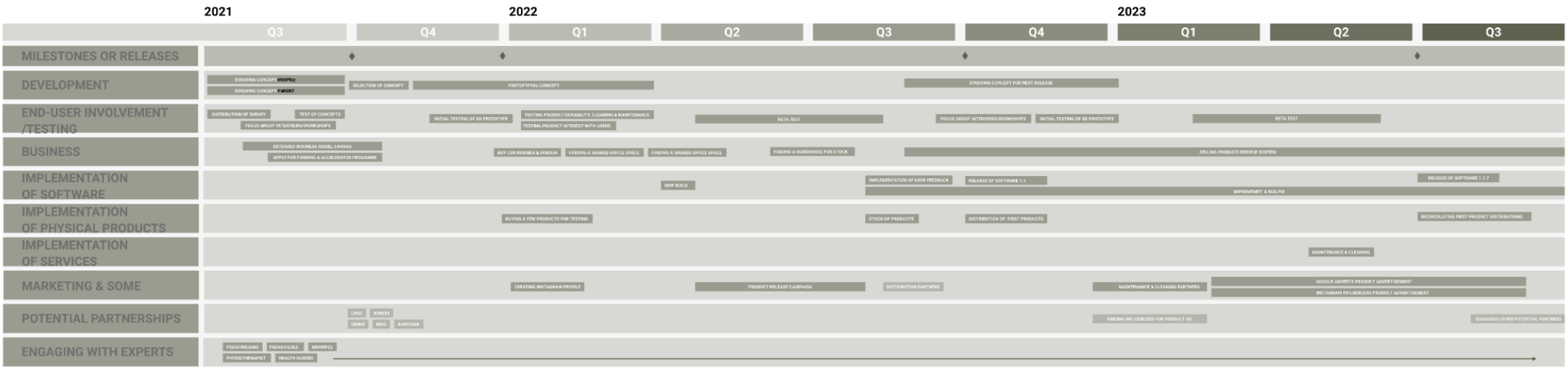


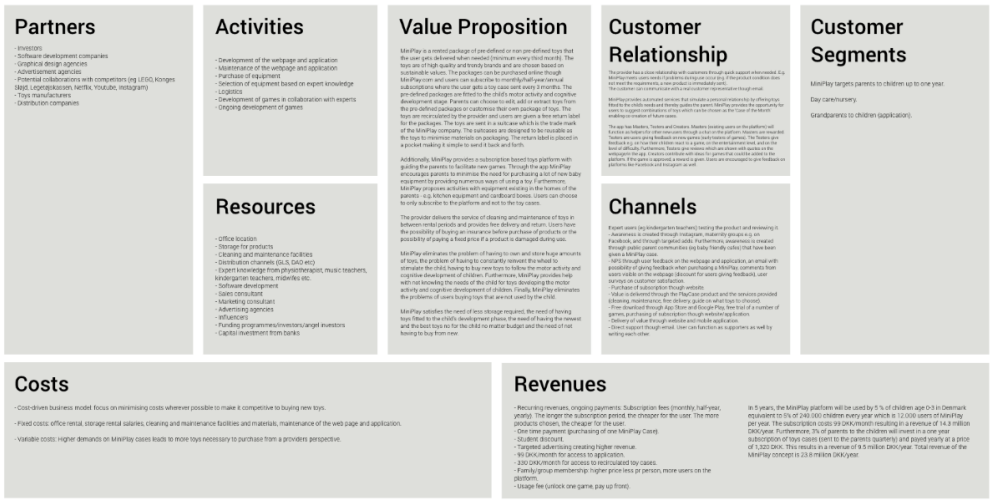
Figure 47: Roadmap

Triple Layered Business Model Canvas

Several methods from the *Create* and *Catalyse* phase could be used again in the *Continuing the Journey* phase, to gain a deeper knowledge on the two created PSS concepts. These methods include *Decision Tree to Navigate through PSS Typologies, 11 PSS Characteristics, Concepts against Personas, The Triple Layered Business Model Canvas, LCA Clinic, Rebound Effects, Ecosystem mapping, Attractiveness map, Affinity Diagram, Survey Analysis* and *Criteria checklist*..

The Triple Layered Business Model Canvas is added for now as it explores and sums up the sustainability-oriented business model generated for the two concepts Appendix 8 *The Triple Layered Business Model Canvas*. Using the method it shows how to generate multiple types of value - economic, environmental and social for *MiniPlay* and *PaRENT*, see Figure 48 and Figure 49.

MiniPlay Economic Business Model Canvas



MiniPlay Environmental Life Cycle Business Model Canvas

MiniPlay Social Stakeholder Business Model Canvas

Figure 48: *MiniPlay* Economic Business Model Canvas

PaRENT Economic Business Model Canvas

Partners

- Investors
- Software development companies
- Graphical design agencies
- Advertisement agencies
- Potential collaborations with competitors (eg MoonBoon Baby Studio, Stokke, Medela)
- Equipment manufacturers
- Distribution companies

Activities

- Development of the webpage
- Maintenance of the webpage
- Purchase of equipment
- Selection of equipment based on expert knowledge
- Logistics

Resources

- Office location
- Storage for products
- Cleaning and maintenance facilities
- Distribution channels (DLS, DAO etc)
- Expert knowledge from physiotherapist, midwifes etc.
- Software development
- Sales consultant
- Marketing consultant
- Advertising agencies
- Influencers
- Funding programmes/investors/angel investors
- Capital investment from banks

Value Proposition

PaRENT is a rented package of pre-defined or non pre-defined short usage products for parents used in the first 12 months of parenthood. PaRENT products are recirculated and cleaned and maintained in between rental periods.
PaRENT products can be rented online through a webpage and additional services are provided through a mobile application. These services provides the users with a guide on what equipment is necessary for them dependent on the phase of the parenthood. Furthermore, users have the possibility to extend the rental period or send a product back before an ended rental period through the app or webpage. The app pushes notification to users on what equipment is now needed based on the phase of the parenthood. The app provides transparency features on the specifications of the products available and chosen by the provider, the working conditions for the workers producing the equipment, and transparency on the transportation and manufacturing of each product. Furthermore, the app provides best-in-test reviews of the products and comments from users.
PaRENT eliminates the problem of having to own and store equipment used for short periods of time. Furthermore, PaRENT eliminates the problem of having to buy new equipment and figuring out what to buy at what time. Finally, PaRENT eliminates the problem of buying expensive short use equipment that will potentially not used.
PaRENT satisfies the need of less storage required, the need of wanting the newest, high quality equipment at an affordable price and the need of not having to resell products after a short use period.

Customer Relationship

The provider has a close relationship with customers through quick support when needed. E.g. PaRENT meets users needs if problems during use occur (e.g. if the product condition does not meet the requirements, a new product is immediately sent).
The customer can communicate with a real customer representative through email.
PaRENT provides automated services that simulate a personal relationship by offering equipment fitted to the parent/child's needs and thereby guides the parent.
PaRENT creates an online community through user feedback on the equipment (e.g. visible comments on the webpage/app for each product).

Channels

- Expert users to choose products portfolio.
- Awareness is created through Instagram, maternity groups e.g. on Facebook, and through targeted adds e.g. in maternity apps.
- Feedback is given via a NPS through user feedback on the webpage and app, a mail with the possibility of giving feedback when purchasing PaRENT equipment, comments from users visible on the webpage (discount for users giving feedback) and user surveys on customer satisfaction.
- Purchasing of subscription though website and extension/change in order though app/website.
- Value is delivered through the PaRENT product and the services provided (e.g. cleaning, maintenance, free delivery and a guide on what equipment to choose).
- Direct support is given through email.

Customer Segments

PaRENT targets all parents no matter how many children they have.

Costs

- Cost-driven business model: focus on minimising costs wherever possible to make it competitive to buying new equipment.
- Fixed costs: office rental, storage rental salaries, cleaning and maintenance facilities and materials, maintenance of the web page/app.
- Variable costs: Higher demands on equipment leads to more equipment necessary to purchase from a providers perspective.

Revenues

- Recurring revenues, ongoing payments. Subscription fees (monthly, half-year, yearly). The longer the subscription period, the cheaper for the user. The more products chosen, the cheaper for the user.
- One time payment (purchasing of one box of PaRENT equipment or just one type of equipment).
- Student discount.
- Targeted advertising creating higher revenue.

In 5 years, the PaRENT products will be used by 5% of new parents equivalent to 5% of around 61 000 couples equals 3050 new users a year. The 5 products (in a bundle) cost 499 DKK/months and is rented out for 9 months resulting in a revenue of 13.7 million DKK/year. Statistics extracted from 'Danmarks statistik' - https://www.dst.dk/da/.

Environmental Life Cycle Business Model Canvas

Supplies and Out-sourcing

Equipment production

Energy and water for processes

Energy used in Data Centers for cloud storage.

Energy use of electronically equipment (PC etc.)

Production

Manufacturing of equipment

Production of data in data centers (should be a provider running on green energy)

Materials

Equipment (plastic, wood etc)

Development of the application - web page (storing data).

Functional Value

Delivery of 1 piece of equipment per week per user multiplied by the amount of users during one year in Denmark.

Dematerialisation of equipment - the platform eliminates the need of owning equipment.

End-of-Life

Reuse of equipment

When not functioning end recycling/repurpose/disassembly of equipment

Distribution

Transportation/shipment of equipment

Transportation of equipment between users

Distribution of application/web page (storing data)

Use Phase

Maintenance and repair of equipment

Cleaning of equipment

User: Energy consumed for using the web page/application.
Provider: Energy used for storing data.

Environmental Impacts

Assumption (rebound effects):

– The concept could lead to extra equipment because users would still buy the equipment as before, which would lead to a higher environmental impact

Environmental Benefits

Assumption:
- Less equipment are bought (dematerialisation)
- Sharing of equipment between users

Social Stakeholder Business Model Canvas

Local Communities

PaRENT supports having the best equipment fitted to the first 9 months of parenthood.

PaRENT supports users with limited storage (e.g. people in apartments, with a lot of kids).

Governance

Autonomy in the workplace (employees): individual flexibility, accountable culture, employee opinion matters.

Transparency in decision making within the company.

Employees

The work place has a focus on equality and diversity.

The work place has a focus on individual job satisfaction.

Provide engagement courses for employees (eg courses in different equipment, courses in child development)

Social Value

PaRENT eliminates the problem of having to own and store parent equipment used for short periods of time. Furthermore, PaRENT eliminates the problem of having to buy new equipment and figuring out what to buy. Finally, PaRENT eliminates the problem of buying expensive short use equipment that are potentially not used.

PaRENT satisfies the need of less storage required, the need of wanting the newest, high quality equipment at an affordable price, the need of not having to resell products after a short use period.

PaRENT saves you time and energy on researching and gaining knowledge on equipment to fit the child and parent's need.

Students get discounts on the subscription giving users with smaller budget the opportunity to join the platform.

The work environment of the work place supports a safe and healthy environment with a focus on equality and diversity.

Long term value from mutually beneficial relationships with experts in the fields (physiotherapists, midwifes etc).

Societal Culture

Culture of individualism providing the exact equipment fitted to users needs and child's age.

Sharing culture through recommendation of different kinds of equipment.

Culture of environmental responsibility through the choice of dematerialising new equipment produced.

Scale of Outreach

Targeting users in Denmark with the possibility of expanding to other countries in the future.

Long term strategies: Eg large online platform community.

End-User

Offerings:

- Time
- Surplus energy
- Change in equipment needed for the child's age
- Engagement in the child's needs
- Proud of contributing to a dematerialisation culture
- Happiness
- Wellbeing
- Exchange of knowledge between parents

Social Impacts

Social rebound effects:

- Potentially using equipment that they would not have bought

Social Benefits

Parents:
- Knowledge sharing
- Economic equality

Figure 49: *PaRENT* Economic Business Model Canvas

Through *The Triple Layered Business Model Canvas* more knowledge was gained about the objectives and environmental and social aspects of the two concepts. Through the environmental layer it is appraised how to generate more environmental benefits than environmental impacts. This allowed for a better understanding of where the environmental impacts lie within the business model and provides insights on where to focus. Through the social layer key social impacts were captured between stakeholders and the startup. Furthermore, a better understanding of where the startup's primary social impacts are were found as well as insight for exploring ways to innovate the organisation's actions and business model to improve the social value creation potential.
The goal of the thesis was to create a guideline for developing sustainable PSS startups enabling a CE. To ensure that this goal is met, the key characteristics of the concepts are presented below. The key characteristics mapped clearly show that MiniPlay and PaRENT are sustainable PSS concepts enabling a CE.

MiniPlay

Economic Sustainability Aspects

MiniPlay is a rented package of pre-defined or non predefined toys that the user can rent when needed.The predefined packages are fitted to the child's motor activity and cognitive development stage. The toys are recirculated by the provider. MiniPlay provides a subscription based toys platform with guiding the parents to facilitate new games. Through the app MiniPlay encourages parents to minimise the need for purchasing a lot of new baby equipment by providing numerous ways of using a toy. Furthermore, MiniPlay proposes activities with equipment existing in the homes of the parents.

Type of PSS

- Use Oriented - Renting

Environmental Sustainability Aspects

- Benefits: Less toys are bought (dematerialisation) & Sharing of toys between users

CE Strategies Implemented

The products are not designed and manufactured by the MiniPlay provider but selected based on the following circular product design strategies (Nancy M. P. Bocken et al., 2016):

- Product Design Strategies
    - Slowing loop: choosing long-life products
    - Slowing loops: designing for product-life extension (e.g. maintenance & repair and design for disassembly)
    - Closing: Design for a technological cycle (maintenance and reuse of products)

- Business Model Strategies
    - Slowing loops: Access and performance model
    - Slowing loops: Classic long life model
    - Slowing loops: Encourage sufficiency
    - Closing: Extending resource value

Social Sustainability Aspects

Social Value

- Eliminates the problem of having to own and store huge amounts of toys
- Having to constantly reinvent the wheel to stimulate the child
- The need of having toys fitted to the child's development phase

Social Benefits

- Social Benefits (Parents)
    - Community engagement
    - Personal development of parents
    - Knowledge giving.
    - Knowledge sharing
    - Economic equality
- Social Benefits (Child)
    - Personal development
    - Motor activity and cognitive learning
    - Equality between children

PaRENT

Economic Sustainability Aspects

PaRENT is a rented package of pre-defined or non predefined short usage products for parents used in the first 12 months of parenthood. PaRENT products are recirculated and cleaned and maintained in between rental periods. PaRENT provides the users with a guide on what equipment is necessary for them dependent on the phase of the parenthood. PaRENT eliminates the problem of buying expensive short use equipment.

Type of PSS

- Use Oriented - Renting

Environmental Sustainability Aspects

- Benefits: Less equipment are bought (dematerialisation)
- Sharing of equipment between users

CE Strategies Implemented

The products are not designed and manufactured by the PaRENT provider but selected based on the following circular product design strategies (Nancy M. P. Bocken et al., 2016):

- Product Design Strategies
    - Slowing loop: choosing long-life products
    - Slowing loops: designing for product-life extension (e.g. maintenance & repair and design for disassembly)
    - Closing: Design for a technological cycle (maintenance and reuse of products)

- Business Model Strategies
    - Slowing loops: Access and performance model

    - Slowing loops: Classic long life model
    - Slowing loops: Encourage sufficiency

Social Sustainability Aspects

Social Value

- Eliminates the problem of having to own and store parent equipment used for short periods of time
- Time and energy saving on researching and gaining knowledge on equipment to fit the child and parent's need
- The need of wanting the newest, high quality equipment at an affordable price

Social Benefits

- Social Benefits (Parents)
    - Knowledge sharing & Economic equality

Summarise of the *Continuing the Journey* Phase

The methods tested in the *Continuing the Journey* phase helped in generating two concepts with a circular brand strategy and understanding their service process. A reflection on what is needed to be done for further work was elaborated through the Roadmap. The two final PSS concepts were defined and the sustainability aspects and circular strategies of each of the concepts were mapped ensuring that the concepts are sustainable PSSs enabling a CE. The project is open-ended and the startup needs to further converge and gain more knowledge to proceed further with only one concept.
Through the *Catalyse* Phase the Guideline 4.0 have now been tested which have resulted in the revised version 5.0

Presentation of ‘Guideline for Developing a Sustainable and Circular PSS Startup’

Through the DS II the Guideline 1.0 was successfully tested and a final Guideline 5.0 had now been created. The startup team has followed necessary, initial steps of establishing a project in connection with the initial phases of the thesis project. Methods guiding the startup practitioner through the same steps are proposed in the *Orientation & Vision Setting* phase. These have not been tested but are suggestions.
The result of the test of the guideline has led to the final guideline with proposed methods and templates to these. The guideline is named *Guideline for Developing a Sustainable and Circular PSS Startup* and can be seen in Figure 50, *Developing a Sustainable and Circular PSS startup* (Appendix 7).

The templates for the *Guideline for Developing a Sustainable and Circular PSS Startup* (Appendix 7) and the *Methods Tested Throughout the Case Study* (Appendix 8) have been developed in Adobe Xd. It can all be accessed through the following link:

Adobe Xd prototype: Guideline for Developing a Sustainable and Circular PSS Startup and the Methods Tested Throughout the Case Study

The guideline proved to support the development of a sustainable PSS startup enabling a CE. This is visually depicted in Figure 50.

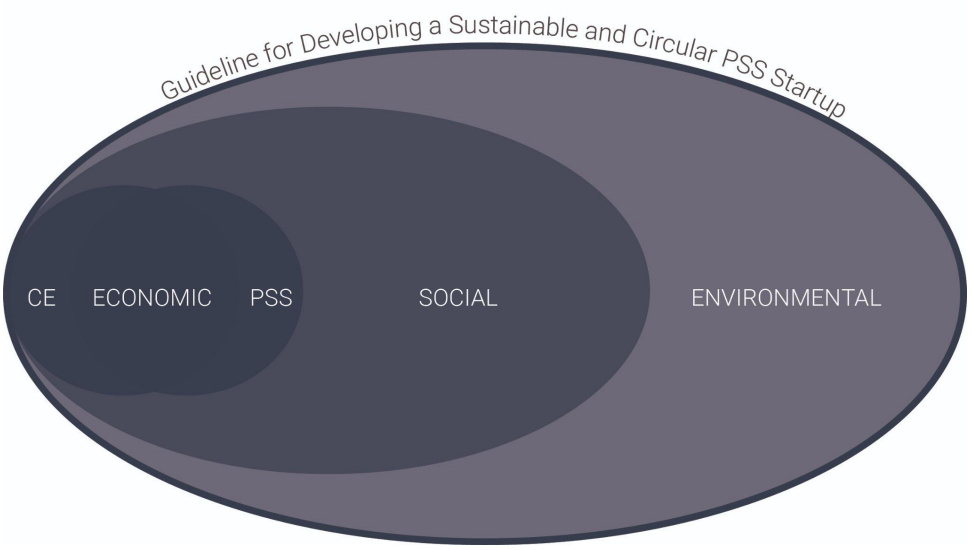


Figure 50: PSS startups following the guideline will be enablers of a CE and incorporate social, environmental and economic sustainability practice

Choosing Methods from each Phase of the Systemic Design Approach

For startups to easier navigate through the methods a guide has been made for how many methods to choose from each phase according to time and according to the rating of the method. It is worth empathising how important stakeholder engagement is. Therefore, it is highly recommended to have a sufficient amount of data for the methods and thereby the workshop method and survey method is highly recommended. Based on how much time available the practitioners have, a guide on what methods to apply have been created. Here are the suggestions based on if the practitioner has: *1 day, 3 weeks, 4 months* or *+4 months*. The different plans can also be found in Appendix 16 *Choosing Methods.*

1 day for the Guideline

Due to the limited time available, the practitioner is recommended to select methods with a rating 5 (on a scale from 1-5). It is recommended to choose;

- 2 methods from the *Explore & Reframe* phase
- 1method from the *Create* phase
- 1 method from the *Catalyse* phase
- 1 method from the *Continuing the Journey* phase.

If the practitioner chooses to apply the *Conducting a Survey* method, it is recommended to only use one hour on creating the survey and one hour for collecting responses..

3 weeks for the Guideline

Due to the limited time available, the practitioner is recommended to select methods with a rating 5 (on a scale from 1-5). It is recommended to choose;

- 5 methods from the *Explore & Reframe* phase
- 2 methods from the *Create* phase
- 3 methods from the *Catalyse* phase
- 2 methods from the *Continuing the Journey* phase.

4 months for the Guideline

For the 4 months guideline it is recommended to apply the methods tested throughout this project from guideline 5.0. It is recommended to choose;

- 22 methods from the *Explore & Reframe* phase
- 12 methods from the *Create* phase
- 7 methods from the *Catalyse* phase
- 3 methods from the *Continuing the Journey* phase.

Therefore the final guideline without the recommendations.

4+ months for the Guideline

For the 4+ months guideline it is recommended to apply the methods tested throughout this project and suggested but not tested methods from guideline 5.0. It is recommended to choose;

- 5 methods from the *Orientation & Vision Setting* phase
- 42 methods from the *Explore & Reframe* phase
- 23 methods from the *Create* phase
- 11 methods from the *Catalyse* phase
- 8 methods from the *Continuing the Journey* phase.

Concluding notes on the Descriptive Study II

- *How can the methods of the guideline be tested and evaluated through a startup case study and how can the Systemic Design Framework contribute to it?*

The methods of the guideline were tested through the case study by following the design process phases proposed in the guideline from the SDF design process suggested by the (Design Council, 2021) through the four phases *Explore & Reframe*, *Create*, *Catalyse* and *Continuing the Journey*.

The *Explore & Reframe* phase provided insights to the market through workshops with BabySam, Moonboon Baby and seven users. Further knowledge was gained through a comprehensive survey with 1.093 respondents from DK and 150 respondents outside DK. From a literature study on existing PSSs within the baby equipment and toys market. The insights gained through methods were analysed in terms of **needs** and **problems** of the stakeholders of the ecosystem. The identified problems and needs were translated into final criteria for the sustainable PSS to be developed through the startup case study.

In the *Create* phase personas were generated to support the ideation and creation of ideas and concepts. By applying and testing several ideation and brainstorming methods numerous PSS characteristics with the possibility of being combined into concepts were identified. These characteristics were gathered in a morphology chart from which the users were able to generate new PSS concepts fitting their needs and solving their problems. Many concept ideas were brainstormed and three of these concepts were chosen to move forward with. The three concepts were tested and developed through different PSS, CE and sustainability oriented methods.

Through the converging *Catalyse* phase a revised ecosystem based on the changes in flows and interactions between stakeholders caused by the implementation of the three concepts were made. This provided insights to changes to the ecosystem of the current way of purchasing baby equipment and toys. All three concepts generated flows of established product-, service-, money- or information flow that do not exist in the market today of baby equipment and toys. MiniStream and PlayCase were chosen to be combined because of the understanding of a PSS. Both economic, social, and environmental sustainability aspects, feedback from 267 users and possible CE strategies were taken

into account. The concepts MiniPlay and PaRENT were thereby chosen to be explored further in the *Continuing the Journey* phase.

The testing of the guideline in the Descriptive Study II ended in the *Continuing the Journey* phase. Here MiniPlay and PaRENT were elaborated through their brand strategy and in understanding their service process. A reflection on future work and development was elaborated through a Roadmap from 2021-2023. The startup's future hereby ends openly with the two concepts to be explored further before moving on and creating the PSS for only one of the concepts.

All methods for the guideline are provided with a text evaluating *the aim of each method*, *area of knowledge* and *why it is added as a method to the guideline*. Several methods were added through the Descriptive Study II to gain a deeper understanding of PSS, CE and sustainability aspects and develop a concept meeting all criteria for the PSS startup. These were found through online guidelines or inspired by learnings throughout the studies at the Technical University of Denmark and at Aalborg University. All methods in the Final Guideline 5.0 are 1) *descriptive/self explanatory*, 2) *have a template*, and 3) *applicable by users with different professional backgrounds*.

An elaboration of the PSS, CE, and sustainability characteristics of the two final proposed startup concepts MiniPlay and PaRENT proved that both concepts offer both environmental, economic, and social value. Hereby, it was proved that the guideline supports the development of a sustainable PSS business model concept enabling a CE.

Discussion

Summary of Key Findings

Throughout the Research Clarification it was found that there are many guidelines and methods supporting sustainable development and circular economy. Thus, the conducted literature search indicates that there is a lack of a comprehensive guideline gathering methods through a design process to support the development of a sustainable product/service-system business model enabling a circular economy.
The study demonstrates the initial phases of the development of a comprehensive guideline tested with a startup case study going through the *Systemic Design Framework* phases. An early evaluation of applied methods in the guideline has been performed, to determine the quality of insights provided by the methods, accompanied by a designed template for the process of establishing this particular type of enterprise.

Interpretations & Implications of the Study

The methods applied and implemented in the guideline through the diverging and converging phases of the *Systemic Design Framework* covers product/service-system, circular economy, and the three aspects of sustainability. Interpretation of empirical data from tests of the selected methods was used for *1) providing direct feedback on the guideline* and *2) building design support for the development of the concepts*.

As opposed to guidelines found in the literature, numerous online methods and guidelines are offering applicable templates that vary in standard from vaguely defined and thoroughly explained. This study builds on the knowledge and the intuitiveness from these but differs in that it approaches both product/service-system, circular economy, and sustainability and gathers it all in one guideline.
The results suggest that the developed guideline can be used for startups. In theory, it has the potential for being applied by different types of practitioners such as students, SMEs, and larger companies. However, whether it is as successful in practice as it is, in theory, is yet to be explored through several tests with actual entrepreneurs and other potential practitioners.

The study implies that the methods and their templates act as a bridging element contributing to a common understanding of the methods and processes within teams, between professors and students, or between colleagues. The templates and examples from the applied methods contribute to the MSc degrees of *Sustainable Design Engineering* & *Design & Innovation* by providing the guideline which could be relevant to use in product/service-system courses or other entrepreneurial courses.

Although the focus has been on developing a startup by a startup team, the guideline could equally be applied by actual entrepreneurs in established startups, or for startup accelerator programs such as Skylab & SEA AAU. Additionally, elements of the guideline have the potential to inspire larger companies, and as a positive effect of that create awareness of the two MSc degrees.

The guideline supports the establishment of an interrelationship between product/service-system, circular economy, and sustainability and has the potential of challenging existing guidelines. E.g. by

challenging the circular economy framework by Ellen MacArthur Foundation by incorporating several theoretical areas rather than just one.
In contrast to the findings from the Research Clarification, this study differs by guiding practitioners through the phases in the *Systemic Design Framework*. The study provides new insights into how to apply and combine the two frameworks (*Systemic Design Framework* and *Design Research Methodology*), by navigating in the diverging and converging phases suggested by the *Systemic Design Framework* through the DS II of the Design Research Methodology, when testing the guideline.

The present study shows that in line with (Trautwein, 2021) who concludes that there is hardly any product/service-system development process designs addressing the particular needs of startups, and there is a lack of guidance on how to implement the methods. Meanwhile, startups play a major role towards sustainable development and therefore the guideline should support this. Agreeing, researchers (Sassanelli et al., 2015) argue that the success on the market relies on the decisions taken during the initial phases of the development of the product/service-system emphasising the importance of the focus on startups.

In practice, the guideline has contributed to the practice of developing sustainable and circular product/service-system startup concepts. The study proposes two startup concepts that meet the criteria defined in the *Explore & Reframe* phase. Both concepts equally solve the identified user needs and problems that follow when purchasing baby equipment and toys. By reflecting on the research by (O. K. Mont, 2002), the study hopes to support the challenge of developing a product/service-system system solution where pieces fit together and the outcome provides a certain quality of life to users while at the same time minimising the environmental impacts of the system. Additionally, the aim of the startup concepts, being sharing equipment/toys amongst parents, ties well with other previous studies, where scholars suggest that the key to tackling environmental challenges is by sharing resources (de Pádua Pieroni et al., 2018; O. Mont, 2004; Tukker, 2015).

The two concepts have the potential to mitigate the environmental impacts. However, similar to the research of (Pigosso & McAloone, 2016) and (Medini & Boucher, 2016) the impact assessments from the LCA in the startup case study need to be further investigated through a consequence analysis of the developed concepts that take into account the potential rebound effects.

Limitations of the Study & Recommendations for Further Work

Reflecting on the scope of the project it turned out to be fairly immense both to create a guideline and contributing with the experience to other practitioners by simultaneously developing a product/service-system startup within the field of baby equipment and toys.

It is beyond the scope of the study to test the guideline more extensively than through the startup case study, however, the guideline should ideally be tested with other practitioners within different areas of consumer goods to make it possible to conclude whether it is applicable for other startups or not. The limited testing with actual entrepreneurs and other practitioners suggests a need for further investigation on how the guideline would be received and thus determining how it could be evaluated. An apparent limitation of the applied methods is that none of the tested methods have been removed from the guideline despite some methods only getting the score of 2 on a scale from 1-5. Considering the credibility of the rating from 1-5 it is proposed to gather data from a sufficient number of practitioners and have them rate the methods, and based on the sum of the ratings draw conclusions about the actual contributions. As a result of not excluding any, the many methods could come across extensively, and therefore it is recommended that a practitioner could navigate between the methods depending on the time available. It is beyond the scope of the study to develop the guideline as an interactive guideline, but potential improvements for the guideline could be a filtering system, enabling the user to easily gain access according to the specific needs.

Regarding the startup case study, the two sustainable and circular product/service-system concepts would require improvements and further elaborations of the business model before being able to enter the market. Further interventions with the user groups are needed to find potential improvements and kick start the startup. Thus, it will be necessary to conduct a new retrospective study in the future, when the startup is kicked off to validate the intended allocations in the ecosystem map and assess the potential rebound effects. It is an anticipated obstacle that the team did not develop the startup fully, as the result of actually having a startup made based on the guideline, would have acted as a proof of concept. Therefore, it is recommended that a future study could build on this study by investigating practice around making a startup and use practice analysis to improve the guideline.

Reflecting on Learning Objectives

Throughout this project, the team aims to reach the learning objectives set at the beginning of the project. These are assessed to be successfully met. In addition, the team has developed a guideline for product/service-system startups and a product/service-system startup concept - the team hopes to create a startup or consultancy that could potentially build on the project's outcomes.
Through the study, an understanding of different product/service-system notions in the research field was explored and understood. Thus, confusion on the product-related aspect of a product/service-system arose. A *product* was perceived to have the possibility of being a digital product, but further elaboration and exploration led the team to conclude that a product/service-system needed to incorporate a physical aspect. Therefore, a concept change happened.
Startup approaches were analysed throughout the literature, but further study of the online guidelines was considered. This is because the online guidelines were of high relevance to this study. Therefore it could have been valuable to look into these earlier in the guideline development and do a comparative analysis of more online guidelines.
A substantial amount of user needs were identified through the *Explore & Reframe* phase (initially called the *Value Offering Gallery*). Because of scoping wide (both baby equipment and toys), it was hard to narrow down where to focus the product/service-system startup. If the study had to be conducted again, it might have been more valuable to have chosen one or only a few products to focus on before starting the analysis. This could have led to a more focused study, and thereby a better solution might have been created.
A lot of new knowledge was gained throughout this process and especially for the sustainable potential. It was mastered how to do a quick LCA, and two new types of business model canvases were performed through the *Triple Layered Business Model Canvas*. This will help the team later to do quick calculations and investigations of the sustainable potential.
The purpose of the thesis was to develop a startup. The team did not end on a final concept as the two final concepts needed to be explored further. The economic viability of the concepts was calculated at its minimum. Again it is noted that the scope might have been too broad. Therefore, it is arguable whether the team ends up being a startup, which challenges the guideline in being too comprehensive. The team created a guideline using UX principles, but the guideline is yet to be evaluated using external feedback. The goal is that other startups will test the guideline and that it can be used in product/service-system related courses to help students in developing a product/service-system startup concept. It has been a very knowledgeable journey where the team has learned to follow two project tracks simultaneously from wanting to create a startup to end up with a complete guideline on how to do so.

An exciting change of perspective in the thesis was when the team, throughout the development of the guideline, saw potential in creating a startup in consulting, helping other startups developing sustainable product/service-system business models through the means of circular economy.

Conclusion

The aim of the thesis was to close the gap in literature on guidelines for developing sustainable product/service-system startups enabling a circular economy. The study shows the beginning of developing a comprehensive guideline, through a startup case study, using the revised Double Diamond from the *Systemic Design Framework*. An early evaluation and test of applied methods in the guideline has been made by the authors, to conclude on the quality of insights provided by the methods.
The purpose of the study was to gather empirical data for the guideline through testing of the selected methods. The interpretation of the empirical data was used for *1) providing direct feedback on the guideline* and *2) building design support for the development of the startup concepts.*

Research Question: *Which process and methods are needed to create a guideline that supports the development of a sustainable product/service-system business model enabling a circular economy?*

To develop a guideline that provides a sustainable product/service-system enabling a circular economy, a design process needs to be followed. The design process chosen to solve the problem was the *Systemic Design Framework*. Using this framework, divergent and convergent thinking provided space and confidence to challenge the problems and supported a more sustainable and systematic design process. Criteria were defined to select the methods required to develop a sustainable product/service-system enabling a circular economy. Through the study the interrelationship between product/service-system, circular economy and sustainability was defined and became the foundation of the development of the guideline. A final guideline was successfully created closing the gap in the literature for developing a sustainable product/service-system enabling a circular economy.

- ***SQ1:*** *Which sustainable product/service-system startup guidelines enabling a circular economy exist in the literature and online?*

Through the study it was identified that there are no guidelines in the literature collecting methods for developing sustainable product/service-system startups that contribute to the enabling of a circular economy. Numerous methods and guidelines were identified that cover development within areas of product/service-system, circular economy, or sustainability, but none that cover the whole spectrum. Finally, the literature study showed that there is a tendency to only vaguely define the terms sustainability and circular economy in the methods and guidelines.

- ***SQ2:*** *What are the criteria for a guideline for developing a sustainable product/service-system startup enabling a circular economy?*

Three different types of criteria were identified for the guideline to develop a sustainable product/service-system startup enabling a circular economy. The first type of criteria were based on the *Systemic Design Framework* and required that identified methods should contribute to the design process following the *Systemic Design Framework*. The second type of criteria were designed to close the lack of guidelines and methods for developing a sustainable product/service-system startup focusing on all three sustainable dimensions and incorporate circular economy strategies. The third type of criteria were applied to ensure that the final guideline would be understandable and applicable by the practitioners. Assessing methods against the three types of criteria, the relevant methods were chosen.

- ***SQ3:*** *How can a guideline through a startup case study be tested and evaluated?*

The guideline was tested and evaluated in the *Descriptive Study II* phase of the *Design Research Methodology* by following the *Systemic Design Framework* by the (Design Council, 2021) The *Explore & Reframe* phase from *Systemic Design Framework* provided insights to the market and identified needs and problems translated into final criteria. This phase was followed by the *Create* phase in which three concepts were generated. In the *Catalyse* phase, an ecosystem map provided insights to how the concepts changed the current way of purchasing baby equipment and toys. Finally, the three concepts were combined into two concepts and a further elaboration plan was created in the *Continuing the Journey* phase.

Through the startup case study, the guideline methods were tested and evaluated and all the methods chosen for Guideline 5.0 were 1) *descriptive/self explanatory*, 2) *had a template*, and 3) *applicable by users with different professional backgrounds*.

Limitations and Further Work

The research results in a final Guideline 5.0 but raises the question of ending with a complete startup guideline, as the startup case study ends with two concepts. Still further steps are needed to be taken to establish a PSS company. Further user feedback and testing of the concepts is needed before launch of the startup and the intended allocations in the ecosystem map caused by the implementation of the developed concepts to the market are yet to be assessed.

The main limitation of the study is the lack of testing of the guideline with actual entrepreneurs and other practitioners. It presents some limitations, such as not knowing how the guideline will be received and interpreted. Similarly the rating of the methods lacks credibility, due to lack of sufficient data.
Ratings from other practitioners could help improve the guideline by gathering the sum of the ratings of the methods, and follow up with elaborative workshops.

Based on these conclusions, to better understand the implications of the results the developed guideline could take advantage of:

1) Future research in a more realistic setting, testing of the guideline with actual entrepreneurs and practitioners and subsequently using the evaluation to improve the guideline.
2) Further investigation of startups in collaboration with startups to disentangle the complexities around the practice of developing a startup and use these insights to improve the guideline.

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