

Circular Furniture Continuation Framework

Mitigating the risks of premature discard of household furniture
by providing decision support to furniture brands
for circular PSS design interventions

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Abstract

This graduation project develops the Circular Furniture Continuation Framework (CFCF), which aims to reduce premature discard of household furniture. It does so by supporting furniture brands in design decision-making toward circular product-service-system intervention directions that mitigate the risks of premature discard. Findings from literature and design research suggest that premature discard stems from challenges with use continuation, as furniture is often disposed of while still functional. The systemic conditions that contribute to this problem include product limitations, changes in household contexts, and weak continuation support, which together make continued use or value retention difficult.

The design outcome resulted from sector specialists confirming both a gap in circular decision support for furniture brands and the observation that furniture brands generally limit the application of circular strategies at the material level, as well as from formulating design principles that address recurring mechanisms through which furniture continuation may break down.

Through a series of steps that guide the diagnosis of where and why furniture continuation may be at risk, and translate breakdowns into fitting intervention directions that address them, the CFCF supports furniture brands in their design decision-making. Although validation of the CFCF with furniture practitioners and relevant experts supports this, a conceptual pivot aimed to improve the CFCF's ability to convey a more convincing value proposition and to improve its actionability, interface, and information presentation.

The project's main contribution, however, remains the CFCF; a structured framework that supports decision-making. It supports an early step towards reducing premature furniture discard by helping brands turn a furniture continuation risk into a testable direction for a circular PSS intervention.

Table of Contents

Abstract	2
Table of Contents	3
Glossary	8
<i>Concise definitions</i>	8
Introduction	10
<i>Scale and urgency of the problem</i>	10
<i>Scope and target actors</i>	13
<i>Project aim and design intervention</i>	14
<i>Research questions</i>	14
<i>Thesis structure</i>	15
<i>Introduction conclusion</i>	15
Theoretical foundation	15
<i>Key concepts</i>	15
<i>Existing circular strategies</i>	16
R-ladder, Value Hill and lifetime extension	16
Circular product service systems and continuation routes	19
Existing circular furniture responses	19
<i>Early-exit indicators for premature furniture disposal</i>	21
Condition-based indicators: usable furniture still leaves use	22
Time-based indicators: shortened use cycles.....	22
Route-based indicators: value retention after household exit.....	24
Trigger-based indicators: moments when disposal risk becomes active	24
<i>Theoretical foundation conclusion</i>	25

Methodology	25
<i>Design approach</i>	<i>25</i>
<i>Sources and uses</i>	<i>26</i>
<i>Project process</i>	<i>27</i>
<i>Methodology conclusion</i>	<i>28</i>
Understanding the problem space	28
<i>Analytical lenses for continuation breakdowns</i>	<i>29</i>
<i>Furniture disposal as a systemic continuation problem</i>	<i>30</i>
<i>Continuation decision gap</i>	<i>31</i>
<i>Disposal journey mapping</i>	<i>32</i>
<i>Evolving living contexts and furniture misfit</i>	<i>35</i>
<i>Product-route mapping and value loss</i>	<i>36</i>
Route friction and fallback logic	38
<i>Recurring continuation mechanisms</i>	<i>39</i>
<i>From continuation mechanisms to synthesis clusters</i>	<i>40</i>
<i>Conclusion problem space</i>	<i>42</i>
Concept development.....	44
<i>Design principles.....</i>	<i>44</i>
<i>Form ideation: diverge</i>	<i>45</i>
<i>Selection of form: converge</i>	<i>46</i>
<i>Design framework introduction</i>	<i>49</i>
<i>Intended users</i>	<i>49</i>
<i>Use context</i>	<i>49</i>
<i>Medium</i>	<i>50</i>

<i>Design requirements</i>	50
List of Requirements.....	51
Use of the requirements	52
<i>Framework requirements</i>	53
<i>Concept development direction conclusion</i>	54
Design: Framework	54
<i>Framework overview</i>	54
<i>CFCF process</i>	55
<i>Framework components</i>	57
<i>Framework output</i>	60
<i>Framework design conclusion</i>	61
CFCF validation	61
<i>Purpose and scope of validation</i>	61
<i>Validation questions and criteria</i>	62
<i>Validation setup and evidence roles</i>	65
<i>Materials and procedures</i>	67
<i>Analysis method</i>	67
<i>Evidence-based improvement</i>	68
<i>Validation criteria findings</i>	68
Validation improvement findings	70
<i>Validation conclusion</i>	71
Iteration based on validation findings	72
<i>Findings to iteration</i>	72
Furniture brand-facing value proposition improvements	73
<i>Design decision and scope</i>	74

<i>Concept development</i>	76
<i>Designed iteration</i>	78
<i>Improvements made</i>	81
<i>Iteration conclusion</i>	82
Discussion	83
<i>Interpretation of the design contribution</i>	83
<i>Meaning of the value-proposition pivot</i>	84
<i>Use conditions and applicability</i>	84
<i>Feasibility, viability, and adoption</i>	85
<i>Limitations</i>	85
<i>Future development and research</i>	86
Conclusion	86
Notes	88
<i>Human research ethics and handling of data</i>	88
<i>AI use</i>	88
References	89
Methods	92
Problem space	93
<i>Actor table</i>	93
CFCF code key	95
<i>CFCF code key</i>	95
Disposal-journey stages	95
Continuation-breakdown patterns.....	96

Intervention objectives.....	96
Circular PSS strategy families	97
Capability and infrastructure codes.....	97
Current capability-fit labels.....	98
CFCF screenshots.....	99
Application examples.....	105
<i>Purpose and case selection</i>	<i>105</i>
<i>Application format.....</i>	<i>106</i>
<i>Application cases</i>	<i>107</i>
Flat-pack wardrobe relocation.....	107
Sofa repair and aesthetic renewal	109
Chair buy-back and take-back	111
<i>Case comparison</i>	<i>113</i>
<i>Implications for validation</i>	<i>114</i>
Validation.....	116
<i>Detailed validation criteria and evidence rules</i>	<i>116</i>
Detailed criteria and claim boundaries	116
<i>Participant & session overview.....</i>	<i>118</i>
Validation texts	119
Iteration	130
<i>Value proposition canvas adaptation</i>	<i>130</i>

Glossary

Table 1: Abbreviations and organisations

Short form	Meaning
AI	Artificial intelligence
CFCF	Circular Furniture Continuation Framework
CE	Circular economy
CIRCO	Dutch circular-design and circular-business programme
DPP	Digital product passport
EEB	European Environmental Bureau
ESPR	Ecodesign for Sustainable Products Regulation – Regulation (EU) 2024/1781
EU	European Union
HREC	Human Research Ethics Committee
I&W	Ministry of Infrastructure and Water Management
LCA	Life-cycle assessment
MVP	Minimum viable product
PBL	PBL Netherlands Environmental Assessment Agency
PSS	Product-service system
TNO	Netherlands Organisation for Applied Scientific Research
TU Delft	Delft University of Technology

Concise definitions

Table 2: Concise definitions

Term	Definition and single source
Artificial intelligence (AI)	A machine or computer system’s capability to perform tasks that would typically require human intelligence. (ISO, n.d.) The discipline concerned with researching and developing mechanisms and applications of AI systems. (ISO/IEC, 2022, cl. 3.1.3)
Circular economy	An economic system that uses a systemic approach to keep resources circulating by recovering, retaining or adding value, while contributing to sustainable development. (ISO, 2024, cl. 3.1.1)
Circularity	The degree to which a system aligns with circular-economy principles. (ISO, 2024, cl. 3.1.15)

Continuation (of furniture)	Furniture remaining in use through its current or a new use cycle because obsolescence is prevented, postponed or reversed. (Adapted from den Hollander et al., 2017, pp. 519–520)
Digital product passport (DPP)	A product-specific data set that is accessible electronically through a data carrier. (European Parliament & Council of the European Union, 2024, Art. 2(28))
Durability	A product's ability to retain its functions and performance under specified use, maintenance and repair conditions until a limiting event prevents continued functioning. (European Parliament & Council of the European Union, 2024, Art. 2(22))
Ecodesign	The integration of environmental-sustainability considerations into product characteristics and the processes across the product value chain. (European Parliament & Council of the European Union, 2024, Art. 2(6))
End-of-life product	A product taken out of use when its resources are recovered or the product is disposed of. (ISO, 2024, cl. 3.5.30)
End-of-use	The point when a product or resource is transferred from one holder to another. (ISO, 2024, cl. 3.5.29)
Life-cycle assessment (LCA)	The compilation and evaluation of a product system's inputs, outputs and potential environmental impacts throughout its life cycle. (ISO, 2024, cl. 3.6.8)
Maintenance	An action carried out to keep a product in a condition in which it can function as required. (European Parliament & Council of the European Union, 2024, Art. 2(19))
Minimum viable product (MVP)	A product version designed to obtain the greatest amount of validated learning about customers with the least effort. (Ries, 2011, p. 77)
Premature obsolescence	A situation in which a product becomes non-functional or loses performance before the expected end of its average lifetime because of product design, component design, software or other actions or omissions. (European Parliament & Council of the European Union, 2024, Art. 2(21))
Product-service system (PSS)	A marketable combination of products and services that jointly fulfils a user's need. (Goedkoop et al., 1999, p. 21)
Prototype	An approximation of a product along one or more dimensions of interest. (Ulrich & Eppinger, 2012, p. 291)
Recycling	Activities that process recovered resources into inputs for a product or process, excluding energy recovery. (ISO, 2024, cl. 3.5.24)

Refurbishment	Work performed during a product's expected service life to restore it to a useful condition for its original purpose, with similar quality and performance. (ISO, 2024, cl. 3.5.19)
Remanufacturing	An industrial process that returns a used item to a like-new condition in quality and performance. (ISO, 2024, cl. 3.5.21)
Repair	An action that restores a product to the condition needed to function for its intended purpose. (ISO, 2024, cl. 3.5.16)
Reuse	Use of a product or its components after initial use for the same purpose for which they were conceived. (ISO, 2024, cl. 3.5.17)
Reverse logistics	The management, collection and movement of products after end-of-use in order to recover or retain value. (ISO, 2024, cl. 3.5.14)
Traceability	The ability to trace the history, application or location of an object. (ISO, 2024, cl. 3.6.9)
Upgrading	Enhancing a product's functionality, performance, capacity or aesthetics. (European Parliament & Council of the European Union, 2024, Art. 2(17))
Usability	The extent to which specified users can achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use. (ISO, 2018, cl. 3.1.1)
Value recovery	A process through which value is recuperated. (ISO, 2024, cl. 3.1.8)
Value retention	A process through which value is maintained. (ISO, 2024, cl. 3.1.9)

This glossary was generated using AI and may include errors.

Introduction

Large volumes of EU furniture waste are landfilled or incinerated, while Dutch evidence indicates that more than half of furniture disposed of or passed on is still in good condition, indicating that usable value may remain (Forrest et al., 2017, p. 12; Koch & Vringer, 2023, pp. 11, 31). These figures indicate a continuation problem, but do not show that every disposal event is avoidable. Premature furniture discard should therefore be understood as a problem of continued use, rather than only as a waste problem.

This chapter lays out the scale & urgency of this problem, followed by an overview of how this graduation project aims to address it.

Scale and urgency of the problem

Annual EU furniture waste



≈

same
mass

Equivalent combined body mass



13 symbols × 10 million people

10.8 million tonnes

10.8 billion kg per year

≈130 million people

assuming 83 kg per person

Figure 1: EU waste scale comparison

Each year, the European Union generates an estimated 10.8 billion kilograms of furniture waste, of which 80–90% ends up landfilled or incinerated, with only around 10% recycled in the EU (Forrest et al., 2017, p. 12; Consultancy and Research for Environmental Management, 2004)¹. The strongest urgency, however, does not come from waste mass alone, but from evidence that furniture often leaves use before technical failure. Dutch data suggest that 62% of household furniture is replaced before it becomes defective, often because people want a new or more modern product (Milieu Centraal, as cited in Planbureau voor de Leefomgeving [PBL], 2025, p. 38). More than half of furniture disposed of or passed on is also reported to be in good condition (Koch & Vringer, 2023, pp. 11, 31).

62%	>50%
Dutch household furniture replaced before defect	Discarded or given-away items reported in good condition

Figure 2: Early-exit indicators: these numbers suggest that premature furniture disposal takes place (PBL, 2025; Koch & Vringer, 2023).

These figures suggest that value may be lost before furniture reaches the end of its functional life, so technical failure cannot explain exit on its own (Forrest et al., 2017, p. 12; Koch & Vringer, 2023, pp. 11, 31). They do not suggest that every disposal event is avoidable. When an item is discarded, part of the value embodied in its materials, labour, production energy, transport, capital and remaining functionality can be lost; material recovery may preserve only part of that value. Replacing usable furniture can also create further production and distribution impacts.

¹ (Consultancy and Research for Environmental Management, 2004)
The landfill/incineration share is reported as UEA statistics and repeated in CREM (2004) and later grey-literature summaries, but the available references do not show the original dataset or method behind these numbers. This share is therefore used here to indicate how furniture waste was broadly reported to be handled, not to claim precise current EU waste flows.



Figure 3: Bulky furniture awaiting municipal collection in Rotterdam. Photo: Donald Trung Quoc Don, 2020 · CC BY-SA 4.0

In these situations, keeping, adapting, moving, repairing, reselling, or transferring the item has become too difficult, uncertain, or unattractive, thus the item loses value before the waste route is initiated. Furniture may still be usable, but lose fit with the household, available space, user expectations, or available continuation routes.

A major factor influencing early exit is the mismatch between furniture and evolving living contexts. When households move, split, merge, downsize, redecorate, or their requirements for use change, furniture that was once suitable may no longer ‘fit’ (Hebrok, 2014, 2016)20/08/2026 06:31:00. Hebrok (2014, 2016) suggests that shifting needs, limited flexibility, aesthetic obsolescence, and the gradual loss of fit between furniture and the home context influence furniture disposal. This supports treating premature disposal as a problem that often starts while furniture is still part of the home.

Fast-furniture dynamics intensify this problem regarding continuation. Risks associated with shortened furniture use include increased purchase frequency, quality decline, lower prices, economic obsolescence, and reduced motivation to maintain or repair furniture (Forrest et al., 2017, p. 15; Hebrok, 2014, p. 214; Technopolis Group, 2024, pp. 7, 49). Forrest et al. (2017, p. 15) also suggest that durability and repair are not automatically attractive for manufacturers’ or retailers’ commercial incentives unless product-service, leasing or other continuation models make value retention commercially attractive. In addition, the EU is a key player in the furniture sector, both in consumption and production, so it is not surprising that several EU institutions identify furniture as a critical sector that requires proactive sustainability improvements (European Commission, n.d.; European Commission, 2020; Joint Research Centre of the European Commission, 2023; Yang et al., 2025, p. 1).

Recent circular-economy policies make furniture continuation more relevant. EU and Dutch policy increasingly emphasise durability, repairability, reuse, product information and substantiated sustainability claims (European Commission, 2020, 2024, p. 2023; European Parliament & Commission, 2024; I&W, 2023a, 2023b). Implementation still depends on product architecture, route access, customer acceptance, operational capability and brand decision-making. This thesis therefore focuses on helping furniture brands identify where continuation breaks down and what type of circular PSS intervention direction is worth testing next.

The statistics regarding waste mass, premature replacement, premature discard, shortened use cycles, and disposal routes all indicate that premature disposal may occur, and will guide further analysis into where and why this may occur, in order to develop an appropriate method to support furniture brands in the development of circular PSS intervention directions.

Here, disposal refers to furniture leaving use or the household, whereas discard refers to an outcome in which continued use and higher-value retention do not occur. Chapter 2 defines these terms further.

Scope and target actors

The project focuses on premature disposal of domestic movable furniture in evolving living contexts. Domestic movable furniture is relevant because it is closely connected to household routines, moving, spatial change, aesthetic preferences, and personal meaning, and is therefore subject to the household’s disposal decisions. According to Forrest et al. (2017, p. 12), domestic furniture accounts for an estimated 82% of EU furniture, which supports a focus on the consumer market, since household use, replacement, and disposal decisions account for the largest part of the sector's furniture flow.

In chapter 4, furniture brands will be identified as the target actor because they can influence product, service, route, and business conditions across multiple cases. Home dwellers remain central to the problem because they experience the mismatch and make many disposal decisions. Repair actors, refurbishers, logistics providers, resale platforms, municipalities, policy actors and infrastructure influence whether continuation succeeds, and are treated as system actors, not as the main framework users.

Table 3: Scope overview

In scope	Out of scope
Domestic movable furniture	Built-in, commercial and institutional furniture
Households & evolving living contexts	General sustainability unrelated to premature disposal or continuation
Furniture brands as target actors	Household as target actor
Circular PSS intervention directions	Complete circular PSS concepts

Proof of long-term circular or environmental impact

Project aim and design intervention

The goal of this project is to reduce the premature discard of domestic movable furniture by supporting continued use and value retention as living contexts change.

Research into the continuation problem identified recurring breakdowns shaped by household, product and wider system conditions. It also identified the continuation decision gap as a design opportunity: furniture brands may need support to bring relevant information together, identify the relevant continuation breakdown and translate it into a suitable circular PSS intervention direction.

The Circular Furniture Continuation Framework (CFCF) was developed as the project's design response to this opportunity. The framework's output does not provide a finished solution or a product redesign. Instead, it helps furniture brands identify a continuation breakdown and develop a circular PSS intervention direction that addresses it. The framework is therefore a means towards reducing premature discard, rather than the project goal itself. Achieving that reduction ultimately depends on the subsequent development and implementation of the resulting intervention.

Chapter 5 explains how this design response was selected through divergence and convergence among alternative concepts.

Research questions

The main research question is:

How can furniture brands be supported in developing circular PSS intervention directions that aim to reduce the premature discard of domestic movable furniture in evolving living contexts?

Five sub-questions further address this research question:

1. What does premature furniture discard entail, and what conditions make domestic movable furniture vulnerable to premature discard in evolving living contexts?
2. How does premature furniture disposal lead to value loss across the furniture continuation journey?
3. Which recurring breakdown mechanisms explain why usable furniture fails to continue in use?
4. How can design implications, derived from these breakdown mechanisms, be used to guide the development of circular PSS intervention directions?
5. To what extent is the resulting design outcome suitable as guidance for furniture brands when applied to varied furniture cases?

Thesis structure

The thesis moves from explaining the continuation problem to identifying the continuation decision gap, developing the CFCF, applying and validating it, implementing an evidence-based iteration, and discussing its bounded contribution to reducing premature discard.

Introduction conclusion

Furniture can leave use while functional value may remain, and disposal routes often fail to preserve that value (Forrest et al., 2017, p. 12; Koch & Vringer, 2023, pp. 11, 31). This indicates a continuation problem, but not that every disposal event is avoidable.

Whether furniture can continue in use is shaped by household, product, route and wider system conditions. The research therefore investigates these conditions and the resulting continuation decision gap among furniture brands. Furniture brands may need support to bring relevant information together, identify continuation breakdowns and translate them into suitable circular PSS intervention directions.

The CFCF is therefore a means for developing an intervention direction, not the project goal or a finished solution that reduces premature discard by itself. Any reduction depends on later development, implementation and verified outcomes.

The next chapter defines the concepts used to distinguish household exit, continued use and value retention.

Theoretical foundation

In this project, premature furniture disposal is treated as a problem concerning continuation, in which usable furniture may leave use before it breaks down. Circular strategies may help retain value and reduce disposal risks across contexts. Furniture-sector examples illustrate how selected circular strategies are currently offered. This chapter lays out key concepts such as premature disposal and circular options, showing how disposal differs from discard and how continued use differs from value loss. It provides the basis for Chapter 4, where the analysis assesses, in more detail, where and how continuation breaks down.

Key concepts

Furniture leaving the household is not necessarily problematic. Therefore, to avoid treating every household exit as waste, this overview differentiates between disposal, discard, continuation, End-of-Use and End-of-Life. Related literature uses concepts such as premature replacement and premature discard to describe products that are replaced while still working or disposed of when value may remain (Cox et al., 2013; Magnier & Mugge, 2022). This project uses those ideas to

define premature furniture disposal as a situation with a risk of early discontinuation, in which furniture leaves use before its technical or functional potential has been exhausted and before continuation routes have been properly enabled or tested.



Figure 4: Terminology timeline for disposal, continuation, discard, premature disposal, End-of-Use and End-of-Life. The figure separates the act of leaving use from the value outcome after leaving use (Cox et al., 2013; Magnier & Mugge, 2022; Yla-Mella et al., 2022; Hebrok & Asdal, 2013).

In this thesis, disposal refers to the process by which furniture is removed from use or from the household. Disposal may preserve value when the item continues through reuse, repair, refurbishment, resale, donation, take-back, redistribution or redeployment. Discard refers to disposal outcomes in which the furniture's function is not fully continued. Material value may still be partly recovered, but some of the furniture's higher-value function is lost.

Continuation refers to routes through which furniture, components or remaining value stay in use. End-of-Use is the moment when a household stops actively using a piece of furniture. This differs from End-of-Life, because the product may still have functional, technical, emotional or material value after the household no longer wants or can keep it. Yla-Mella et al. (2022) support this distinction by separating use discontinuation from final waste status in product lifecycles. In this thesis, early exit refers to furniture leaving the household in the risk zone between End-of-Use and End-of-Life, where continued use may still be possible.

The process through which usable furniture can come to be at risk of disposal is referred to as *dis-domestication*, in which objects lose their household role due to changes in life circumstances, aesthetics, maintenance, sentimental value, or functional relevance (Hebrok and Asdal, 2013; Hebrok, 2014).

This definition moves the focus from the moment furniture leaves the household to what happens to its remaining value afterwards. The next section therefore introduces circular product service systems and continuation routes as ways in which early exit can lead to continued use rather than discard.

Existing circular strategies

This section connects existing circular strategy frameworks to the project's focus on continuation. It first uses the R-ladder and Value Hill to explain why retaining product and component value is prioritised, then introduces circular product service systems and current furniture-sector responses. Its purpose is to define a theoretical foundation for the later analysis.

R-ladder, Value Hill and lifetime extension

Circularity concerns retaining or recovering the value of products, components and materials while reducing resource use and waste (European Commission, 2020; International Organization for Standardization, 2024). Potting et al.'s (2017) R-ladder ranks strategies into more sustainable product design, manufacturing, and use

(R0 refuse, R1 rethink and R2 reduce), product and component lifetime extension (R3 reuse, R4 repair, R5 refurbish, R6 remanufacture and R7 repurpose), and material or energy recovery (R8 recycle and R9 recover).

Circularity strategies within the production chain, in order of priority

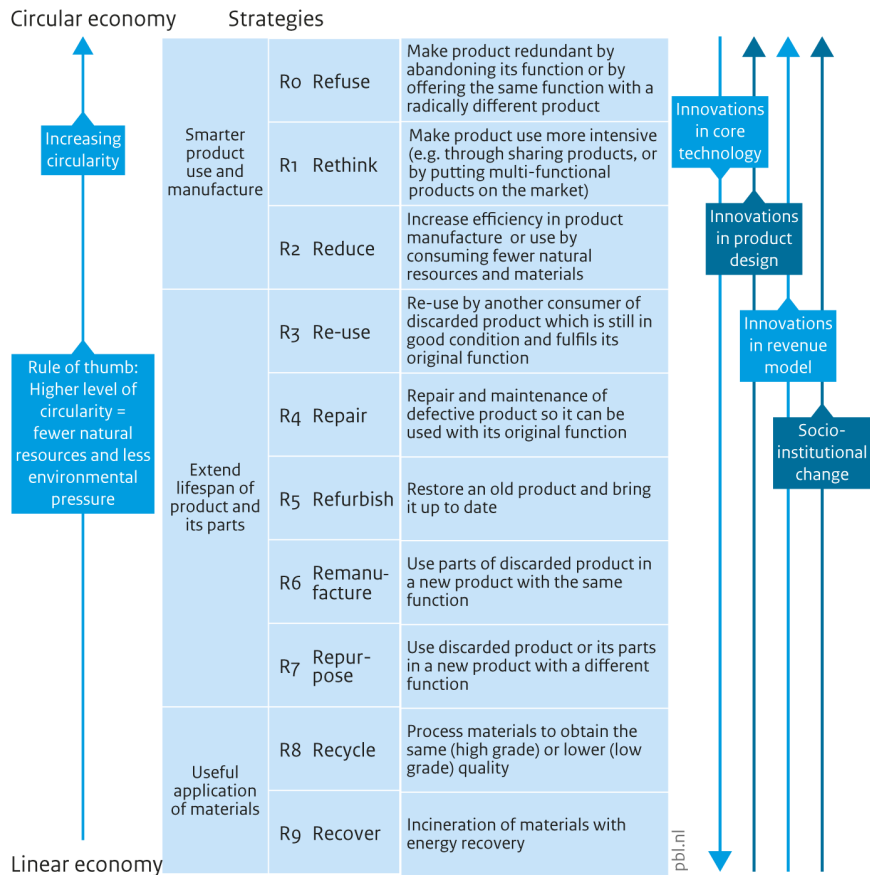


Figure 5: R-strategies, often referred to as R-ladder (Potting et al, 2017).

Lower R-numbers often indicate higher circularity because they avoid resource demand or retain more product, component or material value.

The Value Hill complements this ladder by showing where value is added, retained and recovered across pre-use, use and post-use phases (Achterberg et al., 2016). Circular design supports the uphill phase, maintenance, repair and service models keep products near the top, and reuse, refurbishment, remanufacturing and recycling retain different forms of value after use. These strategies depend on coordination between actors, such as users, service providers, repairers and logistics partners.

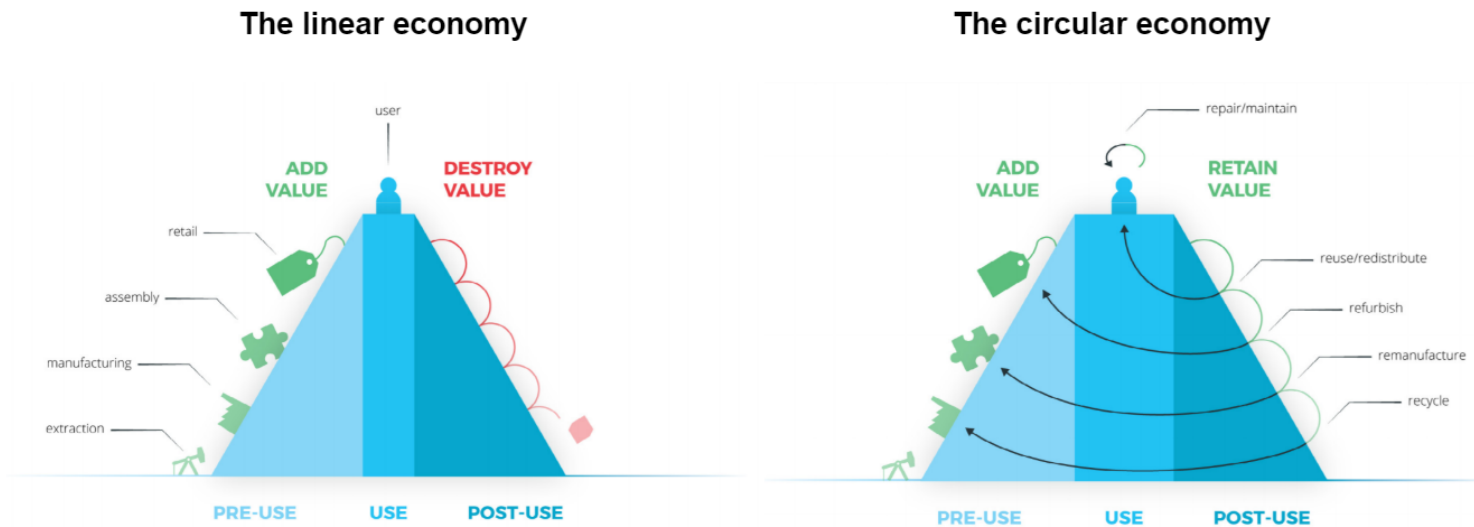


Figure 6: Value hill (Achterberg et al., 2016).

The Value Hill makes the importance of lifetime extension clear. Prolonging product or component use and delaying material and energy recovery can be achieved by keeping furniture at the top, or returning it towards the top through maintenance, adaptation, repair, reuse, refurbishment or redeployment. These responses correspond mainly to R3-R7 and are especially relevant because this project concerns furniture that already exists. R0-R2 remain relevant where demand can be avoided or use intensified.

Building on Section 2.1, continuation asks whether furniture, components or remaining value stay in use after the current household no longer can or wants to use the item. Lifetime extension is the added product or component use that results. A return, resale listing or recycling route therefore provides only a possible path; it

does not prove lifetime extension or value retention. This project prioritises product- and component-level continuation before material recovery, while recognising that transport, repair effort, additional materials, utilisation and replacement timing can alter the environmental outcome.

Circular product service systems and continuation routes

The Value Hill positions several service-based models around optimal use and value recovery. A product service system (PSS) is a marketable combination of products and services that jointly fulfils a user need (Goedkoop et al., 1999). PSS offers range from product-oriented services such as maintenance and repair, through use-oriented offers such as rental or leasing, to result-oriented offers that deliver an outcome rather than product ownership (Tukker, 2004). A PSS is not circular by definition; it becomes relevant when the product-service combination creates incentives and practical capacity to reduce resource use or retain product, component or material value (Kjaer et al., 2019).

In furniture, circular PSS strategies can combine durable or adaptable product architecture with planning, maintenance, spare parts, repair, upgrades, relocation, take-back, refurbishment, resale or access services. These responses distribute continuation work among households, brands, repair actors, logistics providers and resale or refurbishment partners.

A strategy is the designed response, while a continuation route is the path through which furniture or its value moves. Possible routes include continued use by the same household, repair, transfer to another user, return and redeployment, parts harvesting or material recovery. Offering a strategy or entering a route does not establish the outcome: a take-back service may end in rejection or recycling, while a resale listing may not find a buyer. Access, eligibility, condition assessment, logistics, organisational capability, demand and downstream fate therefore affect whether continuation succeeds. Distinguishing strategy, route and outcome prevents every PSS from being treated as circular or route availability as proof of lifetime extension, and makes visible the actors, services and capabilities a suitable response requires.

Continuation conditions are also shaped before End-of-Use. Sector analysis indicates that weak incentives for durability, disassembly and repair, together with concern that longer product life could reduce new-product sales, can constrain continuation. Lower-quality construction and limited disassembly or reconfiguration can also reduce second-life potential (Forrest et al., 2017, p. 15). These sector-level mechanisms suggest that enabling continuation may require combined product, service and business-model changes; they do not apply equally to every brand.

Existing circular furniture responses

Current furniture responses show how product, service, route and organisational measures can combine across the R-ladder and Value Hill. The examples below are illustrative rather than exhaustive and do not cover the complete strategy hierarchy. They show offers described by the companies, but do not independently establish environmental performance or guaranteed lifetime extension.

Table 4: Existing circular furniture responses

Response type	Current furniture-sector example	Continuation contribution and boundary
Adaptable product with planning and parts support	Vitsœ 606 shelving combines a modular kit with a free planning service and additional components that can be added over time (Vitsœ, n.d.).	Supports reconfiguration and relocation. Continued use depends on long-term compatibility, fit with the new space, and continued access to parts and service.
Repair, buy-back and resale	IKEA Netherlands offers spare parts and a Buy Back service through which eligible furniture is assessed and resold in its Second Chance area (IKEA, n.d.-a, n.d.-b).	Supports repair or transfer to another user. Eligibility excludes several furniture categories, and return does not guarantee that product value will be retained.
Take-back, refurbishment and redeployment	Royal Ahrend's Circular Hub combines furniture take-back, condition assessment, refurbishment and resale or redeployment for office furniture (Royal Ahrend, n.d.).	Shows the downstream capabilities required after return. It depends on grading, parts, logistics, demand and a viable recovery cost.
Access-based subscription	NORNORM's office furniture subscription includes space planning, changes during use, support, collection, refurbishment and recirculation (NORNORM, n.d.).	Keeps continuation responsibility with the provider and supports adaptation or redeployment. It still depends on utilisation, reverse logistics, condition management and customer fit.

Table 2: Examples of current circular furniture strategies.

The examples span household and office furniture because circular PSS implementation is visible in both contexts. The office examples show more integrated service and reverse-flow systems, but their organisational conditions cannot be assumed to transfer directly to domestic furniture.

Together, these responses show how furniture offers can operationalise selected R-ladder strategies and Value Hill positions, but they do not remove the need for case-specific diagnosis. A modular product does not resolve repair access, take-back does not guarantee redeployment, and a subscription does not automatically reduce resource use. Chapter 4 therefore examines where continuation is at risk and which conditions a suitable response would need to address before an intervention direction is selected.

Early-exit indicators for premature furniture disposal

An early exit cannot be reliably identified for every individual item because the expected lifespan, remaining functional value, household motivation, and the outcome after household exit are difficult to determine, let alone record together. The analysis therefore uses four early-exit indicators as proxy measures for situations in which early exit may occur. These indicators do not prove premature disposal in every case, provide a rate of premature disposal, or explain each disposal decision, but rather point to where the analysis should look for breakdowns in continuation. These areas include the remaining product value at the time of disposal, the furniture's actual use duration, events that might trigger disposal, and the chosen disposal route after household exit.

INDICATOR	SIGNALS	WHAT IT ILLUSTRATES
Condition	62% is replaced before defect; more than half of discarded items remain in good condition.	Technical failure does not explain all exits
Time	Sofa use fell from 14.2 years to about 6.0; some wardrobes reach only 39% of expected use.	Lifetime decreases & use may end early
Route	About 80 million kg enters waste routes; 30 million kg is reused in the cited Dutch estimate.	Household exit does not ensure value retention
Trigger	Moving, downsizing, limited space, household change and aesthetic mismatch can activate disposal risk.	Intervention may be needed before disposal decision

Figure 7: Overview of the four indicators for premature discard risk may occur. They are not a measured premature disposal rate or proof that every exit is avoidable, but are proxy signals to be used for analysis. The sources used for the signals are found in the corresponding paragraphs.

Condition-based indicators: usable furniture still leaves use

Condition indicators are the strongest predictors of premature disposal risk because they reveal that the furniture may still have functional value at the time of replacement or disposal. In the Netherlands, 62% of household furniture is replaced before it becomes defective, often because consumers want something new (PBL, 2025, p. 38). Hebrok (2016, p. 11) offers qualitative Norwegian evidence supporting this, noting that 12 out of 14 interviewees had replaced or planned to replace furniture they discarded. Similarly, Koch and Vringer (2023, p. 31) report that over half of discarded Dutch furniture still is in good condition.

These data do not suggest that every replacement was avoidable or could have been postponed through a circular process. They mainly show that technical failure alone does not account for furniture disposal. Furniture may still be usable but could become unsuitable due to changes in household fit, desirability, perceived value, or access to a suitable continuation route. This underlines the importance of viewing premature disposal as an issue regarding continuation rather than only a waste management challenge.

Time-based indicators: shortened use cycles

Time-based indicators show declining expectations for furniture lifetimes and actual use periods that are shorter than expected lifetimes. Although furniture lifetime estimates are very broad and affected not only by product type (TAUW, 2022b), the expected period of furniture use has been decreasing, with sofa lifespans dropping from 14.2 years in 1985 to 7.8 years in 2006 (ARG, as cited in Cooper et al., 2021, p. 5). TAUW estimates that this decline continued, reducing the average lifespan to around 6.0 years by 2019 (TAUW, 2022a) and expects further declines, likely increasing waste generation (TAUW, 2022b, p. 25). Some pieces of furniture are discarded well before they reach their expected lifespan for durability or proper functioning, as Austrian consumers report using wardrobes and desks for approximately 39% and 35% of their expected lifetimes, respectively (Wieser et al., 2015, p. 4).

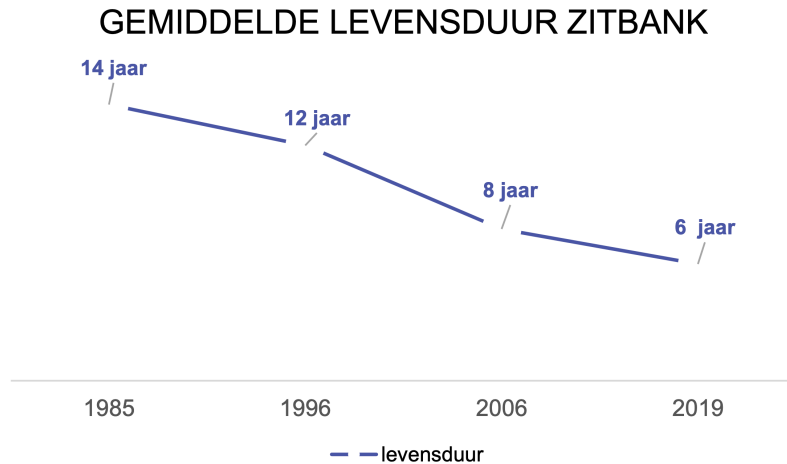


Figure 8: Average lifespan of seating furniture. Source: TAUW (2022a).

A question that arises is whether this indicates that furniture breaks earlier than respondents expect, or that it is replaced before it breaks? These statistics do not identify the dominant mechanism, but do suggest accelerating turnover.

Although this data combines data from different countries, product categories, and lifetime measures, it does not explain why products leave use or directly prove premature disposal.

Shortened use cycles therefore indicate possible early exit from use, but they do not explain which product, household and route conditions help shape that early exit.

Route-based indicators: value retention after household exit



Figure 9: Route based indicator: Household exit does not ensure value retention. Rounded estimated annual Dutch flows for large seating furniture. Source: adapted from TAUW (2022b, pp. 3-4).

Route-based indicators show that household exit does not automatically lead to value retention. In the Netherlands, environmental consultancy firm TAUW estimates that consumers buy about 90 million kg of large seating furniture each year, while around 110 kton leaves households. About 80 million kg of this flow is discarded directly as waste, without reaching a new owner, and mostly enters collection or waste routes where it is incinerated (TAUW, 2022b, p. 3). Another 30 million kg is estimated to be reused, either directly through second-hand channels or after entering waste collection routes. These data show that value retention not only depends on why furniture leaves the household, but also on the route it takes after leaving. After exit, the chosen route can still preserve product value, material value, or neither, making it important to analyse the route outcomes separately from household exit.

Trigger-based indicators: moments when disposal risk becomes active

Trigger-based indicators show when usable furniture becomes at risk of an early exit. Moving, limited space, changes in household composition and aesthetic dissatisfaction can make furniture lose fit within a changed living context (Hebrok, 2014, 2016; Koch & Vringer, 2023). These triggers don't indicate that an item has reached end-of-life, but rather moments when fit, meaning, convenience and available

routes determine whether it is kept, adapted, stored, transferred or discarded, and when continuation support may need to act prior to disposal becoming the easiest option.

Theoretical foundation conclusion

This chapter defined premature furniture disposal as a continuation problem.

Large furniture flows enter disposal routes even though usable value may remain, while circular strategies and continuation routes can extend use (Forrest et al., 2017, p. 12; Koch & Vringer, 2023, pp. 11, 31). Discard is preceded by a disposal decision followed by a route execution. The most sustainable strategies that have the most potential to prevent furniture being incinerated or landfilled is to extend its use-phase through lifetime extension. Circular strategies and continuation routes that extend the use-phase and lifetime of furniture exist.

In order to extend the use-phase and the lifetime of furniture, we need to understand why households choose dispose of their furniture, and why this disposal leads to discard.

Furniture leaving a household is not automatically discarded, but depends on product, service, route, and actor conditions, that may influence the disposal decision. Existing circular PSS strategies for furniture can provide continuation options. The following analysis therefore examines how these conditions interact in specific disposal situations. It focuses on how remaining value is preserved, downgraded or lost, and on the recurring mechanisms that shape these outcomes.

Methodology

This chapter explains the methodologies used to develop the framework and focuses on how evidence was collected, analysed, and translated into the CFCF.

Design approach

Findings from literature and design research informed the design of a framework to guide furniture brands in translating disposal risks into circular PSS intervention directions. This is a fitting design outcome, given the systemic nature of the problem. It aims to guide furniture brands in making decisions across furniture cases and contexts, rather than addressing only a single specific case.

This project frames premature disposal within the household context, where home dwellers may experience a mismatch and make many disposal decisions. This focus makes the research approach human-centered. However, because furniture brands have greater influence over aspects such as product design, available services, and continuation options, they are the intended users of the framework. The CFCF therefore supports the design process rather than being a tool that directly helps the consumer.

Design methods were used as tools to support decision-making and structure the collection, analysis, synthesis and integration of knowledge, as well as design development. This aligns with the Delft Design Guide, which treats methods as ways to communicate work and support collaboration (Boeijen et al., 2020). This section therefore focuses on how the selected methods contributed to the framework.

The approach and selection of methods were based on the systemic nature of the problem and how the project evolved over time. Literature research was used to define the context of the problem, while system and actor mapping helped clarify how premature disposal is affected by multiple stakeholders and overlapping responsibilities. To understand where and why continuation breaks down before, during, and after leaving the household, journey maps were created for both the user and the product. Finally, the synthesis clustered findings and translated recurring mechanisms into a coherent design direction. Together with the development of the framework, application examples, and validation, this resulted in a traceable result and grounded evidence.

Sources and uses

Academic literature and sector reports supported problem framing, sector context, and known mechanisms. Insights from practice, gathered through interviews with stakeholders, revealed their challenges and validation needs. Benchmarks helped illustrate the status quo and identify possible intervention directions. Familiarity with contexts such as high-mobility rental and shared housing was used as background knowledge for creating and evaluating scenarios. Methods and their products developed during the project, such as the various maps, scenarios, synthesis clusters, and requirements, helped improve understanding and inform design decisions.

Different claims require different types of evidence. External sources supported claims about the furniture system and known mechanisms, whereas quantitative sector data mainly provided context and direction, depending on the data's source type, scope, and comparability. Qualitative input from practice was used to better understand the conditions and needs, rather than as representative evidence. The project's outputs, such as maps and design implications, are not direct evidence but interpretations resulting from the design research, intended to make the reasoning and traceability clear. This project's analysis provides the basis for the rationale and supports the translation into the framework.

Project process

The project process moved from problem evidence to a design result through several steps. Figure 2.1 summarises the key steps and their outputs, and illustrates that the initial evidence contributed to the development of the framework. Although displayed chronologically, several steps overlapped and were revisited, resulting in an iterative design process.

The order of the project's process was:

context research → system and actor analysis → disposal journey and product-route analysis → synthesis → design principles and requirements → CFCF development → application examples → validation

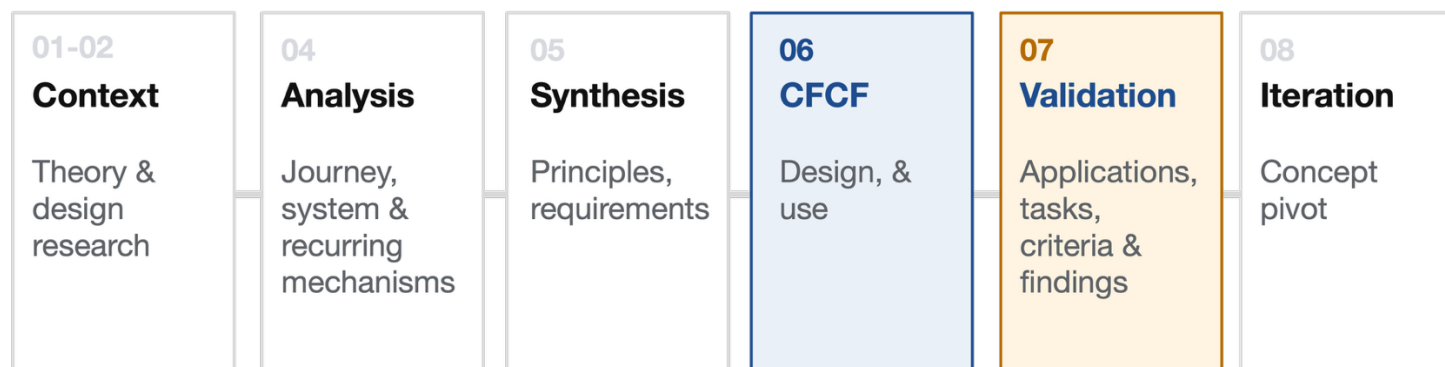


Figure 10: The research and design process: The figure shows the main process steps for developing the CFCF.

The translation of evidence into the design direction followed the following steps:

evidence → observations → recurring mechanisms → synthesis clusters → design principles and requirements → framework components

The synthesis layer and framework layer were kept separate. Synthesis clusters and design principles explain broad mechanisms and design direction. Breakdown patterns, intervention objectives, and strategy families are used in the CFCF because they are more specific and more useful for cases and decision guidance. This translation from the synthesis layer to the framework layer is based on design judgments.

Methodology conclusion

The selected methodology was suitable for developing the CFCF and preparing it for later application and validation because it combined a human-centered design approach to create an understanding of household disposal with a systemic, traceable, evidence-based design process that used furniture-brand decision-making.

Literature and sector research framed the problem, while system and actor mapping and user-journey and product-route analyses helped clarify interacting conditions across the furniture-continuation process.

Evidence was translated through observations, recurring mechanisms, synthesis clusters, and design principles and requirements into framework components; these stages overlapped and were revisited as the project developed.

This approach provides a traceable development rationale for the CFCF, but it does not turn qualitative practice input into representative sector evidence or project-produced maps, clusters and design implications into direct evidence; these remain contextual input, research synthesis and design judgment.

The next chapter therefore presents the problem-space findings produced through this approach and examines how interacting conditions can cause furniture continuation to break down.

Understanding the problem space

To extend the use phase and lifetime of furniture, we need to understand why households choose to dispose of furniture, why this disposal can lead to discard, and where opportunities may exist to address the problem. Building on the earlier discussion of the domestic furniture context and the issue of premature disposal, this section examines the context in more depth to identify opportunity areas for intervention.

Building on the disposal and circular concepts defined in the background, the analysis pinpoints where continued use becomes difficult. It starts from early-exit signals and then examines the conditions that influence whether furniture stays in use, is transferred to another user, or loses value after leaving the household.

The analysis determines where premature disposal risk becomes visible, and how this risk is influenced by actors, changing household contexts, the disposal process, route outcomes and existing circular responses. It then identifies recurring continuation mechanisms, to be translated into design implications.

Analytical lenses for continuation breakdowns

The problem's background and context are analysed from three connected perspectives that help structure the analysis and clarify why premature disposal can't be explained solely by product condition. These lenses are system and market conditions, product and service characteristics, and user and household context.

At the system level, external literature and indicators, such as trends and sector patterns, help define the larger context shaping furniture disposal and continuation. These sources are used to identify relevant relationships and early-exit risks, rather than as direct proof of premature disposal themselves. The following quantitative indicators therefore provide a starting point to understand where early-exit risk may occur and which conditions call for further analysis.

Furniture disposal as a systemic continuation problem

Factors beyond furniture’s physical characteristics shape furniture disposal. Whether furniture continuation occurs depends on the interactions among household context, product characteristics, service support, route availability, organisational capability, and practical decision-making conditions. A usable product can still leave the household when keeping, adapting, moving, repairing, reselling, or transferring it becomes too difficult, unattractive, or uncertain.

The actor map indicates that home dwellers are the primary decision-makers. However, other actors also play important roles. Brands shape aspects such as product design, spare parts, guidance, service offers, take-back options, and customer relationships. Repair and refurbishment actors influence whether technical continuation remains possible. Logistics providers may make the moving or collection of bulky furniture accessible. Resale and recirculation channels influence whether the product's value can be transferred to the next user. Municipal waste routes often offer the most reliable exit route, but they may also risk turning remaining product value into low-value material or energy recovery.

The system map shows that routes for continued use compete with discard routes on practical conditions, not only on environmental preference. Even when households prefer reuse, repair, resale, donation or refurbishment, they may still

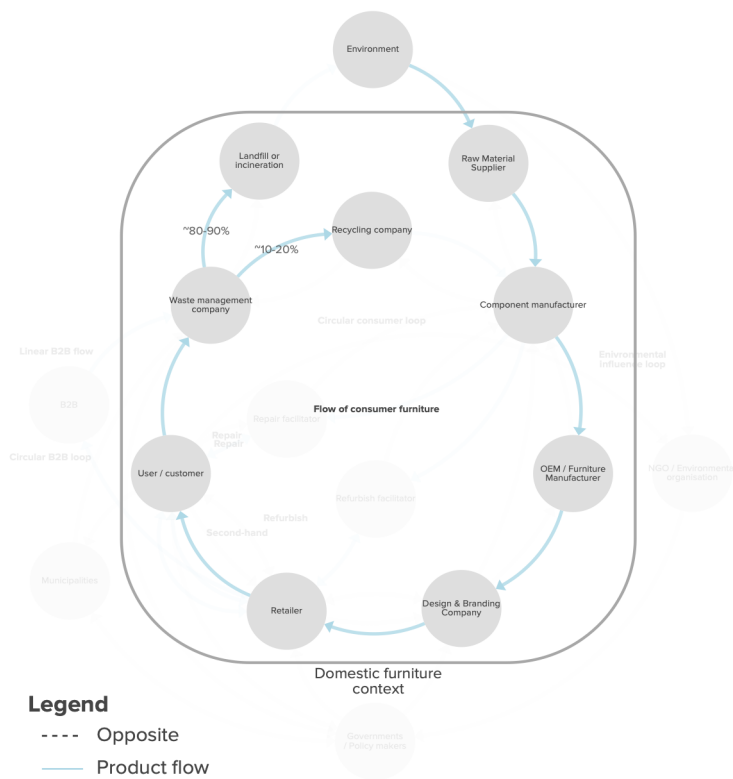


Figure 11: Current linear domestic furniture flow. Visualises the key actors involved in the context of moveable domestic furniture and the dominant linear product flow, from raw material supply to end-of-use routes via waste management.

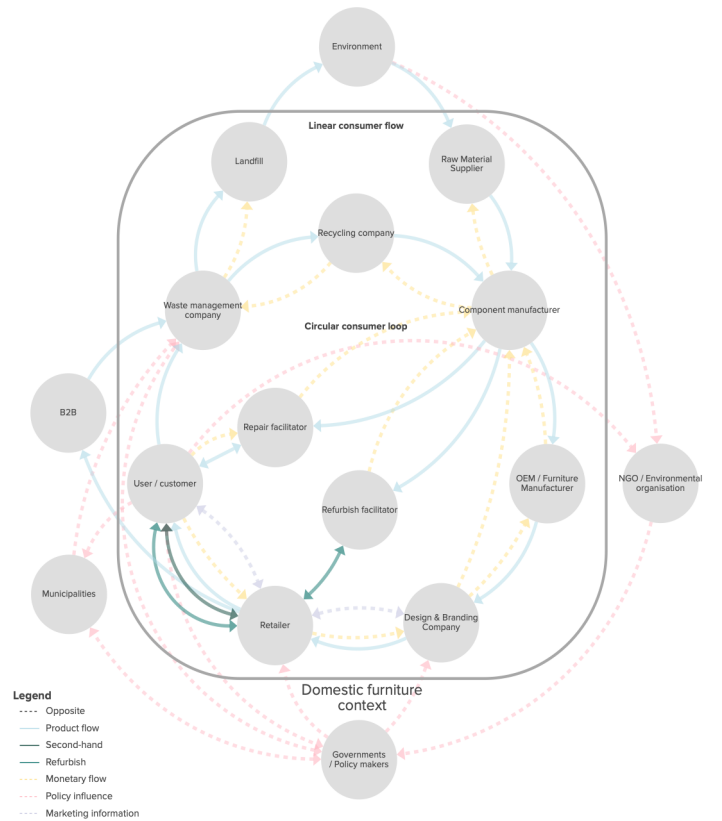


Figure 12: Actor map of furniture context with approximation of possible flows between actors. It visualises the key actors involved in the context of moveable domestic furniture and the dominant linear product flow, from raw material supply to end-of-

choose bulky waste if these routes seem slower, uncertain, costly, physically difficult or unclear. The CFCF therefore needs to help users identify why routes for continued use are not chosen, or why they fail before value is retained.

Continuation decision gap

Note: Validation evidence is referenced by participant and finding: (e.g., E3:1; E4:2; P1:2, 3; P2:2). The letters identify the participant type, the first number identifies the participant, and the number after the colon identifies the finding. Multiple finding numbers indicate that one participant supported several findings (e.g., P1:2, 3).

Furniture brands can shape parts of the system that keep furniture in use through decisions regarding products, services, routes, and business models. However, each breakdown requires a different circular response. The decision problem is therefore not simply whether a brand should become more circular, but which breakdown is preventing continued use and which intervention direction best fits that situation.

Sector reports and stakeholder input suggest that when circular strategies are considered, support often focuses on materials, recycling, and environmental impact, rather than on continued use and value retention (Van den Berg & Hintzen, 2023; E1). However, this differs between companies. CBM describes 'koplopers' or front-runners in circularity that have worked on sustainability for longer (E2). Another practitioner expected that few front-runners may already consider circularity more broadly (P1). Circular product properties alone do not ensure continued use, because route, organisational, and economic conditions can still block continuation (E1; E2; E3; P2; P3).

Entrepreneurs in the furniture sector need support with circular business models, design, and chain setup, while tools for environmental impact assessment already exist, including LCA-like tools (TNO et al., n.d.; Van den Berg & Hintzen, 2023). The issue therefore appears not to be a complete lack of circular support, but whether existing support sufficiently helps furniture brands translate circular ambitions into concrete decisions and actions.

Several experts and practitioners described that furniture companies have little to no insight into what happens to furniture after sale and unclear responsibility for continuation, with very few frontrunners as an exception (E1; E2; E3; P1; P2; P3). Limited post-sale insight may also make it harder for companies to recognise the

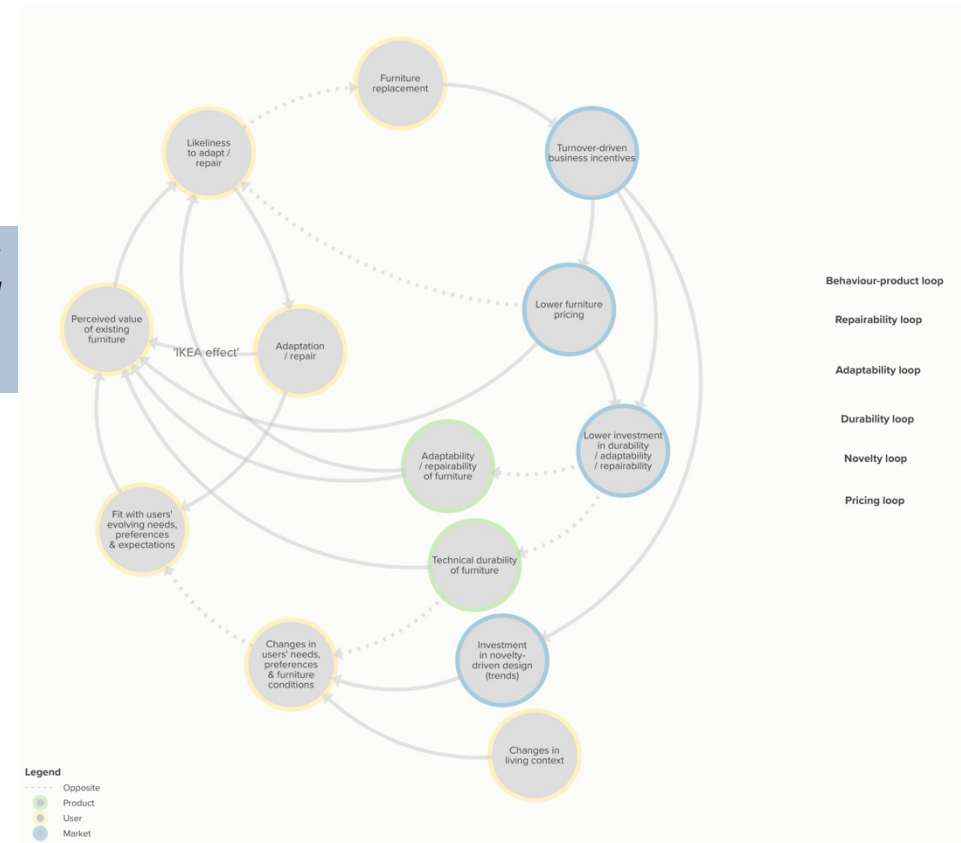


Figure 13: Map which incorporates several systemic effects, and ow they shape eachother. Labels on the right side show which effects are incorporated. Brought realisation how interwoven the system is.

different situations in which consumers may dispose of furniture. This may make it relevant to make these disposal risks visible, and demonstrate how these risks might be reduced through product, service, or route interventions. One expert suggested that companies should first ask what happens to products at end-of-use and how reuse or material recovery could be improved (E1). Products may also continue outside the original brand's direct control, as shown by Swapped, which enters after the user has disposed of the product and strives towards continuation (E4). This makes it relevant to precede the design process by identifying where continued use breaks down before moving towards a circular intervention direction.

The findings suggest that the possible gap is not simply a lack of circular support, but difficulty bringing existing knowledge and methods together for a specific continuation decision (E1; E2; P2; P4). Other findings indicate that the suitability of a continuation route depends on the case and its practical conditions (E1; E2; P1; P2). Together, these findings may support first identifying the continuation breakdown before selecting an appropriate intervention direction that addresses it. The possible practice need appears strongest where post-sale information, organisational responsibilities, and existing circular knowledge are not yet brought together in one decision process, which few front-runners may already do partly (E2; P1; P4). This makes it relevant to first identify the problem and define the intervention objective before moving towards development. Later pre-exposure practice discussions suggest that practitioners recognise parts of this gap, but do not show that it exists for every furniture brand (E1; E2; E3; P1; P2; P3; P4). Whether the CFCF provides useful guidance is assessed separately in the validation chapter.

Disposal journey mapping

The disposal journey map helps treat premature furniture disposal as a process that develops over time, rather than a single end-of-use decision. Furniture can become vulnerable to premature disposal before it actually leaves the household, when acquisition conditions, everyday use, mismatch recognition, coping attempts, route search and hand-over conditions reduce the feasibility or attractiveness of continuation. The map is used here to identify where value may still be preserved before the furniture leaves use or loses functional value.

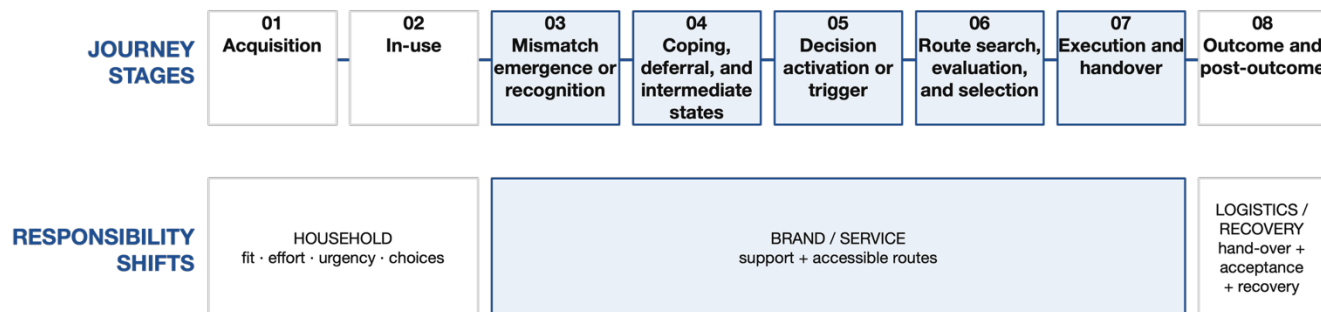


Figure 14: Top: The disposal journey model for premature furniture exit that was developed. Illustrates the eight journey stages where continuation pressure, route search and fallback risk appear. Bottom: The shift of responsibility among actors.

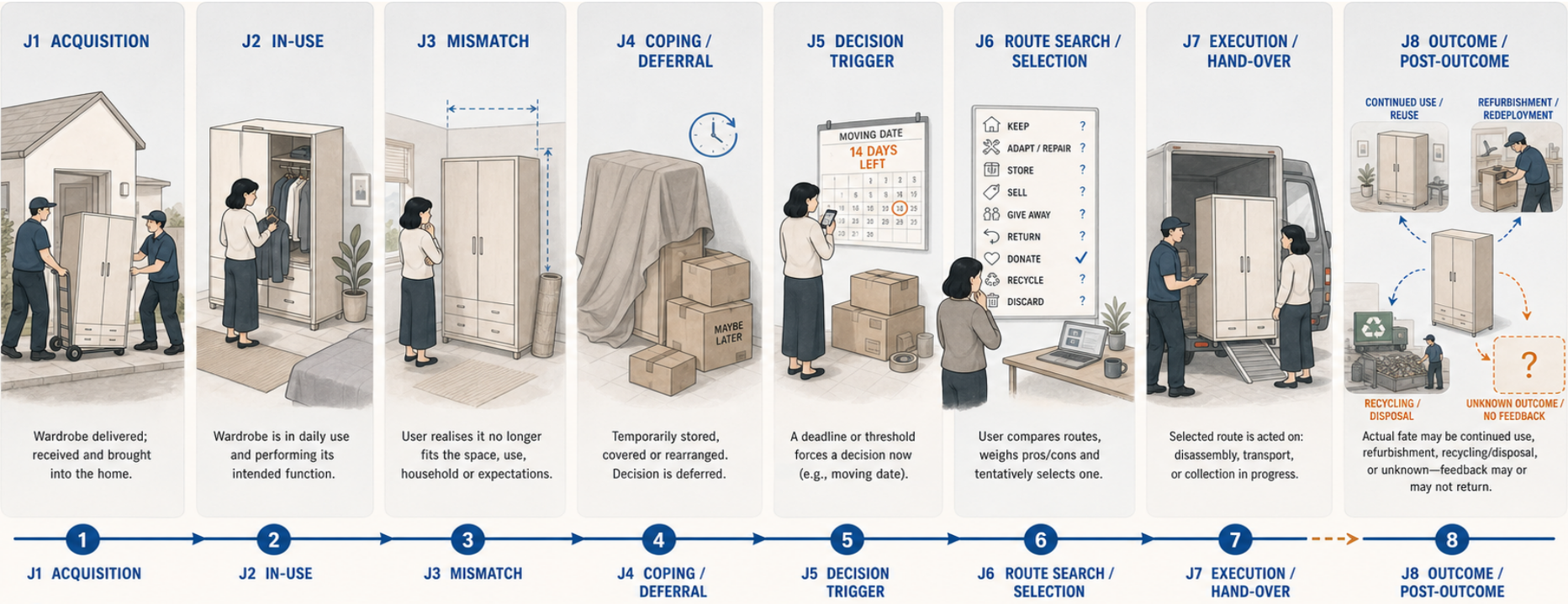


Figure 15: User journey stages for furniture disposal. Visualises the 8 journey stages and shows where continuation pressure, route search and fallback risk appear. Created using generative AI.

Table 5: More elaborate descriptions of the disposal journey stages

Stage	Description
1. Acquisition	Product quality, adaptability, information, and service conditions enter the household with the furniture and limit or enable later continuation.
2. In-use	Furniture performs its everyday role and is maintained, adapted, moved, cared for, emotionally embedded in, or gradually neglected.
3. Mismatch emergence or recognition	The user recognises that the furniture no longer fits the space, use situation, household composition, aesthetic preference, emotional meaning, or condition expectation.

4. Coping, deferral, and intermediate states	The household temporarily tolerates, stores, relocates, repurposes, delays repair, or offers the furniture through informal channels without resolving the issue of its continued use.
5. Decision activation or trigger	a threshold or event that makes action necessary while remaining value may still exist. Typical triggers include moving, loss of storage cohabitation, separation space, downsizing, , renovation, repair cost or urgent space pressure.
6. Route search, evaluation, and selection	The household searches for, compares, and selects possible routes for keeping, adapting, repairing, storing, selling, giving away, returning, donating, recycling, or discarding the furniture.
7. Execution and handover	The selected route and its needed actions are carried out. These activities could include disassembly, transport, collection, sale, transfer, donation, return, or disposal. Continuation may still fail at this stage due to handling burden, coordination issues, logistical issues, rejection, or damage.
8. Outcome and post-outcome	The actual route outcome becomes visible or remains unknown. Furniture may continue through reuse, repair, refurbishment, resale, redistribution, or storage, but may also be downgraded, recycled, discarded, or get out of sight, depending on the route's success.

The route-based indicators show why the split between Execution and handover and Outcome and post-outcome is necessary. Furniture only enters an opportunity for continuation at handover. The outcome that follows is determined by the various conditions that influence product, route, and context. A returned item may still be rejected after inspection, a donation may not be accepted, a resale attempt may fail, or a collected item may be recycled or discarded after assessment. The analysis therefore does not treat handover as proof of continuation, but rather differentiates between whether a route can be executed and whether it leads to the product's remaining value being retained.

Nilsson et al. (2025, p. 95) describe divestment as the process of letting go of a product. Physical disposition and emotional or mental detachment are separate subprocesses that can occur independently (Poppelaars et al., 2020, as cited in Nilsson et al., 2025, p. 95), and both may require support (Nilsson et al., 2025, p. 104)(Nilsson et al., 2025, p. 104).

The journey model produced two main findings. First, intervention opportunities exist before the final disposal moment. Disposal journey mapping revealed that acquisition information, modularity, service availability, care guidance, and route visibility can all shape later continuation. Second, route choice is affected by practicalities such as time pressure, effort, cost, transport, storage, disassembly, eligibility, trust and expected value. These constraints may turn an intention for continuation into a discard route. PBL (2025, p. 46) reports that costs and practical barriers can prevent consumers from choosing circular options. This identifies possible mechanisms, but does not show which condition caused a particular outcome.

Route friction may therefore contribute to continuation breakdown. A household may prefer reuse, repair, resale, donation, return or refurbishment, but still choose bulky-waste disposal when the continuation route is slower, uncertain, costly, physically difficult or poorly explained. This shifts the analysis from asking only why a

user discards an item to asking which continuation route became unavailable, unattractive, uncertain or impossible to execute. In Nilsson et al.'s exploratory household study, carrying, transport and pickup availability were barriers to handing over larger products, including furniture (2025, pp. 101–102).

Divestment involves more than moving a product. Participants in the exploratory household study described the effort of deciding what to do, preparing the item, arranging a sale or handover, and finding a route that would accept it. Anticipated effort could delay action even when the product was no longer wanted (Nilsson et al., 2025, pp. 102, 104–105). This suggests four sources of route friction: decision-making, coordination, handling and route acceptance. The study did not identify effort thresholds or test whether reducing one burden changed behaviour.

Coping, deferral and storage do not necessarily mean that continuation has failed. Some products were stored for a credible future use. Others were kept even though owners considered future use unlikely, or because attachment continued after active use had ended (Nilsson et al., 2025, pp. 96, 101, 103, 105–107). It is therefore useful to distinguish active use, credible planned reuse, temporary storage and indefinite retention. The study does not provide a universal time threshold for these states.

The disposal journey map makes visible when continuation becomes difficult. The problem may emerge while furniture is still being used, when a household delays action, when route options are compared, when the chosen route has to be carried out, or after the item has left the household. The timing matters because the conditions that affect continued use before household exit are not the same as the conditions that determine what happens to the product afterwards. The next section therefore follows the product after household exit to examine whether it continues in use, loses part of its value, or becomes waste.

Evolving living contexts and furniture misfit

Changing living contexts may create moments in which the furniture's fit is re-evaluated. Scenario analysis was used to examine how moving, downsizing, cohabitation, separation, household reconfiguration, room changes and changing preferences place pressure on furniture continuation. These situations were treated as analytical perspectives, with the aim of understanding how a previously useful item can become difficult to keep, adapt, move, store, repair, resell, or pass on.

The main scenario finding is that premature disposal is often shaped by a range of conditions rather than solely by technical factors. Furniture can still function, while becoming a poor fit for the household. A wardrobe may remain structurally sound but no longer fit a new room. A sofa may still be usable but no longer match household use, aesthetic expectations or repair affordability. Dining chairs may be technically reusable but still lose value when collection, value estimation or resale certainty are weak.

This matters because contextual misfit requires different intervention directions than technical defect. Spatial fit problems may point towards modular reconfiguration, relocation support or access-based alternatives, such as furniture rental. Aesthetic mismatch may require renewal layers or refurbishment routes.

Household redundancy may require product return, exchange or redistribution. Scenario analysis therefore supports the CFCF's focus on identifying the specific mismatch before selecting a circular PSS intervention direction.

Product-route mapping and value loss

Product-route mapping shifts the analysis from how disposal develops to what happens to the product after End-of-Use. The analysis of the disposal journey showed that continuation may become difficult throughout the process. The analysis of the product-route follows the product after it leaves active use to assess whether it remains in use, retains value in another form, or becomes waste. Furniture leaving one household is therefore not treated as a discard by default. Whether value is preserved depends on the route the item enters and on whether that route keeps it in use as furniture, recovers components, or captures only residual value through recycling or energy recovery.

The key product-route finding is that disposal and discard should be separated. Disposal refers to furniture leaving use or leaving the home. Continuation refers to routes through which furniture, components, materials or embedded value remain in use. Discard refers to situations where functional value is not fully preserved, such as incineration, landfill, failed reuse or low-value recovery, where the item no longer continues as furniture. This distinction is consistent with literature on premature replacement and premature discard (Cox et al., 2013; Magnier & Mugge, 2022).

Product-route mapping also shows that continuation may still break down after a household selects a seemingly circular route. A collected product may be rejected after inspection; donation may fail because the item is damaged, too large or difficult to transport; and resale may fail when perceived value does not match market value. Refurbishment and repair may also be technically possible but economically unattractive. These examples show that route entry is not proof of value preservation. Route outcomes can depend on acceptance, information and economic conditions that need checking whenever a case claims continuation.

Route acceptability may also depend on what owners expect to happen after handover. In Nilsson et al.'s exploratory study, some participants waited for a recipient who would value, use, care for or fairly compensate them for the product (2025, pp. 102–105). A credible recipient or visible next-use outcome may therefore reduce uncertainty and, in some cases, make it easier to let go. The study does not show that recipient matching or route-outcome feedback causes reuse.

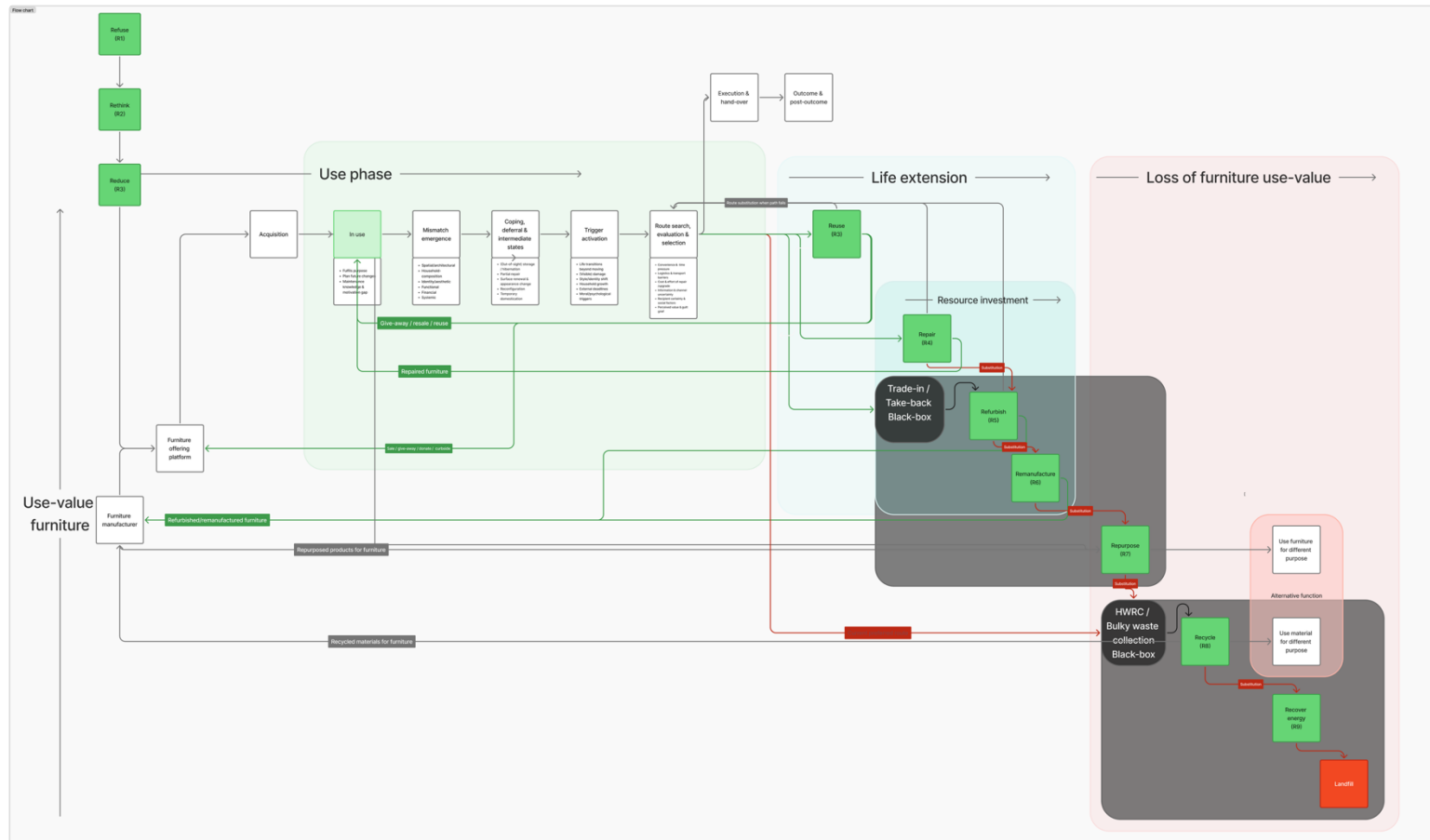


Figure 16: Product-route map from End-of-Use to continuation or discard. Visualises exit routes, which routes may contribute to life extension, where value can be lost, and the fallback logic when a route fails. The black boxes indicate where households may lose sight of the route outcome.

Route friction and fallback logic

The system map, disposal journey and product-route map point to one route-friction finding. Circular routes may fail when they are not easy, fast, trusted, valuable or available at the decision moment. This is not only a behavioural issue. It may also be shaped by product and service conditions, because continuation may depend on product information, transport, disassembly, repair capacity, collection criteria, partner coordination and value communication.

Fallback situations show how furniture that could continue in use can still end up as bulky waste. Resale may fail, repair may be unavailable, donation may be refused, transport may be missing, return instructions may be unclear, or a moving deadline may leave too little time. The relevant question is therefore not only why the item was discarded, but which continuation route broke down and what would have made that route easier to access, faster, clearer or more trusted.

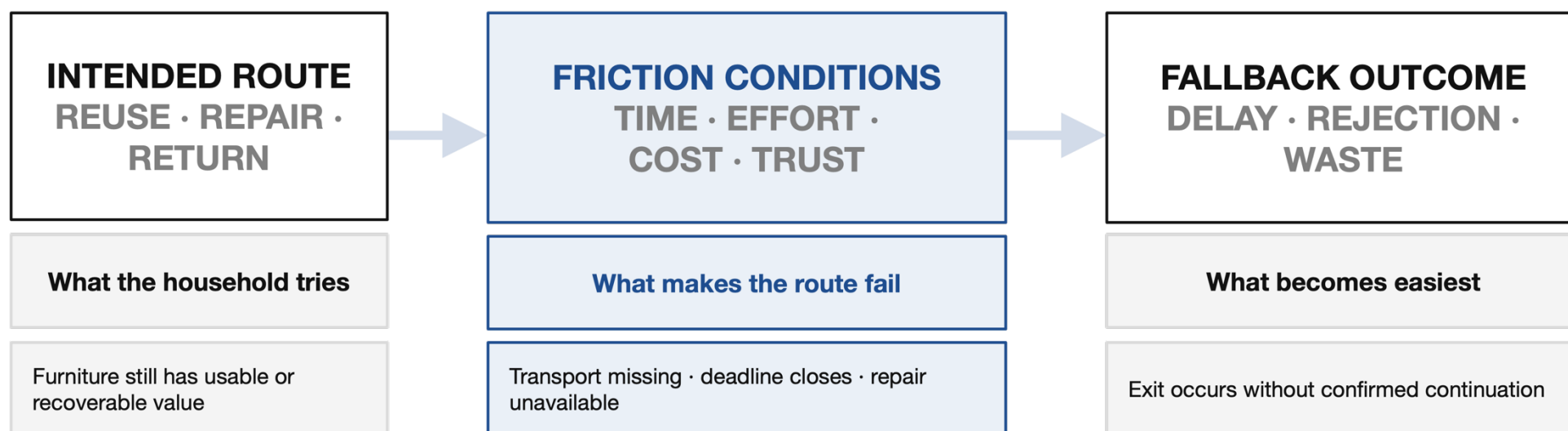


Figure 17: Route friction and fallback logic. Value retention depends on route completion, not only route availability or household intention. A circular route can exist and still fail at the decision moment, and route entry does not automatically result in route success. The actual route outcome should be recorded whenever the continued use or value retention is claimed.

Route friction should therefore be analysed not only as a barrier to choosing continuation routes, but also as a factor that affects whether the route succeeds afterwards. Value retention therefore depends not only on whether a circular route exists, but also on whether that route can be completed under the time, effort, cost, trust and handling conditions of the disposal moment. The insights form the basis for comparing existing circular furniture responses.

Route convenience can override reuse potential. At one Swedish recycling centre, researchers estimated that up to 35% of items brought for disposal had reuse potential, while users still defaulted to recycling because of convenience, time pressure and low confidence in reuse or repair (Hedlund & Jaca, 2025). This setting does not establish the same share for Dutch furniture flows.

Route labels can obscure the actual outcome. The Dutch monitor classified 61% of respondents' last discarded furniture as 'recycled', but this category combined street placement, recycling-centre delivery, bulky-waste or specialist pickup, supplier collection and 'do not know' responses (Milieu Centraal, 2025, p. 11). The figure therefore describes a reported route category, not verified material recycling or product reuse.

Support needs may change as a decision becomes more urgent. During coping or deferral, care, minor repairs and refurbishment can be planned, whereas moving or pickup deadlines may require immediate route execution (Hedlund & Jaca, 2025; Nilsson et al., 2025).

Recurring continuation mechanisms

The analysis shows recurring mechanisms by which furniture continuation becomes difficult. These mechanisms are a synthesis of the preceding findings, describe broader problem logic, and summarise conditions that repeatedly affect whether furniture is kept, adapted, transferred, recovered at a lower value or discarded.

Table 6: Recurring continuation mechanisms

Recurring continuation mechanism	Description
Contextual misfit	Furniture no longer fits the household’s space, routines, composition or living situation.
Low adaptability	Furniture cannot easily change size, layout, function, configuration or use context.
Aesthetic and identity obsolescence	Furniture becomes visually outdated, socially undesirable or no longer matches the household’s identity, even if it remains functional.
Care, repair and upgrade friction	Maintenance, repair, part replacement or upgrading is too difficult, costly, slow, unclear or unavailable.
Economic obsolescence	Replacement feels cheaper, easier or more certain than continuation.
Handling and logistics burden	Furniture is heavy, large or difficult to disassemble, store, move or transport.

Recurring continuation mechanism	Description
Continuation-route friction	Reuse, resale, donation, repair, refurbishment or product-return routes are unclear, unreliable, effortful or unavailable.
Time-pressure disposal	Deadlines, moving dates or urgent space pressure reduce the time available to decide.
Value-recovery uncertainty	Condition, value, next-use potential or route success are difficult to judge.

In practice, the mechanisms may appear in combination rather than as separate causes. Moving can bring together contextual misfit, handling burden, time pressure and weak route access. A worn sofa may combine repair friction, reduced perceived value, aesthetic decline and limited continuation support. A product return route may reduce household effort, but still fail when eligibility, acceptance, refurbishment or resale outcomes remain unclear. The mechanisms therefore describe interacting conditions whose importance differs by case, product type and route.

Together, these mechanisms suggest that premature disposal may result from interacting conditions rather than a single cause. The same disposal outcome can therefore follow from different conditions, making it important to understand what made continuation difficult in each situation. Nilsson et al. (2025) identify perceived product benefits, divestment conscience and perceived divestment work as interacting factors that help explain why unused products remain in households (pp. 104–107). This exploratory structure is explanatory, not predictive or exhaustive.

From continuation mechanisms to synthesis clusters

The recurring continuation mechanisms are grouped into six synthesis clusters. These clusters provide an overview of the main breakdowns from the analysis and are later transformed into positive design principles for use in the framework.

Table 7: Synthesis clusters

Synthesis cluster	Description
Contextual fit	Furniture becomes vulnerable when it no longer fits the available space, household routines, household composition or expected function.



Adaptability	Furniture becomes vulnerable when its size, function, configuration or use setting cannot change without replacement.
Aesthetic and meaning	Furniture becomes vulnerable when its visual relevance, identity fit or personal meaning weakens.
Care and value retention	Furniture becomes vulnerable when repair, care, upgrading or value recovery becomes too difficult, costly or unclear.
Transitions and handling	Furniture becomes vulnerable during moving, storage, disassembly, transport or time-limited disposal decisions.
Continuation options	Furniture becomes vulnerable when reuse, resale, donation, refurbishment, take-back or redeployment routes are unclear, unreliable or unavailable.

Conclusion problem space

Recurring mechanisms shape the household's risk for disposal that may lead up to discard, and are shaped by contextual and systemic factors, on which furniture brands have the most influence through furniture design decisions.

These mechanisms include several types of misfit, friction, and obsolescence, and were identified through the analysis and mapping of the processes leading up to and following the disposal decision, through the lenses of the user & household context, product & service characteristics, and market and system conditions

Although furniture brands are the actors identified as having the most influence on factors such as product & service characteristics that directly shape the risk of premature discard, current market & system conditions do not incline them to do so.

The questions that will be answered in the next chapter are: How can furniture brands address these mechanisms, thus mitigating the risk of discard, and how can furniture brands be supported in opting for circular design directions?

Furniture continuation may often break down in the household and is shaped by internal and external factors. The interacting conditions that often shape these breakdowns include the evolving household context, the product and service offerings and their characteristics, and the continuation infrastructure available.

Evidence across the analysis shows that premature furniture disposal should be seen as a problem regarding continuation, in which usable furniture can leave use while value remains. Condition-based indicators may suggest that many items are replaced or discarded while still functional, while time-based indicators may suggest shortened use periods for some furniture categories. Trigger-based indicators show when the risks may emerge or become active, for example when lack of space, change in household composition, moving or aesthetic dissatisfaction changes the item's fit. Route-based indicators add that household exit is not the same as value retention, because many items still enter waste routes while only part of the flow may be reused or resold. Together, these signals suggest that early exit can happen while technical, functional, material or emotional value still remains. Whether that value is kept or lost depends on decisions made before, during and after disposal.

The analysis suggests that disposal risk develops through several interacting conditions. Furniture is more likely to remain in use when the household context, product characteristics, service support, available routes, perceived value and circular capabilities fit the situation. Misalignment of these conditions may result in a functional item to become difficult to keep, adapt, transfer or recover. The misfit may start in the household, but it can be strengthened by practical barriers such as effort, uncertainty, availability of options, handling burden, or time pressure. The analysis of disposal journeys and route outcomes therefore shows that premature disposal is not only a decision to remove furniture from the home, but can also become premature discard when continuation attempts fail or when the selected route does not preserve the product's functional or material value.

Circular PSS intervention directions need to address specific breakdowns in continuation rather than being applied as generic circular strategies, since these breakdowns may emerge from different combinations of misfit and friction. Such breakdowns might not be effectively resolved through generic circular

interventions or product-only changes. Different circular interventions each cover different parts of the breakdown. A modular product may still be hard to repair or difficult to recover value from. A repair or refurbishment service may extend use, but it does not necessarily make the item aesthetically relevant again or provide a route when the owner no longer wants it. Take-back solves the return step, but not the earlier problems of adaptation, resale, or continued fit. Minimising disposal risk therefore requires interventions to be tailored to the specific breakdown, and may call for a specific combination of circular product-service-system interventions to be effective. For furniture brands, this means that reducing disposal risk requires more than choosing a familiar circular strategy. Instead, it requires identifying which conditions influence the breakdown, which actors and capabilities are needed, and which intervention direction can realistically address the case.

This analysis shows that minimising and mitigating the risk of premature disposal needs to be structured before design decisions can be made. This structuring must help the identification of recurring continuation conditions, what circular PSS intervention directions should help achieve, and which assumptions. The aim is to translate the analysis findings, such as evidence of possible early exit, into clear design principles and requirements that can help shape intervention directions while leaving the exact manifestation of the intervention development open and case-specific.

Concept development

This chapter explains how the design outcome of a framework was formulated, and how it uses synthesis clusters, design principles and requirements to explain what the framework needs to address.

Design principles

The design principles translate the synthesis clusters into aims for furniture continuation, and help define what the circular PSS intervention directions should achieve.

The design principles are broader than the components that will later be part of the framework, as they help define the circular continuation strategies that the framework should support. These directions will then help create more specific components in the framework that help translate breakdowns into a relevant intervention direction.

Table 8: Design principles

	Design principle	Description
DP1	Enable contextual fit over time	Intervention directions should help keep furniture relevant as the space changes and the household’s routines, composition and functional needs evolve.
DP2	Support adaptation before disposal becomes necessary	Intervention directions should make reconfiguration, resizing, repair, part replacement or functional changes easier, preventing disposal from becoming the default option.
DP3	Enable renewal without full replacement	Intervention directions should allow visual, material or meaning renewal without discarding the complete furniture item.
DP4	Lower the effort of maintaining and recovering value	Intervention directions should reduce the effort, cost, information burden and uncertainty associated with care, repair, upgrading and value recovery.
DP5	Reduce transition and handling friction	Intervention directions should make moving, disassembly, storage, collection or a fast circular exit easier during short decision windows.

DP6	Make continuation routes accessible, trustworthy and clear about value	Intervention directions should clarify available routes, eligibility, expected value, route fate and subsequent steps, making continued use a realistic option.
DP6	Make continuation routes accessible, trustworthy and assessable	Intervention directions should clarify route availability, item eligibility, expected value, route actions and outcomes, making continuation a realistic option.

Form ideation: diverge

The ideation explored the different forms through which the design principles could be developed and made usable for furniture brand teams. The guiding question was what could be designed with these principles and at which level: a furniture product, a service, a circular product service system, supporting guidance or a framework.

The first direction explored how the principles could be applied directly to furniture and related services. Two supporting brainstorming sessions used scenario-based How Might We questions to generate possible responses to different continuation situations. This resulted in a wide range of ideas, many concerning modularity and connector systems. Variations included applying one, several or all design principles to a furniture product, combining the product with supporting services, and extending this combination into a wider circular PSS that also considered the required infrastructure.

The ideation also explored different forms for communicating and applying the design principles.

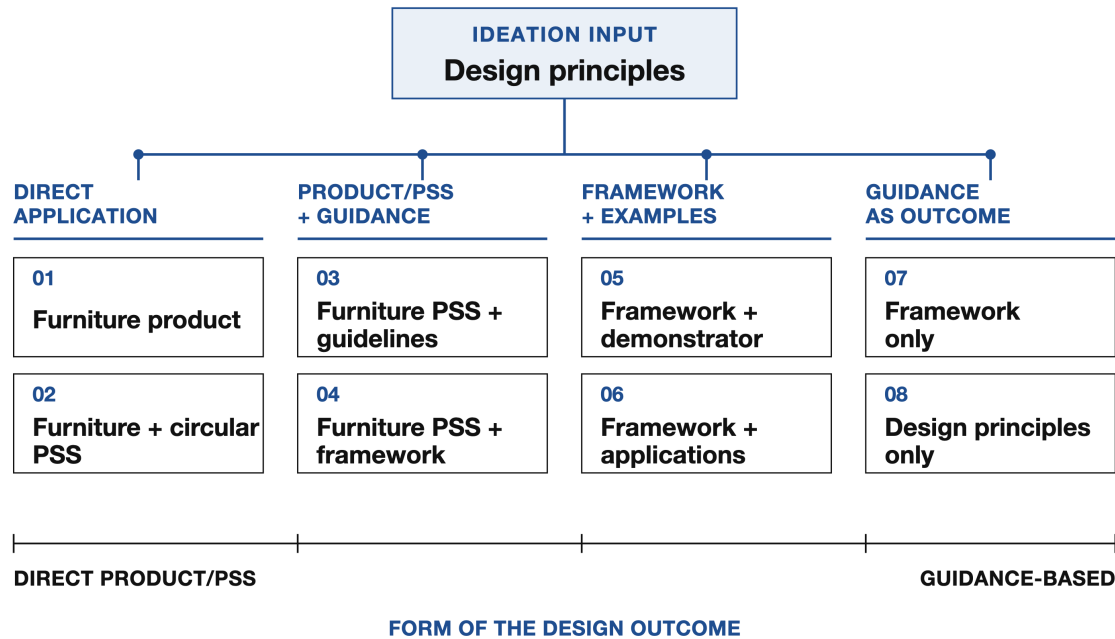


Figure 18: Spectrum of ideation outcomes

Further variations considered whether the outcome should be developed for one furniture category or brand, or remain applicable across different furniture contexts. The explored forms therefore ranged from a concrete furniture solution to more general guidance for applying the design principles. These alternatives were taken forward without selecting a preferred form. Section 5.3 compares them and explains the final choice.

Selection of form: converge

The alternatives described in Section 5.2 were primarily compared according to their potential to contribute to an actual reduction in premature furniture disposal, using the outcome in the state achievable by the end of the graduation project. This included the outcome's expected reach, its applicability to existing furniture, the time required to make it usable, and the amount of further development needed before it could influence furniture continuation.

Designing a new furniture product could provide a concrete example of how continuation might be supported. A well-developed product could, for example, remain suitable for longer through adaptability, repairability or replaceable components. However, communicating this value convincingly would require a highly resolved design supported by engineering, prototyping and user testing. Within the project timeframe, the likely outcome would be a demonstrator rather than a product that could already be produced and adopted at scale.

Its potential impact would also remain limited to the furniture products for which the design was implemented. Even a product that addresses continuation effectively would not improve the large number of existing furniture items for which such measures were not included or cannot be added. Creating another new furniture product also introduces a tension within a project concerned with reducing furniture disposal, particularly when the product does not replace or improve the continuation of existing furniture. Most importantly, selecting one product direction would narrow the project to one combination of breakdown and response. This could divert attention from the wider problem identified in Chapter 4, which also includes household change, service availability, handling, continuation routes, perceived value and organisational conditions.

A complete circular PSS concept could address more of these conditions, but developing it into an operational proposition would require service processes, logistics, partnerships, organisational responsibilities and a viable business model. These dependencies made it unlikely that a complete, credible, and convincing PSS could be developed and implemented within the graduation timeframe.

The framework offered greater potential reach from the state achievable by graduation. It could be developed into a usable and testable outcome within the available time and could be applied more quickly within early product, service and innovation processes. It could also be used for existing furniture, rather than only for products designed after the project. Its value therefore lies in helping brands identify why continuation is at risk and determine which product, service or business-model intervention should be developed for that particular case.

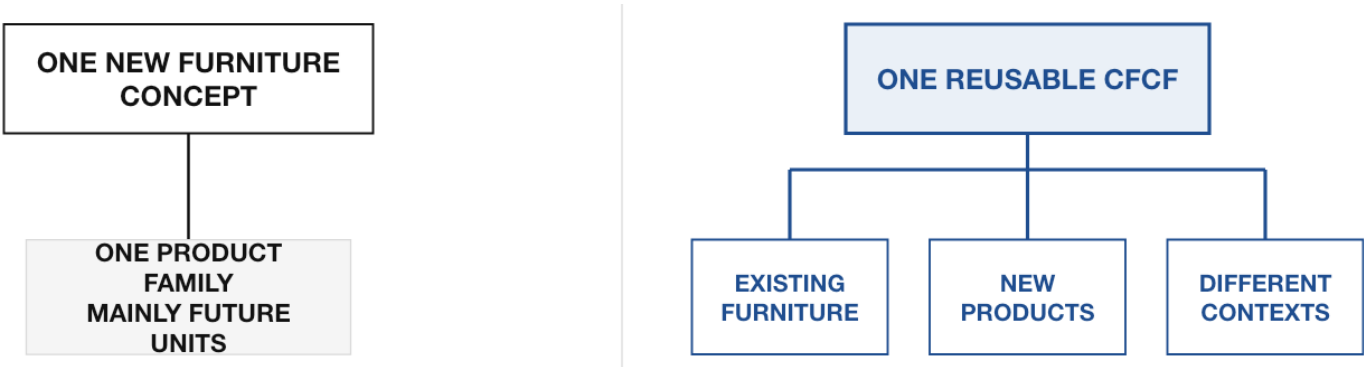


Figure 19: Comparison of possible design outcomes: single furniture concept vs. framework. Left: Illustrates that a single furniture concept may only affect future products, likely for one furniture type. Right: Illustrates that a framework may affect existing and future furniture across different types and contexts.

The framework also preserved more of the breadth of the research. Rather than reducing the findings to one furniture solution, it translated recurring product, household, service, route and organisational conditions into reusable decision support. This creates the possibility of repeated application across different furniture types and situations.

	01-02	03	04	05 SELECTED	06
	FURNITURE PSS	FURNITURE PSS + GUIDELINES	FRAMEWORK + DEMONSTRATOR	FRAMEWORK + APPLICATIONS	FRAMEWORK
Potential to reduce disposal	Potentially direct if implemented and adopted	Potentially direct; transferable guidance	Reusable logic + one concrete response	Indirect through targeted interventions	Indirect through targeted interventions
Achievable state at graduation	Product/PSS concept; implementation unfinished	PSS concept + shareable guidance	Quality split across two outcomes	Usable framework + applied examples	Usable and testable framework
Existing furniture	Limited or case-dependent	Case-dependent; guidance can transfer	Yes, through the framework	Yes	Yes
Repeatability and reach	One product and service proposition	One PSS plus reusable guidance	Reusable; demo may narrow attention	Reusable logic; applications show range	Repeatable across cases and brands
Systemic / research breadth	Product + service	Broader, but centred on one concept	Broad, but example-led	Broad findings made operational and visible	Broad findings made operational

Figure 20: Overview of why framework with application examples was chosen as design direction

The CFCF was therefore selected as the primary design outcome because it was judged to combine greater feasibility within the project timeframe with broader potential to contribute to reduced premature furniture disposal. Its potential impact comes from enabling multiple, more appropriately targeted downstream interventions instead of producing one additional furniture concept. Application examples demonstrate this range, while the clickable prototype provides a medium through which the framework can be applied and tested. The CFCF does not reduce disposal independently; actual reduction still depends on whether brands use it and successfully develop and implement the resulting interventions.

Design framework introduction

This section describes the project's design outcome as a framework: a tool that helps furniture brands make decisions. Its goal is to convert early-stage furniture disposal issues into testable, actionable circular product-service system (PSS) interventions, utilizing the previously defined synthesis clusters, design principles, and framework requirements. The framework clarifies how specific furniture case details and disposal risks inform the selection of intervention strategies, making this reasoning transparent and understandable. This facilitates discussion, comparison, the setting of early design directions, and their testing

Intended users

The framework is intended for business and furniture-brand teams that can influence products, services and the conditions for furniture continuation routes, rather than for consumers. Key users may include product developers, designers, circularity or sustainability managers, service or strategy designers and innovation teams. Consultants or facilitators may also use the framework in circular-furniture projects. An adjacent consultancy case indicates that method relevance can depend on organisational role, expertise and perceived scope of influence; it does not establish the best CFCF user (Chatty et al., 2022, pp. 9–10).

Use context

The intended use moment is early exploration. The CFCF is most relevant when a brand recognises a disposal risk for a furniture item, product family, or service proposition, but has not yet selected, or does not know, which circular intervention direction to pursue.

The CFCF can be used individually, but it is better suited to a guided workshop, case walkthrough, or structured design activity. This setting allows product, service, sustainability, operations, and logistics to be considered together when identifying breakdowns, comparing intervention directions, and identifying validation needs.

Medium

Different media were explored for presenting the CFCF. A digital tool was selected because it can support guided and individual use, accommodate different languages, reveal relevant information step by step, and be shared and updated easily.

The CFCF was translated into a staged, clickable prototype to make the framework testable. It guides users through a structured process, provides instructions, tooltips and examples when needed, and records the output of each step.

Figma Make and ChatGPT were used to create parts of the prototype through carefully composed prompts and specification documents. This enabled an interactive validation prototype to be developed efficiently without manually writing all code.

Each screen follows the same guidance pattern: goal, input, user action, selection rule, output and stop condition. This helps users understand what to do, what information carries forward and when to continue.

Design requirements

The design requirements shape the design outcome by guiding its development. They were derived through design interpretations of the findings from analysing the problem space. The List of Requirements approach described in the Delft Design Guide can be used to support concept development and evaluation (Van Boeijen et al., 2020). In this project, the requirements defined what the design outcome needed to address, supported the comparison of concept directions and continued to guide its further development.

In an adjacent framework case, participants valued traceable sources, visual aids, examples, effort estimates and visible knowledge gaps (Chatty et al., 2022, p. 13). These preferences informed presentation choices, but do not show that each aid improves CFCF performance.

An initial set of requirements guided concept ideation and selection. The list below also includes later decisions concerning the intended users and use setting. It therefore records the concept-level requirements that explain why the framework direction was selected and what the design outcome needed to support. They will be used later in this chapter to serve as the basis for more specific requirements for the framework itself.

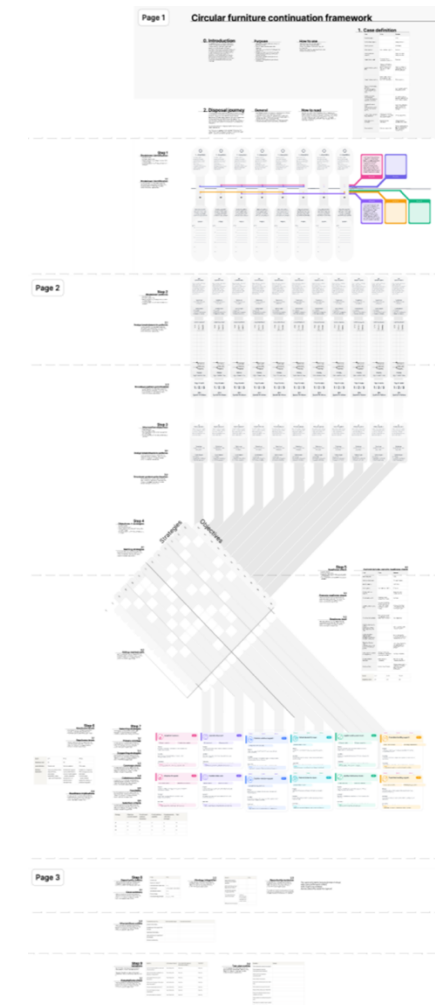


Figure 21: Image first prototype

Table 9: Overview of aims for requirements

Aspect	What it covers
Project aim	How the design outcome should support furniture-brand decisions intended to help households keep domestic movable furniture in use and reduce risks of premature disposal.
Connection to the findings	How the findings and the design principles should guide what circular continuation interventions need to support.
Users and decision need	Who should use the outcome, which decision problem it should address and when that support is relevant.
Feasibility within the project	What can be developed into a sufficiently resolved, usable and testable outcome within the available time and resources.
Range of use	Whether the outcome can support different furniture types, continuation situations and product, service, route or business-model responses.
Expected output and limits	What the design outcome should produce and which effects still depend on later development, adoption and implementation.

List of Requirements

The requirements were prioritised using the MoSCoW method. Only **Must** and **Should** requirements are displayed here. **Must** identifies a condition required for the design outcome, while **Should** identifies an important quality that could remain partly developmental within the graduation timeframe.

Table 10: List of requirements

Name	Requirement	Use
Project aim Must	Must support furniture-brand decisions intended to reduce premature-disposal risks for domestic movable furniture.	Kept the concepts connected to the household problem while focusing the design outcome on furniture-brand decision-making.
Users and decision need Must	Must support furniture-brand teams when a continuation risk is recognised but a suitable intervention direction has not yet been selected.	Defined the target users and the decision point at which the outcome should provide support.

Findings and design principles Must	Must translate the problem-space findings and DP1–DP6 into guidance for circular continuation.	Checked whether concepts carried the findings and design principles forward instead of providing generic circular guidance.
Applicable across cases Must	Must work across different furniture types and continuation situations, including existing furniture, without prescribing one finished product or PSS.	Favoured concepts that could support case-specific product, service, route and business-model responses.
Feasible within the project Must	Must be developable within the available time and resources into an outcome that can be explained, applied to cases and tested.	Supported comparison of what could be developed to a credible and testable level before graduation.
Appropriate use setting Must	Must fit early-stage exploration and support individual or facilitated use without creator-specific explanation.	Guided decisions concerning the use moment, intended setting and required level of guidance.
Further use after graduation Should	Should allow furniture-brand teams or facilitators to continue using and refining the outcome after graduation.	Informed the choice of a medium that could remain accessible, revisable and testable after the project.
Clear and testable output Must	Must produce a clear, traceable intervention direction and next test, rather than a finished solution or proof of impact.	Defined the expected result and prevented claims about implementation or reduced disposal that the project could not demonstrate.

Use of the requirements

Boundaries for concept ideation. The requirements guided the ideation without prescribing one solution form. The ideation therefore explored different ways in which the design principles could be manifested, ranging from furniture product concepts and circular PSS concepts to supporting guidance and decision frameworks.

Criteria for concept selection. The alternatives were compared according to their relationship to the project aim, use of the findings and design principles, range of use, applicability to existing furniture, and achievable level of development. As explained in Section 5.3, a furniture product could provide a concrete but relatively narrow response, while a complete circular PSS would require operational processes, partnerships and business-model development beyond the available scope. The framework direction was selected because it could be developed into a usable and testable outcome within the project while supporting multiple case-specific downstream interventions.

Guidelines for further development. After the framework direction was selected, the requirements continued to guide decisions concerning its intended users, use setting, medium and outputs. The next section sets out the more specific framework requirements that put these directions into practice. The design requirements

can be used to review whether the outcome remains aligned with its intended role, but meeting them does not demonstrate adoption, implementation or reduced premature disposal.

Framework requirements

The framework requirements define what the framework itself must do to appropriately support decision-making, and aim to direct and scope its use. They specify what the framework must cover, how it must guide users, and the goal of its outcomes. They do not directly apply to the actual furniture interventions that may result from the framework. However, they implicitly provide a way to assess the outcome of the design.

Table 11: Overview of requirements specifically for framework

Title	Requirement	Use
Diagnosis of case	The framework must start from a defined furniture case, user context and suspected disposal risk, because intervention directions only become meaningful when the situation is concrete.	Diagnosis of case and Identify breakdown risk ensure that the CFCF starts from a concrete furniture situation and locates where continuation pressure appears.
Identify breakdown risk	Users must first locate where continuation pressure appears in the disposal journey before selecting an intervention direction.	
Intervention relevant to disposal risk	Identified problems must be translated into what an intervention should achieve, rather than into broad circular ambitions.	Intervention relevant to disposal risk and Circular PSS Intervention then help turn the identified problem into a relevant intervention aim and direction.
Circular PSS Intervention	The framework must guide users towards product, service, route and system directions without presenting them as finished concepts.	
Feasible intervention	Users must be able to see what a direction requires in terms of capability, current fit, infrastructure support and likely bottlenecks.	Feasible intervention makes the needed capabilities, infrastructure, and bottlenecks clear.
Intervention is within scope	The framework output must remain an intervention direction, a PSS Opportunity Brief and a first test logic, not a proof of impact or implementation success.	Intervention is within scope limits the result to an intervention direction, which is a suggestion, thereby helping prevent claims about the result's potential impact.
Outcome is traceable	The framework must make visible how the evidence, diagnosis, intervention objective and strategy direction are connected.	Outcome is traceable aims to make the entire process traceable and, together with Usable may help improve understandability for users and others.
Usable	Each step must explain its goal, input, user action, selection rule and output clearly enough to be used in a walkthrough.	Usable aims to make the framework understandable without additional support by providing step-by-step guidance, examples, and output fields.

/ Together with Usable may help improve understandability for users and others.

Together, these requirements help define the framework's functionalities and are derived from the analysis' findings and approach.

Concept development direction conclusion

The design requirements shape the design outcome, through guiding its development, and were derived through design interpretations of the findings of analysing the problem space. An initial selection guided the concept ideation and formed the criteria upon which the concept of the framework was chosen, in addition to its intended users, use-context, and medium.

The framework helps furniture brands identify where continuation breaks down, translate these breakdowns into design principles, and link them to suitable circular PSS strategies.

The design requirement, implications, and principles presented in this chapter continue to guide the further design development.

Design: Framework

Framework overview

The Circular Furniture Continuation Framework (CFCF) helps users identify how continuation breaks down, translate the diagnosis into an intervention direction, and prepare that direction for evaluation and first test planning. These functions are visible and connected through the CFCF process, the framework components and the final output structure.

The CFCF process explains how framework users move from case definition to validation planning. It shows how evidence, diagnostic signals, breakdown patterns, intervention objectives, strategy families, and option checks are connected. The final output and first test plan define what the framework produces.

This structure separates the synthesis layer from the framework layer. The synthesis in Chapter 5 condenses the evidence into distinct layers, including mechanisms, design principles, and requirements. The framework layer in this chapter turns that direction into breakdown patterns, intervention objectives, strategy families, option comparison and validation planning.

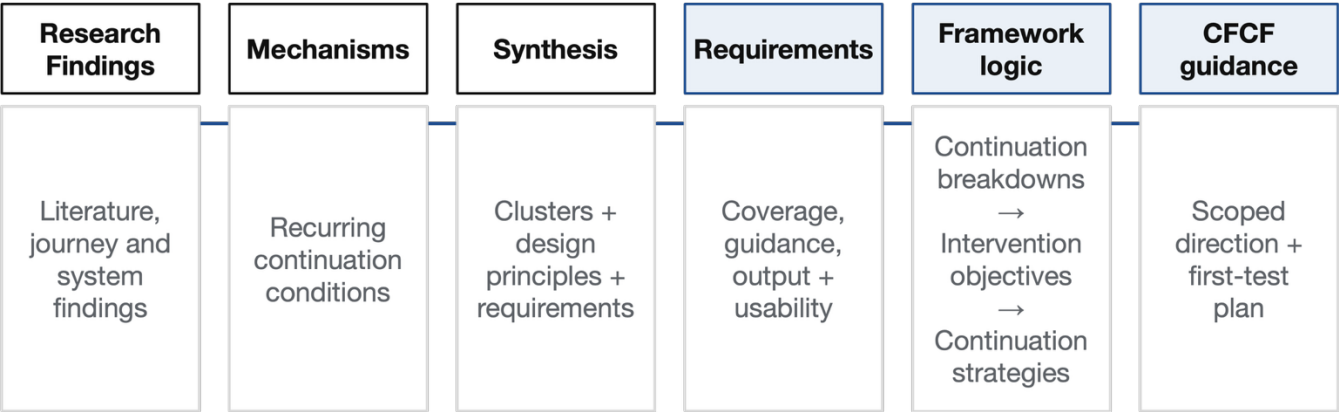


Figure 22: The CFCF was developed through translations from evidence and recurring mechanisms to synthesis, requirements, framework logic and operational guidance.

CFCF process

The CFCF process connects diagnosis, translation, and validation preparation into a single sequence. It starts with a short orientation and then guides framework users through case definition, disposal-journey mapping and breakdown diagnosis, to intervention-objective selection, strategy-family routing, intervention-option

comparison, output formulation, and validation planning.

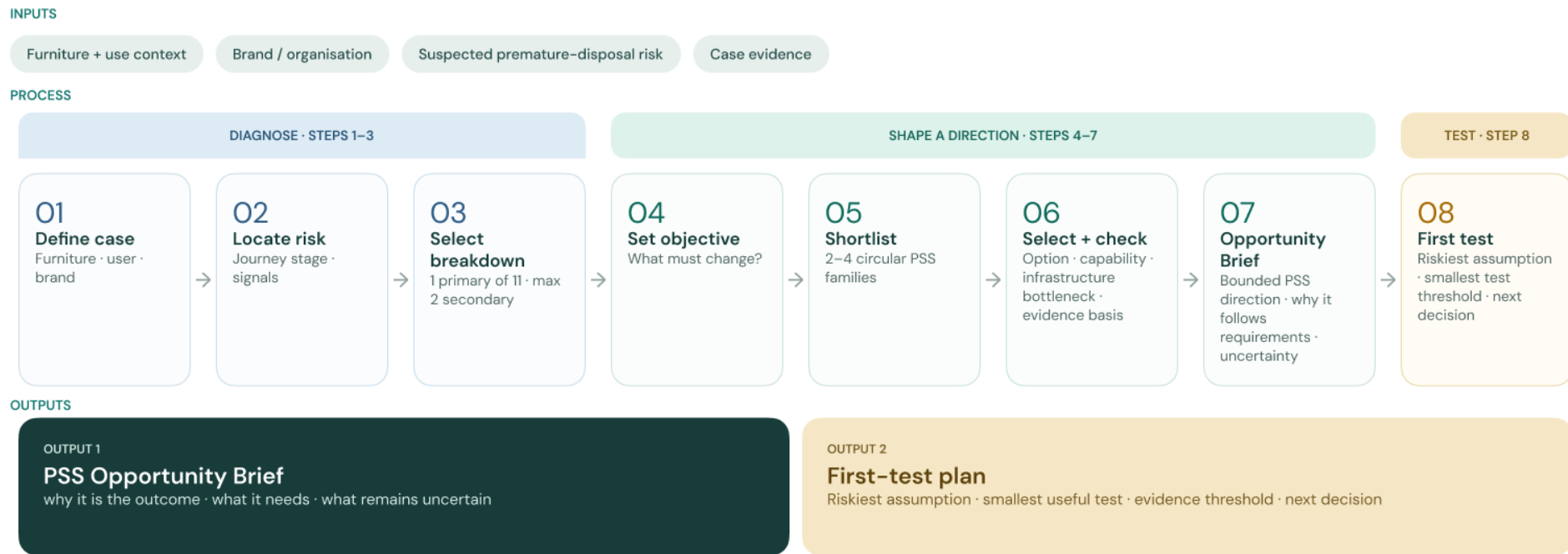


Figure 23: CFCF process. CFCF process from case definition to validation planning. Three phases are visible: diagnosis, shaping a direction, and test planning. The CFCF process starts with a short orientation and then guides the user from case definition, disposal-journey mapping and breakdown diagnosis towards intervention-objective selection, strategy-family routing, intervention-option comparison, output formulation and validation planning

It shows the information and walks users through the process step by step. Each step produces an output that is documented and carried forward to the next step, keeping the reasoning for the translation from evidence to intervention direction traceable and understandable, possibly reducing the cognitive load experienced by its users. Users first identify how use continuation may be at risk of breaking down, then translate this into an intervention direction, and only then examine feasibility and implications.

Additionally, the CFCF is split into steps to prevent users from making premature conclusions and to keep the translation logic clear, separating those that contain early information and signals from those that contain decision moments. Early steps help narrow down what may be happening, while later steps confirm the relevant choice or check whether the direction is realistic enough to continue. For example, the disposal journey shows where continuation may be at risk, but the main breakdown is only selected in the subsequent diagnosis step. Later in the process, strategy families may suggest a possible direction, while the option makes

users aware what that direction requires, whether it fits the organisation, what support is missing and what should happen next. This prevents the process from moving too quickly or from treating journey stages or strategy families as automatic answers.

Framework components

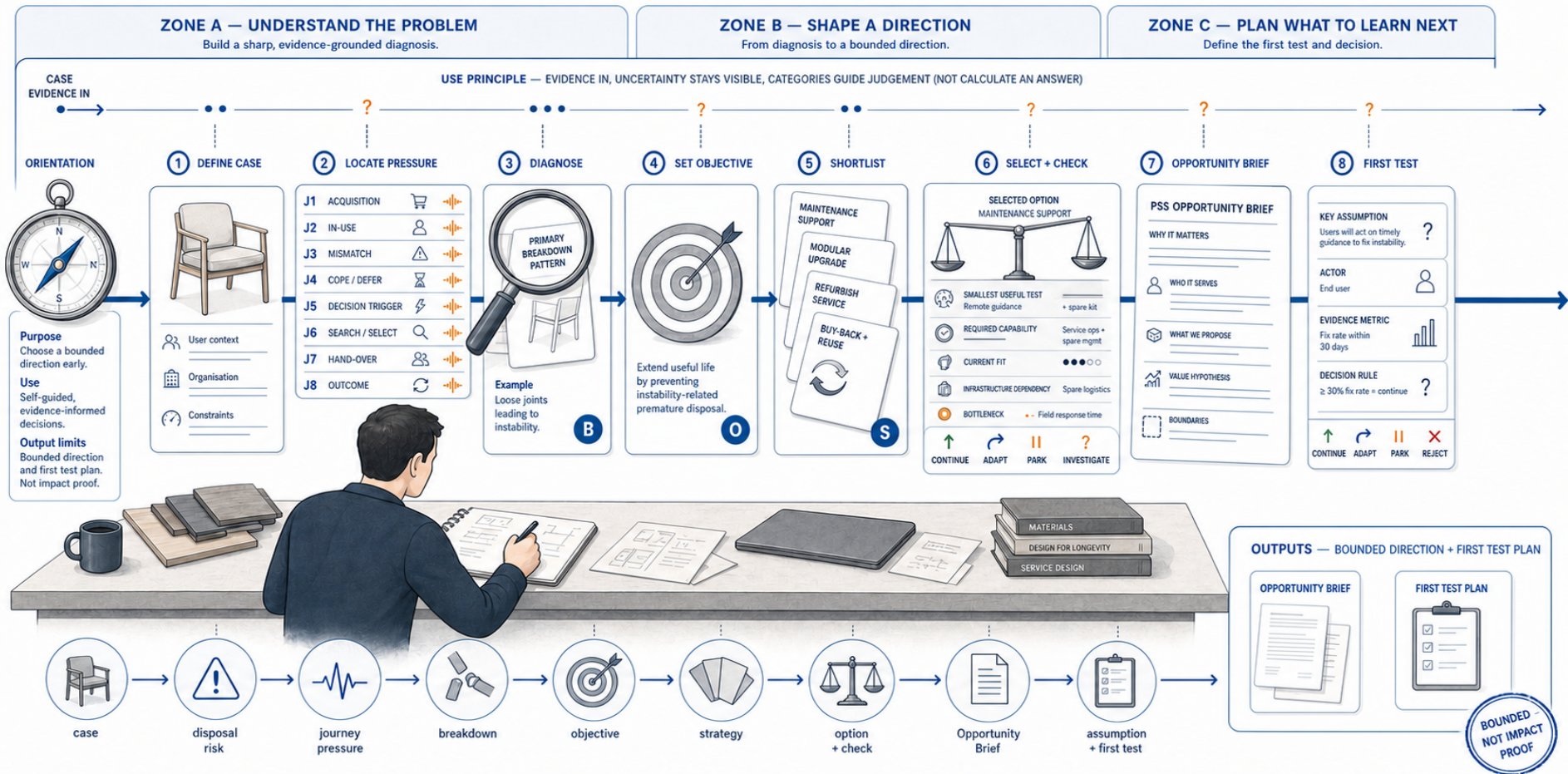


Figure 24: Indicative **overview of CFCF**. Visualisation of how the process and logic are structured, and **shows how it guides the specific case from understanding the problem to the intervention direction**, and an actionable first-test.

The names are not the component names. This image was created using generative AI.

The CFCF uses a set of components to translate a risk of disposal into a circular PSS intervention direction. The key components that aim to scope and structure this translation are the breakdown patterns, intervention objectives, and strategy families. Other components are the journey stages, intervention mechanisms and options. The drivers and triggers are only used to support diagnosis.

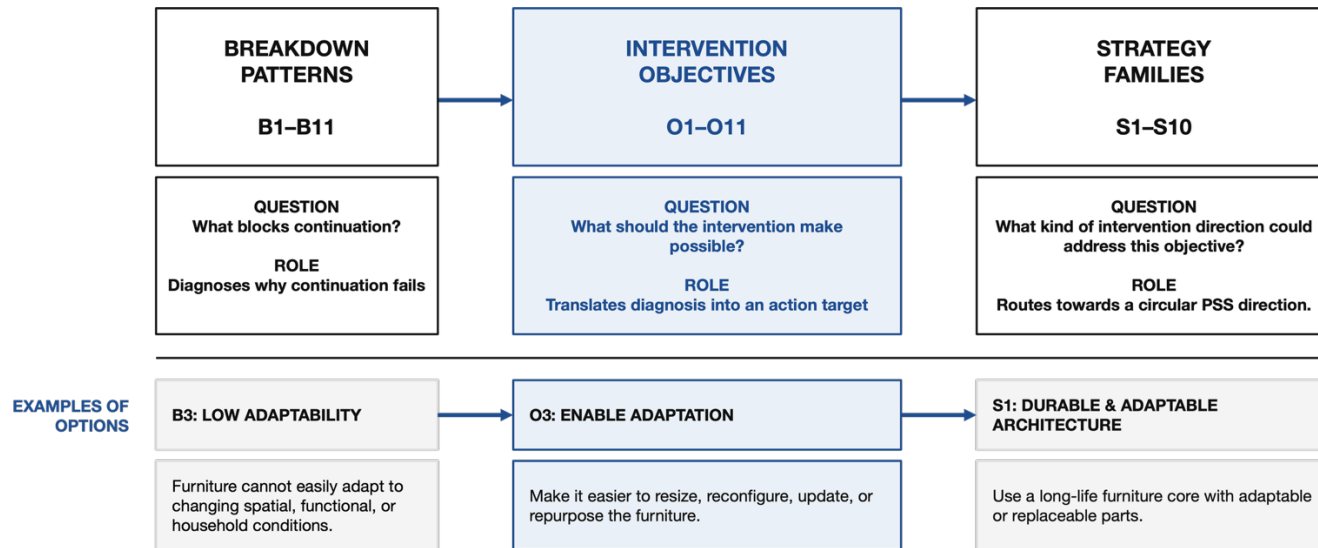


Figure 25: CFCF card types with filled-in examples. The three cards show how the CFCF translates from diagnosis to objective, and intervention direction.

Breakdown patterns define the identified continuation failure. A pattern is selected when it best explains why usable furniture is likely to be prematurely discontinued in a specific case. The primary pattern gives the CFCF user a diagnostic anchor; secondary patterns are used only when they materially affect the intervention direction.

Intervention objectives translate diagnosis into an action target. An objective describes what the intervention must achieve, for example, to preserve spatial fit, reduce repair effort or make continuation routes more accessible. Objectives are not solutions; they define the aim before a strategy family or option is selected.

Strategy families translate objectives into circular PSS directions through a step-by-step process and aim to avoid steering the strategy selection process. In order to do so, the strategy families are first presented through neutral front cards. After selection, the user opens relevant mechanisms and option cards, and the examples help the user understand them.

The feasibility of the intervention direction is addressed after strategy selection. During the comparison of the intervention options, the CFCF user selects an intervention direction, defines the smallest useful test, and checks the conditions required for implementation. This includes checking the organisation's capabilities, fit with current activities, need for external support or infrastructure, the main bottleneck, and what remains uncertain before making the next decision. This aims to prevent early assumptions regarding feasibility to steer the strategy selection.



Figure 26: Overview of the steps (components) that make up the CFCF process.

Table 12: The table provides an overview of how the synthesis clusters were translated into the design principles, and then into the framework logic.

Synthesis cluster	Design principle	Framework routing
Contextual fit over time	Enable contextual fit over time	B1/B2/B3/B5 → O1/O2/O3/O5 → S1/S2/S9
Care, repair and value retention	Preserve value through maintainable architecture	B7 → O7 → S4/S10
Continuation friction and uncertainty	Make routes legible, trustworthy and low-effort	B10/B11 → O10/O11 → S6/S7/S8/S10
Handling and relocation burden	Reduce relocation and handling friction	B8/B9 → O8/O9 → S5/S9/S10
Aesthetic and identity obsolescence	Enable renewal without full replacement	B4/B6 → O4/O6 → S3
Time pressure and fallback disposal	Support action in narrow decision windows	B9/B10/B11 → O9/O10/O11 → S5/S7/S9

Framework output

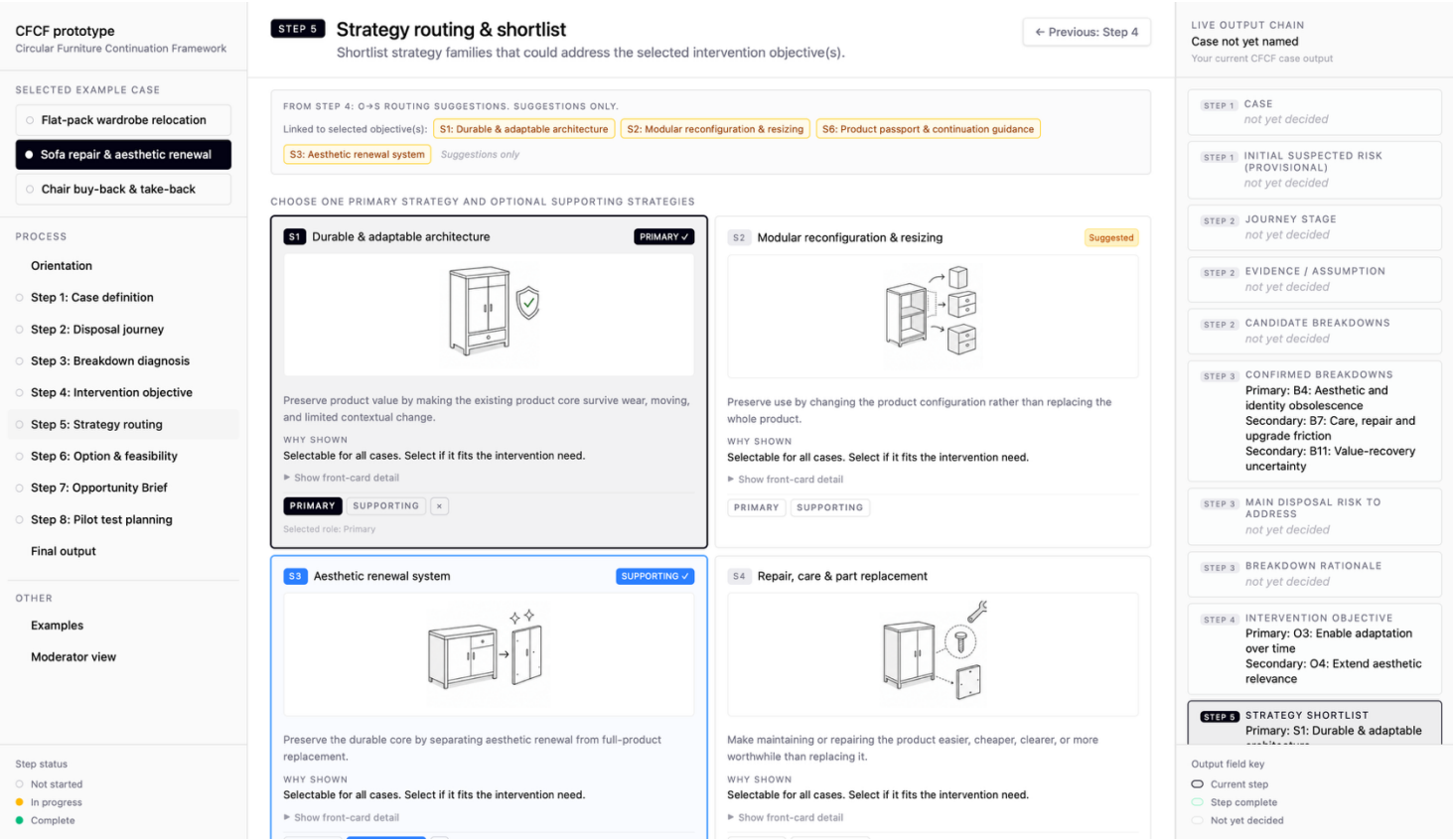


Figure 27: Screenshot of the CFCF prototype interface, the same version that was used for validation. The image shows step 5: the strategy selection.

The CFCF output is a clearly scoped circular PSS intervention direction, not a finished concept. The output formulation step converts the evidence to direction logic into a PSS Opportunity Brief. The validation planning step formulates the first test plan for the riskiest assumption behind the direction, so that the direction can be evaluated before further development.

The PSS Opportunity Brief provides an overview of what has been documented up to until that point, and makes the selected direction concrete enough to discuss, while preventing it from being treated as a finished solution. It provides an overview of the case and reasoning that followed, selected framework components, considerations regarding feasibility, main uncertainties, and scope.

To prevent the pilot from becoming the final outcome without first reviewing what needs to be resolved before implementation, a pilot test plan is created. To help inform the next design or validation decision, it suggests identifying the riskiest assumption, the smallest useful test, the relevant actor or evidence, the measurement metric, the decision rule, and minimum evidence needed. Therefore, it checks whether the direction is worth developing further, rather than proving for the intervention itself.

Framework design conclusion

The Circular Furniture Continuation Framework is a testable design outcome that supports furniture brands in decision-making for furniture continuation. It helps them identify where continuation breaks down, determine what an intervention should achieve, link the case to relevant circular PSS strategies, verify the required capabilities, and formulate a plan for a first-test to test the largest assumption, rather than developing a finished solution.

The role of the framework is to guide and document the process of creating a testable intervention direction that mitigates a risk of furniture discard, so it can be discussed, compared, and tested.

The CFCF will be assessed on several success criteria in order to validate, and further improve its design.

CFCF validation

Purpose and scope of validation

The purpose of evaluating the Circular Furniture Continuation Framework (CFCF) as a decision-support framework is to assess whether the goals and requirements set for the design are met, or what improvements are needed to do so. Several evaluation methods were used for this assessment, such as applying example cases to test the CFCF's ability to structure different cases, before the CFCF's qualities were assessed by practitioners in test settings.

This chapter combines two types of evidence: application examples show how the CFCF can be applied across selected furniture cases, while participant evaluation examines specific framework qualities in defined tasks, versions, and settings. The application examples do not establish usability, practitioner relevance, intervention feasibility, adoption or impact, and the participant evidence is interpreted only within the roles, cases, tasks and settings that were actually assessed.

The validation asks what the CFCF helps relevant users do, under which conditions, and with what limitations. The evaluation considers the framework's qualities as experienced by users rather than the impact of the intervention directions it produces. The validation focuses on the framework itself, not on the individual interventions that may result from the 'validation' step of the CFCF process. The validation does not aim to directly prove reductions in premature furniture disposal, long-term circularity, or business viability, and prioritises depth rather than breadth.

VALIDATION TYPE	WHO / WHAT	TASK	MAIN CRITERIA
APPLICATION EXAMPLES	3 cases	Apply logic	Framework logic
USABILITY TEST	2 Design professionals	Use prototype	Use conditions
EXPERT INTERVIEWS & REVIEWS	5 experts	Assess a case	All, no use conditions
USER-TESTS & REVIEWS	4 Practitioners	Assess a case, and use	All

Figure 28: Overview of validation types and their roles.

Validation questions and criteria

The validation examined whether the CFCF could support a traceable move from a furniture continuation problem to a bounded intervention direction and first-test plan. It did not assess the eventual intervention’s circular impact, business viability, adoption or implementation success.

One context question and seven validation questions guided the validation:

Table 13: Overview validation criteria

Validation criterion	Question
Practice need and current support	Which furniture continuation decisions are difficult, how are they currently handled, and what important support is missing?
Desirability and user fit	For which users, roles, decisions and cases is the CFCF considered relevant and worth using, and why?
Content quality	Are the CFCF's purpose and boundaries, explanations, questions, categories, prompts, options, inputs and outputs clear, relevant and proportionate, sufficiently complete, accurate, evidentially credible, and internally consistent for the tested roles and cases?
Process and framework logic	Does the connected CFCF sequence help participants move from case information to a bounded intervention direction without material gaps, repetition or unsupported jumps?
Reasoning quality	Can participants trace the selected direction to evidence, assumptions and judgement, and do suitably experienced reviewers find the reasoning defensible, appropriately cautious and explicit about material uncertainty?
Decision value	Compared with current practice, does the CFCF help a concrete decision and make the next bounded action, owner, contributors and material conditions sufficiently clear?
First-test quality	Does the first-test plan identify the riskiest assumption, state what is tested and who does what, seek appropriate evidence, and explain how the findings would change the decision?
Use conditions	For which users, cases and settings is the CFCF suitable, and what information, expertise, time and effort, ownership, information upkeep, workflow integration, interface operation, collaboration or facilitation does it require?

Practice need and current support was discussed before showing or explaining the CFCF. This kept findings about existing practice problems separate from participants' reactions to the framework.

The following criteria were used to evaluate the validation findings.

Table 14: Overview of the criteria used to evaluate the validation

Validation criterion	Testable requirement
Practice need and current support	Before seeing the CFCF, a practitioner describes a concrete continuation decision, its current handling and an important support gap.
Desirability and user fit	For a specific decision, the CFCF's value must justify the required effort. The participant's role, knowledge, information access and decision involvement must fit the tested use.
Content quality	Purpose, users, outputs and boundaries must be clear. Content must be relevant and proportionate, sufficiently complete, accurate, credible and consistent. Required inputs must be obtainable or recordable as assumptions or unknowns.
Process and framework logic	Participants must be able to progress through the tested steps without avoidable blockage or substantive answer supply. The steps must form a coherent route from the case problem to a bounded intervention direction.
Reasoning quality	The selected direction must be traceable to evidence, assumptions and judgements. A suitably experienced reviewer must find the reasoning defensible and appropriately cautious.
Decision value	Compared with current practice, the CFCF must help a concrete decision and clarify the next action, owner, contributors and material conditions.
First-test quality	The plan must state the riskiest assumption, what is tested, who does what, what evidence is sought and how the findings affect the decision. The test must be a proportionate way to reduce the main uncertainty.
Use conditions	The tested requirements for information, expertise, time, ownership, workflow, collaboration, interface operation and facilitation must be explicit.
Supplementary Interface usability	The interface must support understanding, navigation and interaction in the tested mode of use. The strength of the claim must reflect how the interface was exposed and operated.

Validation setup and evidence roles

The validation combined different activities because no single participant or task could assess every aspect of the CFCF. Participants and reviewers were selected for the specific knowledge, experience or use perspective required by the assigned questions.

General overview of the sessions held, and the participants involved in the validation.

Table 15: General overview of the sessions held, and the participants involved in the validation.

13 Sessions	11 Professionals
4 full-length user-tests	5 experts
5 reviews	4 brand practitioners
4 interviews	2 design professionals

The validation can be split up into 4 phases:

Table 16: Overview of the 4 phases of the validation.

Phase	Validation focus	Session types	Participants
1	Framework logic	3 Application examples	-
2	Desirability & user fit	Interviews	2 experts & 2 practitioners
3	Usability	Pilot & UX/UI-user test	2 design professionals
4	Participant & session relevant criteria	2 Full-length user-tests & 5 reviews	4 practitioners & 3 experts

The activities served different evidence purposes:

Table 17: Overview of the activity types executed for the validation

Activity type	Main contribution	Main limitation
Pre-exposure practice and context discussions	Existing continuation decisions, current approaches and support gaps.	Did not assess use of the CFCF.

Participant-operated or facilitated tasks	Understanding, process, reasoning, outputs, first-test plans and interface interaction within the exposed route.	Results depended on assistance.
Practitioner and output reviews	Practice relevance, expected value, credibility, decision usefulness and use conditions within the reviewer's expertise.	Researcher operation or explanation did not demonstrate independent use.
Targeted expert reviews	Content quality, framework logic, reasoning credibility and first-test value within a defined area of expertise.	Did not establish complete framework use or desirability for all intended users.

The complete activity overview is provided in the appendices.

The validation setup consists of three evidence sources: application examples, practical usability testing and practice & content validation.

- Application examples support evaluation by demonstrating how the CFCF produces intervention directions for various cases and provide concrete material for participants to review.
- Practical usability testing evaluates whether participants with design experience but no prior CFCF knowledge can use the prototype and understand the purpose and usability.
- Validation of practice & content involves practitioners from the furniture sector and the circularity ecosystem. It includes a desirability evaluation and an assessment of the CFCF's relevance, traceability, actionability, and testability.

These three types of validation complement each other and address different conditions. The usability tests aim to identify issues in usability and understandability, and the practitioner sessions assess whether the framework's content and logic support decision-making and are relevant and useful in practice. Participant selection

Different types of participants are selected to evaluate different aspects of the CFCF. Participants with design experience, such as design students, are appropriate for practical usability testing to assess whether the prototype is understandable, easy to navigate, and usable without extensive explanation. These sessions provide insight into clarity, terminology, task flow, and facilitation, but do not assess relevance to the furniture sector.

Participants involved in practice and content validation should have direct or related experience in furniture development, circularity, product-service systems, repair, refurbishment, logistics, or reuse. Their task is to evaluate if the CFCF tackles recognisable continuation problems, whether the reasoning from breakdown to intervention is convincing, and if the output facilitates a useful next step in practice.

The validation separates participant roles based on the type of evidence they provide. Usability participants mainly test the prototype's structure and process, while practitioner participants evaluate relevance, credibility, actionability, and practical feasibility in the context of furniture continuation.

Materials and procedures

The materials and procedures implement the validation setup outlined above. The main materials are the frozen CFCF prototype, application examples, task instructions, observation templates and questions.

Practical usability testing assesses whether participants with design experience can understand and use the CFCF prototype without prior knowledge. Each session uses a fixed Figma prototype and the wardrobe example application. Participants are asked to explain what the CFCF is for, who should use it, what the expected output is, and its limitations. They are asked to walk through the prototype while thinking aloud and will receive only critical help. They reconstruct the reasoning from case to intervention direction, and identify the most significant usability issue. These sessions give insight into the CFCF's understandability, usability, and traceability.

Practice and content validation assess whether the CFCF can properly address recognisable continuation problems and produce relevant, credible, actionable, and testable intervention directions for practice. The session begins with a discussion and capture of a recent, relevant case before the CFCF, followed by the trigger, decision owner, missing support, workarounds, and consequences, thereby providing evidence of desirability. Participants then apply the CFCF using either their own case or an application example case. This part compares the CFCF output with current practice and provides evidence for understandability, traceability, credibility, actionability, and testability.

Throughout the sessions, the researcher will remain neutral, avoid using CFCF terminology, not defend the framework when questioned, and clearly document all explanations and interventions.

Analysis method

The analysis was done both deductively and inductively.

The deductive analysis looked at the documentation, such as written notes and anonymised transcripts, and looked for findings that matched a validation criterion.

The inductive analysis clustered similar findings and was mainly used for analyzing direct suggestions for improvements and the like.

The analysis was linked as illustrated below:

Evidence item → Criterion link → Findings

An evidence item contained one observation, quotation, output extract or participant explanation with its source and context. It was linked to a criterion only when it directly addressed that criterion.

One evidence item could link to more than one criterion.

The four result categories were:

- **Supports:** The complete requirement was supported in the tested setting without an important contradiction or invalidating assistance.
- **Mixed:** Support existed, but an important limitation, contradiction or assistance dependency remained.
- **Challenges:** Direct evidence showed an important failure, missing element or dependency.
- **Not assessed:** The evidence was insufficient for a direct judgement.

The analysis kept three outcomes separate:

1. **Task completion:** completed, incomplete or not tested.
2. **Criterion result:** Supports, Mixed, Challenges or Not assessed.
3. **Evidence role:** qualifying, supplementary, iteration-only or excluded.

Findings were then clustered under the validation criteria.

Evidence-based improvement

Evidence-based improvement examined which eligible findings required a CFCF change, what decision was made, what was implemented, whether a targeted recheck was needed, and what limitation remained.

I0 was a synthesis and iteration question, not an additional validation criterion. A qualifying iteration required:

finding → interpretation → decision → implemented change → before-and-after evidence → targeted recheck where needed → remaining limitation

A proposed change, accepted recommendation, report edit or unimplemented backlog item did not satisfy I0.

Validation criteria findings

The validation produced both positive and negative or mixed findings. These are grouped by research question to show what participants and experts valued, where the CFCF's use depended on particular conditions, and which parts remained unclear or difficult.

The grouping does not imply that every participant or session addressed every research question.

Note: Validation evidence is referenced by participant and finding: (e.g., E3:1; E4:2; P1:2, 3; P2:2). The letters identify the participant type, the first number identifies the participant, and the number after the colon identifies the finding. Multiple finding numbers indicate that one participant supported several findings (e.g., P1:2, 3).

Table 18: Overview of validation findings. More elaborate overviews can be found in the appendices.

Validation criterion	Positive findings	Mixed or negative findings
Desirability and user fit	- Some participants considered the CFCF a more accessible, time- and cost-efficient tool for faster and clearer decision-making than current practices and alternatives (E3:1; P1:1). - A practitioner considered the CFCF potentially most valuable for organisations that want to improve their circular approach but still need structure (P1:2, 3).	- The follow-up survey rated the CFCF's added value relative to the required time and effort only partly (S1:1). - The CFCF's perceived value depended on the users' roles, expertise and organisational circular maturity, with less additional value expected for advanced circular organisations (E3:1; E4:2; P1:2, 3; P2:2).
Content quality	- The extensiveness and completeness of the stepwise content were explicitly valued by one practitioner (P1:4). - Another practitioner described the broad structure as useful for generating insights and opportunities (P2:6). - The amount of substantive information was not considered inherently excessive for a serious company session, despite the demanding language (PL1:4).	- The CFCF's purpose, contribution, intended user and resulting output were not naturally and consistently understood, although the follow-up survey rated these fully clear (E3:2; E5:3, 4, 5; P3:2; PL1:1, 2; UX1:1, 2; S1:1). - The expected level of detail, terminology and differences between some options remained unclear to participants (E5:7; P2:4, 7; UX1:3, 4). - Although participants could provide much of the requested information, some inputs required knowledge from other organisational owners or actors (E4:3; P2:4, 5; P3:3, 4).
Process and framework logic	- Participants positively evaluated the stepwise progression because it made the problem smaller, more concrete and more credible (PL1:5; UX1:5; P3:1). - The smaller comparison steps supported active comparison, while hesitation between alternatives sometimes produced useful insights and questions about problem ownership (PL1:6, 7; UX1:6, 7).	- Selecting only a few strategies could cause other relevant breakdowns or alternatives to be overlooked (E3:3). - Progression through the steps without unnecessary confusion was rated only partly in the follow-up survey (S1:1).
Reasoning quality	- An expert supported diagnosing the problem before selecting an intervention as sound logic that improves the credibility of the reasoning (E5:10). - A practitioner recognised starting from the user and continuation situation as an appropriate way for sustainability leaders to approach the problem (P1:5).	- The visibility of interacting system elements and dependencies was not always sufficient for judging the relationships between options and their effects (E4:4; P2:9). - The quality of the outcome depended heavily on the quality of the inputs, because weak inputs and assumptions combined with credible-looking suggestions could lead to self-confirming recommendations (P3:4).
Decision value	Across the CFCF user tests, participants developed useful intervention directions, access insights or first-step outcomes (P2:10; P3:3, 6; UX1:8).	The useful outcomes differed in the amount of assistance participants received and in the settings in which they were produced (P2:10; P3:3, 6; UX1:8).

	• These outcomes included a more easily moveable wardrobe and relocation test, better customer access to existing repair capacity, and a lower-cost cover direction (P2:10; P3:3, 6; UX1:8). • The follow-up survey rated the required next decision or action as largely clear (S1:1).	
First-test quality	• The first-test step was recognised as making the CFCF process substantially more concrete (P1:6). • The resulting first-test plan was rated largely clear in the follow-up survey (S1:1).	• Across multiple sessions, the first test initially failed to address the main uncertainty or assumption (P2:11; PL1:8; P3:7). • Facilitator assistance or participant critique was then needed to redirect the test towards a more useful focus (P2:11; PL1:8; P3:7).
Use conditions	• Team, multi-actor, pre-workshop and lightly guided use were identified as relevant ways to use the CFCF (P2:2; P3:1; S1:2). • Most participants were able to complete the CFCF with little assistance (PL1:3). • Some participants considered the interface structured and logical and appreciated its navigation, images, controls and optional suggestions (E4:5; PL1:10; UX1:11).	• Effective use depended on prepared information, relevant contributors, sufficient time, workflow integration and organisational ownership (E4:1; E5:1, 2; P2:2; P3:1). • Team or facilitated use was considered particularly relevant for complex cases, distributed inputs and first-time use (E4:3; P2:4, 5; P3:3, 4, 5). • Interface usability was mixed and depended on who operated the CFCF, while demanding terminology, extensive text and weak visual hierarchy increased the first-use threshold (E4:5; P2:13; P3:5; PL1:9, 10; UX1:4, 10).

Overall, the findings suggest that the CFCF can support a stepwise move from a continuation problem towards useful intervention directions and first steps (P1:4; P2:6, 10; P3:3, 6; PL1:5; UX1:5, 8).

Its value and usability depend on the user's role, preparation, collaboration, input quality, first-use support and interface clarity (E3:1; E4:1, 3, 5; E5:1, 2, 7; P2:2, 4, 5, 13; P3:1, 3, 4, 5; UX1:4, 10).

The clearest repeated weakness concerned the formulation of the first test, while the first-test step itself was considered valuable for making the process more concrete (P1:6; P2:11; PL1:8; P3:7; S1:1).

Validation improvement findings

Participants and experts proposed several ways to improve how the CFCF is explained, used and presented. The table only includes suggestions that arose directly during the validation sessions. These are directions for further refinement rather than implemented changes.

Table 19: Overview of the validation findings that were direct suggestions for improvements.

Research question	Suggestions from the validation sessions
RQ1 Desirability and user fit	• Make the CFCF's decision benefit more visible, for example through faster and clearer decisions and understandable economic or environmental consequences (E3:1; E4:1; P4:5, 6).

RQ2 Content quality	• Explain before use that the CFCF is a method, who it is intended for, and what value and output users can expect (UX1:2). • Reduce the terminology burden while retaining enough detail for serious use, because excessive simplification may also reduce usefulness (E5:7, 8). • Clarify differences between strategy options and use product-family-specific examples where their application differs (P2:1, 7, 8; E5:9).
RQ3 Process and framework logic	• Provide more room to explore and compare possible directions before narrowing, for example through explicit divergence or a mind-map structure that feeds a later brainstorm (P2:3; S1:3). • Make the coverage of possible breakdowns more visible before users prioritise only a few of them (E3:3).
RQ4 Reasoning quality	• Make dependencies between products, services, communication, logistics, suppliers and other system elements more visible (P2:9). • Show the CFCF's relationship with established methods and the literature supporting its journey mapping more clearly (E5:5, 11). • Use the CFCF to connect existing methods and case evidence rather than duplicate specialist work, as proposed in a co-produced finding (P4:2).
RQ5 Decision value	• Show the time, cost, required expertise, organisational value and possible counter-effects of an intervention direction (E3:4; E4:1; P1:7). • After the CFCF was explained, one practitioner suggested making financial and environmental consequences visible to help users explain and justify decisions (P4:5, 6). • One participant suggested an exportable PDF record of the process, while another preferred concise insights or attention points over a long standard report (UX1:9; P2:12).
RQ6 First-test quality	• Focus the first test on the main uncertainty; in one session, the participant redirected it towards customers who rejected reupholstery because of price and identified price, design and comfort as relevant dimensions (P2:11). • Avoid combining repair consideration, information seeking, discovery, understanding and willingness to act in one test when this would not show whether repair is considered worth the effort (P3:7).
RQ7 Use conditions	• Use the CFCF as a team, multi-actor or pre-workshop activity rather than relying only on individual use (P2:2; P3:1). • Support early-stage use with prepared inputs, facilitation, plainer language and one step at a time (P3:1). • Integrate the CFCF through co-creation and alignment with the organisation's existing design process, using small, well-placed interventions (E5:2). • Use more visual examples and a faster, card-like interface where appropriate (P2:13).

The suggestions mainly concern making the CFCF's value and purpose clearer, allowing broader exploration before narrowing, strengthening visible reasoning and consequences, and adapting the use setting and interface to first-time and collaborative use (E3:1, 3, 4; E5:2, 5, 7, 11; P2:2, 3, 9, 13; P3:1).

Validation conclusion

The application examples showed that the CFCF logic & process can structure a traceable translation across several varied cases, resulting in an appropriate intervention direction that addresses the initial breakdown.

Participant validation findings support that the CFCF provides a credible stepwise structure for moving from a continuation problem towards relevant intervention directions and concrete first steps,

Participant validation revealed the most important supported quality to be the CFCF’s stepwise decision support, which made complex problems more concrete and generated useful directions and first steps. However, the most material challenge in using the CFCF as a continuation decision-making tool concerned the quality of the *first-test* that was formulated, because these tests often did not identify, and thus also not address the main uncertainty. Other findings that undermine the CFCF’s intended performance include the unclarities regarding its value, purpose, use conditions, as well as the visual presentation of information.

Some of these findings will be selected and interpreted to create an iteration of the CFCF with the aim of improving its perceived fit and performance.

Iteration based on validation findings

Findings to iteration

The findings that were selected as opportunities for evidence-based iteration are that value and counter-effects were not always explicit enough, the CFCF’s purpose, use setting and flexibility of use were not communicated clearly enough, and interface terminology, text density and visual hierarchy sometimes hindered understanding and usability.

These findings suggested that another round of small interface changes would not be enough. The more fundamental question was whether the CFCF offered furniture brands a convincing reason to use it. The iteration therefore concentrates on the value proposition towards the furniture brand and uses the Value Proposition Canvas [figure] and a more detailed adaptation to develop a different conceptual direction (*See appendices*).

Table 20: How the validation findings informed the iteration.

Validation finding	Iteration interpretation
The value of the framework was not always clear or convincing.	Clarify value opportunity and intended value of each intervention
The purpose, users and use setting were not always understood.	Clarify purpose, target users and use-setting. Allow for multiple use-settings, such show quick, thorough and explorative.
Value for different actors and possible negative effects were not always made clear.	Separate value for the furniture brand, customer and environment, and show the main disadvantage or trade-off.
Dense text, unclear terms and weak visual hierarchy sometimes made the interface difficult to use.	Use short cards, visual comparisons, clear hierarchy and optional supporting information.
The final output and first test were not always formulated clear.	End with a concise value proposition brief, the assumptions that remain and a practical validation plan.

The improvement findings were also interpreted, and taken into consideration.

Furniture brand-facing value proposition improvements

The validation findings show that the CFCF's purpose was not always clear and suggest that the value it provides was not consistently convincing for furniture brands. Although a continuation decision-support gap was identified and addressed, it did not become clear how often this decision is currently a priority for furniture companies.

Furniture brands already working on circular practices may already have knowledge and some capabilities to provide some furniture continuation. Other brands may first face practical, financial and organisational issues. This means that for most companies, continuation cannot be a sustainability goal as of now. The proposition must also show why it is relevant to the brand and valuable to the customer.

Since most furniture brands operate in a competitive consumer market. They need to keep their business running while competing with fast-furniture and large international companies. The iteration therefore explores how continuation could help a brand capture value or provide additional customer value. Sustainability is still part of the proposition, but not as important as capturing and providing value. New legislation, such as the introduction of the DPP may also create opportunity windows when a brand is more open to reconsidering its products and services.

Business decisions, needs and disruptions like these provide possible windows of opportunity for the CFCF. The Value Proposition Canvas was used as an explorative and structured method to find more value propositions and to identify where additional value could be created. For this, three main customer jobs were identified based of general observations throughout the project. These jobs are: capturing value, providing customer value, and meeting sustainability goals or requirements. These are kept separate throughout the process for traceability and show the assumptions and disadvantages that still need to be investigated.

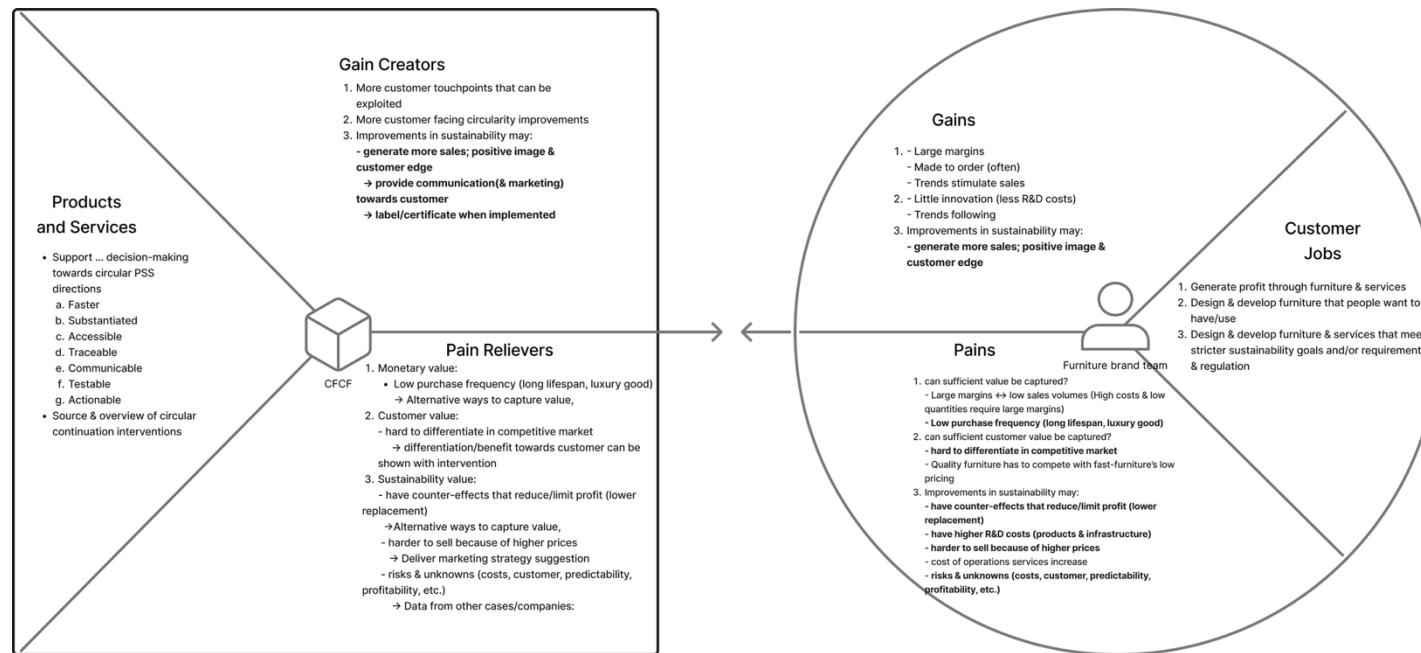


Figure 29: Value proposition canvas filled in for the CFCF to identify opportunities to improve its value for furniture brands (Osterwalder et al., 2014). The pains and gains are grouped per customer job based on the numbered list.

Design decision and scope

Furniture brand-facing value proposition improvements require large changes to the CFCF structure. The iteration was therefore developed as a value proposition concept rather than a smaller revision of the version used during validation

This proposed concept deliberately steps away from the earlier structure. The framework and prototype used in the validation remain unchanged. The result of this iteration is a new way of framing and structuring the research findings.

The suggestions for flexible use and the implementation of supporting technology were also taken into consideration. The concept includes multiple use modes, and allows multiple ways of providing information. The latter can typed, spoken, and imported, with optional AI interpretation. It also provides places to connect costs, comparison cases, environmental assessment, regulation and certification expertise.

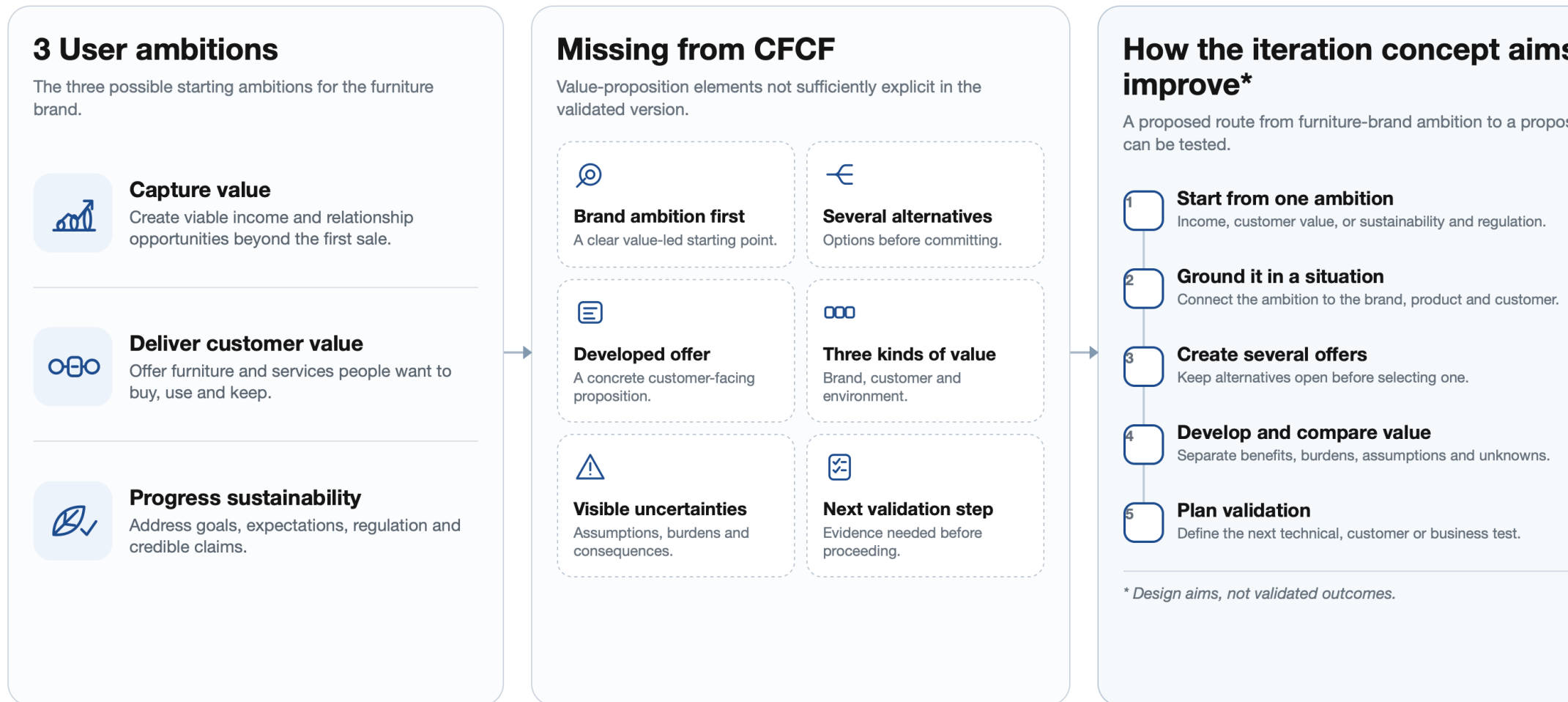


Figure 30: The image explains how the new value proposition became an integral part of the iteration, and was integrated through multiple steps of the process.

Concept development

The concept development was kept deliberately simple. It moves from selecting one of three possible starting ambitions to describing a concrete brand and product situation: providing additional customer value, creating additional income opportunities, or responding to sustainability goals or legislation. Instead of guiding the user through the earlier CFCF sequence, the concept moves from ambition and case understanding, which can lead to several propositions that are then developed, compared, and prepared for validation.

PROPOSED DEVELOPMENT PROCESS

From ambition to testable proposition

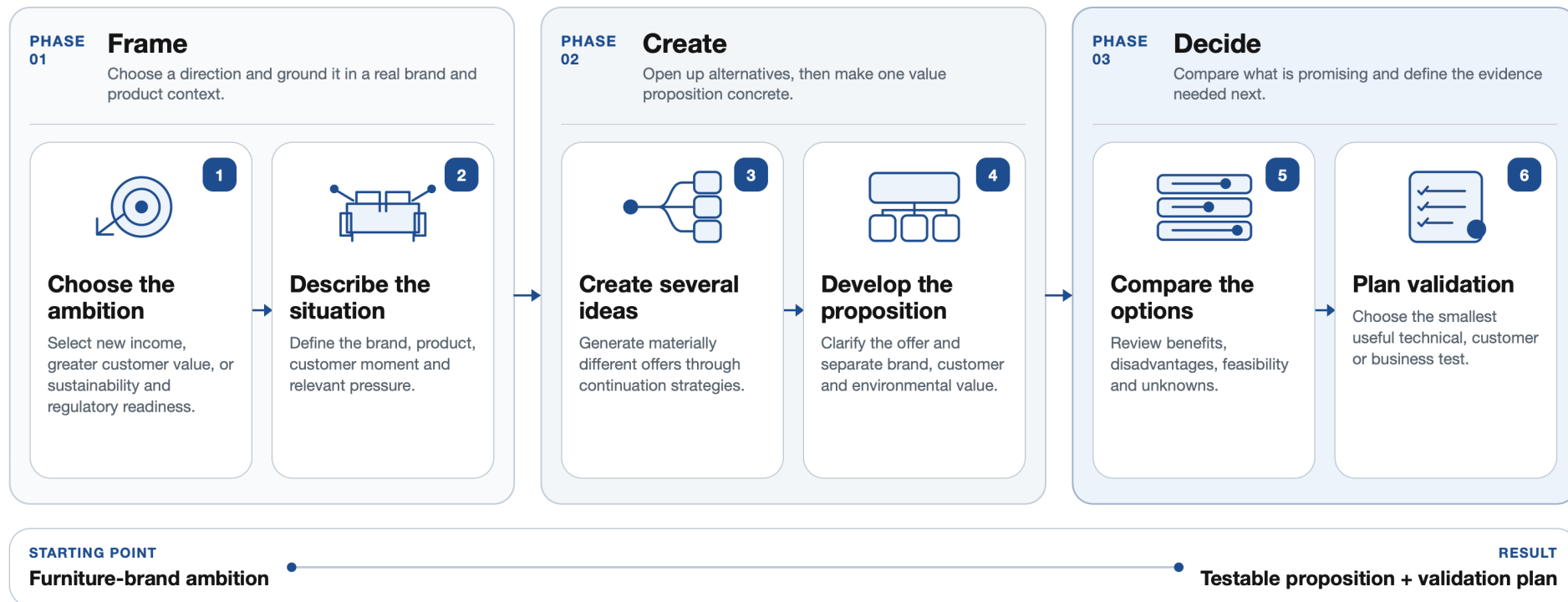


Figure 31: Proposed value proposition development process. The iteration restructures the concept around the development and comparison of offers that may create value for the brand, customer and environment.

For the examples, the same Atlas modular sofa case is used throughout. The main path develops a renewal service. Additional screens explore a paid Refresh Plan and a Product & Care Passport. The renewal service is developed further because it directly addresses the selected ambition of strengthening the customer relationship, while the other ideas remain visible as alternatives. For each proposition, brand, customer and environmental value remain separate, while the main risk, assumptions and next test remain visible.

For every proposition, it shows what the offer provides, who benefits, what environmental improvement is intended, what disadvantage may occur, and what is still assumed. This makes it possible to discuss an attractive proposition without presenting revenue, customer demand or environmental impact as given facts.

Designed iteration

These images show the designed iteration and its main screens. The examples also show that the UI has been made less text-heavy, has been reorganised, and uses more cards and visual comparisons.

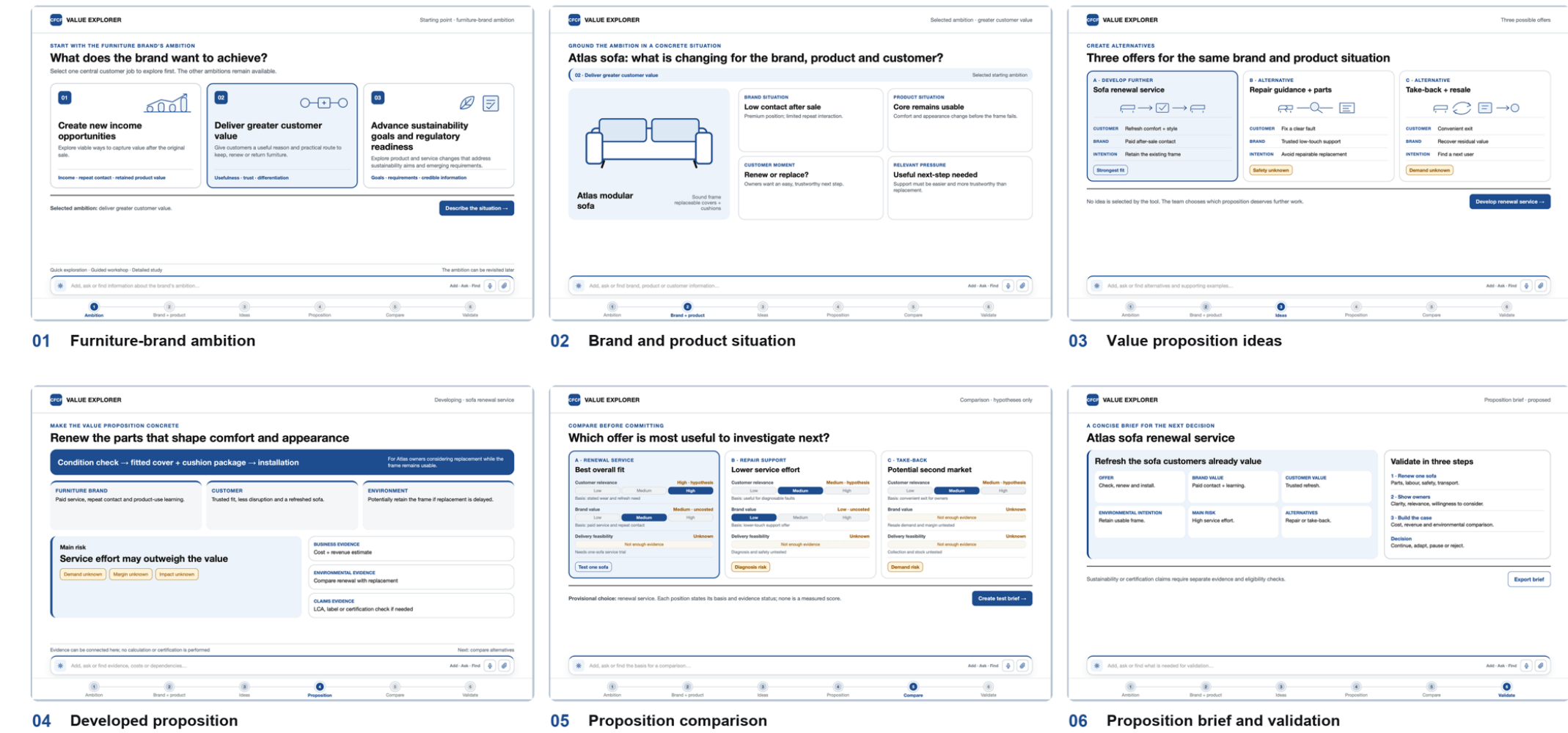


Figure 32: Overview of the six screens that make up the core flow. This shows an example flow of the company's ambition to deliver more customer value. It starts with selecting a value opportunity, then the brand and product situation are specified, and possible propositions are developed.

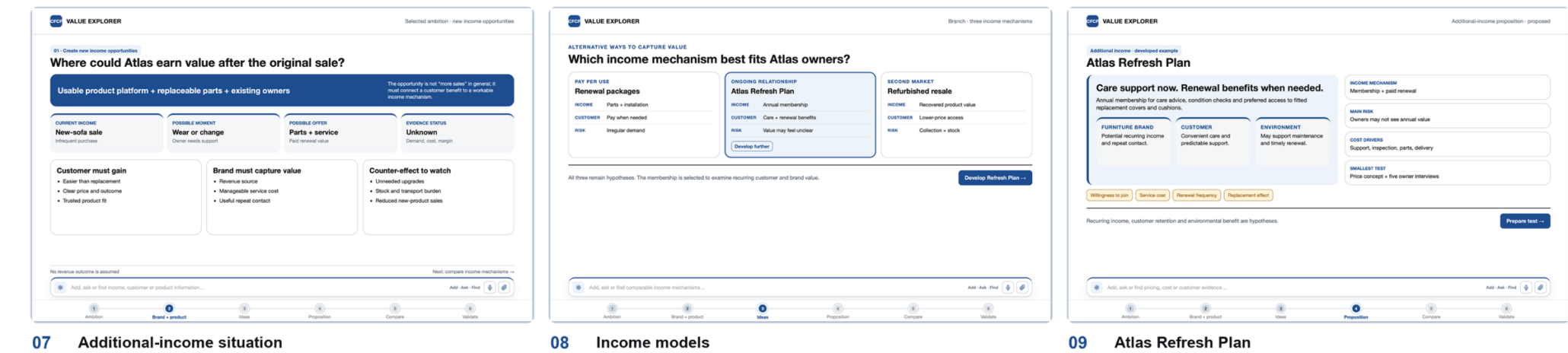
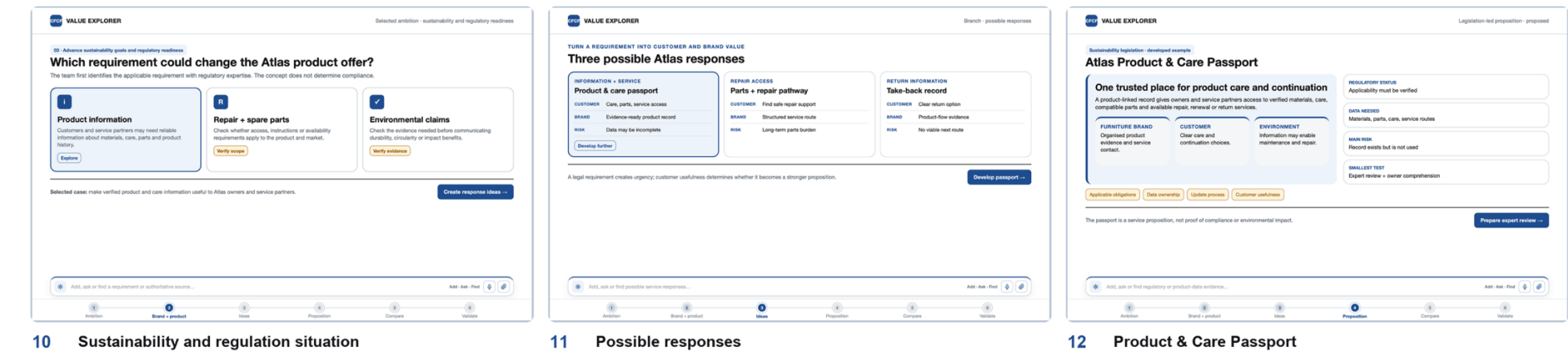


Figure 33: Additional income ambition 3 screen flow. The Atlas Refresh Plan connects a possible recurring-income mechanism to customer support, cost drivers, counter-effects and a small first test.



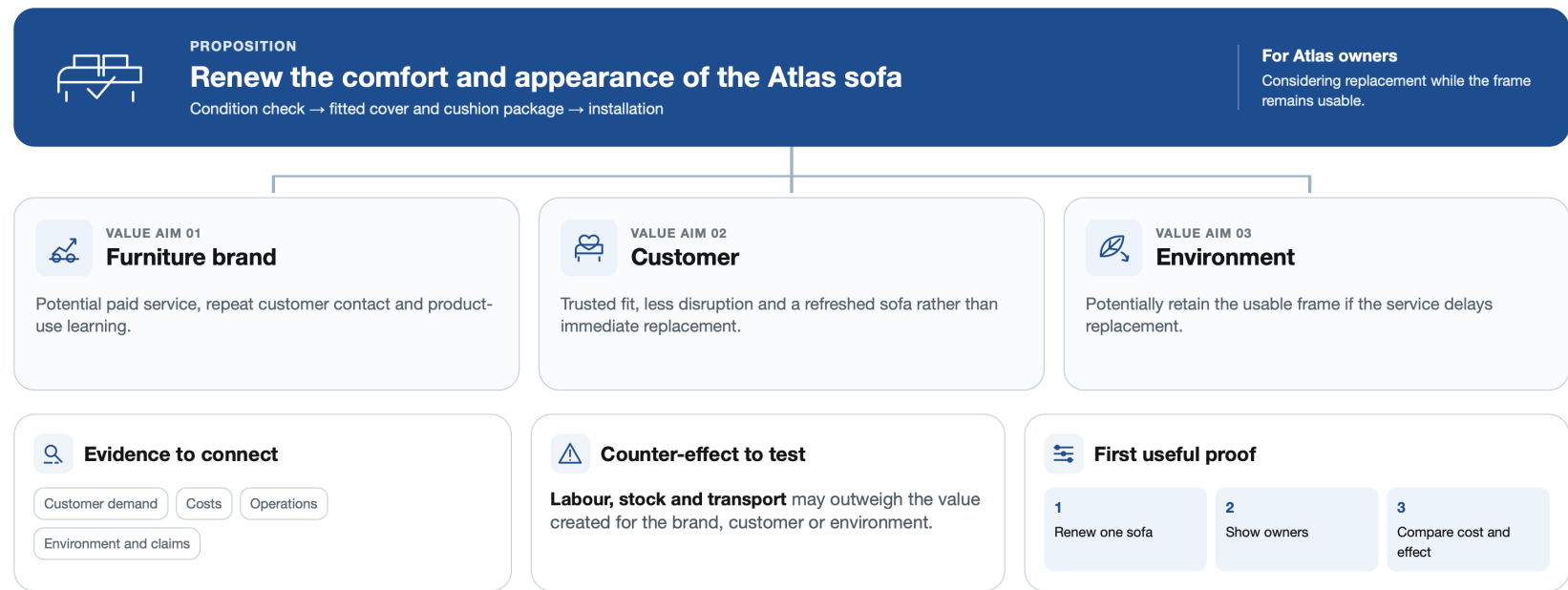


Figure 35: The structure of the developed value proposition shows how a service idea is developed into a proposition that can be examined and tested. Top layer: defines the offer, the intervention steps and intended user. Middle layer: Separates the intended values for the furniture brand, customer, and environment. Bottom layer: Lays out the evidence that is still needed, the most important possible counter-effect, and the first test that has been developed. Together, these create a concise proposition brief.

Improvements made

Table 7 summarises how the iteration concept differs from the earlier CFCF. This comparison describes what the proposed concept aims to achieve.

Table 7: Concise comparison of the earlier CFCF and the iteration concept.

Aspect	CFCF	Iteration concept
Starting point	The furniture continuation problem and the product's disposal journey.	Furniture brand selects ambition.
Main activity	Develop a continuation intervention direction through a structured process.	Develop and compare several continuation-based value propositions.
Value	Value and negative effects were not made clear.	Value for the brand, customer and environment is shown separately, together with the main disadvantage.
Use and input	A visually guided process with text-based input.	Quick, and detailed modes, with typed, spoken or imported notes and optional AI support.
Supporting information	Information, from e.g., partners or experts, to could be added, but wasn't made explicit.	Costs, comparison cases, environmental assessment, regulation and certification can be connected when relevant.
Final output	A continuation direction, documented process, and first-test.	A concise value proposition summary with assumptions, alternatives and a validation plan.

The iteration concept aimed to address the documented design issues through the designed, described, and suggested improvements. However, the iteration was not reevaluated with the same or new participants. Therefore, no conclusions can be drawn regarding improved participant performance, usability, fit, or preference.

Iteration conclusion

To better fit the target user needs & preferences, improvements have been made to the CFCF with the aim to improve areas for which validation findings revealed opportunities based on assessment criteria. Additionally, some developments aimed to address the underlying opportunities for improvement identified through direct suggestions.

The implemented iterations changed the following four main aspects in response to certain validation findings. It changed the starting point from the furniture's disposal journey to a brand ambition. It added three distinct opportunities for which the iteration may be able to provide value. It separated the values for the furniture brand, customer and environment and made risks and assumptions more visible. Finally, it changed the output from solely a continuation direction to an additional value proposition with alternatives and a validation plan.

These improvements are interpretations of the validation findings and aim to address the underlying criteria and characteristics. However, the improvements do not claim to solve or improve the findings directly. This needs to be evaluated, together with some of the assumptions made during the concept design, through another validation iteration.

Discussion

Interpretation of the design contribution

The CFCF's main contribution is a reusable decision structure for furniture continuation. It links case definition, breakdown diagnosis, intervention objectives, strategy families, capability checks, and first-test planning, and helps choose an intervention direction that is specific to the case and addresses an identified breakdown. This combination of a structured approach that can facilitate a variety of cases and outcomes differentiates it from other design outcomes that were considered, including a furniture PSS, and design principles demonstrated through a furniture redesign.

By exposing the route from evidence to a bounded direction, it allows a furniture-brand team to inspect assumptions before further development.

By laying out each step of the process, from understanding the context and problem to creating an actionable plan, it allows furniture brand teams to review and improve their assumptions before further development.

This role complements the circular approaches discussed in Chapter 2. The R-ladder orders strategies by their relationship to resource use and value retention (Potting et al., 2017), while the Value Hill identifies where value can be retained or recovered across pre-use, use and post-use phases (Achterberg et al., 2016). Circular PSS approaches describe combinations of products and services around routes such as maintenance, repair, access and take-back (Goedkoop et al., 1999; Tukker, 2004; Kjaer et al., 2019). These approaches provide strategy-level orientation. The CFCF adds case-specific diagnosis and a decision route from a continuation breakdown to a bounded intervention direction and first test.

Whereas circular frameworks such as the R-ladder and Value Hill provide an overview of possible circular strategies and continuation routes (Potting et al., 2017; Achterberg et al., 2016), the CFCF may make this more concrete by helping decide which intervention direction fits a specific breakdown in continuation.

The three applications examples show that the same structure can produce different and traceable reasoning routes across varying furniture cases. Participants appreciated the step-by-step structured process the most, as it made complex problems more concrete and helped generate useful directions and first-tests in the

validation settings. However, first-tests did not always address the main uncertainty without critique or assistance, making them the main challenge identified. Unclear value, purpose, use conditions, terminology, information density, and visual hierarchy were also identified as limiting the framework's performance.

Meaning of the value-proposition pivot

The validation findings revealed that providing only a traceable decision logic is insufficient. The CFCF's value and purpose were not consistently clear in the tested settings, its usefulness turned out to an important area for improvement, rather than the interface issues that were pointed out more frequently.

The conceptual pivot therefore shifts from a process that identifies and translates breakdowns, to an approach that focuses on the value proposition. This new structure moves from selecting the furniture brand's ambition into developing an actionable proposition based on a furniture continuation. This directly makes the value explicit to the furniture brand. Disadvantages, assumptions, and alternatives are also provided with each proposition, making values and trade-offs them omnipresent.

Nevertheless, this pivot also creates friction. The focus shift towards value opportunities may increase the relevance as perceived by furniture teams. However, the link of the intervention direction to the continuation breakdown may weaken, traceability may fall, and make the justification for the intervention that addresses it less understandable. The outcome may shift from the most appropriate intervention to a more commercially attractive offer. Further development should therefore explore ways to keep the strongest continuation link apparent, so continued use remains feasible. The pivot is a design interpretation with the aim to address some of the CFCF's shortcomings. Its assumptions, fit, and performance need to be validated to be able to make any claims or compare them to the CFCF.

Use conditions and applicability

The CFCF may most suitable to be used as an early exploration tool, used by a multidisciplinary team at a furniture brand. The most relevant roles may include product design and development, as well as circularity or sustainability specialists. For it to be used properly, the validations suggest that relevant case information, some expertise in circularity, product design, and organizational ownership may be useful. When used for the first time, the CFCF may benefit from some preparation, ample time, or some facilitation.

Initially, the pivot may shift the targeted user slightly away from designers, more towards business development and sustainability specialists. Its practical use conditions still need to be evaluated.

These use conditions do not suggest influencing the quality or feasibility of the CFCF's or pivot's outcomes, and are suggested only because they may help use the CFCF properly.

Feasibility, viability, and adoption

The framework validation only addressed the validation criteria. A relevant intervention direction that is developed using the CFCF can still fail if the conditions required for the implementation of the first-test or intervention are not met. The CFCF includes checks and reflections for brands to evaluate what the selected strategy would require to be able to run the first-test. This helps furniture brands evaluate the direction should be pursued, or not, and therefore does not prove whether the direction is feasible or viable. Additionally, to make claims regarding continuation or circular impact routes, outcomes need to be recorded as evidence of what happens after route execution return. Therefore, the validation cannot claim a proposed intervention is technically feasible, commercially viable, adopted or environmentally effective. Those require additional evidence.

Limitations

Throughout the research and design, choices and considerations were made that eventually resulted in the design outcomes. Interpretation has likely affected the outcomes, since these choices often cannot be made without interpretation. The documented development makes it traceable, but the framework cannot causally explain premature disposal or furniture continuation. However, it may be a structured tool to aid decision-making.

The literature and sector findings support problem framing and framework development, but cannot provide insight into the exact amount of premature furniture disposal, or how it can be measured. Additionally, the available sector data varies in age, method, category boundaries, and source quality. The early-exit indicators are therefore used as proxy measures that show where premature disposal may occur, without suggesting that each disposal event is avoidable. The scenarios are partly shaped by familiarity with some of them, which helped to create relevant cases, but do not replace user research.

The application examples show how the CFCF can be applied across different furniture situations and intervention directions. However, because they were developed within the project, they do not yet show how intended users would interpret, trust, or use the CFCF in practice.

The quality of the CFCF output depends on the quality of the case input. When any of the case's inputs are weak, the quality of the resulting intervention direction will also be poorer. The framework can help identify assumptions and uncertainties, but cannot replace the evidence specific to the case needed to strengthen the output.

Validation can provide insight into the CFCF's fit and performance, but is limited by sample size, participant availability, scope, and available time. However, it cannot draw reliable conclusions about adoption, feasibility, long-term use, or impact beyond this project. Nor can it the participant represent every intended role, organisation, furniture category, or continuation case.

The iteration concept may contribute less directly to reducing households' premature furniture discard than the CFCF's current decision-making support. Additionally, the project did not assess participant use of the pivot concept or its outcomes, and no claims about its user fit and performance can be made.

Future development and research

Future research should evaluate the fit and performance of the proposed iteration concept. In order to assess this, stakeholder involvement may provide inspiration and valuable insights, and should be initiated early in the process and maintained throughout the process so that quick adjustments can be made and agility can be maintained.

The next aim would be to carry out a comparison of the assessments of both the iteration concept and the earlier CFCF with a multidisciplinary furniture brand team. Using a concrete case, it should be assessed whether the new value-focused starting point increases perceived value and relevance while maintaining traceability to the breakdown it addresses. The additional information used, the experts who participated, and alternative routes should also be documented, along with whether the first test addresses the proposition's main uncertainty.

Conclusion

Furniture brands can be supported in developing circular PSS intervention directions for domestic movable furniture at risk of premature discard as living contexts change through the Circular Furniture Continuation Framework (CFCF). The CFCF is a framework that supports design decision-making and connects a defined continuation problem to a fitting intervention direction, that also guides assessing required conditions, and formulating a first-test plan for the intervention direction. In the CFCF process, the team defines the case, identifies and prioritises the decisive continuation breakdown, translates it into an intervention objective, considers relevant strategy families, checks capabilities and dependencies, and documents the selected circular PSS intervention direction before formulating a first test. The framework provides a reusable structure to guide diagnosis and decisions across cases, towards a fitting intervention direction.

Across three contrasting application examples, this structure produced different and traceable reasoning routes rather than prescribing one solution. In the tested settings, participant findings support the structured stepwise progression, which was evaluated to make the problem smaller, more concrete, and more credible. The participants challenged first-test formulation, and identify unclear value and purpose, use conditions, textual presentation as limitations. The findings therefore suggest that the CFCF may be used as an early collaborative exploration tool by a multidisciplinary furniture-brand team, with its usefulness dependent on case information quality, relevant expertise, preparation and, for first use, possible facilitation.

Selected validation findings were interpreted through an exploratory value-proposition concept that makes possible brand, customer and sustainability value, disadvantages and assumptions more explicit. This concept is therefore a design direction that participants have not evaluated.

The CFCF therefore remains the project's final design outcome and its main contribution. It is a developed, traceable, and structured framework that supports decision-making, and its qualities were supported and challenged in participant validation settings. The CFCF therefore supports an early step towards reducing premature furniture discard by helping furniture brands turn evidence about why furniture may be discarded into a testable direction for a circular PSS intervention.

Notes

Human research ethics and handling of data

Human participation in this research was conducted and approved in accordance with the TU Delft HREC & Data Management Plan guidelines and processes. This applied to interviews, usability tests, and evaluations through which people provided input for the project. Through this process, the possible risks for participants were identified and minimised, consent procedures were set up, and handling of data was clarified.

Depending on the activity, participants were informed about the purpose of the activity, voluntary participation, handling of data, anonymisation, options for withdrawal and recording permission.

The validation chapter describes the full validation process, including participant involvement.

AI use

Generative AI and Grammarly Pro were used as support for planning, structuring, wording and text refinement, specific reviewing, the creation of placeholders, figures, and digital prototypes. Some of the prototypes were created through instructions provided to Figma Make and ChatGPT, with the goal of efficiently creating an interactive prototype to be used for validation, using carefully composed prompts and specification documents. AI was not used as an evidence source, and suggestions generated by AI were always reviewed. I remain responsible for the process, decisions, and content.

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Appendices

Methods

Overview of the methods, approaches, models and tools with the most contribution to the project, sorted by section appearance.

Method/lens	Take-away	Relevant section	Why used?	Used for	Output
Design for Sustainability	Circularity focused	2.1 Design approach	Circularity focus	Circular framing	Sustainable thinking
Frame Innovation	Outcome fits better	2.1 Design approach	Reframe the problem	Product-to-framework shift	New design frame
User-Centred Design	Framework addresses real disposal situations	2.1 Design approach	Identify and resolve real needs	Understanding needs, barriers and decisions	User & context insights
Map of Systems Thinking	Product focus is insufficient	3.1 System context	Understand system	Actor & system mapping	Actor & system maps
Journey Mapping	Disposal is (complex) process	3.4 Disposal journey	Understand disposal decision	Mapping behaviour & barriers	Disposal journey
Product Journey Mapping	Route discontinuation found	3.5 Value loss	Trace product routes	Continuation mapping	Product journey
Morphological Chart	Provided insight: to pivot outcome, connection strategies	5.3 Strategy synthesis	Need for overview of directions	Create concept architecture	Morphological chart, strategy overview
Design for Behavioural Change	Friction is critical	3.4 Disposal behaviour	Understand disposal behaviour	Understanding barriers, habits and fallback	Behavioural insights

Method/lens	Take-away	Relevant section	Why used?	Used for	Output
Service Design	Services became necessary	4.2 PSS direction	Link product and service	Touchpoint mapping	PSS reasoning
Function Analysis	Essence of functions/features	5.1 Framework logic	Define needed functions	PSS breakdowns & interventions	Overview of functions
How-Tos / HMW	Intervention goals became clear	5.2 Objectives	Reframe problems	Breakdown to goal translation & ideation	Intervention options
Product Concept Evaluation	TBD	7.2 Validation	Test framework value	Expert/user evaluation	Feedback findings

Problem space

Actor table

Actor	Role in current system	Pain point / interest	Interaction with proposed PSS
Household/user	Acquires, use, dispose of furniture	Mismatch → replace. Fit, min. cost, max. convenience	User, sales, service interactions.
Co-dweller / partner / household	Uses furniture, may influence acquisition and disposal	Mismatch → redundant disposal /replace/expand. Fit	User, service interactions.
Furniture brand/provider	Sells furniture, may design and produce furniture	Saturation. Turnover (growth)	Provider, creator, executor

Actor	Role in current system	Pain point / interest	Interaction with proposed PSS
Repair/refurbishment actor	Offers service, enables circularity, may redistribute	Labour cost, demand. Turnover, acceptance	Partner; provides service
Logistics / pick-up	Transports goods to & from clients	Planning pressure. High quantity	Partner; provides service
Second-hand / recirculation channel	Offers more cost-effective & sustainable pathway, at the cost of certainty & convenience for acquisition & disposal	Matching. Sales/visitors	Partner; provides service
Waste route	Offers most convenient, certain disposal route, at the cost of value & sustainability	Contamination waste streams. High recyclable volumes.	Decreasing, ?

CFCF code key

CFCF code key

The tables below provide codes, abbreviations, and labels for use, navigation, and traceability, of, and within the CFCF.

Code family	Meaning
J1–J8	Disposal-journey stages
B1–B11	Continuation-breakdown patterns
O1–O11	Intervention objectives
S1–S10	Circular PSS strategy families
R1–R4	Required-capability levels for the smallest useful test
P0–P3	Infrastructure-dependency levels for the smallest useful test

Disposal-journey stages

Code	Reader-facing label
J1	Acquisition
J2	In-use
J3	Mismatch emergence / recognition
J4	Coping / deferral and intermediate states
J5	Decision activation / trigger
J6	Route search, evaluation and selection
J7	Execution and hand-over
J8	Outcome and post-outcome

Continuation-breakdown patterns

Code	Reader-facing label
B1	Spatial fit failure
B2	Functional fit failure
B3	Low adaptability to change
B4	Aesthetic and identity obsolescence
B5	Household redundancy
B6	Emotional discontinuity
B7	Care, repair and upgrade friction
B8	Handling and logistics friction
B9	Deadline-pressure disposal
B10	Lack of attractive continuation routes
B11	Value-recovery uncertainty

Intervention objectives

Code	Reader-facing label
O1	Preserve spatial fit
O2	Preserve functional relevance
O3	Enable adaptation over time
O4	Extend aesthetic relevance
O5	Absorb household surplus
O6	Support meaningful detachment or renewal
O7	Lower care, repair and upgrade effort

Code	Reader-facing label
O8	Reduce handling and logistics burden
O9	Provide rapid circular exit options
O10	Make continuation routes accessible
O11	Make value recovery legible

Circular PSS strategy families

Code	Reader-facing label
S1	Durable & adaptable architecture
S2	Modular reconfiguration & resizing
S3	Aesthetic renewal system
S4	Repair, care & part replacement
S5	Relocation & transition support
S6	Product passport & continuation guidance
S7	Take-back, return & intake
S8	Refurbishment & redeployment
S9	Access & ownership model redesign
S10	Shared continuation infrastructure

Capability and infrastructure codes

Code	Required-capability level
R1	Product-ready
R2	Service-ready
R3	Operations-ready

Code	Required-capability level
R4	Ecosystem-ready

Code	Infrastructure-dependency level
P0	No additional infrastructure needed
P1	Simple support infrastructure
P2	Coordinating infrastructure
P3	Shared ecosystem infrastructure

Current capability-fit labels

Label	Short lookup meaning
Current-fit	The required capability appears available internally or through an existing partner.
Stretch	The capability is partly available but needs added coordination, commitment, data or process clarity.
Adapt	The direction remains relevant, but the smallest useful test must be reduced or reframed.
Park	A critical capability, infrastructure, partner, mandate or business-case condition is currently absent.
Unsure	Available case information is insufficient for a judgement.

CFCF screenshots

CFCF prototype

Circular Furniture Continuation Framework

SELECTED EXAMPLE CASE

Flat-pack wardrobe relocation

Sofa repair & aesthetic renewal

Chair buy-back & take-back

PROCESS

Orientation

Step 1: Case definition

Step 2: Disposal journey

Step 3: Breakdown diagnosis

Step 4: Intervention objective

Step 5: Strategy routing

Step 6: Option & feasibility

Step 7: Opportunity Brief

Step 8: Pilot test planning

Final output

OTHER

Examples

Moderator view

Step status

Not started

In progress

Complete

Orientation

See what the CFCF does before starting your case.

WHY IT EXISTS

Usable furniture may be discarded too soon when keeping it in use becomes difficult.

WHO IT IS FOR

Furniture brands and the teams that design products, services and circular strategies.

WHAT IT HELPS YOU DO

Identify why furniture may be discarded too soon and choose a practical intervention direction to keep it in use. ?

THE EIGHT STEPS OF THE CFCF PROCESS

Move from a furniture case to a focused direction and a first test.

1 Define the case

Capture the furniture, its context and the risk of early disposal.

2 Map the journey

Find where continued use becomes vulnerable.

3 Diagnose the breakdown

Identify what is blocking continued use.

4 Set the objective

Decide what needs to change.

5 Choose a strategy

Select an approach for achieving the objective.

6 Select a feasible option

Choose a direction and check what it would require.

7 Create the Opportunity Brief

Summarise the direction and the reasoning behind it.

8 Plan the first test

Define a small test and decide what happens after it.

WHAT YOU WILL CREATE

A short Opportunity Brief that explains the problem, what should change, and the first direction to test. ?

WHAT THIS DOES NOT DO

It does not design a finished product or service, build a digital tool, or prove circular impact. Those require further work and testing.

EXAMPLE CASES

SELECTED EXAMPLE CASE

Flat-pack wardrobe relocation

Moving, fit, handling and time pressure.

SELECTED EXAMPLE CASE

Sofa repair and aesthetic renewal

Repair friction, aesthetic renewal and value legibility.

SELECTED EXAMPLE CASE

Chair buy-back and take-back

Eligibility, return, route-fate uncertainty and post-return outcome.

View Examples screen →

Show wardrobe example

Glossary

LIVE OUTPUT CHAIN

Case not yet named

Your current CFCF case output

STEP 1 CASE

not yet decided

STEP 1 INITIAL SUSPECTED RISK (PROVISIONAL)

not yet decided

STEP 2 JOURNEY STAGE

not yet decided

STEP 2 EVIDENCE / ASSUMPTION

not yet decided

STEP 2 CANDIDATE BREAKDOWNS

not yet decided

STEP 3 CONFIRMED BREAKDOWNS

Primary: B4: Aesthetic and identity obsolescence

Secondary: B7: Care, repair and upgrade friction

Secondary: B11: Value-recovery uncertainty

STEP 3 MAIN DISPOSAL RISK TO ADDRESS

not yet decided

STEP 3 BREAKDOWN RATIONALE

not yet decided

STEP 4 INTERVENTION OBJECTIVE

Primary: O3: Enable adaptation over time

Secondary: O4: Extend aesthetic relevance

STEP 5 STRATEGY SHORTLIST

Primary: S1: Durable & adaptable

Output field key

Current step

Step complete

Not yet decided

99

CFCF prototype

Circular Furniture Continuation Framework

SELECTED EXAMPLE CASE

● Flat-pack wardrobe relocation

○ Sofa repair & aesthetic renewal

○ Chair buy-back & take-back

PROCESS

Orientation

○ Step 1: Case definition

○ Step 2: Disposal journey

○ Step 3: Breakdown diagnosis

○ Step 4: Intervention objective

○ Step 5: Strategy routing

○ Step 6: Option & feasibility

○ Step 7: Opportunity Brief

○ Step 8: Pilot test planning

Final output

OTHER

Examples

Moderator view

Step status

○ Not started

● In progress

● Complete

STEP 2

Disposal journey mapping

Identify where in the disposal journey continuation is becoming unstable. ?

← Previous: Step 1

DO THIS

Compare at least two plausible J-stages, select the best fit, and record the evidence or uncertainty.

CREATES: a selected journey stage, evidence note and B-pattern suggestions for Step 3.

COMPARE PLAUSIBLE STAGES, THEN SELECT ONE

J1

Acquisition



Furniture enters the household through purchase, inheritance, gift, rental or previous ownership.

CHOOSE THIS WHEN

The disposal risk stems from the original purchase decision: product fit, cost, architecture or reparability.

TYPICAL SIGNAL

Temporary purchase; low-cost purchase; inherited/gifted item; oversized product; poor reparability; weak disassembly; low modularity.

WARDROBE EXAMPLE

A cheap wardrobe bought for temporary student housing later becomes difficult to move, repair or resell.

CANDIDATE PATTERNS: CHECK IN STEP 3

B1 Spatial fit failure

B3 Low adaptability to change

+4 more

Notes for J1 (optional)

Brainstorm why this stage may or may not fit.

Note or brainstorm here

J2

In-use



Furniture performs its everyday role in the household.

CHOOSE THIS WHEN

The problem is emerging during normal everyday use: comfort issues, minor damage or gradually changing taste.

TYPICAL SIGNAL

Everyday fit; comfort; minor damage; changing taste; underuse; clutter; household routines.

WARDROBE EXAMPLE *(adapted)*

The wardrobe is still usable but increasingly difficult to open and no longer suits changed storage needs.

CANDIDATE PATTERNS: CHECK IN STEP 3

B2 Functional fit failure

B4 Aesthetic/identity obsolescence

+2 more

Notes for J2 (optional)

Brainstorm why this stage may or may not fit.

Note or brainstorm here

J3

Mismatch emergence / recognition



J4

Coping / deferral and intermediate states



LIVE OUTPUT CHAIN

Case not yet named

Your current CFCF case output

STEP 1

CASE

not yet decided

STEP 1

INITIAL SUSPECTED RISK (PROVISIONAL)

not yet decided

STEP 2

JOURNEY STAGE

not yet decided

STEP 2

EVIDENCE / ASSUMPTION

not yet decided

STEP 2

CANDIDATE BREAKDOWNS

not yet decided

STEP 3

CONFIRMED BREAKDOWNS

Primary: B4: Aesthetic and identity obsolescence

Secondary: B7: Care, repair and upgrade friction

Secondary: B11: Value-recovery uncertainty

STEP 3

MAIN DISPOSAL RISK TO ADDRESS

not yet decided

STEP 3

BREAKDOWN RATIONALE

not yet decided

STEP 4

INTERVENTION OBJECTIVE

Primary: O3: Enable adaptation over time

Secondary: O4: Extend aesthetic relevance

STEP 5

STRATEGY SHORTLIST

Primary: S1: Durable & adaptable architecture

Output field key

○ Current step

● Step complete

○ Not yet decided

100

CFCF prototype

Circular Furniture Continuation Framework

SELECTED EXAMPLE CASE

● Flat-pack wardrobe relocation

○ Sofa repair & aesthetic renewal

○ Chair buy-back & take-back

PROCESS

Orientation

○ Step 1: Case definition

○ Step 2: Disposal journey

○ Step 3: Breakdown diagnosis

○ Step 4: Intervention objective

○ Step 5: Strategy routing

○ Step 6: Option & feasibility

○ Step 7: Opportunity Brief

○ Step 8: Pilot test planning

Final output

OTHER

Examples

Moderator view

Step status

○ Not started

● In progress

● Complete

STEP 4

Intervention objective selection ?

Translate the confirmed breakdown pattern(s) into what the intervention must achieve.

← Previous: Step 3

DO THIS

Choose one primary objective that addresses the main breakdown. Add up to two secondary objectives only for a different intervention need.

?

CREATES: prioritised intervention objectives and a brief rationale.

FROM STEP 3: B→O ROUTING SUGGESTIONS

Likely from Step 3 (B→O routing):

O4: Extend aesthetic relevance

O7: Lower care, repair and upgrade effort

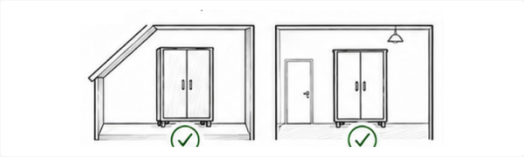
O11: Make value recovery legible

Suggestions only

SELECT PRIMARY (REQUIRED) AND UP TO TWO SECONDARY OBJECTIVES

O1

Preserve spatial fit



Keep the product usable across changing homes, room sizes, layouts, access constraints, and space allocations.

USE WHEN

Select when the primary breakdown is B1 Spatial fit failure. The item no longer spatially fits the household context.

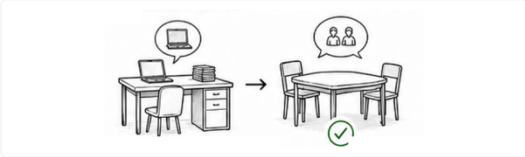
► Show detail

Set as Primary

+ Secondary

O2

Preserve functional relevance



Keep the product aligned with changing storage needs, routines, household activities, and use situations.

USE WHEN

Select when the primary breakdown is B2 Functional fit failure. The item no longer supports current activities or routines.

► Show detail

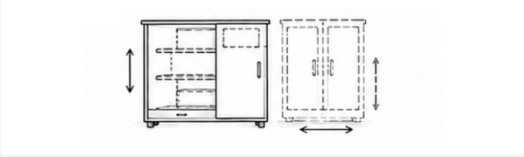
Set as Primary

+ Secondary

O3

Enable adaptation over time

PRIMARY ✓

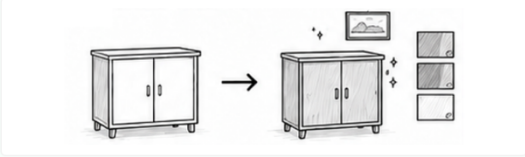


Allow the product to be resized, reconfigured, extended, reduced, repurposed,

O4

Extend aesthetic relevance

SECONDARY ✓



Enable visible renewal, style updates, and identity alignment without replacing the

LIVE OUTPUT CHAIN

Case not yet named

Your current CFCF case output

STEP 1

CASE

not yet decided

STEP 1

INITIAL SUSPECTED RISK (PROVISIONAL)

not yet decided

STEP 2

JOURNEY STAGE

not yet decided

STEP 2

EVIDENCE / ASSUMPTION

not yet decided

STEP 2

CANDIDATE BREAKDOWNS

not yet decided

STEP 3

CONFIRMED BREAKDOWNS

Primary: B4: Aesthetic and identity obsolescence

Secondary: B7: Care, repair and upgrade friction

Secondary: B11: Value-recovery uncertainty

STEP 3

MAIN DISPOSAL RISK TO ADDRESS

not yet decided

STEP 3

BREAKDOWN RATIONALE

not yet decided

STEP 4

INTERVENTION OBJECTIVE

Primary: O3: Enable adaptation over time

Secondary: O4: Extend aesthetic relevance

STEP 5

STRATEGY SHORTLIST

Primary: S1: Durable & adaptable architecture

Output field key

○ Current step

● Step complete

○ Not yet decided

101

CFCF prototype

Circular Furniture Continuation Framework

SELECTED EXAMPLE CASE

● Flat-pack wardrobe relocation

○ Sofa repair & aesthetic renewal

○ Chair buy-back & take-back

PROCESS

Orientation

○ Step 1: Case definition

○ Step 2: Disposal journey

○ Step 3: Breakdown diagnosis

○ Step 4: Intervention objective

○ Step 5: Strategy routing

○ Step 6: Option & feasibility

○ Step 7: Opportunity Brief

○ Step 8: Pilot test planning

Final output

OTHER

Examples

Moderator view

Step status

○ Not started

● In progress

● Complete

STEP 5

Strategy routing & shortlist

Shortlist strategy families that could address the selected intervention objective(s).

← Previous: Step 4

DO THIS

Choose one primary strategy. Add supporting strategies only when they help. ?

CREATES: one main strategy, optional supporting strategies and a short reason.

FROM STEP 4: O→S ROUTING SUGGESTIONS. SUGGESTIONS ONLY.

Linked to selected objective(s): S1: Durable & adaptable architecture S2: Modular reconfiguration & resizing S6: Product passport & continuation guidance

S3: Aesthetic renewal system Suggestions only

CHOOSE ONE PRIMARY STRATEGY AND OPTIONAL SUPPORTING STRATEGIES

S1 Durable & adaptable architecture PRIMARY ✓



Preserve product value by making the existing product core survive wear, moving, and limited contextual change.

WHY SHOWN

Selectable for all cases. Select if it fits the intervention need.

► Show front-card detail

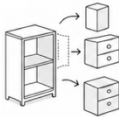
PRIMARY

SUPPORTING

×

Selected role: Primary

S2 Modular reconfiguration & resizing Suggested



Preserve use by changing the product configuration rather than replacing the whole product.

WHY SHOWN

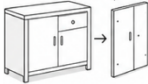
Selectable for all cases. Select if it fits the intervention need.

► Show front-card detail

PRIMARY

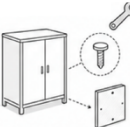
SUPPORTING

S3 Aesthetic renewal system SUPPORTING ✓



Preserve the durable core by separating aesthetic renewal from full product

S4 Repair, care & part replacement



Make maintaining or repairing the product easier, cheaper, clearer or more

LIVE OUTPUT CHAIN

Case not yet named

Your current CFCF case output

STEP 1 CASE

not yet decided

STEP 1 INITIAL SUSPECTED RISK (PROVISIONAL)

not yet decided

STEP 2 JOURNEY STAGE

not yet decided

STEP 2 EVIDENCE / ASSUMPTION

not yet decided

STEP 2 CANDIDATE BREAKDOWNS

not yet decided

STEP 3 CONFIRMED BREAKDOWNS

Primary: B4: Aesthetic and identity obsolescence

Secondary: B7: Care, repair and upgrade friction

Secondary: B11: Value-recovery uncertainty

STEP 3 MAIN DISPOSAL RISK TO ADDRESS

not yet decided

STEP 3 BREAKDOWN RATIONALE

not yet decided

STEP 4 INTERVENTION OBJECTIVE

Primary: O3: Enable adaptation over time

Secondary: O4: Extend aesthetic relevance

STEP 5

STRATEGY SHORTLIST

Primary: S1: Durable & adaptable architecture

Output field key

○ Current step

● Step complete

○ Not yet decided

102

CFCF prototype

Circular Furniture Continuation Framework

SELECTED EXAMPLE CASE

● Flat-pack wardrobe relocation

○ Sofa repair & aesthetic renewal

○ Chair buy-back & take-back

PROCESS

Orientation

○ Step 1: Case definition

○ Step 2: Disposal journey

○ Step 3: Breakdown diagnosis

○ Step 4: Intervention objective

○ Step 5: Strategy routing

○ Step 6: Option & feasibility

○ Step 7: Opportunity Brief

○ Step 8: Pilot test planning

Final output

OTHER

Examples

Moderator view

Step status

○ Not started

● In progress

● Complete

STEP 6

Intervention option & feasibility check

Open the primary strategy, select an option and check the smallest useful version.

← Previous: Step 5

DO THIS

Open the primary strategy, select one option, then assess the smallest useful test, not the full system.

CREATES: a selected option, feasibility categories, bottleneck, judgement basis and next step.

ACTIVE PRIMARY STRATEGY

S1: Durable & adaptable architecture

Context only:

Su: S3: Aesthetic renewal system

MECHANISM LAYER: CHOOSE ONE TO VIEW ITS OPTIONS

S1-M01 · MECHANISM 1

Core-layer architecture

Shows long-life structural systems that can accept later infill, modules or accessories.

Hide options

S1-M02 · MECHANISM 2

Reversible joining logic

Fits repeated assembly, disassembly and component replacement rather than single-use assembly.

View options →

S1-M06 · MECHANISM 3

Fit-resilient dimensions

Shows width, height, depth and bay logic that can absorb different rooms and moves.

View options →

S1-M01: CORE-LAYER ARCHITECTURE: AVAILABLE OPTIONS

Two primary options and one supporting option are shown. All three remain selectable. Examples are clarification only, not feasibility evidence. The full backend library remains hidden.

CURRENT SELECTED DIRECTION

CFCF-OPT-001: Durable core with replaceable infill

S1-M01: CORE-LAYER ARCHITECTURE

PRIMARY DIRECTION 1

Upgradeable carcass standard

Keep the main box, frame or rail stable while later upgrades replace only modules and peripherals.

► Show example / archetype

Select this option

S1-M01: CORE-LAYER ARCHITECTURE

PRIMARY DIRECTION 2

Durable core with replaceable infill

Design the frame or carcass as the long-life element while panels, doors, covers, shelves or soft parts can be replaced independently.

► Show example / archetype

× Deselect

S1-M01: CORE-LAYER ARCHITECTURE

SUPPORTING DIRECTION

Long-life frame, short-life surfaces

Treat visible or wear-sensitive surfaces as renewal layers rather than reasons to replace the full item.

► Show example / archetype

Select this option

CUSTOM

Custom / own option direction. Outside current option-card set; note for review, not a new strategy family.

Use custom direction

LIVE OUTPUT CHAIN

Case not yet named

Your current CFCF case output

STEP 1

CASE

not yet decided

STEP 1

INITIAL SUSPECTED RISK (PROVISIONAL)

not yet decided

STEP 2

JOURNEY STAGE

not yet decided

STEP 2

EVIDENCE / ASSUMPTION

not yet decided

STEP 2

CANDIDATE BREAKDOWNS

not yet decided

STEP 3

CONFIRMED BREAKDOWNS

Primary: B4: Aesthetic and identity obsolescence

Secondary: B7: Care, repair and upgrade friction

Secondary: B11: Value-recovery uncertainty

STEP 3

MAIN DISPOSAL RISK TO ADDRESS

not yet decided

STEP 3

BREAKDOWN RATIONALE

not yet decided

STEP 4

INTERVENTION OBJECTIVE

Primary: O3: Enable adaptation over time

Secondary: O4: Extend aesthetic relevance

STEP 5

STRATEGY SHORTLIST

Primary: S1: Durable & adaptable architecture

Output field key

○ Current step

● Step complete

○ Not yet decided

103

CFCF prototype
Circular Furniture Continuation Framework

SELECTED EXAMPLE CASE

● Flat-pack wardrobe relocation

○ Sofa repair & aesthetic renewal

○ Chair buy-back & take-back

PROCESS

Orientation

○ Step 1: Case definition

○ Step 2: Disposal journey

○ Step 3: Breakdown diagnosis

○ Step 4: Intervention objective

○ Step 5: Strategy routing

○ Step 6: Option & feasibility

○ Step 7: Opportunity Brief

○ Step 8: Pilot test planning

Final output

OTHER

Examples

Moderator view

Step status

○ Not started

● In progress

● Complete

Example cases

Three application examples across wardrobe, sofa and chair. Select a case below to explore its Step 1–8 reasoning trace. Examples clarify the reasoning level (not finished PSS concepts).

SELECTED EXAMPLE CASE

● EXAMPLE CASE

Flat-pack wardrobe relocation

Moving, spatial fit, handling friction and time-pressure disposal.

○ EXAMPLE CASE

Sofa repair and aesthetic renewal

Repair friction, aesthetic obsolescence and value-recovery legibility.

○ EXAMPLE CASE

Chair buy-back and take-back

Eligibility, return, route-fate uncertainty and post-return outcome.

BOUNDARY Examples show the CFCF reasoning path. They do not prove feasibility, desirability, viability, adoption, circular impact, route success or implementation success.

STEP-BY-STEP EXAMPLE: CLICK A ROW TO EXPAND

STEP 1 Step 1: Case definition

YOUR INPUT

Define the brand/product type, furniture category, sales channel, customer use context, context volatility, suspected disposal risk and main constraints.

EXAMPLE INPUT

DTC flat-pack furniture brand. Modular wardrobe system. Online-only sales. Customer use context: urban households that relocate frequently (rental market). Context volatility: high. Moving is a frequent and disruptive lifecycle event. Suspected disposal risk: High. Item is functional but users discard it because disassembly, transport and reassembly feel uncertain and effortful. Main constraint: no current partner network for reassembly support.

WHY SELECTED

The brand actor type (DTC), product architecture (flat-pack modular) and customer use context (urban movers) together make the disposal trigger identifiable and the brand's potential intervention role plausible without requiring major capability leaps.

OUTPUT FROM THIS STEP

Case confirmed: Flat-pack wardrobe relocation. DTC brand. High disposal risk triggered by relocation-handling friction.

STEP 2 Step 2: Disposal journey mapping

YOUR INPUT

Select the journey stage (J1–J8) where continuation becomes most vulnerable. Note evidence, uncertainty and any diagnostic signals.

EXAMPLE INPUT

J5: Decision activation / trigger. Evidence: users report the disposal decision typically happens 2–3 days before the move, when disassembly effort becomes apparent and no continuation route has been identified. The brand has no signal or touch point at this stage.

WHY SELECTED

OUTPUT FROM THIS STEP

LIVE OUTPUT CHAIN

Case not yet named

Your current CFCF case output

STEP 1 CASE

not yet decided

STEP 1 INITIAL SUSPECTED RISK (PROVISIONAL)

not yet decided

STEP 2 JOURNEY STAGE

not yet decided

STEP 2 EVIDENCE / ASSUMPTION

not yet decided

STEP 2 CANDIDATE BREAKDOWNS

not yet decided

STEP 3 CONFIRMED BREAKDOWNS

Primary: B4: Aesthetic and identity obsolescence

Secondary: B7: Care, repair and upgrade friction

Secondary: B11: Value-recovery uncertainty

STEP 3 MAIN DISPOSAL RISK TO ADDRESS

not yet decided

STEP 3 BREAKDOWN RATIONALE

not yet decided

STEP 4 INTERVENTION OBJECTIVE

Primary: O3: Enable adaptation over time

Secondary: O4: Extend aesthetic relevance

STEP 5 STRATEGY SHORTLIST

Primary: S1: Durable & adaptable architecture

Output field key

○ Current step

● Step complete

○ Not yet decided

Screen where examples cases can be viewed (same as application examples).

Application examples

The application examples make the CFCF output assessable across three different furniture situations. They show how the same CFCF process can translate different breakdowns of continuation into distinct circular PSS intervention directions, and whether the framework's logic remains traceable across different cases.

Figure overview cases

Figure 36: overview application example cases

The three domestic furniture cases used are a flat-pack wardrobe during relocation, a worn sofa that could potentially be repaired or renewed, and a chair entering a buy-back route. Together, they show different ways in which continued use can break down. The wardrobe case focuses on moving, fit, disassembly and reassembly. The sofa case focuses on repair effort, visible wear and value assessment. The chair case focuses on product returns, assessment, acceptance, rejection, and the route outcome after return.

The CFCF is therefore evaluated through application examples that demonstrate what it can produce when it is applied to different cases. The validation will evaluate the CFCF itself by assessing whether target users can understand, follow and assess the framework logic.

Purpose and case selection

The three cases were selected for their combined coverage, not based on, e.g., their furniture category's waste impact. A single example would make the framework easier to explain, but it would not show whether the CFCF can handle different breakdowns. The case selection therefore includes one detailed worked example and two focused contrast examples.

The flat-pack wardrobe case is used as the detailed worked example because relocation creates a clear moment when functional furniture may leave use. Moving forces the user to decide whether the wardrobe fits the new home, can be disassembled without damage, and is worth transporting and reassembling under time pressure. This makes the case useful for demonstrating the full CFCF process and showing how a disposal risk caused by a contextual transition can be translated into a circular PSS intervention direction. The sofa case covers repair, renewal and the handling challenges of heavy furniture. A sofa may still be structurally usable, while visible wear, sagging cushions, stains or aesthetic mismatch make replacement feel easier or more attractive than repair. This makes the case useful for assessing whether the CFCF can connect repair effort, aesthetic relevance and value judgment without turning the example into a full sofa service concept.

The chair case is included because it makes the product return route and its outcome visible. Although chairs may not represent the highest-impact furniture category, the case shows what the item may still be worth, whether it is accepted for return, how it is returned, how it is assessed, and what happens afterward. This makes it useful for testing whether the CFCF distinguishes between a product return and actual continuation.

Case	Role	Main continuation problem	Main CFCF value	Main boundary
Flat-pack wardrobe	Detailed example	Relocation creates fit, disassembly, handling and reassembly burden	Shows how a moving breakdown translates into transition support	Does not prove that relocation support prevents disposal
Sofa	Focused on repair and renewal	Repair or renewal may feel too unclear, costly or effortful compared with replacement	Shows how repair friction, aesthetic renewal and value judgement become connected	Does not result in acceptable price, demand or partner feasibility
(Dining) chair	Focused on route continuation	A usable chair needs a trusted and low-effort return or continuation route	Shows the difference between product return, acceptance, resale and fallback	Does not prove that collection leads to reuse or circular impact

Figure 37: Case selection application examples

The three cases differ in furniture type, disposal trigger, and the level of brand or service support they require. This helps assess whether the CFCF can be applied across varied cases, while producing different outputs, and making sure their rationales are traceable and can be compared.

Application format

Each application example follows the same translation logic as the CFCF; it first identifies what is going wrong with the furniture's continuation. Then it translates that breakdown into an intervention objective and routes the case toward a circular PSS intervention direction.

Case → disposal risk → journey stage → diagnostic signal → breakdown pattern → intervention objective → strategy family → intervention direction → smallest useful test → required capability → current fit → infrastructure need → dominant bottleneck → route continuation check where relevant → key assumption → first test idea → claim boundary

Figure 8.1. Application example steps

For example, when that continuation problem is identified as the burden of moving, carrying, disassembling, transporting, or reassembling the furniture, this results in breakdown pattern B8: Handling and logistics friction. For this breakdown pattern, O8 Reduce handling and logistics burden describes what the intervention should achieve. A strategy family that fits this objective is S5 Relocation & transition support.

The identification codes are retained because they enable the examples to be traced to the CFCF and are always paired with readable names.

The feasibility check should not be read as a final business case, but only asks what a furniture brand would need to be capable of to ensure the pilot is feasible, and therefore able to test and develop the smallest useful version of the intervention direction. The route continuation check is included only when the example claims continuation, repair, resale, refurbishment, redeployment or value preservation. In those cases, the furniture's final route should be recorded rather than assumed.

Application cases

Flat-pack wardrobe relocation

Relocation can trigger a breakdown in use before the wardrobe is technically unusable. The wardrobe may still function, but moving changes the context's conditions. The user has to check whether it fits the new room, disassemble it, transport it, keep the parts together and reassemble it under time pressure, without damage. When these tasks become too uncertain or demand too much effort, disposal can become the easier option.

The CFCF identifies *B8 Handling and logistics* friction as the primary breakdown pattern. The main problem is not that the wardrobe is broken. The problem is that the process of continuing use through a move is difficult. *B1 Spatial fit failure* and *B9 Deadline-pressure disposal* are secondary patterns because room dimensions and moving deadlines may still strongly affect the outcome.

This leads to *O8 Reduce handling and logistics burden* as the main intervention objective. A matching strategy family is *S5 Relocation & transition support*. This means the CFCF does not immediately route the case towards a redesigned wardrobe. It first points towards support around the moving transition.

Field	Wardrobe application
Case	Flat-pack wardrobe in a moving household
Disposal risk	A functional wardrobe may be discarded because fit (checking), disassembly, transport and reassembly become too burdensome or uncertain
Main journey stage	<i>J5 Decision activation/trigger</i> , supported by <i>J6 Route search, evaluation and selection</i>
Diagnostic signal	Moving deadline, uncertain fit new room, lost instructions or parts, concern about damage, no clear support route
Primary breakdown	<i>B8 Handling and logistics friction</i>

Field	Wardrobe application
Secondary breakdowns	<i>B1 Spatial fit failure</i> and <i>B9 Deadline-pressure disposal</i>
Main objective	<i>O8 Reduce handling and logistics burden</i>
Strategy family	<i>S5 Relocation & transition support</i>
Intervention direction	Pre-move fit audit and reassembly support
Smallest useful test	Manual continuation check with three moving households
Required capability	<i>R2 Service-ready</i> ; <i>R3 Operations-ready</i> only if physical disassembly or reassembly support is added
Current fit	Stretch for a product-only brand; more suitable if planning, customer support or assembly service already exists
Infrastructure need	<i>P1 Simple support infrastructure</i> , or <i>P2 Coordinating infrastructure</i> if a service partner is involved
Dominant bottleneck	Timing and trust
Route continuation check	Required, because the example claims continued use after relocation
Key assumption	Households will use support early enough to affect the decision to keep or discard

Figure 38: Wardrobe application example card

The proposed intervention direction is to offer a *pre-move fit check and reassembly support*. A furniture brand could help users check whether the wardrobe fits in the new room, provide a disassembly sequence, identify critical fasteners or parts, and suggest how modules could be recombined. A physical assembly service could be added later, but the first version should remain informative to keep the test small.

The smallest useful test is a manual continuation check with three moving households. Users would provide the current dimensions of the wardrobe and of the new room. They could receive a short fit assessment, a disassembly and reassembly checklist, and a follow-up after moving. The test should record whether the wardrobe was reassembled and used, adapted to another room, transferred, stored, disposed of or unknown.

Although relocation support appears to be the clear intervention direction to minimise disposal risk, key uncertainties remain and need to be addressed. The uncertainties are whether the household receives support and is made aware of its availability early enough, and trusts it enough to influence the decision, and need

to be addressed because users may seek help too late, doubt whether the wardrobe will survive the relocation, or prefer replacement if the support seems inconvenient.

Sofa repair and aesthetic renewal

The sofa case shows how repair challenges and style mismatch may reinforce each other, making the item less desirable. This may be caused by visible wear, stains, sagging cushioning, or an aesthetic mismatch, making it unwanted even though the sofa is still functional. Although maintenance, repair, or an aesthetic refresh may be possible, the user may not know what can be repaired, what it will cost, whether the result will look good, or whether replacement is simply easier, because the routes may be unclear or uncertain.

The CFCF identifies *B7 Care, repair, and upgrade friction* as the primary breakdown pattern. The main problem is not only that the sofa looks worn, but also that it is. The problem is that repair or renewal requires too much effort, cost uncertainty, or trust from the user. *B4 Aesthetic and identity obsolescence* is a secondary pattern because appearance can strongly affect replacement pressure. *B11 Value-recovery uncertainty* is also relevant because the user must assess whether repair or renewal is worth the investment.

This leads to *O7 Lower care, repair and upgrade effort* as the main objective. The matching strategy family is *S4 Repair, care & part replacement*, supported by *S3 Aesthetic renewal system*. The resulting direction is not a full sofa-service model. It is a narrow renewal and repair assessment offer that can be tested on one sofa model.

Field	Sofa application
Case	Worn but functionally and structurally usable upholstered sofa
Disposal risk	The sofa may be replaced because visible wear, reduced comfort or style mismatch make repair feel too uncertain or effortful
Main journey stage	<i>J3 Mismatch emergence / recognition</i> , supported by <i>J4 Coping / deferral</i> when repair is postponed
Diagnostic signal	Worn upholstery, sagging cushions, unclear repair cost, uncertain partner availability, uncertain result quality
Primary breakdown	<i>B7 Care, repair and upgrade friction</i>
Secondary breakdowns	<i>B4 Aesthetic and identity obsolescence</i> and <i>B11 Value-recovery uncertainty</i>
Main objective	<i>O7 Lower care, repair and upgrade effort</i>

Field	Sofa application
Strategy family	<i>S4 Repair, care & part replacement</i> , supported by <i>S3 Aesthetic renewal system</i>
Intervention direction	Single-model cover or cushion renewal offer with a repair triage
Smallest useful test	Present (ten) sofa owners with replacement, renewal and repair-partner options
Required capability	<i>R2 Service-ready</i> and <i>R3 Operations-ready</i> , <i>R1 Product-ready</i> if covers or cushions are not yet replaceable
Current fit	Adapt for most product-only brands; more suitable for brands already offering covers, parts or service support
Infrastructure need	<i>P2 Coordinating infrastructure</i> , including parts, partner coordination and fulfilment
Dominant bottleneck	Acceptable balance between price and perceived value
Route continuation check	Required, because the example claims continued use through repair or renewal
Key assumption	A meaningful share of owners will consider repair or renewal if the offer is easy to understand, trusted and clearly preferable to replacement

Figure 39: Sofa application card

The proposed intervention direction is a *single-model sofa renewal offer*. A brand could test a photo-based condition check, one replacement cover option, one cushion-refill option and referral to one repair or upholstery partner. This keeps the direction specific enough to test without turning the example into a complete circular PSS concept.

The smallest useful test would present (ten) sofa owners with three options: replace the sofa, order a cover or cushion renewal, or use a repair partner. The test should record which option they choose or seriously consider, why they choose it, what price they feel is acceptable, and how much effort they expect. This would clarify whether repair or renewal can become clearer and more attractive than replacement.

The main bottleneck is how the balance between cost and value is perceived. Whenever renewal is seen as too expensive compared with buying a new sofa, users may be likely to opt for replacement, and when the outcome is uncertain, they may also lack trust in the renewal route. The route continuation check should therefore record whether repair or renewal was completed, whether the sofa stayed in use, and what happened if repair was rejected.

This example demonstrates how the CFCF can translate a combination of several considerations, such as repair effort, aesthetic relevance, and value assessment, into a single intervention direction. However, it does not prove that customers will pay for the offer or that the service is viable.

Chair buy-back and take-back

The non-upholstered chair case tests route accessibility and the consistency of route outcomes in a furniture category with a high potential for material impact. A chair may still be usable, but become unwanted, redundant, or not worth selling from the user's viewpoint. In such cases, continuation often breaks down because there is no clear, trusted, low-effort route.

The CFCF identifies *B10 Lack of attractive continuation routes* as the primary breakdown pattern. The user needs a route that requires less effort and is at least as reliable as disposal. *B11 Value-recovery uncertainty* is a secondary issue because factors such as value estimation, eligibility, final value, and destination influence whether the route is perceived as worthwhile and trustworthy.

This leads to *O10 Make continuation routes accessible* as the main objective, with a matching strategy family being *S7 Take-back, return & intake*. In this case, *S7* covers route entry, such as value estimation, eligibility, product return, assessment, acceptance, and rejection. *S8 Refurbishment & redeployment* starts only after acceptance, when the chair is cleaned, repaired, resold, redeployed, or directed to another second-life option. This distinction is important because collecting a product alone does not prove that any form of continuation will occur.

Field	Application
Case	Simple non-upholstered chair entering a buy-back or take-back route
Disposal risk	A usable chair becomes unwanted or redundant, while resale value and final route are unclear
Main journey stage	<i>J6 Route search, evaluation and selection</i> , supported by <i>J7 Execution and hand-over</i>
Diagnostic signal	The user needs to know whether the chair acceptance conditions are, what it is worth, how it must be returned and what happens afterwards
Primary breakdown	<i>B10 Lack of attractive continuation routes</i>
Secondary breakdown	<i>B11 Value-recovery uncertainty</i>
Main objective	<i>O10 Make continuation routes accessible</i>
Strategy family	<i>S7 Take-back, return & intake</i> , followed by <i>S8 Refurbishment & redeployment</i> only after acceptance
Intervention direction	Buy-back with return value estimation, acceptance conditions, product return checklist, assessment by staff, store credit and route outcome tracking

Field	Application
Smallest useful test	Single store or city pilot for one chair category, e.g., a pilot testing the return and route outcome tracking of (50) chairs.
Required capability	<i>R3 Operations-ready</i> for assessment, storage and resale <i>R2 Service-ready</i> for value estimation and customer communication
Current fit	Actor with returns and resales; stretch for a product-only brand
Infrastructure need	<i>P2 Coordinating infrastructure</i> , including return location, condition grading, storage, resale channel and fallback-route registration
Dominant bottleneck	Economics of product return and trust
Route continuation check	Required, because the example claims possible resale, redeployment or value retention
Key assumption	Users will return chairs that meet the return conditions when the value, conditions, and destination are clear

Figure 40: Chair application card.

The proposed intervention direction is a *return pilot for one chair model, in a single store or city*. A brand could test: online value estimation, return conditions guidance, product return checklists, return assessments by staff, store credit, and route tracking for both accepted and rejected chairs. It is crucial to track both accepted and rejected items, or else the route may appear circular at the time of collection, even though the actual outcome is still unknown.

The smallest useful test could track 10 or 50 returned chairs within a single product category. The test should record value estimation requests, chairs brought in, reasons for acceptance and rejection, final value, time until resale, fallback route, and customer feedback. This would show whether the route is clear enough for users and whether the brand can manage assessment, storage, resale and fallback.

The main bottlenecks are compensation and trust in the process surrounding product return. When the compensation is experienced as too small, users may be discouraged from participating. Inconsistent or unclear assessment may lower the credibility or trust in the route. Practicalities such as limited storage or processing capacity may also limit the acceptance of returns. These issues do not make the intervention or approach unsuitable, but they provide insight into which questions may need to be addressed in the initial tests.

This case illustrates why a circularity claim requires evidence of what actually happens after the route is executed, and clarifies the distinction between *S7 Take-back, return & intake* and *S8 Refurbishment & redeployment*. *S7* is focused on how the item enters the route, whereas *S8* focuses on what may happen after acceptance.

Case comparison

The case comparison shows how the CFCF process can be applied to varied furniture cases while keeping a consistent evidence-to-direction structure. Each case leads to a different combination of journey stage, breakdown pattern, intervention objective, strategy family, capability need and main bottleneck. This makes the framework logic visible across the selected cases, while also showing that the resulting direction depends on the detail and reliability of the case evidence.

Comparison field	Wardrobe relocation	Sofa repair / renewal	Chair take-back
Main disposal risk	Moving, fit and reassembly burden	Worn appearance, repair effort and uncertain value	No attractive route and unclear value
Main journey stage	<i>J5 Decision activation / trigger</i>	<i>J3 Mismatch emergence / recognition</i>	<i>J6 Route search, evaluation and selection</i>
Primary breakdown	<i>B8 Handling and logistics friction</i>	<i>B7 Care, repair and upgrade friction</i>	<i>B10 Lack of attractive continuation routes</i>
Supporting breakdowns	<i>B1 Spatial fit failure; B9 Deadline-pressure disposal</i>	<i>B4 Aesthetic and identity obsolescence; B11 Value-recovery uncertainty</i>	<i>B11 Value-recovery uncertainty</i>
Main objective	<i>O8 Reduce handling and logistics burden</i>	<i>O7 Lower care, repair and upgrade effort</i>	<i>O10 Make continuation routes accessible</i>
Main strategy	<i>S5 Relocation & transition support</i>	<i>S4 Repair, care & part replacement</i>	<i>S7 Take-back, return & intake</i>
Supporting strategy	<i>S1, S2 or S6 only if product adaptation or guidance is needed</i>	<i>S3 Aesthetic renewal system; S6 Product passport & continuation guidance if value clarity is needed</i>	<i>S8 Refurbishment & redeployment only after acceptance</i>
Intervention direction	Pre-move fit audit and reassembly support	Single model renewal offer and repair triage	Value estimation, acceptance, product return, assessment and route tracking
Required capability	<i>R2 Service-ready; possibly R3 Operations-ready</i>	<i>R2 Service-ready and R3 Operations-ready; possibly R1 Product-ready</i>	<i>R3 Operations-ready and R2 Service-ready</i>

Comparison field	Wardrobe relocation	Sofa repair / renewal	Chair take-back
Infrastructure need	<i>P1 Simple support infrastructure or P2 Coordinating infrastructure</i>	<i>P2 Coordinating infrastructure</i>	<i>P2 Coordinating infrastructure</i>
Dominant bottleneck	Timing and trust	Price-value balance	Economics and trust of product return
First test idea	Three moving households	Ten sofa owners	Return pilot for 10 chairs
Route continuation evidence	Continued or adapted use must be confirmed	Completed repair and retained use must be confirmed	Accepted and rejected routes must be tracked
Main limitation	Interpretation of evidence	Cost and willingness still need testing	Existing route may not transfer to other brands

Figure 41: Case comparison

The cases demonstrate how the CFCF can be applied across different furniture cases, and also show its limits. The same process can route different cases to different breakdowns, and towards different intervention directions. At the same time, the strength of each output still depends on the quality and availability of the evidence for each case, as clearly demonstrated by the outputs from the CFCF application examples, which all show a strong link to the initial breakdown. This suggests that strong evidence may lead to strong, relevant outputs, whereas weak or limited evidence may result in less reliable and relevant outcomes.

Implications for validation

The application examples provide concrete input for evaluating the logic behind the CFCF, which may be done with intended users or experts, but does not validate the CFCF directly. Table 8.6 illustrates how the *application* examples can be used to evaluate the CFCF logic. The application examples show what the framework can produce when applied to three different cases, but validation is still needed to determine whether intended users can understand the process, follow the reasoning, assess feasibility, recognise the limitations, and use the output as a starting point for circular PSS development.

The actual validation will focus on the CFCF itself, not only on its logic or on proving the impact that the intervention directions may have. It will evaluate whether the process is understandable, traceable, and useful for early decision-making. Whether the directions become successful later depends on brand decisions, capabilities, customer responses, and the outcomes of continuation routes, which are outside the scope of the application examples.

Application output

Wardrobe: relocation-support direction with scenario-based evidence

Sofa: repair and renewal direction with a price-value bottleneck

Chair: return route with S7/S8 boundary and route continuation requirement

CFCF evaluation question for chapter 7

Can users explain why handling and logistics friction leads to relocation support, and can they recognise the evidence limitation?

Can practitioners judge whether the direction is actionable and identify which assumptions need testing?

Can users distinguish product return from actual continuation after acceptance?

Figure 42: CFCF-logic evaluation using application examples

Validation

Detailed validation criteria and evidence rules

Detailed criteria and claim boundaries

Criterion	Minimum evidence for Supports
Practice need and support gap	Before CFCF exposure, a relevant practitioner describes a concrete continuation decision, its consequence, the current approach and an important missing form of support.
CFCF desirability	After exposure to or use of the exact version, an eligible participant identifies a case, decision and use condition; compares the CFCF with current or alternative practice; states a conditional preference; and explains why its value justifies the effort.
User and role fit	The participant's responsibilities, knowledge, information access and decision involvement match the demands of the tested task.
Purpose and boundaries	The participant can explain the purpose, intended users, output chain and material non-claims without substantive correction.
Content clarity	Each tested question, explanation, category, option or output can be understood and applied without interpretive clarification or answer supply.
Content relevance and proportionality	Following a relevance and redundancy probe, an eligible participant explains how the tested content supports the decision and identifies no material irrelevant, repetitive or disproportionate burden.
Content completeness	Following an omission or counter-case probe, an eligible practitioner or expert identifies no material missing question, condition, option or input for the CFCF's bounded purpose.
Content accuracy and evidential credibility	Relevant expertise and, where needed, source checking indicate that the content is not materially false or misleading and that its basis, qualifications and uncertainty are defensible.
Content consistency	An active comparison of connected components finds no material contradiction, unintended duplication or meaning drift.
Input answerability	Required information can be supplied, obtained from a realistic source or contributor, or recorded as a bounded assumption or unknown.

Process flow	The tested route reaches its agreed stopping point with the required intermediate outputs and handoffs, without avoidable repetition, unresolved blockage or substantive researcher rescue.
Process logic	The participant can explain how the connected steps form a coherent route from the case problem to the bounded intervention direction, without a material unsupported jump.
Reasoning traceability	The evidence, assumptions and material judgements behind the selected direction can be followed through the connected outputs.
Reasoning credibility	A suitably experienced reviewer explains why the reasoning is defensible, identifies its evidence basis and remaining uncertainty, and finds no unresolved material contradiction.
Decision usefulness	Compared with current practice, the participant identifies a specific difference associated with using the CFCF and explains how it helps a concrete decision.
Actionability	The output and participant explanation specify a next bounded action or decision, responsible owner, required contributors and material preconditions without substantive researcher completion.
Test structure	The plan states the riskiest assumption, test object, actor and task, evidence or metric, minimum evidence or threshold, and decision rule.
Test value	A relevant practitioner or expert explains why the proposed test is a proportionate way to reduce the most important uncertainty and how different results would affect the decision.
Use conditions	Observed and reported evidence identifies the material requirements for information, expertise, time, ownership, upkeep, workflow integration, collaboration, interface operation and facilitation, including who or what must provide them.
Interface usability	Evidence from the exact interface supports the named claim about understanding, navigation, control, data entry, revision, feedback or error recovery. The claim matches whether exposure was participant-operated, facilitated, researcher-operated or expert-inspected.

Participant & session overview

Alias	ID	Professional role	Session type
Expert 1	E1	Ecodesign and furniture-sector expert; research/consultancy practitioner	Expert interview
Expert 2	E2	Furniture-sector sustainability and innovation advisor	Expert interview
Expert 3	E3	Circular value-chain transition practitioner with a strong focus on the furniture sector	Expert review
Expert 4	E4	Founder of a digital platform for circular-continuation routing	Expert review
Expert 5	E5	High-academic in the area of sustainable design; expert in sustainable-design methods and their integration into practice	Expert review
Practitioner 1	P1	Founder and product developer at sustainable furniture brand	Practitioner interview
			Practitioner review
Practitioner 2	P2	Furniture designer and developer at <i>front-running</i> circular furniture brand	Practitioner interview
			Practitioner user-test

Practitioner 3	P3	Sustainability and business-development practitioner at furniture brand and manufacturer	Practitioner user-test
Practitioner 4	P4	Circular interior designer and circularity advisor at <i>front-running</i> circular interior brand	Practitioner review
UX/UI 1	UX1	Digital product strategy and design practitioner	UX/UI-focus user-test
Pilot 1	PL1	Design research practitioner	Pilot (case-focus)

Validation texts

CFCF value and use conditions

The CFCF was considered by some participants to be a more accessible, time- and cost-efficient tool for faster and clearer decision-making than current practices and alternatives (E3:1; P1:1), although the follow-up survey rated its added value relative to time and effort only partly (S1:1). Its value may be further supported by making the consequences of continuation routes visible (P4:5, 6). However, its usefulness depends on several use conditions (P3:1; P2:2; E5:1, 2; E4:1). Participants and experts mentioned that effective use of the CFCF depends on the prepared information, relevant contributors, time, workflow and organisational ownership (P3:1; P2:2; E5:1, 2; E4:1). Furthermore, a practitioner suggested that the circular maturity of the organisation may also determine the CFCF's value (P1:2, 3). reviewer also suggested that advanced circular organisations might experience less additional value, and that the CFCF may be most valuable for 'middle group' organisations that want to improve but still need structure, according to the practitioner (P1:2, 3).

Purpose and scope

During testing, it became clear that the framework's purpose, contribution, intended user, and goal of the resulting output were not naturally and consistently understood from interacting with the CFCF (E3:2; E5:3, 4, 5; P3:2; PL1:1, 2; UX1:1, 2), although the purpose, intended user and expected output were rated fully clear (S1:1). The purpose and explanation of the CFCF as a method were not included in the tested prototype (UX1:2). Therefore, it was not yet clear to the participants that the CFCF method is adaptable to one's preferences, for example by extending the process of selecting a preferred direction with additional brainstorming, despite the possibility for custom inputs being available (P2:3). On top of that, the socio-contextual contribution needs clearer positioning alongside

technical lifetime-extension methods, since technical solutions initially predominated during an expert review whereas the CFCF focuses on relocation, aesthetics, and context (E5:6).

User fit and collaborative use

Some participants deemed the value of the CFCF to be dependent on both the users' roles and expertise (E3:1; P1:2; E4:2; P2:2). Concrete suggestions to use the CFCF with a team, or with multiple actors, rather than alone were also made (P2:2; P3:1). Team value is recognized for three reasons: First, one participant explained that, given their existing expertise, they did not expect to use the CFCF alone but saw greater value in using it as team preparation or a pre-workshop tool (P2:2). Ideation or brainstorming ranked first, lightly guided individual use second and workshop preparation third, while team use ranked fifth (S1:2). The second reason is that the CFCF improves credibility, especially for complex cases (P3:1). Such cases require preparation, stepwise and collaborative use, which the CFCF can facilitate according to a participant (P3:1). The third and last reason is to improve input answerability (P2:4; P3:3; E4:3).

Input answerability

Although the participants were able to fill in the information asked for in the framework, participants (furniture brand practitioners, actors, and experts) described feeling a need for other organizational owners, or actors, to be able to properly fill in some inputs asked (P2:4, 5; P3:3, 4; E4:3). The findings suggest that furniture brands may need input from product-design, customer-facing, sustainability and after-sales roles because these actors hold different information about consumer discard risks and feasible continuation responses (P4:1). Nonetheless, an expert stated that adjacent actors or experts are unlikely to be able to substitute for the intended users (furniture brands) (E4:2). Another participant also questioned whether the amount of detail was necessary or answerable (P2:4). Besides, another participant sometimes found the level of detail which was expected to be provided unclear (UX1:3).

First-use clarity and support

Apart from input answerability, other characteristics of the CFCF may also have urged considering team- or facilitated-use (P3:5). As suggested by UX1, practitioners reported a higher first-use threshold because of the language and terminology level used in the CFCF (UX1:4). Most participants were able to self-complete the CFCF with little assistance (PL1:3), while confusion-free progression through the steps was rated only partly (S1:1).

Content depth and relevance

The expert on methods underscored the terminology burden (E5:7). However, they also pointed out that removing detail and simplification might lead to reduced usefulness, and that therefore, the CFCF must balance low effort with sufficient depth (E5:8). One participant even mentioned to think this overall quantity of substantive information is not inherently excessive for a serious company session, despite the demanding language (PL1:4).

Stepwise process and comparison

One practitioner even explicitly valued the extensiveness and completeness of the stepwise process/route (P1:4). Additionally, another practitioner described the broad structure as insight/opportunity generating, after use (P2:6). Overall, participants positively evaluated the stepwise progression and felt like it made the problem smaller, more concrete, and more credible (PL1:5; UX1:5; P3:1). The smaller steps in the 'define' phase of the CFCF facilitated active comparison (PL1:6; UX1:6). Rather than a reason to remove options, the hesitations between alternatives in these comparisons were considered productive and insightful, even leading

one participant to question who the problem owner of the breakdown was (PL1:7; UX1:7), alongside a suggestion for a more mind-map-like setup with greater exploration before narrowing (S1:3).

Content gaps and reasoning risks

However, the comparisons also brought to light that the clarity of some of the content, such as the differentiation between options, in this case strategies, needs to be improved (P2:7; E5:7). The example cases included in the CFCF also show that some differentiation within the content, for example product families, and elaborating on this differentiation is desired, and may benefit the CFCF (P2:1, 8; E5:9). Another finding suggests that continuation routes should be grounded in the actual furniture and available evidence (P4:7). Route comparisons may be more useful when they show what they are based on, how certain they are, and how continuation compares with the household's realistic alternative (P4:3, 4). Furthermore, one participant described that the visibility of the interacting system of elements, such actors, products, infrastructure, communication, etc. that shape continuation could be improved (P2:9; E4:4). Additionally, an expert questioned whether selecting only a few strategies can cause other relevant breakdowns to be overlooked (E3:3). This links to an important pitfall of the CFCF: quality of the outcome is heavily dependent on the quality of the input, since weak input and assumptions, and credible-looking suggestions can lead to self-confirming or reinforcing recommendations (P3:4).

Process logic and credibility

The expert on methods supported the diagnosis of the problem before selecting an intervention as sound logic that improves the reasoning credibility (E5:10). To build on that, the framework's credibility could be strengthened by making its relationship to established methods more visible, since recognised methods tend to appear more credible than methods that seem to stand alone (E5:5). More specifically, the journey mapping would be more credible when it is clearly linked to the literature supporting it (E5:11). A practitioner recognised that starting from the user and continuation situation was how sustainability leaders should think (P1:5). Another finding further suggests that the CFCF's added value may lie in connecting existing methods and evidence rather than duplicating them (P4:2).

Decision usefulness and outcomes

Across all CFCF user-tests, participants developed several useful directions, access insights, or first-step outcomes, although these varied in assistance and setting (P3:3, 6; UX1:8; P2:10). One participant developed a more easily moveable wardrobe direction and a low-fidelity relocation test (UX1:8). In another session, repair capacity already existed, but the participant identified that customers still lacked a clear way to find and access it (P3:3, 6). In a third test, despite not being the final outcome, the CFCF process led a participant to develop the idea of a lower-cost cover direction (P2:10).

First-test quality and actionability

The first-test in the CFCF was recognised to make the process substantially more concrete (P1:6), while the resulting plan was rated largely clear (S1:1). However, across multiple sessions, a flaw in the formulation for this first-test became apparent (P2:11; PL1:8; P3:7). When the main uncertainty/assumption was not addressed by the participants, facilitator assistance or participant critique then helped redirect it, after which the test became more useful (P2:11; PL1:8; P3:7). Furthermore, in addition to including time, cost, and required expertise estimates, the value, actionability, and credibility of the CFCF may also benefit from providing more insights into what the effects and counter-effects are of the continuation mechanism on the value for the actor(s) and households (P1:7; E3:4).

Lastly, to improve the CFCF's usefulness, the UX/UI-focused test suggested including the functionality to export a PDF documentation of the process, which was then included in the following tests (UX1:9). On the contrary, a practitioner suggested that concise insights may be more actionable than a long standard report (P2:12).

Interface usability

Overall, the findings regarding usability are mixed and depend on who operated the CFCF (P2:13; P3:5; PL1:9, 10; UX1:10). The interface was reviewed as structured and logical by some participants, but it was also experienced as difficult to judge due to a lack of visual focus, linked to the display of too much simultaneous (textual) information, and weak hierarchy (E4:5; UX1:10; P2:13). Participants appreciated the CFCF navigation, images, and controls that show additional information (PL1:10). Although the controls to show details were rarely used, other optional interface elements, such as suggestions provided based on previous inputs, were explicitly appreciated and used by some, while others noticed them but preferred to ignore them, as was revealed in a post-use question (UX1:11).

Expert 3

Expert review

- 1.**Specific summary:** CFCF effort needs a legible decision benefit. The expert suggested faster choice/design processes as a potential reason for a company to use the CFCF.
- 2.**Specific summary:** The walkthrough did not immediately communicate user and use moment. The expert initially interpreted the CFCF as a consumer-facing manufacturer app and needed clarification that the furniture company analyses consumer relinquishment risks.
- 3.**Specific summary:** Coverage before prioritisation may be insufficiently visible. The expert questioned why users select a few disposal reasons instead of checking all, then accepted focused attention but warned of overlooking a relevant issue.
- 4.**Specific summary:** A continuation direction needs an organisational-value mechanism and counter-effect. The expert developed examples involving adaptation/service transactions, customer contact, future-fit products, and marketing value, while warning that longer life may reduce replacement sales.

Expert 4

Expert review

- 1.**Specific summary:** The expert described potential organisational value through upsell, maintenance or service revenue and retained customer contact, and said that economic value should be visible.
- 2.**Specific summary:** The expert explicitly limited their user-fit judgement. They could not judge whether the content met retailer or manufacturer needs because these were not their roles.

- 3.**Specific summary:** Assessment remains hybrid and information is distributed. Image analysis is supplemented by consumer questions about smoking/animals, recipient-defined criteria, driver review, live capacity, and sales feedback.
- 4.**Specific summary:** Downstream capability changes the realised proposition and value. The expert contrasted direct thrift-store resale with cleaning or light repair and a refurbished resale proposition.
- 5.**Specific summary:** The expert said the interface looked calm and the steps felt logical, while the amount of text made content hard to judge quickly and the process potentially complex.

Expert 5

Expert review

- 1.**Specific summary:** Route/actor requirement: continuation through resale/refurbishment needs an identifiable receiving actor and an economic chain covering transport, inspection, repair, quality assurance and resale.
- 2.**Specific summary:** Workflow-integration condition: co-creation, mapping a company's existing design process and inserting small high-leverage interventions were advised as adoption-supporting conditions.
- 3.**Specific summary:** Sellers on an online marketplace were interpreted as the intervention target rather than an information source.
- 4.**Specific summary:** Purpose/boundary challenge: the oral explanation did not clearly distinguish a decision framework from take-back, repair, refurbishment guidance or product redesign.
- 5.**Specific summary:** Method-lineage challenge: the executed explanation made the CFCF sound insufficiently grounded in established methods; adapting recognised methods was presented as more credible.
- 6.**Specific summary:** The expert repeatedly translated socio-contextual disposal into technical product-lifetime-extension practices rather than relocation, aesthetics or context mechanisms.
- 7.**Specific summary:** Terminology challenge: breakdown was interpreted as physical breakage rather than disposal risk.
- 8.**Specific summary:** Simplicity/rigor tension: companies prefer simple, low-effort tools, but excessive simplification can remove usefulness.
- 9.**Specific summary:** Established-method relevance: the expert linked exposed examples to durability, repair, maintenance, disassembly, upgrade, refurbishment and remanufacturing.
- 10.**Specific summary:** Process support: diagnosis before intervention was explicitly supported as avoiding premature problem assumptions.
- 11.**Specific summary:** Literature-to-journey mapping was considered credible when agreement and translation are demonstrated.

Practitioner 1

Practitioner review

- 1.**Paraphrase:** According to the participant, Circo Tracks offers comparable workshops but requires substantially more time and cost, often one or two days.
- 2.**Paraphrase:** Most companies are unlikely to engage with this, while front-runners may. The participant considered their organisation already advanced in this area and therefore expected less added value.
- 3.**Paraphrase:** The participant suggested that middle-group organisations may benefit most, while lagging organisations may be less likely to want the approach.
- 4.**Quote:** ‘Ik ben ervan onder de indruk van hoe uitgebreid het stappenplan is.’
- 5.**Paraphrase:** The participant considered the user-oriented approach logical for their organisation and not unique among sustainability leaders in the furniture sector.
- 6.**Quote:** ‘Goed dat het concreet wordt met de pilot-test opzet.’
- 7.**Quote:** ‘Er worden in organisaties vaak kritische vragen gesteld ... over kennis, kosten, en tijd.’ ‘[Maak] inschatting ... van tijd, kosten, en benodigde expertise.’ ‘Hoe activeer je vervolgens een meubelbedrijf om dit te gaan doen?’

Practitioner 2

Practitioner interview

- 1.**Quote:** “dat voor een kast, een tafel of een soft seating... dat het zo anders is... dat systeemdenken... per productreeks te doorgronden... per productreeks toespitst op wat waardevol is.”

Practitioner user-test

- 2.**Specific summary:** The participant would not personally use the tool as a deeply embedded solo expert, while seeing plausible value as a simpler pre-workshop or team aid.
- 3.**Specific summary:** Premature convergence: despite existing three-mechanism/three-direction/custom options, the participant experienced the route as moving too quickly from problem to solution and wanted explicit comparison/divergence.
- 4.**Specific summary:** Input granularity challenge: Product architecture and maturity prompted questions, and the participant judged some requested detail excessive.
- 5.**Specific summary:** System conditions: data/timely customer reach was selected as the central bottleneck, with traceability, collection points, shared intake and logistics as supporting conditions.

- 6.**Specific summary:** Perceived relevance: the participant called the structure broad and insight-generating and said it could alert companies to product/service continuation opportunities.
- 7.**Specific summary:** Two strategy options were experienced as more overarching, and one required explanation; their time horizon and level of detail were unclear.
- 8.**Specific summary:** An option initially appeared cabinet-specific. After upholstery examples were introduced, the participant recognised its broader application.
- 9.**Specific summary:** The participant described continuation as interacting levers across product, service, communication, logistics and suppliers and wanted the dependencies to be visible.
- 10.**Specific summary:** While discussing interchangeable upholstery covers, the participant developed a design-respectful, lower-cost cover or jacket idea and said the route brought that budget alternative to mind.
- 11.**Specific summary:** First-test value/limit: the participant redirected the proposed setup toward customers who reject reupholstery because of price and named price, design and comfort dimensions, but owner, threshold and adapt/park/reject rules were incomplete.
- 12.**Specific summary:** The participant considered insight or attention points more useful than a long standard report.
- 13.**Specific summary:** Text/visual challenge: the experience was too text-based and deep; the participant wanted more visual examples and a faster card-like interaction.

Practitioner 3

Practitioner user-test

- 1.**Specific summary:** Use-condition signal: early-stage, multi-actor, facilitated use with prepared inputs, plainer language and one step at a time was judged more credible than individual self-use.
- 2.**Specific summary:** The participant initially interpreted the outcome as supporting data-driven furniture design. After the intended product was clarified, the participant described cross-stakeholder comparison as valuable.
- 3.**Specific summary:** Repair-route mechanism: retailer mediation can obscure or discourage repair; the participant described information, parts and instructions as a practical access bottleneck.
- 4.**Specific summary:** Reasoning-credibility challenge: weak or assumed inputs can be followed by plausible suggestions that reinforce the starting belief; missing input readiness and evidence ownership undermine credibility.
- 5.**Specific summary:** Usability/process challenge: the participant said the interface was extensive, terminology difficult and self-completion likely to fail without facilitation.

- 6.**Specific summary:** The participant-owned pivot: the back-end repair route was considered substantially available, while consumer-facing information and activation were seen as the nearer-term leverage point.
- 7.**Specific summary:** Test-method challenge: the simulated label/registration concept combined spontaneous repair consideration, information seeking, discovery, comprehension and willingness to act; the participant noted it would not establish whether repair is worth the effort.

Practitioner 4

Targeted practitioner interview and post-explanation concept review

- 8.**Specific summary:** Relevant design, technical, impact and customer information may be distributed across roles, so information ownership and final decision responsibility should be distinguished (analytical synthesis).
- 9.**Specific summary:** The CFCF may add value by connecting existing methods and case evidence rather than duplicating specialist work (co-produced finding).
- 10.**Specific summary:** Differences in calculation methods and baselines suggest that route consequences should state their basis, assumptions, evidence status and uncertainty (practitioner issue; CFCF implication analytically formulated).
- 11.**Specific summary:** A reported reuse-versus-new case suggests that continuation options should be compared with the credible alternative on cost, effort and environmental consequence (practitioner case; analytical domestic transfer).
- 12.**Specific summary:** After the CFCF was explained, visible financial and environmental consequences were considered a potential source of decision value, without demonstrating use or adoption (assisted value judgement).
- 13.**Specific summary:** After explanation, the CFCF was considered potentially useful for explaining and justifying continuation decisions, although no output or customer response was reviewed (assisted value judgement).
- 14.**Specific summary:** Continuation route selection should begin with the actual furniture and available case evidence before a preferred new concept is developed (practitioner principle; analytical domestic transfer).

UX/UI 1

UX/UI-focused user-test

- 1.**Specific summary:** Orientation/example boundary: before task zero, the example was treated as the task case, and later the participant still lacked a clear account of framework purpose.
- 2.**Specific summary:** Purpose/use boundary: the participant needed clarification that the framework is a method rather than an answer generator; expected value and output needed clearer pre-use communication.
- 3.**Specific summary:** Step 1 answerability was affected by the expected level of detail, changing context and an initial capability assumption; clarification was required.

- 4.**Specific summary:** Advanced academic wording raised the perceived expertise threshold for a first-time user.
- 5.**Specific summary:** Structured-reasoning support: participant said the route made a problem smaller, stepwise and more concrete and helped develop an intervention direction.
- 6.**Specific summary:** In Step 2, the participant inspected multiple journey stages, wrote case-specific notes and selected one, but required clarification about exploring several options versus final convergence.
- 7.**Specific summary:** In Step 3, the participant compared multiple breakdowns and raised a useful person-versus-product continuation question, but required clarification about secondary-selection limits.
- 8.**Specific summary:** Participant-generated direction: the participant developed a more moveable/modular wardrobe and a low-fidelity relocation test, then identified infrastructure/logistics constraints.
- 9.**Specific summary:** Structural traceability was complete, but the final output was experienced mainly as a return of participant inputs rather than a concise, decision-ready communication result.
- 10.**Specific summary:** Too much simultaneous information, weak visual hierarchy, duplicative right-panel content and no dominant focus were reported.
- 11.**Specific summary:** Visible suggestions were noticed but not relied upon; the participant followed their own reasoning.

Pilot 1

Pilot (case-focused)

- 1.**Specific summary:** Orientation purpose challenge: participant did not understand what “process” referred to and later still described Orientation as unclear.
- 2.**Specific summary:** Step-output distinction: retrospective feedback placed the strongest confusion around Step 6 and the distinction between feasibility, Opportunity Brief and pilot test outputs.
- 3.**Specific summary:** The Step 5 shortlist and ranking were largely participant-owned, although abbreviations caused friction.
- 4.**Specific summary:** Density/language boundary: academic English and codes required rereading, but the participant did not consider the total information amount inherently excessive for a serious company session.
- 5.**Specific summary:** Final-output support: participant valued progression from problem to direction to test and regarded it as a concrete first step.
- 6.**Specific summary:** For the breakdown comparison, spatial fit and low adaptability were selected with participant-owned comparison and rationale.
- 7.**Specific summary:** Hesitation across possible intervention objectives in Step 4 was experienced as useful reflection, not a reason to reduce options.
- 8.**Specific summary:** Step 8 test weakness: participant designed a stated-intention survey with a 300/500 threshold, while also debating a connector/reassembly prototype; the result was traceable but not the smallest observable uncertainty-reduction test.

9. Specific summary: The participant mistook displayed example or static content for their own input and required clarification.

10. Specific summary: Top-to-bottom numbered navigation and detail controls were described as clear; images and bold card text supported journey and case comprehension.

Survey 1

Anonymous follow-up survey

A brief self-reported questionnaire filled in anonymously by one of the practitioners who did a full user test. Completed after earlier CFCF user test, this brief retrospective self-report is not an independent participant, session, usability test, or representative survey result. The exact CFCF version judged is unresolved.

All the questions and answers were translated from Dutch to English.

S1:1 - Survey ratings

To what extent did the tool (CFCF) meet the following criteria?

#	Evaluation statement	Rating
1	Added value compared with normal practice, considering the required time and effort	Partly
2	Clarity about what the CFCF does, who it is intended for, and what it does or does not deliver	Fully
3	Ability to progress through the steps without unnecessary confusion or becoming stuck	Partly
4	Clarity and logic of how the case information and choices led to the final result	Largely
5	Fit, accuracy and completeness of the questions, options and outcomes for the case	Largely
6	Clarity of the next decision or action	Largely
7	Clarity of the first uncertainty to investigate, the test approach and the conditions for continuing, adapting or stopping	Largely

S1:2 - Preferred-use ranking

For which type of use do you consider the CFCF most suitable?

Rank the options from “most suitable” to “least suitable.”

Rank	Preferred use
1	As an ideation or brainstorming aid
2	Used by one person with light guidance
3	As preparation for a more extensive workshop
4	Used independently by one person
5	Together with a team
6	As a reference
7	Not suitable in its current form
8	Other

No alternative/other use was supplied.

S1:3 - Improvement suggestion

What do you consider the main areas for improvement in the CFCF?

Please explain why, if applicable.

Original Dutch

Opzetten als mindmap wat input geeft aan vervolg brainstorm sessie. Meer openheid bieden voor mogelijke denkrichtingen dan proberen te snel in te kaderen.

English paraphrase

Structure the CFCF more like a mind map that supports a later brainstorming session, leaving more room to explore possible directions before narrowing.

Iteration

Value proposition canvas adaptation

Customer		v1 CFCF (aims & values CFCF currently provides)	v2 CFCF (areas that the iteration aims to improve upon)	Iteration directions
Jobs				
1. Capture value				
	Generate profit through furniture & services	Circular interventions reduce value capture through higher R&D costs and counter-effects of interventions	Circular interventions may help capture value from additional or alternative income streams	
2. Provide value				
	Design & develop furniture that people want to have/use	Support ... accessible fast traceable ... decision-making towards circular PSS directions.	Support ... understandable usable communicable testable actionable ... decision-making towards circular PSS directions.	
			Circular interventions may help differentiate products from competition	
			Circular interventions may attract new customer segment	
3. Sustainability				
	Design & develop furniture & services that meet stricter sustainability goals and/or requirements & regulation	Support substantiated decision-making towards circular PSS directions.	Support credible decision-making towards circular PSS directions.	
		Source & overview of circular continuation interventions	Provide insight into most sustainability gains per sustainability goal or intervention direction	Add relative comparison through LCA-cases
			Give out labels/certificates for (levels) of continuation achieved (also to companies who have not used CFCF)	(Free) marketing for, and awards sustainable companies -> creates point to get them in & free marketing for CFCF (if they display label, extra customer-facing sustainability visibility, can help make sustainability efforts 'measurable/comparable')
Pain				
	Pains	Pain relievers	Pain relievers	Pain relievers
1. Capture value				
	can sufficient value be captured?		Insights to be provided with intervention directions:	
	Low purchase frequency (long lifespan, luxury good)	→	How it can capture value additional/alternative value (income streams, customer journey/ touchpoints)	
	High costs (labour & material)	→	How it may reduce costs (takeback & reuse material/components/furniture, service (labour) costs through focus on disassembly/repairability/modularity)	
	Low sales volumes (high costs & large margins)			
2. Provide value				
	can sufficient customer value be captured?		Insights to be provided with intervention directions:	
	hard to differentiate in competitive market	→	How it can provide benefit/differentiation towards customer	
	Quality furniture has to compete with fast-furniture's low pricing	→	How it can save customer money long-term	
3. Sustainability				
	can sustainability goals & regulations be met?		Insights to be provided with intervention directions:	
	Improvements in sustainability may:			
	have counter-effects that reduce/limit profit (lower replacement)	→	What its counter-effects (scale) may be, how they can be mitigated, minimised, or countered	
	harder to sell because of higher prices	→	What consumer-facing communication make higher price justifiable (USP, marketing, label/certificate, etc.)	
	risks & unknowns (costs, customer, predictability, profitability, etc.)	→	Evidence/examples/data/findings/tips of cases that have successfully implemented the intervention	
	have higher R&D costs (products & infrastructure)			
	cost of operations services increase			
Gain				
	Gains	Gain creators	Gain creators	Gain creators
1. Capture value				
	Trends stimulate sales	→	Insights to be provided with intervention directions:	
	Conservative market (Little innovation; lower R&D costs)	→	How trends could be exploited to capture additional/alternative value	
	Large margins		Provide insight how more value or higher ROI can be captured through needed innovation	
2. Provide value				
	Made to order (often)	→	Insights to be provided with intervention directions:	
	Trend following can help create sales	→	How it could strengthen/lengthen customer relationship and increase touchpoints	
			Provide insight into how it can be used to capture additional/alternative value from trends	
3. Sustainability				
	Improvements in sustainability may:		Insights to be provided with intervention directions:	
	generate more sales; positive image & customer edge	→	What impact on positive image or USP may be, and how they could be improved with highest ROI (customer-facing communication/marketing, label/certificate)	
		→	Eligibility for CFCF label/certificate/level	