Paving the way towards reuse

Fostering consumer acceptance and long-term adoption of new reusable packaging systems by design

Miao, X.

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Xueqing Miao

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Dissertation

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by

Xueqing MIAO

Master of Science in Product Service System Design, Politecnico di Milano, Italy
born in Zhengzhou, China

This dissertation has been approved by the promotors.

Composition of the doctoral committee:

Rector Magnificus	Chairperson
Prof.dr.ir. R. Mugge	Delft University of Technology, promotor
Dr. L.B.M. Magnier	Delft University of Technology, copromotor

Independent members:

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Prof.dr. H.M.J.J. Snelders	Delft University of Technology, reserve member

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English Summary

Since the mid-20th century, single-use packaging for fast-moving consumer goods (FMCGs) has been valued for its convenience and practicality in modern consumption. Today, supermarket shelves are filled with products in single-use packaging — from pre-cut fruits in plastic trays and individually wrapped snacks to bottled beverages and personal care items. While single-use packaging solutions were once celebrated for their role in preservation, hygiene, and portability, they have now become one of the most pressing environmental challenges. The massive production and disposal of single-use packaging contribute to severe pollution, resource depletion, and ecological degradation. As the global crisis of waste accumulation grows, finding sustainable alternatives has never been more urgent.

Reusable packaging systems (RPSs) have emerged as a promising solution. By extending packaging lifetimes and preventing waste from entering the environment, RPSs play a crucial role in the transition from a linear economy to a circular economy. However, despite their environmental benefits, consumer acceptance and long-term adoption remain a significant challenge.

This dissertation explores how design can tackle this challenge by identifying opportunities and challenges for RPSs and developing design strategies. A mixed-methods approach is employed, integrating both quantitative and qualitative research methodologies through empirical consumer studies and design research. A consumer-centred perspective is adopted to explore what motivates and hinders consumers from adopting RPSs as an alternative to single-use packaging.

The central research question guiding this work is:

How can design foster consumer acceptance and long-term adoption of new reusable packaging systems (RPSs)?

To address this, three sub-research questions (SRQs) are explored:

1. What are the key factors influencing consumer acceptance and adoption of different RPSs?

2. How can specific design interventions address challenges in the long-term adoption of RPSs?

3. What design strategies can support the development and redesign of RPSs in design practice?

The dissertation is structured into three parts.

Part I: Identifying influencing factors.

The first part explores the factors influencing consumer perception and adoption of RPSs. **Chapter 2** uses an online survey to quantitatively assess consumer evaluation of RPSs in comparison to single-use packaging. **Chapter 3** builds on this with in-depth, semi-structured interviews in a controlled laboratory setting, where consumers physically interact with an RPS and share their opinions. The findings in Part I indicate that, while consumers generally view RPSs positively, various barriers emerge at different stages of adoption, such as contamination concerns, complexity, and practical inconvenience. Interestingly, although consumers widely acknowledge the environmental benefits of RPSs, they struggle to quantify or concretely perceive them, leading to green scepticism. Additionally, environmental benefits do not significantly drive purchasing decisions. Instead, emotional and experiential aspects, such as anticipated conscience and enjoyment, play a stronger role in motivating initial adoption. Furthermore, Part I also underscores the critical role of design in shaping consumer perceptions and behaviours – while design features such as sensory interactions (e.g., smell and sound) and practical considerations (e.g., stackability) can encourage reuse, poorly designed systems (e.g., unclear digital instructions) can complicate the reuse process, increase learning costs and discourage continued use.

Part II: Investigating design interventions.

Building on these insights, the second part of the dissertation develops two design interventions aimed at overcoming challenges in long-term adoption: lack of awareness about sufficient reuse, and negative perceptions associated with signs of use. Their effectiveness in influencing consumer behaviour is tested through experimental studies. **Chapter 4** examines the role of communicating the environmental break-even point (e-BEP), the minimum number of uses required for reusable packaging to become more sustainable than its single-use counterpart (Baird et al., 2022; Cottafava et al., 2021). The findings indicate that the effectiveness of e-BEP varies depending on consumers' prior experience with reusable packaging. Experienced consumers demonstrate increased green scepticism and reduced perceived consumer effectiveness when exposed to high e-BEP levels. In contrast, inexperienced consumers are unaffected by variations of e-BEPs. **Chapter 5** investigates whether "concealing patterns" can mitigate negative perceptions of signs of use generated on reusable packaging. The results provide empirical evidence that concealing patterns make signs of use less noticeable. However, their downstream effects on consumer perceptions are not always consistent, suggesting that concealment is not a conclusive solution. While it may maintain aesthetic appeal when directly compared to plain packaging, it cannot fully eliminate contamination concerns, which can stem from psychological mechanisms beyond visual cues, such as mental associations of prior use.

Part III: Providing design strategies.

The third part of the dissertation addresses the lack of structured design strategies for RPS innovation. **Chapter 6** introduces 20 design strategies, developed through four creative workshops with industry professionals and design students. These strategies are structured around the SHIFT framework, including social influence, individual self, habit formation, feelings and cognition, and tangibility (White et al., 2019). To facilitate practical application, **Chapter 7** translates these design strategies into a card-based design toolkit, which is tested in workshops. The design toolkit combines scientific consumer insights and serves as a structured yet flexible resource for designers and businesses, enabling them to integrate consumer-centric design solutions into RPS development. The integration of actionable design strategies with consumer insights within the toolkit is perceived as a valuable approach, as it enables designers to generate novel ideas while addressing challenges identified in scientific research.

Finally, **Chapter 8** synthesises the key findings of this research, highlights its theoretical contributions, and provides practical recommendations for designers, supply chain stakeholders, and policymakers to facilitate the widespread adoption of RPSs. It also discusses the broader role of RPSs within a circular economy, emphasising the systemic changes required for their successful implementation.

As packaging waste continuously pollutes the environment, shifting away from single-use packaging is no longer optional but a necessity. This dissertation offers valuable insights into accelerating this shift by leveraging design to drive consumer adoption of RPSs. We hope it serves as a meaningful step towards making reuse the new norm in the near future.

Nederlandse Samenvatting

Sinds het midden van de twintigste eeuw worden wegwerpverpakkingen voor fast-moving consumer goods (FMCGs) gewaardeerd om hun gemak en praktische bruikbaarheid in de moderne consumptie. Vandaag de dag liggen de schappen van supermarkten vol met producten in wegwerpverpakkingen—van voorgesneden fruit in plastic bakjes en individueel verpakte snacks tot flessen drank en persoonlijke verzorgingsproducten. Hoewel wegwerpverpakkingen ooit werden geprezen vanwege hun rol in conservering, hygiëne en draagbaarheid, zijn ze nu een van de meest urgente milieuproblemen geworden. De massale productie en verwijdering van wegwerpverpakkingen dragen bij aan ernstige vervuiling, uitputting van hulpbronnen en ecologische achteruitgang. Nu de wereldwijde afvalcrisis toeneemt, is de noodzaak van duurzame alternatieven urgenter dan ooit.

Herbruikbare verpakkingssystemen, in het Engels genoemd reusable packaging systems (RPSs), zijn naar voren gekomen als een veelbelovende oplossing. Door de levensduur van verpakkingen te verlengen en afval buiten het milieu te houden, spelen RPSs een cruciale rol in de overgang van een lineaire naar een circulaire economie. Ondanks hun ecologische voordelen blijft echter de acceptatie door consumenten en langdurige adoptie een grote uitdaging.

Deze dissertatie onderzoekt hoe design kan bijdragen aan het stimuleren van de acceptatie en langdurige adoptie van RPSs, door zowel kansen als uitdagingen te identificeren en effectieve ontwerpstrategieën te ontwikkelen. Hiervoor wordt een mixed-methods benadering gebruikt, waarbij zowel kwantitatieve als kwalitatieve onderzoeksmethoden worden geïntegreerd in empirische consumentenstudies en ontwerponderzoek. Een consumentgericht perspectief wordt gehanteerd om te onderzoeken wat consumenten motiveert of juist weerhoudt om RPSs te gebruiken als alternatief voor wegwerpverpakkingen.

De centrale onderzoeksvraag van deze dissertatie is:

Hoe kan design de acceptatie en langdurige adoptie van nieuwe herbruikbare verpakkingssystemen (RPSs) bevorderen?

Om deze vraag te beantwoorden, worden drie deelonderzoeksvragen (SRQ's) onderzocht:

1. Welke factoren beïnvloeden de acceptatie en adoptie van verschillende RPSs door consumenten?

2. Hoe kunnen specifieke ontwerpinterventies uitdagingen in de langdurige adoptie van RPSs aanpakken?

3. Welke ontwerpstrategieën kunnen worden ontwikkeld ter ondersteuning van de ontwikkeling en herontwerp van RPSs in de praktijk?

De dissertatie is opgedeeld in drie delen.

Deel één: Identificeren van beïnvloedende factoren.

Het eerste deel onderzoekt de factoren die van invloed zijn op de perceptie en adoptie van RPSs door consumenten. **Hoofdstuk 2** maakt gebruik van een online vragenlijst om kwantitatief te beoordelen hoe consumenten RPSs evalueren in vergelijking met wegwerpverpakkingen. **Hoofdstuk 3** bouwt hierop voort met diepgaande, semi-gestructureerde interviews in een gecontroleerde laboratoriumomgeving, waarin consumenten fysiek in aanraking komen met een RPS en hun ervaringen delen. De bevindingen uit Deel I laten zien dat hoewel consumenten over het algemeen positief tegenover RPSs staan, verschillende barrières zich voordoen tijdens verschillende adoptiefasen, zoals zorgen over contaminatie, complexiteit en praktische ongemakken. Interessant is dat hoewel consumenten de milieuvoordelen van RPSs erkennen, ze vaak moeite hebben om deze te kwantificeren of concreet te ervaren, wat leidt tot groene scepsis. Bovendien blijken milieuvoordelen geen doorslaggevende factor in aankoopbeslissingen te zijn. In plaats daarvan spelen emotionele en ervaringsgerichte aspecten, zoals gewetensrust en plezier, een belangrijkere rol in de eerste adoptiefase. Verder benadrukt Deel I de essentiële rol van design in het beïnvloeden van consumentengedrag—waar intuïtieve ontwerpkenmerken (bijv. geur en geluid) en praktische eigenschappen (bijv. stapelbaarheid) hergebruik kunnen stimuleren, terwijl slecht ontworpen systemen (bijv. onduidelijke digitale instructies) de leercurve verhogen en hergebruik ontmoedigen.

Deel twee: Onderzoek naar ontwerpinterventies.

In het tweede deel van de dissertatie worden twee ontwerpinterventies ontwikkeld om uitdagingen in langdurige adoptie aan te pakken: een gebrek aan bewustzijn over voldoende hergebruik en negatieve percepties van gebruikssporen. Hun effectiviteit in het beïnvloeden van consumentengedrag wordt getest via experimentele studies. **Hoofdstuk 4** onderzoekt de rol van communicatie over het milieu break-even point (e-BEP) —het minimale aantal keren dat herbruikbare verpakkingen gebruikt moeten worden om duurzamer te zijn dan hun wegwerptegenhanger (Baird et al., 2022; Cottafava et al., 2021). De resultaten tonen aan dat de effectiviteit van e-BEP-communicatie varieert afhankelijk van eerdere ervaringen van consumenten met herbruikbare verpakkingen. Ervaren consumenten vertonen een sterkere groene scepsis en een lagere perceptie van hun eigen effectiviteit wanneer ze worden geconfronteerd met hoge e-BEP-waarden, terwijl onervaren consumenten grotendeels ongevoelig blijven voor variaties in e-BEP-informatie. **Hoofdstuk 5** onderzoekt of verhullende patronen de negatieve percepties van gebruikssporen op herbruikbare verpakkingen kunnen verminderen. De resultaten tonen aan dat dergelijke patronen gebruikssporen minder zichtbaar maken, maar dat hun effect op consumentenpercepties niet consistent is. Hoewel ze de esthetische aantrekkelijkheid waarborgen, elimineren ze besmettingszorgen niet volledig, aangezien deze vaak voortkomen uit psychologische factoren en mentale associaties met eerder gebruik.

Deel drie: Ontwerpstrategieën bieden.

Het derde deel van de dissertatie richt zich op het ontbreken van gestructureerde ontwerpstrategieën voor RPS-innovatie. **Hoofdstuk 6** introduceert 20 ontwerpstrategieën, ontwikkeld via vier creatieve workshops met professionals uit de industrie en designstudenten. Deze strategieën zijn gebaseerd op het SHIFT-framework, dat zich richt op sociale invloed, individuele identiteit, gewoontevorming, gevoelens en cognitie, en tastbaarheid (White et al., 2019). Om de praktische toepasbaarheid te vergroten, **Hoofdstuk 7** vertaalt deze strategieën naar een ontwerptoolkit in de vorm van kaarten, die in workshops wordt getest. De toolkit biedt een gestructureerde maar flexibele methode voor ontwerpers en bedrijven, waarmee ze wetenschappelijk onderbouwde consumenteninzichten kunnen integreren in de ontwikkeling van RPSs.

In **hoofdstuk 8** ten slotte worden de belangrijkste bevindingen van dit onderzoek samengevat, de theoretische bijdragen belicht en praktische aanbevelingen gedaan voor ontwerpers, belanghebbenden in de toeleveringsketen en beleidsmakers om de wijdverspreide toepassing van RPS te bevorderen. Ook wordt de bredere rol van RPS binnen een circulaire economie besproken, waarbij de nadruk wordt gelegd op de systeemveranderingen die nodig zijn voor een succesvolle implementatie.

Omdat verpakkingsafval het milieu voortdurend vervuilt, is het niet langer optioneel maar noodzakelijk om af te stappen van wegwerpverpakkingen. Dit proefschrift biedt waardevolle inzichten in het versnellen van deze verschuiving door gebruik te maken van design om de adoptie van RPS door de consument te stimuleren. We hopen dat het een belangrijke stap is om hergebruik in de nabije toekomst tot de nieuwe norm te maken.

Foreword

Doing this research has often brought back nostalgic memories. When I was a kid, I had a fascination with collecting beautiful product packages and treating them as treasures. From tiny candy wrappers and cookie tins to large gift boxes, I repurposed them in many ways – some sturdy packages were turned into storage boxes, organisers, or pencil holders; cardboard with colourful illustrations was cut out for making collages; and unique packages were placed on shelves or windowsills as decorations (**Figure 1**). My parents admired my creativity in making use of waste. However, not every package found a second life, and some lay in corners. Occasionally, I was asked to sort and let useless ones go into the trash. Packages that were dented, faded, stained or dusty were usually discarded first due to their reduced functional and aesthetic value.

Back then, sustainability was not a concept in my mind. I was reluctant to throw away those packages, simply because of seeing their residual value.

Figure 1. Some packages collected in my childhood

Nowadays, as an adult responsible for my grocery shopping, I have become increasingly aware that packaging plays an important role in my daily consumption - it conveys product information, shapes my expectations, protects the contents, facilitates product usage and so on. Despite these benefits, I cannot ignore the environmental burden packaging creates. Home is like a waste processing unit, with new products coming in and empty packages waiting to be thrown out. This ongoing cycle often leaves me

frustrated. Every piece of packaging is a tangible reminder of the waste I produced, contradicting my pursuit of a sustainable lifestyle.

To ease this frustration, I save some empty packages, hoping to find a proper use for them someday (see **Figure 2**). For some light ones, like plastic trays, I feel satisfied after reusing them once more – perhaps as a desk bin. For other robust ones, like glass jars, I tried to refill them with food that can be kept for a long time.

Figure 2. Some packages currently saved at home

My conflict between discarding packages and feeling frustrated about waste is not an isolated case. You may struggle with the same conflict.

Fortunately, reusable packaging systems are reviving in the consumer market. They seem like a promising solution that can preserve packaging value within a closed-loop system and extend its lifetime through multiple uses. For consumers like me, this brings hope – a chance to reduce packaging waste in our daily consumption.

Yet, some questions are lingering in my mind: How will consumers respond to these systems that may incorporate new features? Can they truly break our ingrained throwaway habits and deliver meaningful environmental benefits? What design strategies will drive the future of reusable packaging systems?

These questions form the core of this thesis.

/ *Chapter 1* /

Introduction

With the global environmental challenges posed by single-use packaging waste, there is an urgent need to explore sustainable alternatives.

Chapter 1 introduces the growing interest of academia and industries in the transition from single-use packaging to reusable packaging systems (RPSs), highlighting the challenges and design opportunities from a consumer perspective.

1.1 Packaging in a linear economy

A world without packaging is unimaginable today. Packaging serves multiple functions, including providing efficient product storage, protection and preservation, facilitating product usage and distribution, and engaging in branding and communication (Lindh et al., 2016; Rundh, 2005). The versatility of packaging constantly enriches our experience and interactions with products. Unfortunately, most packaging is designed to be single-use and discarded once the content is consumed, thereby losing its value immediately after fulfilling its functions. For example, around 95% of plastic packaging is used only once before being discarded, with the majority ending up in landfills or leaking into the natural environment (Kleine Jäger & Piscicelli, 2021).

The packaging sector consumes 40% of plastics and 50% of paper produced (Coelho et al., 2020; Fogt Jacobsen et al., 2022). In 2022, each European citizen generated between 78.8 and 233.8 kg of packaging waste, depending on the country. The overall EU average was approximately 186.5 kg, and this number is still increasing every year (Eurostat, 2022). 'Paper and cardboard' were the main packaging waste material (40.8%) in the EU, followed by plastic (19.4%), glass (18.8%), wood (16.0%), metal (4.9%) and others (0.2%) (Eurostat, 2022). The packaging waste in total accounts for 36% of municipal solid waste (Eurostat, 2022). If no actions are taken, a further 19% increase in packaging waste by 2030 is estimated (Council of the European Union, 2024).

Single-use packaging poses a global threat to the natural environment and human health throughout its lifecycle. The production of packaging consumes significant energy and vast amounts of non-renewable resources such as petroleum (for plastics) and minerals (for metals and glass), which accelerates resource depletion (Casarejos et al., 2018). Transporting packaging from production facilities to retailers and consumers contributes to fossil fuel consumption, emitting carbon dioxide (CO_2) and other greenhouse gases. In the post-consumption phase, the massive littering and accumulation of packaging waste in the environment contaminate soil and oceans. The packaging waste degrades into microplastics and harmful chemicals, which have been found in living bodies and are related to certain cancers and decreases in fertility (Foteinis, 2020; Nihart et al., 2025; Wright & Kelly, 2017). Inadequate waste disposal practices in many regions lead to incineration, which generates significant carbon emissions and other toxic gases in the atmosphere that contribute to global warming (Casarejos et al., 2018; Gallego-Schmid et al., 2019). While plastic packaging often receives the most criticism due to its persistence in the environment and visibility in pollution, other materials like paper, glass and metal are also responsible for substantial environmental impacts.

To date, the linear model of production and consumption is clearly dominant in the packaging industry, where raw resources are extracted, processed into packaging materials, utilised briefly, and then discarded (Casarejos et al., 2018; Muranko et al., 2021). This 'take-make-use-dispose' model offers several short-term advantages. For instance, it allows for cost-effective packaging production using cheap raw materials, making products more affordable; it ensures hygiene and safety by minimising the risk

of contamination; and it also largely simplifies logistics and supply chain management, facilitating fast product distribution and protection in globalised markets (Coelho et al., 2020). However, this linear model relies on the assumption that our planet provides unlimited access to raw materials and infinite capacity to absorb waste (Cooper, 1994), which is unrealistic. Both natural resources and landfill space are finite, and waste disposal systems have their limits. With continuous population growth and ever-increasing consumption, there is an urgent need for more sustainable solutions to meet the demand for packaging.

1.2 Circular economy and its implications in the packaging industry

Addressing the packaging waste problem requires a shift from the linear model (take-make-use-dispose) to a circular model (grow-make-use-restore) (Casarejos et al., 2018). Circular Economy (CE) was introduced as an alternative of the existing linear economy, which aims to "keep products, components and materials at their highest utility and value at all times" (Webster, 2015). The fundamental notion of a CE is to close the loop where the resources are used, reused, and recycled while creating additional values throughout the multiple lifecycles (Kirchherr et al., 2017). This suggests that packaging materials should be designed for durability, reuse, and recyclability (Zhu et al., 2022), to maximise resource retention and minimise the output of pollution and waste.

In the past decades, many practical and research efforts have been put into packaging recycling. Although the recycling rate in the European Union (EU) has steadily increased, it remains at a low level (e.g., 40% for plastic packaging). Meanwhile, the total packaging consumption has been constantly growing due to retail development and the globalisation of the supply chain (Coelho et al., 2020). The current recycling systems also have some limitations. In the EU, many types of packaging are not widely recycled due to several reasons, such as the complexity of separating the layers (e.g., plastic-aluminium laminates used in food packaging), inadequate recycling infrastructure, and contamination issues (e.g., food residue on containers can contaminate paper or plastic and make them non-recyclable) (Casarejos et al., 2018). Additionally, many materials, particularly plastics, often undergo downcycling, where they are recycled into lower-quality products with diminished functionality and value compared to their original form (Casarejos et al., 2018). While recycling can partially help manage waste disposal, it does little to address waste generation. As long as the demand for single-use packaging remains high, recycling alone cannot keep pace with the growing volume of packaging waste (Zhu et al., 2022). To ensure sustainable development, it is crucial to tackle the root cause, which is our reliance on excessive production and consumption, and implement more effective solutions to reduce overall waste generation.

According to the 10R framework strategies of CE (**Figure 3**) (Potting et al., 2017), which ranks resource efficiency actions in a hierarchical order, reuse is considered more effective than recycling for waste reduction. Unlike recycling, which typically involves

material reprocessing and value loss, reuse can retain more value of the product and functionality of the material by extending its lifetime (Coelho et al., 2020).
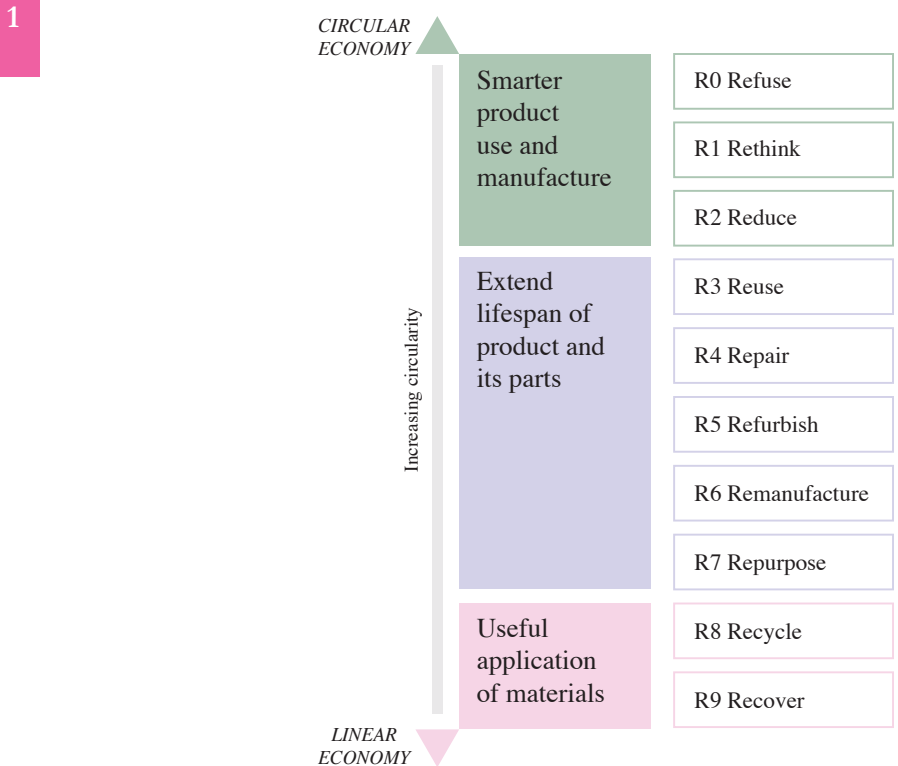
Figure 3. 10R framework strategies, adapted from Potting et al. (2017)

In the packaging domain, reusable packaging systems (RPSs) offer a promising solution for advancing circularity. The International Organisation for Standardization [ISO] defined reusable packaging as 'packaging or packaging components that have been designed to accomplish a minimum number of trips or rotations in a system for reuse' (ISO:18603, 2013). RPSs allow packaging to be reused multiple times within a closed-loop system, either by the same or different users. This approach significantly reduces the overall demand for new packaging production, maximises the value and lifespan of packaging, and helps prevent packaging waste from entering the environment (Coelho et al., 2020; Long et al., 2020; Muranko et al., 2021).

There is growing policy interest in promoting reusables to reduce overall environmental impact**.** Several European countries have implemented extended producer responsibility (EPR) schemes that include the reduction of single-use packaging (Coelho et al., 2020), and adopted national legislation to increase the use of reusable plastic with deposit return systems. The latest packaging and packaging waste regulation (PPWR) introduces binding reuse obligations and quotas to be met by 2030. The required rates vary depending on the type of packaging, with final distributors of alcoholic and non-alcoholic beverages to meet a 10% reuse quota (Council of the European Union, 2024).

In the Netherlands, the new law effective from 1 January 2024 bans on-site consumption of disposables, including both cups and any form of meal packaging (Rijksoverheid, 2024). These policies are likely to drive the development of RPSs, and push both businesses and consumers towards more sustainable practices.

In line with policies and regulations, companies have taken some initiatives. For instance, global companies (e.g., The Coca-Cola Company, Nestlé) and retailers (e.g., Walmart) have already signed up for voluntary schemes such as the New Plastics Economy Global Commitment (Ellen MacArthur Foundation, 2022), which includes targets for implementing RPSs. Efforts are put into addressing the challenges of RPSs, such as designing better infrastructures to support reuse, meeting health and safety standards, and developing profitable circular business models within RPSs (Bocken et al., 2022; Greenwood et al., 2021). However, the success of RPSs depends on their efficiency and the willingness of different stakeholders (e.g., manufacturers, retailers, and consumers) to adapt to changes in the transition from single use to reuse.

Despite efforts from different parties, failures continuously emerge in practice. Implementing RPSs requires the development of a complex ecosystem that supports collaboration, communication and coordination of various stakeholders to facilitate this system change (Bradley & Corsini, 2023; Ellsworth-Krebs et al., 2022). These requirements affect the feasibility of new RPSs. For instance, the nature of RPS is dynamic. For returnable packaging, reverse logistics is required, which means once the products are consumed, the packaging will be returned to the original node for subsequent use (Katephap and Limnararat, 2017). Additional space and labour are needed to sort and clean the packaging after use, install and operate reuse infrastructures, and communicate RPSs to consumers in the retailing context (Tenhunen-Lunkka et al., 2024). These changes reshape the traditional roles of product manufacturers as new service providers and lead to environmental and economic trade-offs from the business perspectives (Coelho et al., 2020; Tenhunen-Lunkka et al., 2024).

RPSs have also been criticised due to their potential link to other types of resource consumption (Mahmoudi & Parviziomran, 2020). Reusable packaging is typically made of resource-intensive materials to support durability and longevity, while also requiring additional energy for cleaning and transportation (Changwichan & Gheewala, 2020; Fetner & Miller, 2021; Greenwood et al., 2021). Therefore, to offset this increased resource usage, each packaging must reach its environmental break-even point (e-BEP), a minimum number of reuses after which reusable packaging is less environmentally harmful than its single-use equivalents (Cottafava et al., 2021; Du Rietz & Kremel, 2024; Greenwood et al., 2021). For example, stainless-steel containers need to be used 13 to 33 times to offset their environmental impact compared to single-use plastic alternatives (Greenwood et al., 2021). Similarly, polypropylene (PP) reusable coffee cups reach the e-BEP after approximately 50 uses when compared to PP single-use cups (Cottafava et al., 2021). In the case of carbonated soft drinks, if polyethylene terephthalate (PET) recycling rates increase to 60%, a glass bottle would need to be reused at least 20 times to achieve a comparable carbon footprint (Amienyo et al., 2013). Despite the essential

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importance of surpassing the e-BEP, it is not guaranteed that consumers will achieve this naturally.

Ensuring sufficient reuse is essential to make the CE effective in reducing the environmental impact of packaging. It not only requires technological improvements in packaging production, but also opens new opportunities for design innovations to facilitate reuse practice, as well as encourages new business models and strategies to shift consumer behaviour towards reuse.

1.3 The past and current trends of RPSs

Overall, reusable packaging is not a new concept but has historically been applied to various product categories (Coelho et al., 2020). It can be characterized by a pattern of adoption, decline, and revival driven by factors such as technological advancements, economic considerations, and environmental awareness.

1.3.1 Adoption and decline of RPSs

Reusable packaging can be traced back to ancient times, when people crafted the earliest primitive packages using natural materials, such as clay pots, wooden containers, and woven baskets (DS Smith, 2019). These early forms of packaging were not part of a system but were reused to serve the fundamental need for transporting and storing food and other products.

The first industrial revolution in the 18th century led to advancements in manufacturing, including the mass production of glass and metal containers (Risch, 2009). Packaging moved from bulk shipping containers to household-sized packages (Twede, 2016). Over time, packaging evolved from merely fulfilling practical needs to becoming integral to brand messaging and consumer experience. Packaging became a strategic advantage, with sales and advertisements of packaged products increased (Ağlargöz & Ağlargöz, 2024).

Reusable packaging became commonplace in the late 19th century. Most goods were sold with the intention that the containers could be reused (Twede, 2016). Meanwhile, home delivery was highly effective when car ownership and public transport infrastructures were limited. A notable example of RPS is the refillable glass milk bottle system, which began in the 1880s. Milk was delivered daily to consumers by the milkman, and empty bottles were collected and refilled (Vaughan et al., 2007). This model continued as a widespread practice of bottle reuse and inspired further innovations in beverage and food sectors. In the early 20th century, companies like Coca-Cola introduced refillable glass bottles with an associated deposit refund system, achieving a 96% return rate for bottles that were cleaned and reused multiple times. Beer and mineral water were traded in reusable glass bottles, and even processed vegetables were sold in reusable glass jars (FBR Sustainable Chemistry & Technology et al., 2022).

The mid-20th century witnessed the rise of plastics as a popular packaging material. The versatile characteristics of plastics, such as lightweight, hygiene and good performance in preserving products, make them impressively useful and nowadays these can be found in almost every single product (Zaman & Newman, 2021). In 1955, the concept of "Throwaway Living" was celebrated in LIFE Magazine, promoting single-use products like plastic cutlery, straws, plates, and cups (**Figure 4**). This lifestyle was highlighted for its convenience and affordability. Consumers no longer needed to clean dishes, which greatly eased the household chores.

Figure 4. Throwaway Living (Photo by Peter Stackpole ©LIFE Picture Collection)

From then on, a trend away from reusable packaging towards single-use plastics spread in all countries (Golding, 1999). By the post-1980s, packaging became increasingly tailored for specific uses. A notable example is the aseptic packaging developed by TetraPak and widely adopted in the food industry (Ağlargöz & Ağlargöz, 2024). Over time, the purchase of convenient, high-quality food in disposable packaging has become the norm in consumer markets. Gradually, packaging has evolved from a solution to a problem that raises global concerns.

1.3.2 Emergence of new RPSs in the retail context

In response to growing environmental awareness and concerns about packaging waste, there has been a resurgence of interest in reviving RPSs for FMCGs in the retailing context (Coelho et al., 2020; Muranko et al., 2021).

The Ellen MacArthur Foundation divides reuse models into four categories based on packaging 'ownership' and the requirement for the user to leave home to refill or return

the packaging, namely, refill at home, refill on the go, return from home and return on the go (Ellen MacArthur Foundation, 2019), as shown in **Figure 5**.
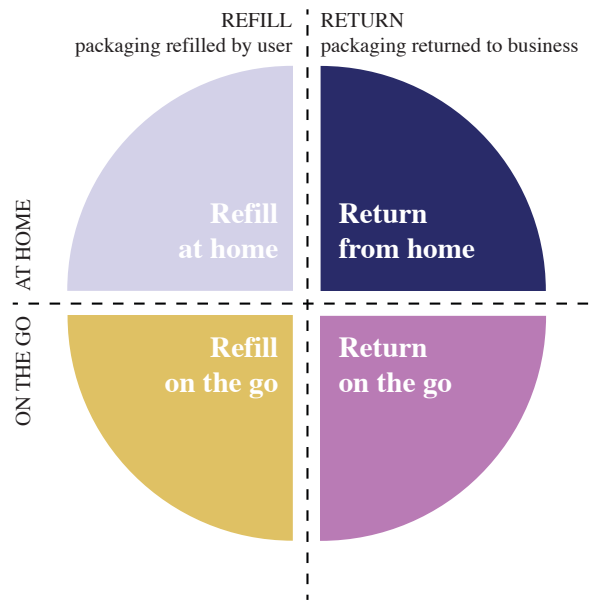
Figure 5. Four reuse models based on Ellen MacArthur Foundation

Refillable packaging systems allow consumers to refill their containers with the product of their choice. Consumers purchase a container once and then refill it with the desired product. **Refill on the go** refers to consumers refilling the packaging from in-store bulk dispensers or at a mobile truck (Coelho et al., 2020; Jiménez Romanillos et al., 2024). Shopping in packaging-free stores is also considered as using refillable packaging, as these stores usually encourage consumers to bring their containers, which they can wash, refill, and pay for by weight or volume (Ağlargöz & Ağlargöz, 2024; Fuentes et al., 2019). **Refill at home** refers to consumers making online purchases and receiving refill products (e.g., refill packs, concentrates, or tablets), which they can replenish the products at home (Tassell & Aurisicchio, 2023).

Returnable packaging systems involve the use of containers that are designed to be returned to the manufacturer or retailer after use. Consumers obtain products packaged in reusable packaging (usually with a deposit) from physical stores or online stores. After finishing the products, consumers can return the empty containers to designated collection points by themselves, which is **Return on the go**; or consumers can make an appointment wherein a company collects the packaging directly at the door, which is **Return from home**. The collection of old packages and the delivery of new ones can be combined. The collected packaging is then cleaned, sterilised, and refilled for future use (Coelho et al., 2020; Greenwood et al., 2021; Jiménez Romanillos et al., 2024).

The major distinction between refillable and returnable packaging systems is ownership of the packaging. In the case of refill models, the packaging is exclusively used and kept

by a single user throughout its lifetime. Whereas, in the case of return models, packaging belongs to the company and is sequentially used by different users (Muranko et al., 2021).

Unlike earlier RPSs, which relied heavily on manual labour and traditional materials, new RPSs have advantages thanks to material innovations, technology advancements, and new businesses. These new features provide additional value to consumers, enhance the shopping experience, and improve supply chain efficiency.

Material innovations. New RPSs move from using relatively low-value packaging materials (e.g., multi-layered plastic film) to more durable and sustainable packaging materials like stainless steel, recycled plastics, and biobased materials (Changwichan & Gheewala, 2020). An example is Dizzie, a start-up that introduced reusable packaging made of durable recycled plastic for groceries. Besides, material innovation improves packaging performance, such as a double-wall stainless steel reusable container that can keep ice cream frozen for several hours after removing it from the freezer (Mahmoudi & Parviziomran, 2020).

Technology advancements. Various digital technologies have been integrated into new RPSs, such as barcodes, QR codes, Wi-Fi, global positioning system (GPS) and radio-frequency identification (RFID) (Maleki & Meiser, 2011; Tonikidou & Webb, 2024). So far, most of these modern technologies are implemented in logistic packaging to support real-time traceability and condition monitoring at a large scale (Ellsworth-Krebs et al., 2022; Hakola et al., 2024). Potentials are also seen in RPSs for FMCGs. For instance, traceability technologies can help retailers determine affordability by measuring return and failure rates of returnable packaging and meet health and safety standards through batch coding and evidencing cleaning checks (Ellsworth-Krebs et al., 2022; Matthews & Webb, 2023). Digital technologies can also gather and provide detailed information to consumers on the environmental benefits of their choices, such as reductions in carbon dioxide emissions and energy savings through refilling their packaging (Tonikidou & Webb, 2024), which can enhance transparency and trust.

New business models. Some new business models and services have emerged to support new RPS adoption. Such as subscription models for acquiring refills via home delivery, refill stations or self-refill stores for refilling packaging with the same products after usage and take-back services that offer pickup service or drop-off locations for collecting empty packaging (Long et al., 2020; Tassell & Aurisicchio, 2023). These models largely increase the accessibility and convenience of new RPSs. Recent research suggests that four dimensions will affect a circular business model for RPSs, including consumer desirability, viability, technical feasibility, and environmental sustainability, which are crucial to scaling up reuse systems (Tenhunen-Lunkka et al., 2024).

While new RPSs hold significant potential for addressing packaging waste, both refill and return systems require consumers' active participation and behaviour change. Yet, there is limited research on how consumers respond to RPSs with new features. Little is known about whether these systems can effectively shift consumer behaviour from single use to reuse and how design can support this transition.

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1.4 Consumer reactions to new RPSs

1.4.1 Consumer acceptance and adoption of RPSs

Multiple studies highlight that while RPSs are promising, consumer acceptance and continued engagement are essential to unlocking long-term sustainability (e.g., Bradley & Corsini, 2023; Matthews & Webb, 2023). With a growing consciousness of environmental sustainability, consumer demand for less plastic and more reusable solutions is on the rise (Coelho et al., 2020; Greenwood et al., 2021; Magnier & Gil-Pérez, 2023). In general, consumers express a high willingness to adopt it (Babader et al., 2016; Greenwood et al., 2021; Magnier & Gil-Pérez, 2023). However, translating positive intentions into corresponding behaviours remains a challenge in the complexity and fast pace of daily routines (Herweyers et al., 2024). As it stands, overall consumer engagement in reuse systems remains low.

Consumer behaviours towards FMCGs are often habitual and routine-driven (Fuentes et al., 2019; Kunamaneni et al., 2019). Decisions are made quickly and automatically to maximise immediate personal benefits (Verplanken & Wood, 2006). While buying durable products, such as a car or a laptop, requires careful consideration and trade-offs, buying FMCGs, such as a bottle of shampoo or ketchup is effortless. As long as consumers are satisfied with the product that does the work, the same purchases are always made (Fuentes et al., 2019). Adopting new RPSs often disrupts ingrained consumption habits and demands consumers' initiative, additional time, and effort to form new reuse behaviour patterns. Consequently, many consumers may resist this change or rationalise that switching to reuse lacks significance unless it becomes a mainstream behaviour that many others engage in (Matthews & Webb, 2023).

Though some early adopters may have explored RPSs intentionally or incidentally, studies indicate a significant drop-off rate after initial adoption, with many consumers failing to maintain regular refills or returns (Kunamaneni et al., 2019). Consumers also exhibit divergent reuse behaviour, such as 1) accumulating multiple reusable items but failing to use or return them due to forgetfulness or lack of incentive (Bethurem et al., 2021; Tassell & Aurisicchio, 2023). For instance, consumers may own several reusable cups but not utilise each one sufficiently; 2) temporarily discontinuing reuse in favour of single-use options or using both types in parallel, often due to weak habits of reuse or the presence of readily available single-use alternatives (Tassell & Aurisicchio, 2023); and 3) discarding reusable packaging, such as food containers, when they become worn or aesthetically unappealing, even though they are still functional (Changwichan & Gheewala, 2020; Herweyers et al., 2024; Tassell & Aurisicchio, 2023).

1.4.2 Consumer motivations to adopt RPSs

When seeking effective solutions for RPSs, it is essential to consider what motivates consumers to engage with reuse options. Reusability offers an opportunity to shift consumer perceptions of packaging from merely cheap and practical to durable, long-lasting, and high-quality (Ellen MacArthur Foundation, 2019). Consumer studies

indicated that motivations to adopt RPSs can generally be divided into two categories, those that add value and those that reduce costs or waste(Lofthouse, 2007; Lofthouse & Bhamra, 2006).

Added value in RPSs can be created in many ways. First, consumers in general recognise the environmental benefits of RPSs, and they associate RPSs with positive emotions and self-satisfaction from contributing to the environment. Besides, RPSs also generate social value that consumers may feel they are setting a positive example for peers and family members by adopting more sustainable practices (De Temmerman et al., 2023b; Keller et al., 2021; Matthews & Webb, 2023). This social value is further supported by government policies against packaging waste, such as bans on single-use plastics, which heighten awareness and increase consumers' sense of responsibility (De Temmerman et al., 2023b). Furthermore, RPSs can positively influence perceptions of food quality and healthiness. Products sold in reusable packaging could be viewed as higher quality and more natural or healthy (Magnier & Gil-Pérez, 2021, 2023). Besides, consumers tend to be brand loyal. When RPSs are implemented by well-known brands, they can reinforce consumer confidence and improve brand image by signalling environmental responsibility (De Temmerman et al., 2023a; Kunamaneni et al., 2019). In addition, RPSs can enrich the shopping experience by fostering an eco-conscious retail environment through sustainable store design and dedicated displays, which can trigger positive emotions (Coelho et al., 2020; De Temmerman et al., 2023b). Moreover, new RPSs increasingly enhance the user experience by incorporating digital features such as smart recognition, automatic refilling, and home delivery and return services via mobile applications (Coelho et al., 2020; De Temmerman et al., 2023a; Herweyers et al., 2023). These features can improve convenience, support habit formation, and attract consumer adoption with RPSs.

Reduced costs and waste usually refer to financial incentives. Certain types of RPSs, such as refillable products by bulk dispensers, allow consumers to purchase only the quantities they need, thereby reducing unnecessary costs (Beitzen-Heineke et al., 2017; Herweyers et al., 2024). This customised purchase also discourages impulse buying and increases consumer appreciation for the products they purchase, thereby reducing food or product waste caused by surplus purchases (Beitzen-Heineke et al., 2017). Additionally, some RPSs offer direct financial incentives, such as discounts for consumers who bring their containers (e.g., reusable coffee cups), or impose fees on disposable alternatives (Coelho et al., 2020; De Temmerman et al., 2023a; Kunamaneni et al., 2019; Long et al., 2022). These cost structures motivate consumers to adopt reuse options through reward or penalty mechanisms. Finally, as reusable packaging generates less household waste, consumers may experience lower personal waste management costs, especially in regions where municipal waste disposal is charged by volume or frequency. This long-term financial benefit can further encourage adoption.

1.4.3 Challenges in consumer adoption of RPSs

While enablers highlight the benefits of RPSs, understanding the barriers that hinder consumer adoption is equally important to pave the way for new RPSs. As we

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demonstrated before, the environmental and financial benefits of RPSs in the long term are recognised by consumers. However, when it comes to daily practice, these enablers can be weakened by instant barriers, such as inconvenience, initial cost, and contamination concerns.

As packaging has evolved, FMCG consumers have been accustomed to a culture of convenience that comes with disposable packaging (Tassell & Aurisicchio, 2023). Existing studies have frequently indicated that RPSs are perceived as inconvenient (Beitzen-Heineke et al., 2017; De Temmerman et al., 2023a; Fuentes et al., 2019; Marken & Hörisch, 2019; Tenhunen-Lunkka et al., 2024). The inconvenience is primarily linked to access, search, and possession (Seiders et al., 2000), as well as home management.

Access convenience is often hindered by the limited availability of stores offering RPSs and the narrow product choices available in RPSs (De Temmerman et al., 2023; Singh & Cooper, 2017; Steinhorst & Beyerl, 2021). Many RPSs designed for FMCGs are restricted to niche zero-waste shops or specialised online grocery platforms and have not become mainstream with larger retailers (Kunamaneni et al., 2019; Louis et al., 2021). Some supermarkets, such as Albert Heijn in the Netherlands, Tesco in the UK, and DM in Germany, have begun partnering with reuse-infrastructure providers to implement RPSs. However, these RPSs are often in the form of a corridor section, or just a refill station alongside traditionally single-use packaging (Ağlargöz & Ağlargöz, 2024), only taking a relatively small space in the store. It is questionable whether this low level of exposure can create sufficient awareness and action. Search convenience is negatively affected by a lack of clear product and ingredient information that is often provided by conventional packaging (Louis et al., 2021); situational constraints, such as being rushed or distracted; and additional time and effort to locate RPSs in a busy supermarket (Herweyers et al., 2024; Jiang et al., 2020; Matthews & Webb, 2023; Zhu et al., 2022). Possession convenience can be hampered by the complexity of using RPSs (Fuentes et al., 2019). New RPSs often incorporate intelligent features that require digital interactions from consumers, such as scanning labels, operating digital interfaces and bulk dispensers, and using applications. Consumers may be unfamiliar with the technology integrated into new RPSs (Ellsworth-Krebs et al., 2022; Mahmoudi & Parviziomran, 2020), perceiving the system as complex to use and doubting whether it will perform as well as the solutions that they are familiar with. In addition, the inconvenience relates to home management. For instance, cleaning and collecting empty packaging are usually seen as extra hassles (Beitzen-Heineke et al., 2017; Coelho et al., 2020; Fuentes et al., 2019; Matthews & Webb, 2023). Moreover, bringing suitable types and sufficient amounts of packaging to refill or return, or arranging a pickup service for collecting empty packaging always costs extra mental and physical effort (Beitzen-Heineke et al., 2017; Fuentes et al., 2019; Matthews & Webb, 2023).

From a cost perspective, as we stated before, consumers could be motivated by buying products in customised quantities or receiving discounts in RPSs. However, the possibility of higher prices in RPSs may cause consumers to be hesitant towards accepting these alternatives (Jiang et al., 2020). In addition, consumers are typically unwilling to pay extra for using reusable packaging provided by the store (Bocken et al.,

2022; De Temmerman et al., 2023a), or are not motivated to pay an initial cost for private reusable packaging (Keller et al., 2021). Besides, RPSs are often implemented with a deposit and refund scheme. This is sometimes discouraging because consumers perceive the deposit as expensive or have concerns about losing their refund (Long et al., 2022; Matthews & Webb, 2023).

Contamination concerns pose another significant barrier, as the shared use of RPSs can raise doubts about safety and hygiene (Collis et al., 2023; De Temmerman et al., 2023; Long et al., 2022). For instance, returnable packaging is owned sequentially by multiple consumers who are provided with temporary access throughout its lifetime (Muranko et al., 2021). Consumers lack understanding of the washing process and can question the hygiene of RPSs (Jiménez Romanillos et al., 2024; Long et al., 2022). Furthermore, the frequent washing, transportation and refilling of packaging can result in flaws and stains, wear, and discolouration. Consumers can interpret this superficial damage as contamination cues that activate concerns about the health and safety of the product (Argo et al., 2006; Kunamaneni et al., 2019; White et al., 2019). The visual imperfections make packaging less desirable and can reduce reuse intentions or trigger the replacement of containers (Greenwood et al., 2021; Magnier & Gil-Pérez, 2021; Numata & Managi, 2012). However, to achieve environmental benefits, reusable packaging must reach sufficient reuse cycles before being deemed unacceptable (Baird et al., 2022).

1.4.4 Consumer characteristics as determinants of RPS adoption

Consumer responses are not always homogeneous (Herweyers et al., 2023). Some factors can be particularly relevant for certain consumer segments while being less impactful for others. This diversity helps explain why consumers may prefer different RPSs. For instance, some may choose returnable packaging to avoid cleaning, others may favour refillable options for a sense of ownership, while online alternatives may appeal to those prioritising convenience (Jiménez Romanillos et al., 2024). Therefore, understanding varied consumer characteristics and individual differences is crucial for tailoring approaches to different consumer groups.

Herweyers et al. (2023) identified four consumer segments based on their intentions and underlying motivations to avoid single-use plastics (SUP) and adopt reusable options, namely SUP addicts, SUP avoiders, the apathetic and situation-driven SUP users. Each segment exhibits distinct behavioural patterns and barriers. SUP addicts heavily rely on SUP and are least motivated to change their habits; SUP avoiders are strongly committed to reducing SUP usage and actively seek out reusable alternatives driven by their **green self-identity** (i.e. the extent to which people perceive themselves as green consumers) and **environmental concern** (i.e. the extent to which people are aware of and concern environmental problems); the apathetic SUP users show little motivation to alter their SUP habits, often due to a lack of awareness or environmental concerns; and situation-driven SUP users are open to change but make choices based on situational factors like availability or convenience.

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Similarly, Temmerman et al. (2023) defined three clusters of consumers who are likely to adopt reuse options: Proximity Shoppers (36%), who prioritise convenience and accessibility and typically seek nearby stores that offer reuse options, often with less focus on product quality or shelf life; Quality and Health Seekers (27%), who prioritise product quality, naturalness, and healthiness, often driven more by product attributes than environmental considerations; and Minimal Waste Buyers (37%), who desire to reduce packaging and food waste but may not consistently align their intentions with actions, requiring support and strategies to facilitate their engagement.

Some individual differences also influence consumers' intention to adopt RPSs. **Disgust sensitivity** is associated with consumer willingness to reuse packaging (Baird et al., 2022). For instance, consumers who have low disgust sensitivity are more willing to eat or drink from dirty-look reusable containers (Baird et al., 2022). Consumers with high disgust sensitivity showed heightened hygienic concerns about cross-contamination from shared usage or accessed-based service (Hazée et al., 2019; Wallner et al., 2023). Disgust can be triggered by seeing superficial imperfections on reusable packaging, spillage, and others' improper use behaviour (Baird et al., 2022; Collis et al., 2023; Long et al., 2022; Magnier & Gil-Pérez, 2021; Matthews & Webb, 2023).

Prior experience also shapes consumer perceptions and initial engagement with RPSs. Previous research in other domains has shown that experience can impact consumers' acceptance (Lo et al., 2019), consumers' perception of barriers (Silva et al., 2021), and consumers' trust and repurchase intention (Zaid, 2020). While studies suggested that consumers who have performed reuse behaviours are more likely to adopt reusable packaging (Greenwood et al., 2021; Kunamaneni et al., 2019), a recent qualitative study highlighted that consumers who had prior experience with reusable packaging reported more practical barriers (e.g., limited choices, lack of product information) than inexperienced consumers, who indicated more risk-related barriers (e.g., uncertainty about quality and taste traits, hygiene concerns) (De Temmerman et al., 2023a).

These findings suggest that a one-size-fits-all strategy is unlikely to be effective due to the diverse challenges and differences among consumers. Effective design strategies for RPSs should be tailored to the target groups. For instance, for consumers who recognise environmental benefits provided by reusable packaging and actively seek such options (Herweyers et al., 2024; Lofthouse, 2007), increasing accessibility of RPSs and offering personalised reusable alternatives that signal green self-identity might be attractive (Herweyers et al., 2024). In contrast, for those consumers who lack motivation or environmental concerns, strategies that reshape perceptions, normalise reuse, and enhance the desirability of RPSs may be more effective. Understanding these characteristics provides essential insights, guiding the tailored design interventions and strategies.

1.5 The need for design innovation in RPSs

The transition to RPSs requires more than improving the collection and sorting systems; it necessitates a fundamental redesign of the packaging system to facilitate reuse.

Existing literature has identified some design considerations for RPSs, mainly suggesting that functionality, aesthetics, and convenience are likely to influence consumer adoption of RPSs (e.g., Bradley & Corsini, 2023; Kunamaneni et al., 2019).

Functionality. The functionality of reusable packaging is influenced by material choice, packaging format, and performance. For example, durable materials like glass are preferred by consumers due to their recyclability and robust nature compared to more fragile films, flexible plastics, or foils (Greenwood et al., 2021; Kunamaneni et al., 2019). Some light and flexible materials (e.g., silicone), are also becoming popular for reusable food storage due to their durability, flexibility, and heat resistance. As for packaging format, a recent study has shown that consumers are more inclined to reuse jars (36%), bottles (20%), and boxes or cartons (23%), compared to wraps (2%), cans (3%), and aerosols (4%). It also found that consumers are willing to reuse packaging with lids and dispensers as closure mechanisms due to their good resealability (Greenwood et al., 2021). Besides, stackable, and foldable designs, such as refill pouches or collapsible containers, offer practical solutions, which are ideal for home storage and on-the-go usage (Karmarkar & Bollinger, 2015).

Aesthetics. The visual appeal of reusable packaging plays a significant role in consumer engagement. Research suggests that attractive, well-designed packaging fosters emotional attachment, encouraging consumers to integrate RPSs into their daily routines (Ertz et al., 2017b; Kunamaneni et al., 2019). Besides, branded reusable packaging may benefit from designs that incorporate familiar brand aesthetics as this will foster consumer trust and ease of adoption, whereas unfamiliar designs need to offer additional benefits (Kunamaneni et al., 2019). A challenge in reusable packaging aesthetics is maintaining an appealing appearance over multiple reuse cycles. Consumers are often reluctant to reuse packaging that shows visible wear, discolouration, or surface imperfections, as these flaws trigger concerns and reduce perceived product value (Baird et al., 2022; Magnier & Gil-Pérez, 2021). To address this, it is important to select materials that are scratch-resistant or can age gracefully (Collis et al., 2023; Greenwood et al., 2021; Lilley et al., 2019; Tenhunen-Lunkka et al., 2024). However, while aesthetic designs may increase engagement, they may also lead consumers to keep packaging at home rather than return it, which contradicts the purpose of returnable packaging systems.

Convenience. Convenience is one of the strongest determinants of RPS adoption, as consumers prioritise convenience over sustainability considerations in the retail context (De Temmerman et al., 2023b; Kunamaneni et al., 2019). Existing studies have frequently indicated that RPSs are perceived as inconvenient (Beitzen-Heineke et al., 2017; De Temmerman et al., 2023a; Fuentes et al., 2019; Marken & Hörisch, 2019; Tenhunen-Lunkka et al., 2024). Design should thus simplify return and refill processes. One approach to improving convenience is the integration of Product-Service Systems (PSSs), which combine physical products with service-based solutions to create accessible and efficient reuse models (Long et al., 2020). For example, automated bulk dispensing systems in retail settings allow consumers to purchase and store products in customisable quantities without additional tools (Beitzen-Heineke et al., 2017;

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Herweyers et al., 2024). Subscription-based refill models allow consumers to receive pre-filled reusable containers and ensure a continuous supply of products (Tassell & Aurisicchio, 2023). In return models, companies retain ownership of packaging and manage cleaning and redistribution, ensuring that consumers can always access hygienic and high-quality packaging (Greenwood et al., 2021; Kuzmina et al., 2019; Mahmoudi & Parviziomran, 2020). The associated deposit-return scheme can be enhanced by a digital tracking system to offer incentives or provide refill notifications to motivate reuse (Ellsworth-Krebs et al., 2022; Heeremans, 2025). By expanding drop-off networks, integrating returns with existing retail systems, and enabling pick-up service, companies can make RPSs more practical and convenient for everyday consumer use.

Although existing research has provided some directions for improving RPSs, most suggestions remain scattered across emerging academic studies, often lacking guidance on how to implement in practice. Besides, most research has primarily explored consumer preferences for well-established reusable packaging formats, such as returnable beverage bottles and reusable coffee cups (Greenwood et al., 2021; Herweyers et al., 2024; Novoradovskaya et al., 2021), less attention has been given to explore new designs for RPSs.

Design as a tool is said to be adaptive, resilient, and transformational, but design thinking approaches cause business strategy and innovation to be much more human-centric (James et al., 2019). Several recent studies have proposed new concepts aimed at enhancing RPSs through design elements. These include digital product passports to enhance supply chain transparency (Ellsworth-Krebs et al., 2022), environmental communication (e.g., reductions in CO_2 emissions, water, and energy savings) and safety information to encourage reuse behaviour (Tonikidou & Webb, 2024), and digital integration in reuse systems across different shopping contexts (Matthews & Webb, 2023). While these insights contribute valuable knowledge, they only highlight a fraction of the design potential for RPSs, many more opportunities should exist.

To drive widespread adoption and behaviour change, it is crucial to equip designers with clear insights into promising directions for RPS designs. Further exploration of design opportunities and development of design strategies for RPSs would be valuable.

1.6 Research objectives and questions

The primary objective of this thesis is to explore how to foster consumer acceptance and long-term adoption of new RPSs by design. By integrating empirical consumer studies and design research, this work provides new insights and practical solutions.

The central research question guiding this thesis is:

> **How can design foster consumer acceptance and long-term adoption of new reusable packaging systems (RPSs)?**

To answer this central research question, the thesis is divided into three parts, each corresponding to a sub-research question (SRQ).

In Part I '**Identifying influencing factors'**, consumers' responses to new RPSs are explored through quantitative and qualitative approaches, aiming to provide an overview of influencing factors that can be leveraged by design. The first SRQ is formulated accordingly:

SRQ 1: What are the key factors influencing consumer acceptance and adoption of different RPSs?

In Part II '**Investigating design interventions'**, two different design interventions aiming to promote long-term adoption are created and tested. Mixed-method approach is used to evaluate their effectiveness with qualitative insights. The second SRQ is formulated accordingly:

SRQ 2: How can specific design interventions address challenges in the long-term adoption of RPSs?

In Part III '**Providing design strategies'**, 20 design strategies are developed through workshops with industry practitioners and design students. These strategies were then translated into a card-based design toolkit, and its applicability was tested through two workshops. The third SRQ is formulated accordingly:

SRQ 3: What design strategies can support the development and redesign of RPSs in design practice?

1.7 Thesis outline

The remainder of this thesis is organised into six chapters under three main parts, followed by a general discussion and conclusion.

Part I   Identifying influencing factors

Despite growing interest in RPSs, their success depends on consumer adoption. While RPSs offer various benefits to consumers, there are also challenges hindering their long-term adoption. To date, research on consumer perceptions and behaviours towards different RPSs remains limited.

Part I (Chapters 2 and 3) addresses this gap by examining consumer responses to various RPSs through quantitative and qualitative approaches.

Chapter 2 investigates consumer perceptions of two types of RPSs – refillable and returnable packaging systems – compared to single-use packaging. An online experiment with Dutch consumers (n=250) examines how consumers perceive three benefits (environmental benefits, anticipated conscience, and enjoyment) and three risks (performance risk, contamination risk, and complexity) associated with each packaging type. Additionally, the study also explores how these perceptions influence purchase intentions of RPSs.

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Chapter 3 delves deeper into consumers' reactions, perceived enablers, and barriers towards RPSs. A qualitative approach was employed, using in-depth semi-structured interviews with Dutch consumers (n = 27) who interact with a physical refillable packaging system in the lab setting. Follow-up phone interviews further capture insights into consumer behaviour at home.

Together, these studies address **SRQ1** by providing a comprehensive understanding of consumer perceptions regarding different RPSs. The insights can inform companies, designers, and policymakers on how to leverage enablers (or benefits) and mitigate barriers (or risks) to facilitate a wide adoption of RPSs.

Part II   Investigating design interventions

RPSs only become less environmentally harmful than single-use after each packaging is reused a minimum number of times, which is defined as the environmental break-even point (e-BEP) (Cottafava et al., 2021). A lack of awareness about this threshold can lead to insufficient reuse, undermining the environmental potential of RPSs. Furthermore, repeated use often results in visible signs of wear and tear, which may negatively affect consumer long-term adoption (Baird et al., 2022; Collis et al., 2023; Magnier & Gil-Pérez, 2023). Thus far, little research has explored design interventions to tackle these issues and encourage sufficient reuse.

Part II (Chapters 4 and 5) examines the effectiveness of two design interventions for refillable and returnable packaging systems, respectively. Both interventions aim at addressing specific challenges and encouraging long-term adoption of RPSs.

Chapter 4 sheds light on how communicating the e-BEP on refillable packaging influences consumer intention to reuse through green scepticism and perceived consumer effectiveness. A mixed-method approach consists of an experiment with four e-BEP conditions (absent, low, medium, and high) followed by open-ended questions. A post-test (N=208) further examines how prior experience with reuse influenced consumer perceptions.

Chapter 5 investigates whether 'concealing patterns' can mitigate the negative associations with signs of use on reusable packaging. Through three online studies (N=121, N=78, N=154, respectively) integrating quantitative experiments and qualitative insights, this study provides an initial understanding of implementing concealing patterns to improve consumer acceptance of reusable packaging.

These two studies address **SRQ2** by demonstrating how targeted design interventions can tackle specific challenges to encourage sufficient reuse over time, outlining benefits and potential drawbacks.

Part III   Providing design strategies

Design has the potential to address challenges in RPSs through providing novel solutions. Yet, existing research lacks comprehensive design strategies tailored specifically for RPSs.

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Part III (Chapters 6 and 7) aims to offer actionable design strategies and tools for future development of new RPSs.

Chapter 6 outlines the development of design strategies for RPSs. We conducted four workshops with practitioners (N=15) and design students (N=10), collecting a large number of potential design ideas for RPSs. Through a thematic analysis following a mixed inductive-deductive approach, these ideas are developed into 20 design strategies for consumers' continued usage of RPSs, fitting in the five overarching themes proposed by the SHIFT framework (White et al., 2019). These findings can inspire future research and the development of RPSs.

Chapter 7 translates all design strategies into a user-friendly, card-based design toolkit, named 'RePacKit'. This chapter details the iterative process of toolkit development, demonstration, and evaluation through two workshops with design students (N=13), and subsequent improvements made based on feedback. We envision this design toolkit as an inspirational resource for designing new RPSs.

These two studies address **SRQ3** by offering actionable design strategies for practitioners. The toolkit supports innovation in new RPSs and the redesign of existing ones to foster consumer acceptance and long-term adoption of RPSs.

This thesis concludes with a discussion and conclusion in **Chapter 8**, which reviews all research findings and answers the research questions. After that, the key contributions and implications of this PhD research are presented. This chapter ends with reflections on limitations and potential avenues for future research.

The outline of the thesis is illustrated in **Figure 6**.

Main Research Question:

How can design foster consumer acceptance and long-term adoption of new reusable packaging systems (RPSs)?

Chapter 1
Introduction

Chapter 2
Developing reusable packaging for FMCG: Consumers' perceptions of benefits and risks of refillable and returnable packaging systems

Chapter 3
Switching to reuse? An exploration of consumers' perceptions and behaviour towards reusable packaging systems

Part I
Identifying influencing factors

SRQ 1: What are the key factors influencing consumer acceptance and adoption of different RPSs?

Chapter 4
How many times should I use my reusable packaging? Exploring the role of an environmental break-even point in shaping consumers' intention to reuse

Chapter 5
Out of sight, out of mind? Investigating how concealing patterns mitigate consumer negative perceptions of reusable packaging with signs of use

Part II
Investigating design interventions

SRQ 2: How can specific design interventions address challenges in the long-term adoption of RPSs?

Chapter 6
Design strategies for consumers' continued usage of reusable packaging systems

Chapter 7
Let's RePacKit! Development and evaluation of a design toolkit to support consumers' sustained use of reusable packaging systems

Part III
Providing design strategies

SRQ 3: What design strategies can support the development and redesign of RPSs in design practice?

Chapter 8
Discussion and Conclusion

Figure 6. The outline of the thesis

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PART I

IDENTIFYING INFLUENCING FACTORS

Part I examines consumer responses to various RPSs through quantitative and qualitative approaches, and answers SQ1:

What are the key factors influencing consumer acceptance and adoption of different RPSs?

/ *Chapter 2* /

Developing reusable packaging for FMCGs: Consumers' perceptions of benefits and risks of refillable and returnable packaging systems

While theoretical and practical advancements have underscored the environmental potential of RPSs, achieving widespread consumer adoption remains a critical challenge.

Chapter 2 examines two distinct RPS models (i.e. refillable and returnable packaging systems) designed for fast-moving consumer goods. Specifically, we investigate consumers' perceptions of several benefits and risks associated with RPSs compared to single-use packaging. Additionally, we explore how these perceptions influence their purchase intentions. The results provide insights into how RPSs can be improved to enhance consumer adoption and contribute to a more sustainable society.

2.1 Introduction

Since the mid-20th century, single-use packaging has been widely embraced by consumers for its convenience, affordability, and versatility in protecting products (Rundh, 2005; Zaman & Newman, 2021). However, the widespread adoption of single-use packaging has resulted in a pressing global issue: a continual increase in packaging waste. Despite ongoing recycling efforts, around 35% of packaging waste is still incinerated, landfilled, or ends up in oceans (Eurostat, 2022). Besides, while recycling can partially help manage waste disposal, it requires additional energy and contributes to greenhouse gas emissions. As long as the demand for single-use packaging remains high, recycling efforts are insufficient to keep pace with the growing volume of packaging waste (Zhu et al., 2022). There is a need for effective solutions that can address waste generation at its source.

According to the zero-waste hierarchy for a circular economy, reuse retains more of a product's value and material functionality over multiple lifecycles, making it more effective in reducing waste than recycling (Coelho et al., 2020). Within the packaging industry, reusable packaging systems (RPSs) have emerged as a promising alternative to single-use packaging, which consist of long-lasting packaging designed for multiple uses within a closed-loop system. RPSs can be broadly divided into two categories (Greenwood et al., 2021; Muranko et al., 2021): (1) returnable packaging systems, where consumers buy pre-filled products and return empty packaging after use, which is then cleaned and refilled by suppliers for the next user, and (2) refillable packaging systems, where consumers bring their own packaging or use brand-specific packaging to refill products by themselves.

RPSs are particularly gaining traction in the fast-moving consumer goods (FMCGs) sector (Muranko et al., 2021), where products are frequently purchased at relatively low cost and consumed rapidly to meet daily demands (Kuzmina et al., 2019). However, RPSs nowadays often come with new features, requiring consumers to engage with reuse-enabling infrastructures, such as in-store dispersers, mobile refill stations, collection points, and deposit-refund systems (Coelho et al., 2020). The success of RPSs will depend on active consumer adoption, which is a challenge given that single-use packaging is highly aligned with consumers' current preferences. To date, there is limited research on whether consumers appreciate RPSs as an alternative to single-use packaging, and how different types of RPSs influence their evaluations.

This research addresses these gaps by examining consumers' perceived benefits, risks, and purchase intentions associated with RPSs in comparison to single-use packaging. Specifically, we investigate and compare attitudinal and behavioural responses to two distinct RPSs - refillable and returnable packaging systems - designed for two product categories (shampoo and ketchup). Moreover, we identify key predictors of purchase intentions for these two RPSs (among the factors we tested). By uncovering these insights, this research contributes to the literature on consumer perceptions of RPSs and offers practical suggestions for designers and practitioners to improve RPSs.

2.2 Theoretical background and hypothesis development

The theoretical framework of the current study is based on the widely used consumer decision-making model (EKB model). This model outlines five key stages of the consumer decision-making process: need recognition, information search, evaluation of alternatives, purchase, and post-purchase behaviour (Engel et al., 1968). Among these stages, the evaluation of alternatives is pivotal, as it involves consumers' subjective comparison of the benefits and risks associated with different options before arriving at a final purchase decision on the product alternative (Mugge et al., 2017).

This study focuses on this stage to better understand how consumers evaluate RPSs in comparison to single-use packaging. The investigation of perceived benefits and risk is one of the key research topics in the consumer behaviour domain (Zeng & Durif, 2019). Our study draws upon the theory of perceived risk (Mitchell, 1992) to investigate the extent to which RPSs (i.e. refillable and returnable packaging) differ from single-use packaging. To determine the potential perceived benefits and risks related to RPSs, we examined literature from related fields, including consumer evaluation of sustainable packaging, access-based services, and circular products.

2.2.1 Perceived benefits related to the adoption of RPSs

Single-use packaging contributes to global environmental issues like littering, resource depletion, and CO_2 emissions (Casarejos et al., 2018; Kleine Jäger & Piscicelli, 2021; Moretti et al., 2021). With the growing awareness of environmental protection, consumers are shifting their attitudes and behaviours, and their demand for sustainable packaging alternatives is on the rise (Accorsi et al., 2020; Choi et al., 2021; Ferrara et al., 2020; Jain & Hudnurkar, 2022). Previous studies suggest that sustainable packaging, which are designed to reduce material use and waste, have a positive effect on consumer perceived environmental benefits (Magnier & Crié, 2015; Monnot et al., 2015; Wang et al., 2021). RPSs can reduce demand for raw materials, retain the functionality of packaging, and prevent waste generation (Coelho et al., 2020; Muranko et al., 2021), which has been suggested as a more environmentally friendly alternative (Cottafava et al., 2021; Gallego-Schmid et al., 2019). It is likely that consumers recognise the environmental potential of RPSs in comparison to single-use packaging. Correspondingly, we expect that:

> **H1a:** The perceived environmental benefits of RPSs (both refillable and returnable) are higher than those of single-use packaging.

Sustainable actions (e.g., using products made from recycled materials or driving an electric car) often evoke a sense of moral satisfaction, enhancing consumers' belief that they are making responsible choices (Magnier et al., 2019; Rezvani et al., 2017; Venhoeven et al., 2020; Welsch & Kühling, 2011). This is reflected in the concept of anticipated conscience, which refers to consumers' expectation that using a product will evoke positive moral emotions (Magnier et al., 2019). By adopting sustainable

alternatives, consumers align their behaviour with broader societal goals of transitioning towards a circular economy (Lindh et al., 2016; Zhu et al., 2022). As a result, they may anticipate a sense of moral satisfaction from adopting RPSs, knowing that their choices will contribute to environmental sustainability. Moreover, the anticipation of positive moral emotions, such as pride and satisfaction from choosing sustainable options, strongly predict pro-environmental behavioural intentions (Rezvani et al., 2017; Venhoeven et al., 2020). Compared to the habitual disposal of single-use packaging which results in a large volume of waste, RPSs offer a proactive way for consumers to reduce packaging waste. Given the active engagement required in refilling or returning packaging, RPSs are likely to heighten anticipated to a greater extent. Hence, we hypothesise that:

> **H1b**: Consumers experience greater anticipated conscience when using RPSs compared to single-use packaging.

When evaluating a product, consumers do not assess it only based on utilitarian value but also expect to obtain enjoyment from using this product (Sweeney & Soutar, 2001). Sustainable products, particularly those that introduce novel experiences, tend to evoke enjoyment in the consumption experience (Ali & Bodur, 2020; Choi & Johnson, 2019; Rapp et al., 2017). Besides, enjoyment has been found to positively influence pro-environmental behaviours, such as recycling and purchasing sustainable products (Choi & Johnson, 2019; Rapp et al., 2017). In this study, we define enjoyment as the hedonic pleasure, excitement, and engagement that consumers obtain from using RPSs. Unlike single-use packaging displayed on the shelves, RPSs offer more interactive shopping experiences with reuse-enabling infrastructures, which may enhance enjoyment. For example, refilling own containers may feel more exciting than simply picking up a pre-packaged product, while collecting and returning packaging for reuse may provide a higher level of engagement in sustainable practice than disposing of empty packaging after each use. Correspondingly, we expect that:

> **H1c:** Consumers get more enjoyment from using RPSs than that from single-use packaging.

In summary, the adoption of RPSs may be positively influenced by perceived benefits, such as environmental benefits, anticipated conscience, and enjoyment. While RPSs offer considerable benefits to consumers, they also present potential risks that may hinder consumer adoption.

2.2.2 Perceived risks related to the adoption of RPSs

According to the EKB model, perceived risks during the evaluation phase are likely to hinder the decision on an offer (Engel et al., 1968; Mitchell, 1992).

RPSs are regarded as a product-service system; instead of simply selling a product, they offer consumers a service to refill or return their packaging (Long et al., 2020). Many refillable and returnable packaging systems require consumers to interact with an in-store infrastructure to obtain the product. Thus, the system performance is essential for

consumers to adopt this innovative solution. Performance risk refers to concerns about whether a product or service can perform correctly as expected, fulfil consumers' needs, and deliver the promised benefits (Keh & Pang, 2010). In the context of RPSs, consumers may worry whether refill and return infrastructures are functional and efficient. For instance, refill stations with digital mechanisms may experience technical malfunctions, incorrect product dispensing, or payment processing errors. Similarly, deposit-refund systems may fail to recognise packaging or delay refunds, leading to frustration and discouraging consumer engagement.

Furthermore, prior research highlights a significant relationship between performance risk and product complexity (Trattner et al., 2019). RPSs often require consumers to independently engage with new technologies and processes, such as scanning (electronic) labels, operating bulk dispensers, and sometimes navigating digital apps for tracking and managing packaging usage (Ellsworth-Krebs et al., 2022; Mahmoudi & Parviziomran, 2020; Matthews & Webb, 2023). While these technological features are designed to enhance efficiency and facilitate management, they can introduce layers of complexity. According to Rogers' diffusion of innovation theory (Rogers, 2003), complexity refers to the degree to which an innovation is perceived as difficult to understand or use. Innovations with higher perceived complexity tend to experience slower adoption rates, as consumers may struggle with new behaviours, interfaces, or additional cognitive effort required for usage (Claudy et al., 2015). In the context of RPSs, if consumers perceive unfamiliar reuse-enabling infrastructures as complicated or inconvenient compared to the straightforward, habitual use of single-use packaging, it will create barriers and lead to consumer rejections. Therefore, we assume that:

> **H2a:** Consumers perceive RPSs (both refillable and returnable) to have higher performance risk than single-use packaging.

> **H2b:** Consumers perceive RPSs (both refillable and returnable) to have higher complexity to use than single-use packaging.

Another risk that may be especially important for RPSs is contamination, which can arise when consumers perceive that an object has been in physical contact with someone else and could transfer germs or residue (Nemeroff & Rozin, 1994). Single-use packaging is often valued for preventing physical contact with other consumers, ensuring the contents are hygienic and safe for consumption (Lindh et al., 2016; Rundh, 2005). In contrast, RPSs operate similarly to access-based services (ABS), in which packaging or associated infrastructure is temporarily accessed and repeatedly handled by multiple users (Muranko et al., 2021). Prior research has shown that ABS can evoke contamination concerns or feelings of disgust, especially when consumers believe previous users may have left behind visible or invisible contaminants (Hazée et al., 2019). Accordingly, we hypothesise that:

> **H2c:** Consumers perceive RPSs (both refillable and returnable) as more contaminated than single-use packaging.

From these insights, we assumed that RPSs may lead to perceived risks related to performance, complexity, and contamination, and eventually have a negative impact on consumer purchase intention of RPSs.

Figure 7 presents a graphical representation of the tested relationship between perceived benefits, perceived risks, and purchase intention.
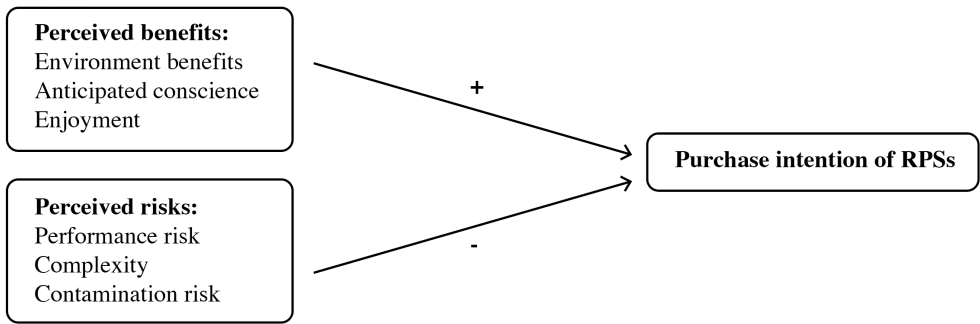
Figure 7. Influence of perceived benefits and perceived risks on consumer purchase intention of RPSs

2.3 Method

2.3.1 Study design and stimuli

An experimental study using a 3 (types of packaging: single-use vs. refillable vs. returnable) × 2 (product categories: shampoo vs. ketchup) between-subjects design was conducted. Shampoo and ketchup were chosen as the two stimuli products in this experiment. The selection of these two product categories was deliberate. First, food and personal care goods are two of the main categories for which RPSs are applied in the current FMCG sector (Muranko et al., 2021). Next, the consumption of both shampoo and ketchup is relatively high in Dutch households and thus purchasing these categories would be a familiar setting for our participants. Furthermore, both shampoo and ketchup are thick liquid products that are often packaged in similar plastic packaging, and consumers utilise both by squeezing. These similarities make shampoo and ketchup comparable.

We created two packaging designs for shampoo and ketchup without a brand indication to prevent potential biases related to brand familiarity (Magnier et al., 2016; Orth et al., 2010). Both shampoo packaging and ketchup packaging had the same shape, size, and material to reduce the potential confounding effects, but differed in terms of liquid colour and label because of category differences. These two packaging designs were used identically in all three packaging types (i.e. single-use packaging, refillable packaging system and returnable packaging system). **Figure 8** shows our stimuli and six conditions used in this study.

	Single-use packaging	Refillable packaging system	Returnable packaging system
Stimuli 1: Shampoo	**Condition 1:** Single-use packaging for shampoo	**Condition 2:** Refillable packaging system for shampoo	**Condition 3:** Returnable packaging system for shampoo
Stimuli 2: Ketchup	**Condition 4:** Single-use packaging for ketchup	**Condition 5:** Refillable packaging system for ketchup	**Condition 6:** Returnable packaging system for ketchup

Figure 8. Stimuli and six conditions used in the questionnaire

To engage participants in the scenarios and stimulate them to imagine using the packaging, we created six animations with subtitles to demonstrate how packaging solutions work. The solution presented in each animation illustrated the role of specific packaging in an assigned condition. Each animation started with a situation where a character ran out of either shampoo or ketchup and needed to buy a new bottle at the supermarket. One of the three packaging solutions was then presented. In single-use packaging scenarios, the character bought a product sold in single-use plastic packaging, used it at home and disposed of the empty packaging in the PMD container (which stands for plastic, metal packaging, and drinking cartons in the Netherlands). In refillable packaging scenarios, the character chose empty plastic packaging and filled it with shampoo or ketchup from the bulk dispenser in the supermarket. Besides paying for the product, the character also paid a small amount for the refillable packaging. When the packaging was empty, the character washed it and refilled it again at the supermarket. In returnable packaging scenarios, the character chose pre-filled plastic packaging of shampoo or ketchup and paid for it with a small deposit for the packaging. When the packaging was empty, the character rinsed it, returned it at the supermarket and received the deposit refund. The returned packaging would be refilled and sold again to the next consumer. **Figure 9** provides a visual storyboard to show one animation example.

1. You are enjoying french fries and notice you have run out of the ketchup.

2. You go to the supermarket and look for the ketchup you usually buy. You find out it is now sold in a returnable packaging system!

3. You look at its packaging. It is a transparent plastic bottle. You put this ketchup in your shopping cart.

4. At the cashier, you pay for your products, plus a deposit for ketchup packaging.

5. After coming back from the supermarket, you place your ketchup in the kitchen and consume it as usual.

6. A few weeks later, your ketchup packaging is empty again. You simply rinse it.

7. The next time you go to the supermarket, you return the empty packaging to the system and receive a deposit receipt.

8. (You learn that the returned packaging will be refilled and sold to the next consumer.)

9. At the cashier, you pay for your products, and get a refund for the deposit on the returned packaging.

Figure 9. Visual storyboard depicting the returnable packaging system for ketchup, composed of animation screenshots

2.3.2 Data collection and sample

The participants were recruited from a university-based Dutch consumer panel. The online questionnaire was created using Qualtrics and sent to 810 individuals. 250 complete responses were received (53.2% male; age range: 21–91 years, M = 59 years). The response rate was 30.9%, which is considered normal for this panel. To minimise social desirability bias, participants were informed that their responses would remain anonymous and confidential. Each participant was randomly presented with one of the six conditions. After reading the textual scenario, watching the animation, and observing the packaging image, participants responded to a series of multi-item 7-point Likert scales (1 = strongly disagree, 7 = strongly agree) and 7-point semantic differential scales to assess the presented packaging. As a token of appreciation for their time and effort, participants had an 8% chance to receive a €10 voucher through a randomised prize draw. The study was approved by the Human Research Ethics Committee of Delft University of Technology (reference number: 1424).

2.3.3 Measures

The measurement scales used in these studies were mainly adapted from previously validated instruments to suit the context of reusable packaging. Items in each scale were displayed in a random order. The reliability of all the scales was adequate with Cronbach's alpha and Spearman–Brown coefficient with all scores above 0.70, indicating good internal consistency (Mackison et al., 2010). All construct items of the measurements are presented in **Appendix A**.

In each questionnaire, we first asked our participants to evaluate the following three perceived benefits: environmental benefits, using three items including "Using this packaging is" (1= bad for the environment; 7=is good for the environment) adapted from (Chang, 2011); anticipated conscience, using two items including "I would feel good about buying shampoo/ketchup in this packaging" (1=strongly disagree;7=strongly agree) adapted from (Bradu et al., 2014); and enjoyment, using five items including "This packaging is the one that I would enjoy" (1=strongly disagree;7=strongly agree) adapted from (Sweeney & Soutar, 2001).

We then asked them to rate three perceived risks: performance risk, using three items including "There is a chance that there would be something wrong with this packaging" (1=strongly disagree; 7=strongly agree) (Keh & Pang, 2010); Contamination, using three items including "I believe this packaging is contaminated" (1=strongly disagree; 7=strongly agree) (Argo et al., 2006); and complexity, using five items including " How much effort do you think it costs to learn how to use this packaging?" (1=not much; 7=very much) adapted from (Rogers, 2003). After these evaluations, we asked them to fill in their purchase intention, using two items including "Given the information above, I am likely to buy shampoo/ketchup in this packaging" (1=strongly disagree;7=strongly agree) (Mugge et al., 2017).

Besides, environmental concern (Kim & Choi, 2005) and involvement (Chandrashekaran, 2004) were evaluated to consider individual differences that could potentially affect the dependent variables in the analysis. To check our manipulation, we asked participants to rate two questions "Is this packaging single-use? (Yes/No)" and "Is the reusable packaging you were presented with, refilled by yourself? (Yes/No). Finally, demographic information (age, gender, and education level) was collected.

2.4 Results

2.4.1 Manipulation checks

We conducted manipulation checks to assess whether participants correctly understood the packaging type assigned to them. Among the participants in the single-use condition (N=87), 13 mistakenly reported that the packaging was not single-use. This may be because the packaging was disposed of in a PMD container that is typically used for recycling plastic, metal, and drink cartons. Some participants may have perceived recyclable packaging as non-single use. In the refillable (N=83) and returnable (N=80)

packaging system conditions, 25 participants (14 in refillable, 11 in returnable) incorrectly classified the reusable packaging as single use. While this might seem unexpected, it likely reflects a general consumer tendency to associate FMCG packaging with disposability. Consumers may discard reusables out of habit, similar to how reusable shopping bags or bottles with deposits are discarded despite their reuse potential. Additionally, 13 participants (8 in refillable, 5 in returnable) misunderstood the distinction between the two RPSs, particularly regarding who is responsible for refilling the packaging.

To determine whether these misinterpretations affected the results, we conducted all analyses with and without these samples (N=51). As the results remained consistent, we retained the full sample to preserve the statistical power and to reflect real-world variations in consumer understanding.

2.4.2 Consumers' responses among types of packaging and product categories

To examine consumers' responses to different types of packaging and product categories, a series of analyses of covariance (ANCOVAs) were conducted. The types of packaging and product categories were entered as independent variables, while perceived benefits, perceived risks, and purchase intention served as dependent variables. To account for individual differences in consumer behaviour, involvement and environmental concerns were included as covariates to control their potential influence on the results. In cases where the assumption of homogeneity of variances was violated ($p < .05$), we performed non-parametric Kruskal–Wallis tests as a robustness check to ensure the reliability of our findings. When significant differences were detected, we conducted pairwise Mann–Whitney U tests with Bonferroni correction to identify specific group differences.

Our results revealed a significant main effect of packaging type on the dependent variables, which we elaborate on in the subsequent sections. However, no significant main effect of product category was observed ($p > .10$), indicating that consumer responses did not differ between product categories. Furthermore, no significant interaction effect was found between product category and packaging type ($p > .10$), suggesting that the influence of packaging type was consistent across product categories. Given these findings, product category was excluded in the subsequent analyses, and we focused on exploring the main effects of packaging type.

Descriptive statistics for all variables are presented in **Table 1**.

Table 1. Descriptive statistics of responses to three packaging solutions for different products

	Single-use packaging (N=87)			Refillable packaging system (N=83)			Returnable packaging system (N=80)		
	shampoo	ketchup	total	shampoo	ketchup	total	shampoo	ketchup	total
Environmental benefits	3.81 (1.54)	3.85 (1.64)	3.83 (1.59)	6.01 (1.16)	6.14 (0.99)	6.08 (1.07)	5.89 (1.03)	6.06 (0.88)	5.98 (0.96)
Anticipated conscience	4.19 (1.39)	4.08 (1.47)	4.13 (1.43)	5.71 (1.32)	5.67 (1.09)	5.69 (1.20)	5.46 (1.16)	5.81 (1.11)	5.64 (1.14)
Enjoyment	3.82 (1.45)	4.24 (1.21)	4.03 (1.34)	4.89 (1.45)	4.50 (1.64)	4.69 (1.56)	4.85 (1.16)	4.84 (1.43)	4.84 (1.30)
Performance risk	2.37 (1.24)	2.33 (1.10)	2.35 (1.16)	2.24 (1.42)	2.75 (1.31)	2.51 (1.38)	2.22 (0.94)	2.13 (1.06)	2.17 (1.00)
Complexity	1.43 (0.79)	1.51 (0.66)	1.47 (0.72)	1.87 (0.89)	2.25 (1.18)	2.07 (1.06)	1.75 (0.90)	1.86 (1.01)	1.80 (0.95)
Contamination risk	2.14 (1.07)	2.08 (1.09)	2.11 (1.08)	2.34 (1.42)	2.64 (1.46)	2.50 (1.44)	1.83 (0.85)	1.78 (0.95)	1.80 (0.90)
Purchase intention	3.99 (1.62)	4.70 (1.41)	4.35 (1.55)	5.27 (1.84)	5.06 (1.63)	5.16 (1.73)	4.95 (1.74)	5.39 (1.55)	5.17 (1.65)

[a] Means are reported (constructs measured on scales 1 to 7), standard deviations in brackets.

2.4.2.1 The effect of packaging type on perceived benefits

To examine how consumers evaluate the perceived benefits of different packaging types, we conducted three ANCOVAs (or Kruskal–Wallis tests) on environmental benefits, anticipated conscience, and enjoyment as dependent variables.

The results revealed a significant difference among the three types of packaging in terms of perceived environmental benefits (H (2) = 93.87, p < .001). Both refillable (Mean Rank = 162.31, p < .001) and returnable packaging systems (Mean Rank = 152.27, p < .001) were perceived as offering greater environmental benefits compared to single-use packaging (Mean Rank = 65.77), which supported **H1a**.

A significant difference was also found in the evaluation of anticipated conscience among the packaging types (F (2,245) = 44.33, p < .001). Consumers reported higher levels of anticipated conscience when using refillable ($M_{refillable}$ = 5.69, p < .001) or returnable packaging systems ($M_{returnable}$ = 5.64, p < .001) than single-use packaging ($M_{single-use}$ = 4.13), which supported **H1b**.

A significant difference was also observed in enjoyment across the packaging types (F (2, 245) = 9.18, p < .001). Both refillable ($M_{refillable}$ = 4.69, p < .05) and returnable packaging systems ($M_{returnable}$ = 4.84, p < .001) were rated as providing greater enjoyment compared to single-use packaging ($M_{single-use}$ = 4.03), which supported **H1c**.

Importantly, no significant difference was found between refillable and returnable packaging systems for any of the three perceived benefits (p values > .10).

2.4.2.2 The effect of packaging type on perceived risks

Since Levene's tests indicated violations of the homogeneity of variances assumption for all perceived risk variables, we conducted three Kruskal-Wallis tests to compare performance risk, complexity, and contamination risk across three packaging types.

The results showed no significant differences in performance risk among the three packaging types (H (2) = 1.47, p > .10), failing to support **H2a**. This suggests that consumers did not perceive the refillable packaging system, returnable packaging system, or single-use packaging as differing substantially in their ability to perform as expected.

However, there was a significant difference in complexity across the three packaging types (H (2) = 24.24, p < .001). Consumers perceived both refillable (Mean Rank = 151.36, p < .001) and returnable packaging systems (Mean Rank = 128.65, p < .01) as significantly more complex to use than single-use packaging (Mean Rank = 97.94), which supported **H2b**. Additionally, the refillable packaging system was perceived as more complex than the returnable packaging system (p < .05), indicating that consumers may find the refill process more demanding than returning empty packaging.

The results also indicated a significant difference in contamination risk across packaging types (H (2) = 9.63, p < .01). The refillable packaging system (Mean Rank = 141.58) was perceived as carrying significantly higher contamination risk than the returnable packaging system (Mean Rank = 107.24, p < .01). However, no significant differences were found between the refillable packaging system and single-use packaging, or the returnable packaging system and single-use packaging (p values > .10). These findings did not support **H2c**.

Although significant differences were observed in complexity and contamination risk among three types of packaging, it is worth noting that the mean values for all perceived risks were well below the midpoint of the scale (i.e., mean values < 4). This suggests that, overall, consumers did not perceive these risks associated with any packaging type as particularly severe.

2.4.2.3 The effect of packaging type on purchase intention

To investigate differences in purchase intention across packaging types, we conducted an ANCOVA with the packaging type as the independent variable, and purchase intention as the dependent variable.

The results showed that there was a significant difference among the three types of packaging in terms of purchase intention (F (2, 245) = 7.62, p < .001). Consumers demonstrated significantly higher purchase intentions for both refillable packaging systems ($M_{refillable}$ = 5.16, p < .01) and returnable packaging systems ($M_{returnable}$ = 5.17, p < .001) compared to single-use packaging ($M_{single-use}$ = 4.35). No significant difference was found between refillable and returnable packaging systems (p > .10). This indicated that both systems are perceived as desirable solutions for consumers to replace single-use (plastic) packaging. **Table 2** provides a detailed comparison of all dependent variables across the three packaging types.

Table 2. Differences among all dependent variables across the three packaging types

	1 Single use	2 Refill	3 Return	Statistics	Pairwise comparison	Covariates
Environmental benefits	3.83 (1.59)	6.08 (1.07)	5.98 (0.96)	H (2) = 93.87***	2>1***, 3>1***	/
Anticipated conscience	4.13 (1.43)	5.69 (1.20)	5.64 (1.14)	F (2, 245) = 44.33***	2>1***, 3>1***	Inv: F=10.50*** EC: F=4.92*
Enjoyment	4.03 (1.34)	4.69 (1.56)	4.84 (1.30)	F (2, 245) = 9.18***	2>1*, 3>1***	Inv: F=13.65*** EC: F=6.69**
Performance risk	2.35 (1.16)	2.51 (1.38)	2.17 (1.00)	H (2) = 1.47	/	/
Complexity	1.47 (0.72)	2.07 (1.06)	1.80 (0.95)	H (2) = 24.24***	2>1***, 3>1**, 2>3*	/
Contamination risk	2.11 (1.08)	2.50 (1.44)	1.80 (0.90)	H (2) = 9.63**	1>3ᵃ, 2>3**	/
Purchase intention	4.35 (1.55)	5.16 (1.73)	5.17 (1.65)	F (2, 245) = 7.62***	2>1**, 3>1***	Inv: F=5.34* EC: F=6.90**

Note:
The F statistics correspond to the results of the ANCOVAs, with pairwise comparisons based on mean values.
The H statistics correspond to the results of Kruskal-Wallis tests, with pairwise comparisons based on mean ranks.
Inv=Involvement, EC= Environmental concern
[a] $p < .10$ (marginal); * $p < .05$; ** $p < .01$; *** $p < .001$

2.4.3 Influence of perceived benefits and risks on purchase intention of RPSs

To assess how perceived benefits and risks on consumers' purchase intention for RPSs, two linear regression analyses were conducted separately for the refillable packaging system and the returnable packaging system. Perceived benefits and perceived risks were entered as independent variables, while purchase intention served as the dependent variable.

For the **refillable packaging system**, the overall regression model was statistically significant (F (6, 76) = 29.41, $p < .001$), explaining 69.9% of the variance in purchase intention. As illustrated in **Figure 10**, anticipated conscience emerged as the strongest positive predictor of purchase intention ($\beta = .55$, $p < .001$), highlighting the critical role of ethical satisfaction in motivating consumers to adopt refillable packaging systems. Enjoyment also significantly contributed to purchase intention ($\beta = .28$, $p < .001$), suggesting that an enjoyable user experience is likely to drive consumer adoption. Notably, contamination risk was a significant negative predictor ($\beta = -.35$, $p < .01$), indicating the contamination concerns associated with refillable packaging systems may hinder consumer adoption. Other factors, including environmental benefits, complexity, and performance risk, did not significantly influence purchase intention (p values > .10).

For the **returnable packaging system**, the overall regression model was also statistically significant (F (6, 73) = 29.37, $p < .001$), explaining 70.7% of the variance in purchase intention. As seen in **Figure 11**, enjoyment emerged as the strongest positive predictor ($\beta = .49$, $p < .001$) of purchase intention, followed by anticipated conscience ($\beta = .43$, $p < .001$). These findings align closely with those observed for the refillable packaging system, suggesting that fostering anticipated conscience or enjoyment are effective strategies to increase purchase intention of RPSs. Unlike in the refillable packaging system, contamination risk did not significantly impact purchase intention

for the returnable packaging system. Like the refillable packaging system, environmental benefits, complexity, and performance risk did not significantly impact purchase intention for the returnable packaging system (p values > .10).
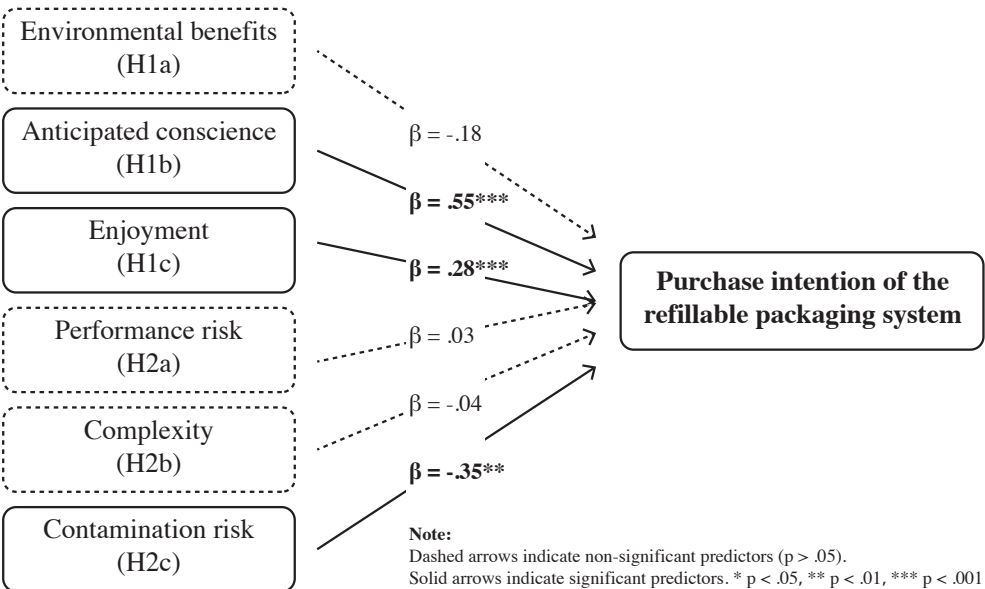
Figure 10. Linear regression model of the perceived benefits and risks on purchase intention of the refillable packaging system
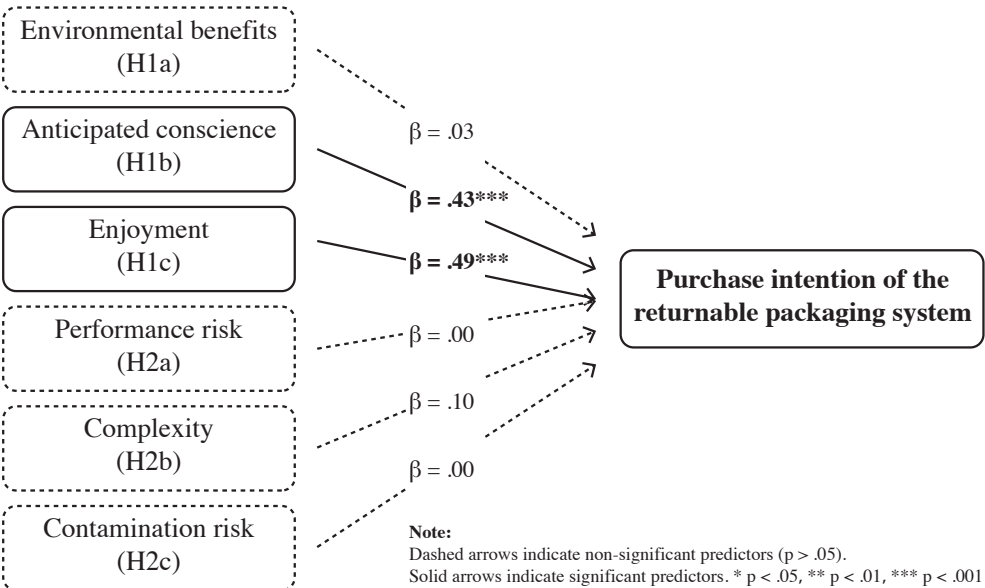
Figure 11. Linear regression model of the perceived benefits and risks on purchase intention of the returnable packaging system

2.5 General discussion

While scientific research and industry practices show increasing interest in RPSs, a gap remains in understanding consumer perceptions. Since consumer acceptance is crucial to determine whether RPSs can achieve widespread adoption, our study addresses this gap by examining the perceived benefits and risks of two types of RPSs for FMCGs and assessing how different solutions influence purchase intentions.

2.5.1 Theoretical implications

First, our findings suggest that consumer perceptions of RPSs are generally positive, with high purchase intentions for both refillable and returnable packaging systems. This supports the viability of RPSs as attractive alternatives to single-use packaging in physical retail settings, complementing prior research on reusable packaging in online FMCG shopping (Ertz et al., 2017b). Specifically, we identified three perceived benefits of RPSs - environmental benefits, anticipated conscience, and enjoyment – all which consumers rated higher than those of single-use packaging. These findings suggest that RPSs possess some relative advantages over single-use solutions, a key factor in adoption as proposed by Rogers' Diffusion of Innovation Theory (Rogers, 2003). According to this theory, the greater the perceived superiority of an innovation compared to existing alternatives, the more likely it is to be adopted. Notably, while environmental benefits were acknowledged, they did not directly predict purchase intention of RPSs. This finding contradicts prior literature that usually identifies perceived environmental benefits as a key driver of purchase intentions of sustainable products (Mugge et al., 2017). Instead, anticipated conscience and enjoyment emerged as stronger drivers of purchase intention across both refillable and returnable packaging systems. These findings align with prior research on pro-environmental behaviours, which suggests that anticipation of positive emotions, such as pleasure, excitement, and joy, plays a direct role in shaping behavioural intentions to adopt sustainable products (Choi & Johnson, 2019; Magnier et al., 2019; Schuitema et al., 2013). Similarly, this finding supports the idea that consumers are more likely to choose reusable products when they align with their novelty-seeking tendencies or environmental conscience in daily grocery shopping (Kunamaneni et al., 2019).

Next, our study extends research on risk perception in sustainable product adoption by uncovering contamination risk and the complexity of RPSs. While previous studies suggest that contamination related to reusable packaging is particularly relevant for food-related products (Baird et al., 2022; Magnier & Gil-Pérez, 2023), we found no significant differences in contamination risk across product categories. Instead, contamination risk seems to be more influenced by how reusable packaging is handled —whether it is refilled or returned, and whether consumers or professionals are responsible for cleaning. Interestingly, contamination risk was perceived as higher for refillable packaging systems than for returnable packaging systems. One possible explanation is that spillage during the refilling process may create an unclean perception, making bulk dispensers seem contaminated. Besides, consumers may trust professional cleaning services more than their own cleaning practice at home. Although

contamination risk was not severe overall, their negative impact on purchase intention for refillable packaging systems underscores the need for targeted strategies to mitigate these concerns.

Finally, perceived complexity emerged as a risk, with both RPS models rated as more complex to use than single-use packaging. Nevertheless, complexity overall was rated at a low level, and it did not significantly influence the purchase intention of RPSs. This result suggests that while consumers find RPSs more demanding than single-use packaging, it does not necessarily deter their adoption. Notably, refillable packaging systems were perceived as more complex than returnable packaging systems. This is likely due to the limited implementation of refill models in the current market, leading to lower familiarity and greater perceived effort in using them. In contrast, returnable packaging systems benefit from participant familiarity with deposit-refund schemes in countries like the Netherlands (Bocken et al., 2022), where returning bottles is already an established habit.

2.5.2 Practical implications

From a practical perspective, our findings offer actionable strategies for improving RPS adoption.

Leveraging anticipated conscience and enjoyment

Since anticipated conscience and enjoyment are strong motivators for purchase intention, enhancing the experiential and emotional aspects of RPSs may be an effective strategy for increasing adoption. Future RPS designs could integrate interactive elements, such as gamification, sensory appeal, or reuse tracking features to create a more engaging and fulfilling consumer experience. However, while anticipated conscience and enjoyment may initially motivate adoption, their long-term influence on consumer behaviour change remains uncertain. If enjoyment is mainly driven from a novel experience, it may diminish once consumers become accustomed to the process (refers to hedonic adaptation effect; Frederick & Loewenstein, 1999). Similarly, the influence of anticipated conscience may weaken unless consumers receive effective communication or incentives to enhance their habit formations.

Mitigating contamination concerns

Although contamination risk was relatively low overall, they were found to significantly reduce purchase intention for refillable packaging systems. To mitigate these concerns, stakeholders can implement strategies to reassure consumers about cleanliness (Long et al., 2022), such as airtight refill mechanisms (e.g., sealed dispensers that avoid spilling and cross-contamination), transparent hygiene protocols (e.g., information that explains how system is sanitized on a daily basis); and easy-to-clean packaging materials (e.g., dishwasher-safe designs).

Reducing complexity and enhancing usability

Both RPS models were perceived as more complex than single-use packaging, with refillable packaging systems rated as the most complex. This suggests that future RPS designs should aim to simplify user interactions with in-store infrastructures. For instance, introducing user-friendly interfaces and well-designed instructional signals to improve consumer confidence; integrating familiar design elements to make refill process more intuitive; and providing in-store assistance when there is a need (Greenwood et al., 2021; Kunamaneni et al., 2019).

2.5.3 Limitations and future research

While this study provides valuable insights for designers and researchers working on RPSs, several limitations highlight opportunities for future research.

First, our study was conducted with Dutch participants, a population known for its relatively high environmental awareness and concern (Magnier et al., 2019). This may have positively influenced perceptions of environmental benefits and anticipated conscience towards reuse options. To enhance the generalisability of our findings, future research could replicate this study in diverse cultural and geographic contexts, particularly in regions with varying levels of environmental concern and different formats of reuse infrastructures.

Second, our study focused on RPSs as alternatives to single-use plastic packaging, which is widely perceived as environmentally harmful. However, in practice, single-use packaging comes in various materials, some of which—such as carton boxes and glass jars—are often considered more sustainable (Steenis et al., 2017). Future research could explore whether RPSs are seen as more competitive or desirable than other sustainable packaging formats. This would provide deeper insights into consumer decision-making and the potential market positioning of RPSs within the broader landscape of sustainable packaging.

Third, although our study included two product categories (shampoo and ketchup), we did not find significant differences in consumer responses between them. Future research could explore whether product-specific characteristics influence perceptions of RPSs. For example, future research could compare perishable products that require quick consumption (e.g., fresh fruits, dairy and beverages) to shelf-stable products that have longer storage periods (e.g., dry goods and personal care products). Perishable products often generate more packaging waste due to frequent repurchasing, which may heighten consumer motivation to adopt reusable alternatives. However, they may also introduce barriers, such as inconvenience or doubts about product freshness. Shelf-stable products may allow for easier integration of RPSs, as consumers only interact with disposal and replacement occasionally. Yet, lower purchase frequency may hinder habit formation or limit consumer motivation to return or refill packaging. Understanding these can help refine strategies for encouraging widespread adoption across different product categories.

2

Finally, our study relied on an online survey using hypothetical scenarios, which offered strong internal validity. Unlike most quantitative studies on RPSs that rely on textual scenarios or static images, incorporating self-created animations may have improved participant engagement and provided a more immersive research setting. However, multiple samples failed in our manipulation checks, which suggests that short demonstrations may not provide participants sufficient time to process or fully mirror real-life interactions with RPSs. Future research could improve ecological validity by adopting laboratory experiments or field studies, in which participants can physically interact with an actual RPS in a realistic setting. Additionally, qualitative approaches, such as in-depth interviews or focus group discussions, could uncover nuanced insights into the specific benefits and risks of RPSs. For example, they could explore when and why contamination risk emerges or identify which aspects of RPSs consumers find complex. These deeper insights would be valuable in designing new RPSs to gain widespread social acceptance in a circular economy.

2

/ *Chapter 3* /

Switching to reuse? An exploration of consumers' perceptions and behaviour towards reusable packaging systems

Chapter 2 examines several benefits and risks associated with reusable packaging systems (RPSs) based on hypothetical scenarios presented through an online survey. However, it remains unclear why consumers associate these benefits and risks and what additional factors might influence their adoption in practice.

To address this gap, Chapter 3 adopts a qualitative approach, conducting in-depth interviews with consumers who physically interact with an RPS in a laboratory setting. Follow-up phone interviews further capture consumer experiences and behaviours at home. This exploratory approach offers more insights into how packaging and system design can introduce enablers and barriers for consumers at different stages of the consumption process. The findings provide a comprehensive understanding of consumer perception and engagement with RPSs, which can guide future development of RPSs.

3.1 Introduction

Product packaging serves multiple functions, including efficient product storage, product protection and preservation, promoting hygiene and safety, and facilitating distribution (Rundh, 2005). However, most packages have a short lifetime, becoming waste immediately after the contents are consumed or transferred. Consequently, excessive packaging production and consumption pose a threat to the natural environment and human health through a waste of resources, littering and accumulation, as well as landfilling and incineration.

Past research has mainly focused on reducing and recycling but has largely ignored the reuse of packaging, which can successfully limit the use of virgin material and have a positive environmental impact on waste reduction and resource conservation (Ertz et al., 2017b). With a fast-growing need for sustainable consumption, numerous companies have implemented reusable packaging systems (RPSs) for fast-moving consumer goods (FMCGs). For instance, Ecover offers refillable packages for cleaning products that consumers can fill in-store from bulk dispensers; and British supermarket chain Tesco in partnership with Loop provides some daily products packaged in reusable containers and requests consumers to return empty packages for reuse purposes. RPSs can be broadly divided into two types (Greenwood et al., 2021; Muranko et al., 2021) - returnable packaging systems and refillable packaging systems, with some RPSs integrate features of both types in one system (Coelho et al., 2020). For example, the RPS investigated in the present study consists of packages that can either be repeatedly refilled and cleaned by consumers or returned to the company to be cleaned and then reused by another consumer.

Although these solutions are promising to lower the amount of packaging waste, their success strongly depends on consumer adoption. Nowadays, consumers are paying more attention to the environmental impact of their consumption, but this awareness does not necessarily lead to behaviour change (Heidbreder et al., 2019; Herrmann et al., 2022). There is limited understanding of consumer attitudes and behaviour towards RPSs. A few notable exceptions are studies investigating consumers' first responses by testing these systems via visuals and storyboards (Long et al., 2022; Miao et al., 2023a). Other studies have used online surveys to explore different types of packaging and reuse models that consumers are willing to adopt (Greenwood et al., 2021; Jiang et al., 2020); emotional and social factors associated with consumers' shifts from single use to reuse (Keller et al., 2021); and the role of context, motivations, and culture in consumers' reuse behaviour (Ertz et al., 2017b). Although these studies are valuable, they only provide fragmented knowledge about consumers' adoption and are limited to consumers' preliminary reactions to hypothetical usage. There is a need for research investigating consumer responses after the actual experience of an RPS.

This chapter starts by presenting a literature review on why consumers have not yet widely adopted RPSs and describes the knowledge gap that is addressed by our study. Subsequently, we present the research methodology and elaborate on how participants used an RPS and were interviewed about this experience. Next, we elaborate on the

results of the semi-structured interviews exploring consumers' general reactions to the RPS and the enablers and barriers of adoption. Finally, we discuss the theoretical and practical implications of our results and propose suggestions for future research, which can help shape future packaging solutions and increase their societal impact.

3.2 Potential barriers to consumer adoption of reusable packaging systems

Switching to reuse can be difficult. One recent consumer research indicated that although 85% of people want to buy products in reusable packaging, only 16% of people actually engage with RPSs (Poole, 2019), suggesting that consumers face barriers towards reuse. Previous literature has uncovered several factors that may negatively influence consumer adoption of RPS and broadly clustered these into three aspects: the inconvenience of reuse behaviours, contamination concerns about the shared access to the system and the hampered functional features of the reusable packaging. Below, we elaborated on each aspect.

3.2.1 Reusing packaging is inconvenient

As RPSs are not widely applied, consumer actions can be limited by a lack of availability of the reuse-enabling infrastructure (Singh & Cooper, 2017; Steinhorst & Beyerl, 2021). Meanwhile, recycling has become a deeply entrenched norm, and well-established recycling schemes have been developed in past decades in many European countries. Consequently, consumers are more willing to recycle the packaging than reuse it (Greenwood et al., 2021; Kunamaneni et al., 2019). Using RPSs can be perceived as inconvenient, resulting in a shopping experience that consumes much time and effort, such as returning empty packaging to retailers or refilling products in-store (Jiang et al., 2020; Lofthouse et al., 2009; Zhu et al., 2022). A limited product range and the possibility that specific products will be unavailable increase the uncertainty of the purchase (Beitzen-Heineke et al., 2017). Furthermore, a potentially higher packaging cost or an upfront deposit hinders consumer adoption (e.g., Long et al., 2022). However, to our knowledge, all prior results are generated from consumer responses to hypothetical usage, making it difficult to capture what inconveniences may occur during the actual use of RPSs.

3.2.2 Repeated usage and shared access bring contamination concerns

Reusable packaging is designed for multiple uses and can only be considered environmentally better than its single-use equivalent after it has been reused a minimum number of times (Cottafava et al., 2021). This can be challenging for consumers because frequent washing, transportation and refilling will cause signs of use and superficial damage on the packaging over time. This wear and tear on the packaging can act as a contamination cue, activate concerns about health and safety (White et al., 2016) and thus hinder acceptance (Magnier & Gil-Pérez, 2021) or trigger replacement. In addition,

research on contaminated interactions revealed that people are less willing to use products that belong or have belonged to someone else due to the fear of contamination (Baxter et al., 2016). Some hygiene issues also emerge in the use context of RPSs, such as sharing use of the system with unfamiliar users or seeing others touch the packaging (Long et al., 2022). It is however not yet fully understood how these concerns influence consumer adoption.

3.2.3 The functions of packaging in RPSs can be hampered

Packaging provides a wide range of functionalities and benefits that consumers consider crucial (Löfgren & Witell, 2005). Packaging is capable of attracting consumer attention, triggering aesthetic appreciation (Celhay & Trinquecoste, 2015), and bringing expectations about price and quality, taste, naturalness and health (Becker et al., 2011; Magnier et al., 2016; van Rompay et al., 2016). Furthermore, the packaging informs consumers regarding the contents, instructions, and storage conditions of products (Singh et al., 2016), ensures the hygiene of products against germs (Lindh et al., 2016), and prevents food waste and loss (Steenis et al., 2017; Verghese et al., 2015). Packaging can also facilitate product usage by making it easy to open, pour or take out the product, reseal and empty (Williams et al., 2012), It is also acknowledged that the environmental aspects of packaging design play a significant role in consumer choices (Magnier & Schoormans, 2015; Rokka & Uusitalo, 2008). However, those functions have thus far been investigated only in the context of single-use packaging. We lack an understanding of RPSs, especially how consumers perceive RPSs if certain packaging functions are missing due to the fundamental nature of reuse. It is worth exploring how these missing functions may influence consumers' purchase decisions and how to compensate for these through packaging or system design.

3.3 Method

3.3.1 Semi-structured interviews

Semi-structured, in-depth interviews were conducted with participants who used an RPS that was being implemented in a few, specialised supermarkets at the time the study took place (November/December 2021). This enabled us to test consumers' first impressions and reactions to an actual working system. We selected semi-structured interviews because participants can provide depth, insight and understanding from their personal perspectives on consumer behaviour, motivations and experiences concerning topics selected by researchers (Patton, 2002). Before data collection, the research set-up was piloted to test the procedure and questions.

3.3.2 Participants

We recruited participants via a university-based consumer panel. To enable in-person interviews, we selected 27 participants that lived close to the university, varying in age (18-74 years; mean: 50.6 years), gender (44% male; 56% female), monthly income and education level. Each participant received monetary compensation (15euro voucher)

for their participation. The study was approved by the Human Research Ethics Committee of Delft University of Technology (reference number: 1792).

3.3.3 Stimulus and Procedure

The RPS used in this study integrated the functions of filling products from airtight dispensers, weighing products and printing product information on labels. Instructions were presented on a touchscreen embedded in the system. In this system, consumers can use their own reusable containers or pay a deposit to use the system's standard refillable packaging, which they can then use multiple times until they return it in the supermarket and get their deposit refunded. In the latter case, the standard packaging is cleaned by the RPS provider and reused by another consumer or properly recycled when it has too much damage. This allowed us to generate comprehensive consumer insights about the RPS, in supermarket-like settings (**Figure 12**). Six dry food products (i.e. lentils, rice, porridge, coffee beans, cookies, and crackers) were provided by the system (**Figure 13**). No brand was specified for these products to prevent participants' potential biases.

The study consisted of two parts. First, in-person interviews took place in a consumer research lab facility of the university, where the RPS was installed. The lab facility ensured high-quality video and audio recordings. The second part consisted of follow-up phone interviews conducted about two weeks after the in-person interviews.

Figure 12. Research set-up

Figure 13. Six food products provided by the system

Each in-person interview lasted between 40 and 60 minutes. It started with an introduction about the procedure, data confidentiality and research purpose, after which the participant could ask questions. All participants signed informed consent. As a first task, each participant was asked to use the RPS by filling products from the dispensers in three different packages: two reusable packages of different sizes and one private container brought by the participant (**Figure 14**). This encouraged participants to share their insights on different types of packaging and helped us understand their preferences. For all packages, participants first selected the food product, then dispensed it in the packaging, weighed the amount of food and printed a label. Through several semi-structured questions, participants described their general feelings about operating the RPS, their packaging preferences, what would motivate or dissuade their adoption of reusable alternatives, and the perceived environmental impact of the RPS. The interview concluded with questions about the participant's evaluation of different RPSs available on the market (Loop, Ecover, Pieter Pot and MIWA), which were presented as visuals and supporting text. After the interview, we asked participants to take the reusable container they had filled with cookies and use it at home. Finally, we scheduled a 10-15minute follow-up phone interview with each participant about two weeks after this interview. The follow-up interview aimed at understanding consumer behaviour (e.g., cleaning and storing) related to this refillable packaging at home, and collecting additional thoughts that came up after the interview, therefore providing a holistic overview of consumer behaviour in the different use stages of the RPS.
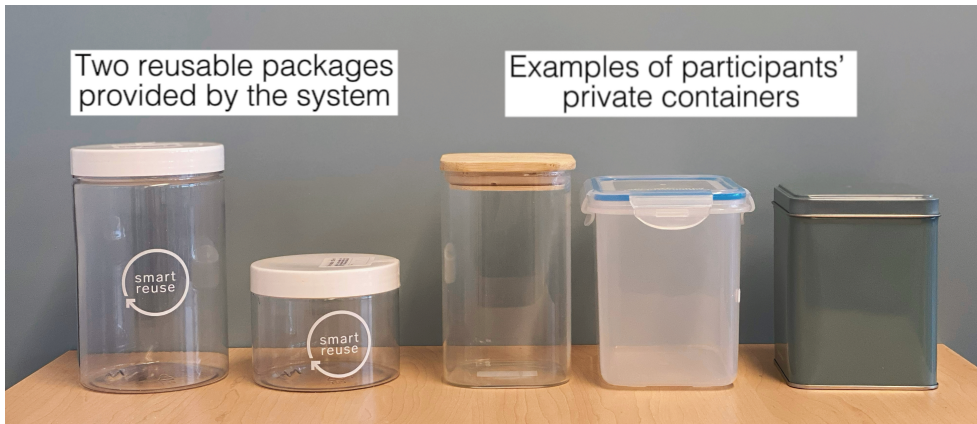
Figure 14. Packages used in the study

3.3.4 Data analysis

All interviews were audio-recorded, transcribed, and coded using Atlas.ti software. The coding followed an inductive procedure intending to group conceptually similar topics into more general codes. First, individual quotes were coded. Second, codes with similar meanings were grouped into categories. Third, categories were clustered into three themes. To ensure reliability and avoid misinterpretation of the data, the organisation of the codes, categories and themes was discussed and iterated among the research team. We prevented irrelevant or overlapping codes or categories. The last iteration of coding resulted in a final set of 132 codes and 16 categories fitting in three overarching themes. See **Table 3** for an example of the coding structure.

Table 3. An example of coding structure

Theme	Categories	Codes
General reactions to the experience of an RPS	Design of the dispenser	Novel appearance triggers exploration
		Naturalness evokes an association with sustainable behaviour
		Transparency enables the evaluation of the content
		The product stock should be indicated
		Sensory interactions are enjoyable

3.4 Results

Our main research findings are presented in three themes and 16 categories. **Figure 15** provides an overview of the uncovered categories, which are organised according to three dimensions. First, the 16 categories are clustered vertically according to the three themes: consumers' general reactions to RPSs and important design aspects that impact their usage; possible enablers for consumers to switch to RPSs; and barriers that can result in a reluctance to use RPSs in the long term. Second, categories are organised horizontally based on the adoption stages where they occurred: pre-purchase evaluation, system usage and post-purchase behaviour. Third, these categories are related to the following three aspects of RPSs: reuse behaviours, the dispensing system and its

features, and the reusable container and its features, which are marked by different symbols (ΔO   ).

Figure 15. Overview of categories covering general reactions to RPSs, enablers and barriers of adoption of RPSs at different stages of the consumption process (from left to right: pre-purchase, system usage and post-purchase), and in relation to aspects of reuse behaviours (Δ), the dispensing system (   ) and the reusable container (O)

3.4.1 General reactions to the RPS experience

3.4.1.1 Positive attitude towards reuse models

Participants' initial reactions towards the RPS were predominantly favourable and they reported a high willingness to adopt reusable packaging to prevent domestic packaging

waste if the product quality and price were satisfactory. This indicates that the potential for consumer acceptance of RPSs is promising.

Comparing the options of refilling and returning the package after usage, most participants preferred to keep reusing the same packaging as long as it remains functional rather than returning it every time for an empty replacement. This preference lies in their consideration of the energy consumption of collective cleaning and transportation, and because they did not believe that containers need to be cleaned and redistributed after each use. Therefore, most participants perceived that refilling the same packaging results in better environmental performance than returning it and getting a clean one to refill.

3.4.1.2 Design of the dispenser

Novelty. At first glance, participants indicated that the appearance of the RPS differed from the normal pre-packaged products displayed on shelves. Most participants stated that the novel appearance surprised them and would trigger exploration while shopping.

Naturalness. Participants expected the dispenser to have a natural appearance because this would make them feel that the system enabled sustainable actions and was filled with superior products. Participants reported that several design elements, such as mild colours, natural materials, and printed food pictures, could contribute to a natural appearance and stimulate purchase.

Transparency. Before filling the container, participants strongly desired to see what the product looks like. The opaque dispensers used in this study caused participants to feel more uncertain about the freshness and quality of the product inside. They indicated that opaque dispensers led to a high chance of getting unwanted items. Besides, participants could not assess how much food was available in the opaque dispenser, which made them afraid that the dispenser would not give them enough.

Sensory interactions. Compared to simply picking up a pre-packaged product from the shelf, participants experienced several sensory interactions with products when they operated the RPS. These sensory interactions positively affected their evaluations. Participants reported that products came out of the dispenser with a pleasant pouring sound, which gave them a sense of joy. The smell of the food triggered direct contact with the food, which created positive inferences about quality and flavour and contributed to hedonic pleasure.

3.4.1.3 Complexity of using a new system

Participants reported that learning to use an RPS can at first be difficult, especially for those who are not confident in understanding digital instructions. Some participants stated they needed more explanations on how to use the system before starting its use. Clear step-by-step instructions and explanations of major functional components were deemed necessary to understand how to use the system properly.

Participants reported that manual control of the product flow was difficult. Consequently, some product spillage occurred; the overflow was regarded as food waste, which conflicted with the participants' intention to be sustainable and evoked feelings of embarrassment. Therefore, most participants wished for greater control and consistent product flow.

Some unpredictable system performance failures regarding the software (e.g., incorrect displays) or the mechanics (e.g., stuck products) occurred in the study. Participants stated they would be nervous and impatient if they were trying to solve such problems in a busy supermarket. It is worth noting that when failures occurred, participants tended to blame themselves rather than the system and questioned their competence in using the system. When this happened, the participants expected to receive quick responses or help from the system.

Most participants indicated that if they could not quickly solve the problem and adequately dispense their product, they would be frustrated and turn to a pre-packaged product. Performance failures can thus interrupt the habit formation of buying products in reusable packaging to replace pre-packaged products.

3.4.1.4 Design of the reusable container

Unlike single-use packaging, a reusable container is used multiple times. Consequently, consumers see and use it frequently in their daily life. As a result, participants reported the attractiveness of the container as important. Specifically, many of the participants stated that they favoured a minimalistic and transparent design. Most participants preferred stackable cuboid containers as those take up less room in kitchen cupboards. They also expected a variety of designs to fulfil different demands. Many participants stated they appreciated the option of using private containers.

In most refill systems, the RPS prints a sticker for the consumer after dispensing the product. This sticker is necessary to provide the information that is included on most conventional packaging. Participants stated the sticker should also be aesthetically pleasing and easily removable afterwards.

Next to the sticker, the lid was perceived as the most critical component of the reusable container. Participants reported it should be easy to open, reclosable and tight to ensure protection during transportation (to avoid leakage) and preservation at home (to keep products fresh).

Participants also identified several preferred features of the packaging material. They indicated that it should be safe for storing food, lightweight for transportation, scratch-proof over multiple reuse cycles, and recyclable at the end of its life.

Table 4 shows example quotes of participants.

Table 4. The categories and example quote of the theme "General reactions to the RPS experience"

	Categories		Example of quotes
3.4.1.1	Positive attitude towards reuse models		"I generated much more plastic waste than other types of garbage. Yeah, it's awful. So, I'd be very pleased with those kinds of machines that reduce plastic." (P3)
3.4.1.2	Design of the dispenser	Novelty	"I've been surprised. When I'm surprised, I will also explore it. Because I don't know what that means for me. It's a new system." (P14)
		Naturalness	"It looks natural and gives the feeling that I'm sustainable, I'm buying something sustainable." (P22)
		Transparency	"The only thing is you don't really see the product. So, what happens if you decide you don't want it after you see it?" (P13)
		Sensory interactions	"There was a swooshing sound and then this container was completely full. That was the relaxing part. You could smell everything when it came out. So, you had contact with the food itself. That was so nice." (P20)
3.4.1.3	Complexity of using a new system		"What's happening? Am I doing it wrong? Is this the idea? Because you know it should work. It feels a bit like you're silly because you don't understand it." (P6)
3.4.1.4	Design of the reusable container		"The lid is easy to screw on and screw off. It seems like the food, or the product is well protected in it." (P23)

3.4.2 Enablers to switch from single-use packaging to RPSs

3.4.2.1 Environmental value

Overall, participants were aware of the over-consumption of plastic packaging and the short lifespan of most FMCG packaging. Most participants complained that disposable plastic packaging constituted the major waste in their households. They were looking for solutions and saw RPSs as an opportunity to help them reduce their plastic consumption and waste.

Some products were perceived to have a stronger negative environmental impact in terms of packaging waste than others, such as products in robust packaging (e.g., detergent in hard plastic bottles, jam and spices in glass jars), products consumed frequently (e.g., pasta, rice and cereals), products packaged in excessive packaging (e.g., cookies and candies) and products packaged in non-recyclable packaging (e.g., coffee in laminated plastic packaging). Participants stated they were more likely to adopt RPSs to replace these types of pre-packaged products. Organic products and fairtrade products were perceived as more suitable for use in RPSs.

Furthermore, participants stated that RPSs enabled them to customise product portions based on demands, which helped them better plan their product consumption and prevented food waste.

3.4.2.2 Anticipated positive emotions

Many participants anticipated that noticing less waste in their households would spark positive emotions; although they would only assess this reduction in general terms, rather than precisely quantifying the resources conserved, they anticipated satisfaction with this result.

Participants said that sometimes they were aware that reducing domestic packaging waste only represented a small step in terms of the overall environmental impact on society. Nevertheless, it gave them a good feeling of contributing to the environment and increased their perceived social value as an individual.

3.4.2.3 Reliability of hygienic standard

Participants generally felt that they could depend on the hygienic standard of the RPS in terms of safely storing products because it was a closed system and (re)sealed packaging maintained by professionals. Several participants compared dispensing products from an RPS with buying loose unpackaged products in bulk with a scoop. RPSs were viewed as more hygienic because they were airtight and prevented consumers' direct contact with products.

Participants also indicated they would prefer to adopt RPSs for dry food and long shelf-life products rather than for fluids and fresh products. The latter were associated with risks concerning leakage and loss of product freshness.

3.4.2.4 Financial benefits

A financial benefit mentioned frequently by participants was that using an RPS helped them save money through customising product portions instead of being restricted to a predetermined package size. Participants also stated that reusing the packaging enabled them to produce less waste in their household, thereby reducing their waste collection charge.

3.4.2.5 Familiarity with reuse practices

Shifting behaviour from buying a single-use package to an RPS requires forming new habits. For participants who had the habit of transferring products from disposable packages to their private containers at home, using an RPS to directly fill their containers in the supermarket was considered to be more efficient and reduce packaging waste.

Participants also reported that engaging in similar types of self-services (e.g., buying bulk candies, filling freshly squeezed juice in bottles) and reuse systems (e.g., returning empty beverage bottles to the deposit-refund system) could help them switch to RPSs. Furthermore, participants engaging in sustainable actions, such as purchasing organic products and using reusable shopping bags, were overall positive about adopting RPSs in their daily routines.

Table 5 shows example quotes of participants.

Table 5. The categories and example quote of the theme "Enablers to switch from single-use packaging to RPSs"

	Categories	Example of quotes
3.4.2.1	Environmental value	"When you buy too much, the product quality goes down. Then I'd have to throw it away. And in the system, I can choose what I need. So, there is not so much waste." (P8)
3.4.2.2	Anticipated positive emotions	"I feel that I'm a better person. I think I'm helping the world in my own small way." (P9)
3.4.2.3	Reliability of hygienic standard	"You don't have to touch food with your hands. When using a scoop, other people might touch the food with their hands. Here you can only push buttons [...] It feels much cleaner." (P4)
3.4.2.4	Financial benefits	"In many cities, you have to pay for your garbage by weight. So, when people have the experience of reducing their garbage by using these kinds of containers, they benefit themselves by lowering the cost." (P3)
3.4.2.5	Familiarity with reuse practices	"That [bringing a container] is the same as bringing your own shopping bags and not buying another plastic bag every time. So, it's kind of a new routine." (P15)

3.4.3 Barriers to long-term adoption of RPSs

While participants reported several enablers that could help them transition from single-use packaging to RPSs, they also pointed out some barriers that may hinder their adoption.

3.4.3.1 Scepticism about environmental impacts

Although most participants exhibited a positive attitude towards the sustainability of the system and a good feeling about using an RPS, some questioned the overall environmental impacts. For instance, some participants perceived recycling as a better-established social norm. They trusted the effectiveness of recycling and felt more at ease recycling than reusing. Correspondingly, participants expressed that reuse by individuals has a limited effect, and that collective action by society was more promising to make a difference.

Some participants reported they did not understand how using the system saves natural resources. Participants believed that the raw materials and energy needed to manufacture reusable containers and systems should not be overlooked. They also recognised that operating and maintaining systems required resources. Furthermore, they indicated that when the system still involved single-use packaging (e.g., secondary and tertiary packaging), the overall packaging waste reduction and environmental impacts would be limited.

When comparing different packaging materials in RPS examples (e.g., Loop uses metal containers, Pieter Pot uses glass jars, and Ecover and MIWA use plastic containers), some participants reported it was difficult to associate plastic packaging with sustainability even if it was reusable because plastic is controversial and widely viewed

as being bad for the environment. Participants also questioned how many cycles a reusable container will complete in its lifetime.

3.4.3.2 A lack of availability and variety

Some participants reported low awareness of RPSs due to a lack of availability. When RPSs were not offered in their neighbourhood, participants indicated that they would not seek such an RPS. Besides, participants stated that not all of the products they are used to buying might be available in RPSs. As they usually put little effort into thinking during grocery shopping and just purchase the same products, participants said it would not be easy to switch products to the ones provided in RPSs just for the sake of pursuing sustainability.

3.4.3.3 Concerns about product quality and safety

Most participants reported that they were used to checking the information on the product packaging before purchase. They stated that if this information was not present on the reusable packaging, it should be easily available elsewhere, such as displayed on dispensers. The most important information mentioned by participants consisted of ingredients, nutrition facts and expiration dates. These help them evaluate the product's quality and freshness, which are considered more important than pursuing sustainability. A lack of information (e.g., allergens) can also trigger health and safety concerns. When participants mentioned the expiration date, they also questioned how long the products had already been in dispensers, as they perceived the product quality may decline quickly over time in the system compared to pre-packaged products.

3.4.3.4 Contamination risks

Participants stated that they had become more sensitive to product hygiene after the breakout of COVID-19. Some participants reported that observing others' improper use (e.g., using noticeably dirty containers to dispense products) and the degree of intimate contact with the packaging (e.g., touching and putting it back after opening the lid) would trigger their contamination concerns.

Furthermore, participants generally associated fewer contamination risks with non-food products than with food products. Possible spillage around dispensers may evoke negative associations of improper use and unsatisfactory hygienic standards. Participants suggested that frequent cleaning of the system and communicating its cleanness were necessary to reduce their concerns.

In addition, participants expressed uncertainty about the previous usage and a lack of cues about the cleanness of the reusable packaging provided by the system. Even though most participants claimed they trusted that the packaging had been professionally cleaned, they wished to be provided with some indications that the packaging had been properly cleaned.

3.4.3.5 Packaging wear and tear

As reusable packages are designed for multiple uses, signs of wear and tear (e.g., scratches and other damage) may appear on the surface over time. Participants associated such wear and tear with contamination and bacteria, thereby triggering health and safety concerns.

Although signs of wear and tear on the reusable containers make the packaging less attractive and desirable in general, participants felt that it was more important for them to look neat than new. Participants reported worrying less about scratches made by themselves than those made by others. Superficial damage was more acceptable than functional damage. External scratches were more acceptable than internal ones because external scratches are not in direct contact with the product. However, severe scratches may trigger participants to return the packaging or switch to their private containers. To avoid wear and tear, participants stated that they would compare and select the neatest-looking container due to their habit of buying a new product.

3.4.3.6 Upfront financial investments and willingness to pay

Adopting RPSs on a large scale requires consumers to use many reusable packages at home. Buying containers or paying the deposit for reusable packaging increases the upfront investments necessary to use the system. Participants also expressed concerns about packaging damage that may cause them to forfeit their deposit.

Participants also stated that RPSs should reduce the product price to reward their waste-reduction efforts to bring and reuse the packaging. They were not willing to pay a premium unless the product quality was superior. Nevertheless, other participants recognised that using a sustainable system can be more costly considering the manufacturing and operating cost of the system.

Another barrier relating to the price mentioned by participants was that the final price was only shown when weighing the product and it was sometimes surprisingly high. Considering that items cannot be put back into the dispenser for reasons of hygiene, participants stated they would leave the filled packaging at the supermarket. These abandoned items will be problematic for the supermarket and were considered food waste because they cannot be sold again.

3.4.3.7 Extra time and effort

Compared to buying pre-packaged products, using RPSs requires more time and effort at different stages of adoption.

Preparation for reuse. Before going to the store, participants reported they would need to plan, such as checking which products should be refilled and deciding on the amount and type of packaging to bring. Or they would need to carry empty packages if they decided to return them to get a refund. Remembering to bring the packaging also increased the mental effort involved because several participants stated they did their

grocery shopping spontaneously after work. Taking the packaging with them the whole day was therefore not convenient.

In-store operation. Compared to grabbing pre-packaged products from the shelf, using RPSs involves more steps to get the desired products, which increases consumers' cognitive load, especially if consumers would need to queue for the product dispenser in a busy supermarket.

Storage and collecting. Participants stated that when they had several reusable packages, they wanted to store them together. Therefore, they needed to make enough space for storage. If they decided to return empty packages, they need to collect them after each use.

Dealing with leftovers. Many participants stated they usually buy more products before they run out of them. Consequently, small amounts of the product may be left in the reusable packaging when participants intended to refill it. Dealing with leftovers was considered a hassle. To tackle this issue, some participants stated they would keep some spare containers at home for refilling. However, they noted that those containers will take up more space.

Cleaning. Most participants reported they wanted to wash their packaging conveniently. Some participants stated it was a hassle to completely empty the packaging and wash the residue from inside the packaging by hand, especially if the product is fluid or sticky.

Table 6 shows example quotes of participants.

Table 6. The categories and example quote of the theme "Barriers to long-term adoption of RPSs"

	Categories		Example of quotes
3.4.3.1	Scepticism about environmental impacts		"I'm not even sure whether this is more environmentally friendly than just producing a new container that isn't reusable. You can also make the packaging cheap and not use so many raw materials." (P23)
3.4.3.2	A lack of availability and variety		"It depends on the product. You'll use the system only if it can provide the product you want." (P5)
3.4.3.3	Concerns about product quality and safety		"When you have something like cookies, quite often when they're exposed to the air, they become soft. So, oxygen shouldn't have an influence on the product – and not heat either." (P11)
3.4.3.4	Contamination risks		"Another thing is that people bring their own containers, and they are not clean, and their containers are touching the machines and get some cross-contamination as well." (P2)
3.4.3.5	Packaging wear and tear		"There are scratches. Um, that may be a hygiene issue, because if there are scratches, there may be bacteria in the scratches." (P6)
3.4.3.6	Upfront financial investments and willingness to pay		"It looks expensive. I think it's a compliment that it looks expensive, but you don't want that to be turned off. You want to show people it's not only durable but also probably economically attractive to do this." (P13)
3.4.3.7	Extra time and effort	Preparation for reuse	"You have to be prepared when you go shopping [...] I often do my groceries spontaneously after work or before I pick up the kids. So, you have to remind yourself to take this with you before you go." (P13)
		In-store operation	"You have to open the lid, put the container under the system, you have to perform a few actions. It takes me more effort than when I take just one package from the shelf." (P6)
		Storage and collecting	"You have to keep a lot of stuff at home. So, you need space for these. That will be a negative thing." (P13)
		Dealing with leftovers	"I want to refill, but there's still something left. Yeah, perhaps then you just buy a new pot. But what you wouldn't want is that you have everything twice because you didn't finish it. Then you buy a new one that doesn't fit in the cupboard." (P15)
		Cleaning	"If this one can't go in the dishwasher, that's a disadvantage for me to take into account." (P16)

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3.5 General discussion

3.5.1 Theoretical implications

This study provides a comprehensive overview of the different enablers and barriers that influence consumer adoption of RPSs at different usage stages. Our research corroborates and extends the existing literature in different ways.

First, we contribute to the literature on the design and form-giving of RPSs. Specifically, we add knowledge on the design of dispensers, while prior studies have focused on reusable packaging (e.g., Long et al., 2022; Madria & Tangsoc, 2019). Our study revealed that by having a novel appearance, dispensers could trigger consumers' exploration. Next, a natural appearance of the dispensers appeared to be congruent with the sustainable nature of RPSs. Furthermore, transparency was deemed important and contributed to positive inferences about product quality and freshness. These findings extend and corroborate prior research on single-use packaging demonstrating that transparent packaging attracts attention in-store, provides a visual cue for consumers to evaluate freshness and quality, and enhances the product's trustworthiness (Billeter et al., 2012; Simmonds & Spence, 2017). The effect of transparency appeared to be reinforced by the sound of product flow and the product's smell, which evoked hedonic pleasure. Despite these positive design features in RPSs, consumers also reported difficulties (e.g., controlling the product flow from dispensers, understanding digital instructions, etc) in effectively using the new system for the first time, resulting in high learning costs. This corresponds to prior research on product newness, which demonstrated that when the functional attributes of a new product are different from those of existing products stored in consumers' memory, it can be difficult for consumers to transfer relevant knowledge on attributes and usage to this new product (Mugge & Dahl, 2013). Therefore, even though novelty may stimulate consumers' interest and curiosity in the shopping experience, consumers will also look for familiar aspects that ease the perceived complexity and the learning burden of the novel offering by drawing on existing knowledge. Correspondingly, our results show that consumers who had already performed reuse behaviours and had engaged in similar systems appeared more prone to adopt this new RPS. In addition, we noticed that when any performance failure occurred, consumers tended to attribute the responsibility to themselves rather than the system, and felt they were not competent in using the system. Anxiety caused by in-store crowding could exacerbate this negative attribution (Dabholkar & Spaid, 2012), which might further impede the consumer from executing subsequent actions in the system.

Second, the findings extend research on product contamination (e.g., Argo et al., 2006; Baxter et al., 2016) that can lead to reluctance in adopting RPSs or undesired early replacement of reusable containers. According to Baxter et al. (2016), contamination is driven by three mechanisms, namely hygiene, utility, and territory. Our findings suggest that all three contamination mechanisms may occur for RPSs. First, although consumers generally trust the hygienic standards of RPSs, their sensitivity to disgust and observation of contaminated interaction with other users can activate hygiene concerns.

Next, the signs of wear and tear on the packaging, generated over multiple reuses, may evoke territorial contamination by being marked by strangers (Baxter et., 2016). Furthermore, our findings demonstrate that reusable packages with severe scratches in places in contact with the packed products or with functional damage are deemed less acceptable because these scratches may represent contaminants and a reduced aesthetic and functional value of the packaging. This is consistent with prior studies about utility contamination concerns (Baxter et al., 2017; Wallner et al., 2022). These visual imperfections make the packaging less desirable and decrease consumers' reuse intentions or trigger the replacement of containers, supporting previous research on returnable packaging (Magnier & Gil-Pérez, 2021). We contribute by showing that this effect could happen with both refillable packages offered by the system and consumers' private containers, although consumers minded less about wear and tear on their private containers. It is important to note that perceptions of contamination have important implications for the actual sustainability of RPS. To be environmentally better than an equivalent single-use package, it is crucial to ensure reusable packaging achieves a certain number of cycles before consumers deem them unacceptable to reuse due to wear and tear (Baird et al., 2022).

Third, our study enriches consumer perception regarding the environmental impact of RPSs in the literature. Prior studies mainly focussed on comparing RPSs' emissions, energy, and water usage, as well as food and packaging waste to those of disposable packaging (Beitzen-Heineke et al., 2017; Verghese et al., 2015), but consumer perceptions of RPSs' environmental value were not yet widely discussed. Overall, our results indicate that participants are generally positive about the environmental value of RPSs. Previous studies about pro-environmental behaviour suggest that sustainable actions can elicit positive emotions and a 'warm glow', which are viewed as an intrinsic reward and an increase in social worth (e.g., Hartmann et al., 2018; Tezer & Bodur, 2020). We found this warm glow also exists in the context of RPSs usage as consumers perceived a good feeling about preventing packaging waste and an increased social value as individuals. Nevertheless, the results of our study also demonstrated the challenge of consumers' scepticism towards the environmental impact of RPSs. This scepticism is triggered by the experienced difficulty in making inferences about the environmental benefits of RPSs and a lack of feedback to assess the outcome of reuse behaviours. Past research suggested that green scepticism negatively impacts consumers' evaluation of a product's environmental friendliness (Grebmer & Diefenbach, 2020) and decreases consumer intention to perform pro-environmental behaviours (Leonidou & Skarmeas, 2017). Consequently, there is a need to reduce scepticism about RPSs by providing trustworthy information and knowledge about the environmental impact of RPSs in comparison to single-use packaging for consumers to make informed purchase decisions.

Finally, our study suggests that, on the long term, the success of RPSs strongly depends on new habit formation. While most consumers exhibited a high willingness to adopt RPSs, they also reported a lack of availability and product variety, uncertainty about product freshness, higher costs, and inconveniences related to the usage of RPSs. These factors may require consumers to make compromises when replacing their habitually

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purchased products with reusable alternatives. Therefore, consumers' purchase intentions may not always translate into actual buying behaviour in the context of RPSs, corresponding to the 'intention-behaviour gap' widely acknowledged in environmental consumerism (e.g., Carrington et al., 2014; Gupta & Ogden, 2009). Furthermore, prior research suggests that the difficulty to form a new habit contributes to this gap (Bhamra et al., 2011). To use RPSs, consumers need to alter existing routines and develop new shopping patterns. Such changes are difficult because they require breaking well-ingrained unsustainable habits (buying products in single-use packages) to form new sustainable ones (reusing packaging through a system). Insights from psychology suggest that changing the environmental context can contribute to habit change because, in a new context, people will more easily review their behaviours and form new mental connections between this context and new behaviour (Mazar et al., 2021; Verplanken & Whitmarsh, 2021). It is questionable whether existing RPSs trigger a sufficient change in the environmental context to achieve such habit disruptions, as RPSs are generally implemented in stores next to traditionally single-use packaging, and therefore only represent a relatively small part of the total store space. To break habits, supermarkets and RPS designers should aim to make these context changes more prominent so that consumers can form new routines to use RPSs.

3.5.2 Practical implications for developing RPSs

In this section, we illustrate how practitioners can tackle barriers to adopting RPSs through design and marketing communication.

3.5.2.1 Reusable packaging system design

First, it is crucial to expand the availability and compatibility of RPSs to facilitate consumers' refill or return behaviour in different stores. For instance, retailers can select product categories for RPSs based on purchasing volume and supporting consumer decision-making on these FMCGs.

Second, consumers are used to evaluating products based on their packaging. In most RPSs, consumers read product information displayed on dispensers or receive labels afterwards, leading to a packaging-information separation that differs from pre-packaged products. Furthermore, consumers see the final price only after they have dispensed the products into the packaging. Informing consumers in advance about the price could prevent them from abandoning filled containers due to unexpectedly high prices. To offer sufficient information for consumers, smart technology can be implemented in RPSs. For instance, barcode systems or radio frequency identification (RFID) tags can track the location and contents of products and aid in managing value chains (Mahmoudi & Parviziomran, 2020), thereby conveying important information to the supply chain and consumers. This can compensate for the potential lack of communicative functions and increase the communicative power of the packaging in the RPS.

Third, regarding the structural and material durability of the packaging, consumers were more willing to reuse packaging that was robust for product protection, resistant to

changes in appearance, and easy to clean. This suggests that it is important to select materials that age gracefully and are not easily damaged or contaminated (Lilley et al., 2016; Greenwood et al., 2021). According to White et al. (2016), positioning wear and tear as a virtue (e.g., by emphasising the environmental benefits of multiple reuse cycles) could also increase the acceptance of reusable packaging with signs of usage.

3.5.2.2 Marketing communication on environmental impact

We advise practitioners to inform consumers about the conditions under which the environmental impact of RPSs is more virtuous than that of single-use packaging. For example, consumers expect that refilling the same packaging has a better environmental impact than returning the refillable packaging. However, this conflicts with the LCA of RPSs, which demonstrated that return shows slightly lower impacts than refill due to the differences between cleaning at home and collective cleaning by businesses (Greenwood et al., 2021). Consumers are not always correct in their perceptions of what is sustainable, suggesting that more communication is needed. Furthermore, past studies showed that consumers generally preferred paper, glass, and wood packaging over plastic packaging (Fernqvist et al., 2015; Greenwood et al., 2021). Consequently, when plastic is used in RPSs consumers tend to doubt their sustainability, indicating that the environmental impact of reusable plastics could be communicated better. We suggest that practitioners could reduce consumers' scepticism and evoke anticipated positive emotions by communicating the environmental and social impacts of RPSs, such as:

a. Emission and energy savings, packaging waste reduction and food waste prevention.

b. Environmental friendliness of the packaging (material).

c. Guidance on how to prolong the lifespan of reusable packaging and clarification on waste management of obsolete packages.

d. Tailored feedback about personal environmental contributions to emphasise the effectiveness of repeated RPSs usage.

3.5.2.3 Forming a new habit with RPSs

To help consumers form a new habit with RPS, practitioners should consider strategies that make the new habit more attractive and effortless (Bhamra et al., 2011; Verplanken & Whitmarsh, 2021). For instance, consumers complain that the cost of reusable packaging can be a barrier to start using RPSs. Instead of encouraging high consumer reuse rates through a deposit-refund system, free use of reusable containers may stimulate consumers to try out the RPS to break the old habit, as the first step to establishing a new habit. Next, an effortless repetition requires a stable and effective context that allows unobstructed and fast performance. In addition to the in-store RPS, it may also be effective to promote RPSs in the online context where a larger context change can easily be implemented. For instance, incentives can be provided in a supermarket application to indicate which products are available for consumers in

reusable packaging. The online context will also make it easier for consumers to return containers after use because they are delivered and picked up at their door.

3.5.3 Limitations and future research

The first limitation of this research is that only Dutch participants were included. The Dutch generally have a high education level and environmental awareness. Future research could recruit a wider range of participants from different cultural contexts. Second, the study took place in a lab setting and the researcher cleaned and reset the system after each session. In comparison to field studies in supermarkets, this lab setting enabled us to include a diverse range of participants and gain an understanding of general perceptions. Nevertheless, it may also have limited the external validity. Furthermore, our follow-up interviews aimed to understand the post-purchase usage of reusable packaging through self-reported behaviour. Consequently, there was no observation of their use at home or of repeated purchases in the supermarket. Future field research could investigate consumers' repeated interactions with RPSs. Third, we only explored one specific refillable packaging system with six dry food products. Some responses may differ for other RPS models (e.g., a returnable packaging system through a delivery service) or other product categories (e.g., liquid products, fresh products, and non-food products).

3.6 Conclusion

RPSs present a promising solution to tackle packaging waste by rethinking consumption patterns, thereby contributing to a societal transformation and more sustainable lifestyles. To increase adoption, practitioners should not only actively attract consumers to choose RPSs as alternatives in the pre-purchase stage but also reduce barriers and promote enablers to encourage consumers' long-term usage.

Our research aims to give an initial overview of factors influencing consumers' adoption in different stages. We encourage future research to explore specific interventions built on our insights to increase the adoption of RPSs and contribute to a more sustainable society.

3

PART II

INVESTIGATING

DESIGN INTERVENTIONS

Part II investigates two design interventions for RPSs and addresses SRQ2:

How can specific design interventions address challenges in the long-term adoption of RPSs?

/ *Chapter 4* /

How many times should I use my reusable packaging? Exploring the role of an environmental break-even point in shaping consumers' intention to reuse

Reusable packaging systems (RPSs) only become less environmentally harmful than single-use after each packaging is reused a minimum number of times, defined as the environmental break-even point (e-BEP). It is important that consumers have knowledge or awareness regarding this critical threshold at the moment of purchase, aligning their choices with behaviour, and improving the chance of sufficient reuse.

Chapter 4 explores the effect of communicating an e-BEP on consumers' perception and intention to reuse. This research consists of an experiment (N = 276) followed by open-ended questions, and a follow-up study. Based on the results, we propose the effect of e-BEPs on consumer evaluations and derive theoretical and practical implications to encourage sustained reuse behaviour in the long run.

4.1 Introduction

Reusable packaging systems (RPSs) can only offer environmental benefits in comparison to single-use equivalents if these are reused a minimum number of times by consumers (Caspers et al., 2023; Cottafava et al., 2021). In this paper, we define this critical juncture as the environmental break-even point (e-BEP) of RPSs. Despite the essential importance of surpassing the e-BEP, it is not guaranteed that consumers will achieve this naturally.

Reusable packaging is usually made from durable materials to support extended use and requires additional energy for cleaning and transportation (Changwichan & Gheewala, 2020; Greenwood et al., 2021). Therefore, to achieve a lower environmental footprint, each packaging must reach its e-BEP, a minimum number of reuses after which reusable packaging is less environmentally harmful than its single-use equivalents (Cottafava et al., 2021; Du Rietz & Kremel, 2024; Greenwood et al., 2021). This metric is used to measure the environmental performance of an RPS, usually through a life cycle assessment (LCA) comparing different types of reusable and single-use packages (Betts et al., 2022; Hitt et al., 2023). For instance, reusable takeaway polypropylene (PP) containers demonstrate environmental benefits after being reused 3-39 times in comparison to extruded polystyrene containers (Gallego-Schmid et al., 2018); PP reusable coffee cups achieve the e-BEP after ±50 uses when compared to PP single-use cups (Cottafava et al., 2021); stainless-steel coffee cups even require 140 reuse times to offset the environmental impact compared to single-use takeaway cups (Changwichan & Gheewala, 2020). These studies showed that whichever material is chosen for reusable packaging, ensuring sufficient reuse, and thereby surpassing the e-BEP of the RPS is essential to make the CE effective in reducing the environmental impact of packaging. Consequently, RPSs should help consumers adapt their behaviours and guide consumers to perform sufficient reuse practices (Bradley & Corsini, 2023; Du Rietz & Kremel, 2024), while preventing unintended consequences that may offset environmental gains (Das et al., 2023).

Several recent studies indicated that consumers generally exhibit positive attitudes towards the concept of reuse and express high intentions to adopt RPSs (Magnier & Gil-Pérez, 2023; Miao et al., 2023a, 2023b). However, actual reuse behaviours especially the number of reuses per packaging can vary drastically among consumers (Caspers et al., 2023; Du Rietz & Kremel, 2024). Challenges include overconsumption of reusables, underuse due to forgetfulness, discontinuation in favour of single-use options, and premature disposal (Herweyers et al., 2024; Tassell & Aurisicchio, 2023). These unintended behaviours may partly stem from the gap between consumer subjective perception of packaging sustainability and objective LCA results, in that consumers often overestimate the sustainability of their packaging choices due to limited knowledge (Boesen et al., 2019). Without being informed of e-BEPs, consumers can inaccurately deem that they have already behaved sustainably when they first began using an RPS, unaware that their packaging never passed the e-BEP throughout its entire lifespan, thereby leading to more detrimental environmental consequences than

single-use packaging (Cottafava et al., 2021). Communicating the e-BEP can be beneficial in helping new consumers purchase reusable packaging consciously and serving as a reminder for sustained reuse.

Despite the merits of communicating e-BEPs for RPSs, there are also some potential drawbacks. First, the e-BEP communicates that reusable packaging is made of more resource-intensive materials or consumes additional energy (Fetner & Miller, 2021), potentially triggering consumers' green scepticism about the intrinsic sustainability of reusable packaging. This may make them doubt whether using robust, reusable packaging is a more sustainable option compared to lightweight single-use packaging. Second, passing a high e-BEP might be viewed as difficult because it requires frequently reusing the same packaging over a certain period (Cottafava et al., 2021). Consumers may question the effectiveness of their individual reuse behaviour in contributing to environmental sustainability, deterring their intention to continue reusing the RPS.

While multiple studies have examined consumer perceptions towards the sustainability of reusable packaging (Greenwood et al., 2021; Magnier & Gil-Pérez, 2023), empirical studies that test the effects of communicating e-BEPs on consumer perceptions remain scarce. The purpose of this study was two-fold: (a) to quantitatively examine the effect of different e-BEP conditions on consumers' green scepticism, perceived consumer effectiveness and intention to reuse, and (b) to explore consumers' estimations of reuse times and to understand their underlying rationales qualitatively.

4.2 Theoretical background and hypotheses development

4.2.1 The influence of an e-BEP on consumers' intention to reuse

Various studies suggest that providing consumers with comparable and numerical information about environmental impacts can aid informed purchase decisions, such as using eco-labels or CO2 emission levels on the packaging (Camilleri et al., 2019; Krah et al., 2019). Similarly, the e-BEPs represent numerical indicators that allow consumers to compare the environmental impact of reusable packaging with single-use alternatives. Moreover, e-BEPs can also serve as concrete goals for consumers to judge their performance and anticipate either the satisfaction of achievement or the disappointment of failure (Andor & Fels, 2018). This notion aligns with the goal-setting strategy, which has proven to be successful in encouraging sustainable consumption, such as household energy conservation (Abrahamse et al., 2007), preference for unpackaged products over packaged ones (Tate et al., 2014), and selection of sustainable products (Kanay et al., 2021).

Our study assesses the effect of e-BEPs on shaping consumers' intention to reuse. We define intention to reuse as the likelihood that consumers will continue engaging with an RPS after trying it once. While an e-BEP provides a concrete goal for consumers to

strive for and is likely to influence intention to reuse an RPS, we propose that this effect varies depending on the communicated e-BEP level. Prior research has shown that while difficult goals can lead to greater achievement, goals set at too high a level may deter individuals from initial action (Locke, 1996). Goals are more likely to be effective motivators when perceived as attainable (Locke & Latham, 2002). Hence, when consumers are presented with a low e-BEP, the perceived low effort of meeting this goal may enhance their intention to reuse. In contrast, a high e-BEP may be perceived as demanding, potentially hindering consumers' initial adoption and diminishing their intention to reuse. Accordingly, we hypothesise:

> **H1:** Consumers' intention to reuse the RPS will be higher when a low e-BEP is communicated, in comparison to when a high e-BEP is communicated.

4.2.2 The role of green scepticism and perceived consumer effectiveness

Despite the use of sustainable materials in packaging being increasingly advertised (Granato et al., 2022a; Magnier & Schoormans, 2015), consumers still have a limited understanding of the environmental impact associated with packaging (Du Rietz & Kremel, 2024), and their perceptions may diverge from LCA outcomes (Ertz, et al., 2017a; Steenis et al., 2017). Some recent qualitative studies found this also applies to RPSs. When environmental communication of RPSs is absent, consumers may demonstrate green scepticism or worry PRSs produce more carbon footprints due to additional transportation and cleaning and doubt the effectiveness of their reuse actions in RPSs (Liu et al., 2023; Miao et al., 2023b). Consequently, consumers expect to notice the environmental analysis associated with reusable packaging (Liu et al., 2023; Miao et al., 2023b).

Drawing from a measure of scepticism developed by Mohr et al (1998), we define green scepticism as consumers' doubts about the intrinsic sustainability of reusable packaging. Green scepticism often arises from mislabelling, misinterpretation, and misrepresentation of products (Grebmer & Diefenbach, 2020). Consequently, even though consumers may want to purchase green products, green scepticism may lead them to deter the purchase or discontinue existing green purchases (Nguyen et al., 2019). Previous studies have suggested enhancing consumer trust in eco-products by communicating their environmental impact transparently (Navas et al., 2021; Polyportis et al., 2022). In our study, an e-BEP represents a threshold that aims at improving consumers' understanding of the environmental performance of reusable packaging. However, a potential challenge arises as consumers may associate a high e-BEP with high resource demands and additional energy consumption, raising doubts about the packaging's intrinsic sustainability, and thereby triggering green scepticism. Therefore, we propose:

> **H2:** Consumers' green scepticism about the RPS will be lower when a low e-BEP is communicated, in comparison to when a high e-BEP is communicated.

In addition to green scepticism, previous research has highlighted the importance of perceived effectiveness at every stage of sustainable consumer behaviour and decision-making (Straughan & Roberts, 1999). Perceived consumer effectiveness is defined by Ellen et al. (Ellen et al., 1991) as the extent to which individuals believe their actions can make a difference in solving a problem. In most cases, consumers are more likely to engage in sustainable behaviour when the environmental benefits are communicated, as they are aware of the positive outcomes of their actions (Kim & Choi, 2005). If consumers are informed of e-BEPs, they might be more convinced that they can contribute to the environment after achieving these numbers. However, whether consumers can surpass an e-BEP in reusable packaging may vary depending on the specific e-BEP level. Previous research has indicated that consumers prefer and commit to easily attainable goals in their sustainable actions, as they perceive such goals as a quick way to realize sustainable changes (Scott et al., 2011). In contrast, an abstract or difficult goal may lead to green fatigue and demotivation due to a lack of hope for a meaningful change (White et al., 2019). Correspondingly, we expect that a low e-BEP represents an easy goal, and a high e-BEP represents a difficult goal. We hypothesise:

> **H3:** Perceived consumer effectiveness about using RPSs will be higher when a low e-BEP is communicated, in comparison to when a high e-BEP is communicated.

4.2.3 Serial mediation of green scepticism and perceived consumer effectiveness

Building on the above arguments, we also proposed examining the serial mediation effect of green scepticism and perceived consumer effectiveness on the relationship between e-BEP levels and intention to reuse. Prior studies have consistently shown a negative correlation between green scepticism and perceived consumer effectiveness (van der Waal et al., 2022), while perceived consumer effectiveness is positively related to green purchase intention (Kim & Choi, 2005). Based on our hypotheses above, we anticipate that a lower e-BEP will lead to reduced green scepticism towards an RPS, thus improving perceived consumer effectiveness about reuse behaviour and, ultimately leading to a higher intention to reuse this RPS than that with a higher e-BEP. Accordingly, we expect:

> **H4:** The green scepticism and perceived consumer effectiveness serially mediate the effect of e-BEP levels on the intention to reuse the RPS.

4.3 Method

4.3.1 Pre-test for determining the e-BEPs used in the study

To establish e-BEP conditions, we conducted a pre-test with 41 participants recruited from Prolific. Prolific is a platform based in the UK that helps researchers recruit participants globally and has produced high-quality data for scientific research (Greenwood et al., 2021; Peer et al., 2017). The pre-test used a within-subjects design

with seven e-BEP levels (3 to 45 times) for rice packaging. Rice was selected as our target product because it usually comes in single-use plastic bags, paper bags or cardboard boxes, which makes various e-BEPs of reusable packaging possible. Besides, rice is a dry staple food product readily available in supermarkets, and consumers can easily imagine using RPSs for it. For each e-BEP, participants rated their perceived effort to reach it on a 7-point scale (1= 'It will be easy to reach'; 7= 'It will be difficult to reach'). A repeated-measures ANOVA was performed to evaluate the effect of these e-BEP levels on perceived effort. Results are presented in **Table 7**.

Table 7. Means (M) and standard deviations (SD) of perceived effort

	M	SD
3 times	1.46	1.00
5 times	1.73	0.92
10 times	2.61	1.60
15 times	3.29	1.85
25 times	4.07	2.10
35 times	4.88	2.06
45 times	5.24	2.01

Post-hoc pairwise comparisons with a Bonferroni adjustment indicated that all stimuli were significantly (or marginally) different from each other. We decided on 5 and 45 to represent low and high e-BEPs (M_{low} = 1.73 vs. M_{high} = 5.24, p < .001). Besides, we included 25 as a boundary condition to represent a medium e-BEP (M_{medium} = 4.07) that participants perceive as neither easy nor difficult to reach. These three selected numbers align with the LCA of reusable plastic packaging compared to single-use alternatives made of plastic or cartons (Thomassen et al., 2024; Zimmermann & Bliklen, 2020).

4.3.2 Study design and stimuli of the main study

We adopted a mixed-method approach to provide both quantitative and qualitative insights. A between-subject design with a single factor consisting of four conditions (environmental break-even point: absent vs. low vs. medium vs. high) was used. The stimuli consisted of four reusable packaging labels for rice designed by the researcher using the digital graphic design software Adobe Illustrator CC 2022. Basic information about rice, a rice picture and a reuse logo were consistently shown on all labels. A fake brand, 'Sunrice', was created to make the stimuli realistic and avoid brand biases (Orth et al., 2010). The control condition contains a sentence 'This packaging is reusable.' In three experimental conditions, an additional sentence about the e-BEP 'It will have a lower environmental impact than single-use packages after being reused 5/25/45 times.' was added. **Figure 16** shows the final design of the stimuli.

Figure 16. Packaging labels with absent, low (5 times), medium (25 times) and high (45 times) e-BEPs

In addition, a professionally produced video was used in the survey to demonstrate all the steps of using an RPS and stimulate participants to consider the potential barriers of RPSs in their evaluations. To maintain neutrality and eliminate potential biases, the video excludes the face of the actor, focusing solely on hand movements throughout the process. This prevents potential biases resulting from a lack of identification (e.g., age, gender, and culture) with the actor in the video. **Figure 17** provides a visual storyboard of this video.
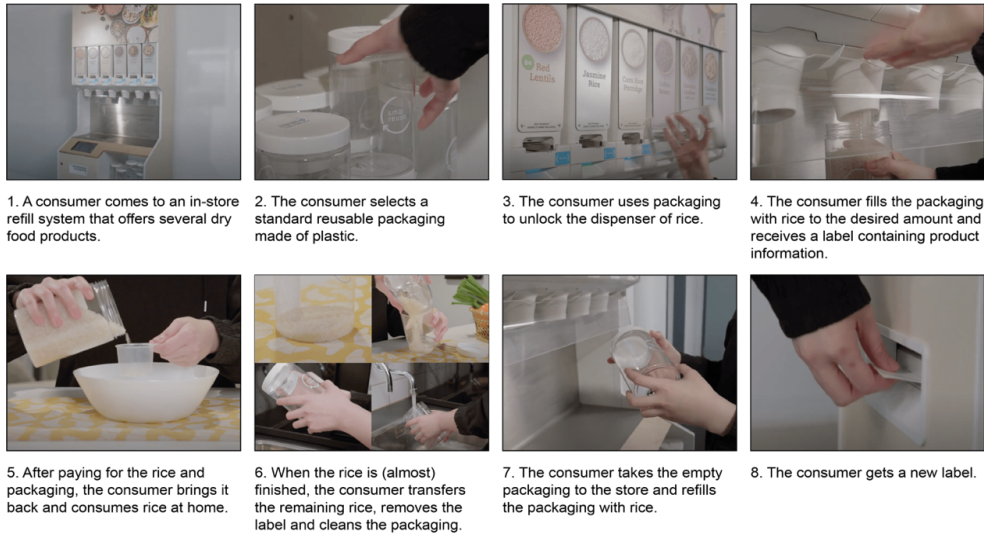
Figure 17. Visual storyboard consisting of video screenshots

4.3.3 Data collection and sample

The online survey was created using Qualtrics and distributed to 281 participants recruited via Prolific in May 2023. The participant pool of Prolific is known for its demographic diversity (Peer et al., 2017). Several pre-screen criteria of interest were used based on the following criteria: age between 18 and 75 years to ensure competence in using the RPSs presented in this study; residency in the UK or the Netherlands, where reusable packaging is available in the market; fluency in English to comprehend the textual scenarios and questions; and being the primary grocery shopper in the household to provide more informed responses about packaging. Participants were informed that their responses would be anonymous and confidential, reducing the social desirability bias. Each participant was randomly presented with one of the four experimental conditions. After watching the video and reading the information on the assigned label, participants responded to a series of questions about the packaging and their individual characteristics. Each participant was paid £ 1.5 for completing the survey in approximately 10 minutes. The study was approved by the Human Research Ethics Committee of Delft University of Technology (reference number: 2544).

4.3.4 Measures and open-ended questions

The measurement scales used in this study were mainly adapted from previously validated instruments to suit the context of reusable packaging. Items in each scale were displayed in a random order. The reliability of all the scales was adequate with Cronbach's alpha, with all scores above 0.70 indicating good internal consistency (Mackison et al., 2010). All construct items used a seven-point scale, as presented in **Appendix B**.

Previous studies have shown consumers seem overly optimistic about RPSs (Magnier & Gil-Pérez, 2023; Miao et al., 2023b). It is thus crucial to instil a more realistic mindset and stimulate critical evaluations within the study. To achieve this, the survey started with an open-ended question prompting participants to identify potential barriers to adopting this RPS. Following this, participants assessed use complexity, product availability and value barriers associated with RPSs (adapted from Adjei et al., 2010; Sang et al., 2022). These questions were not subject to a specific analysis but aimed to trigger deliberate responses. Subsequently, to test our hypotheses, participants rated the dependent variables and mediators including intention to reuse (ITR), which is the extent to which participants would be likely to reuse the packaging to purchase rice; green scepticism (GS), which represents the doubt or certainty about the intrinsic sustainability of reusable packaging; and perceived consumer effectiveness (PCE), which is related to the belief in their ability to contribute to the environment by adopting this RPS (adapted from Kim & Choi, 2005; Leonidou & Skarmeas, 2017). One item "To show you are still paying attention, please select 'strongly disagree'" was inserted between the items of PCE and acted as an attention check to prevent the inclusion of respondents who did not pay sufficient attention to the questionnaire. Additionally, we also asked participants to estimate the number of reuses per year (i.e. reuse frequency per year) and the number of years they would reuse this packaging (i.e. lifespan of packaging), complemented by open-ended questions seeking rationales for their estimates. After that, participants also responded to two manipulation checks regarding the information meaningfulness of the e-BEP (adapted from Pettinico & Milne, 2017) and the perceived effort to achieve the e-BEP (self-developed). Green purchase behaviour (GPB) was measured as a control variable to remove potential bias due to higher environmental concern of certain participants. The questionnaire ended with several questions about demographic characteristics including age, gender, and education level, as well as the size of the household.

4.4 Results

4.4.1 Attention check and manipulation check

Five participants who failed the attention check were excluded from the analysis to maintain data quality. This resulted in 276 responses that also fully completed the questionnaires being examined (age range between 18 and 75 years, M_{age}=41.46, SD_{age} = 13.81, female: 52.9%, male: 46.7%, prefer not to say: 0.4%). The results of the independent t-test showed that participants perceived a higher information meaningfulness of the e-BEP when it was present on the packaging than when it was absent ($M_{present}$ = 5.71 vs. M_{absent} = 1.87, t (274) = -18.89; p < .001). The one-way ANOVA test with linear contrasts indicated a positive linear trend for perceived effort across e-BEP levels (M_{low} = 3.43 vs. M_{medium} = 4.24 vs. M_{high} = 4.54, p < .001), suggesting that higher e-BEP levels were perceived as more effortful for consumers to surpass. Therefore, our manipulations of the e-BEP conditions were successful.

4.4.2 The effects of e-BEP conditions on intention to reuse, green scepticism and perceived consumer effectiveness

To determine how e-BEP conditions influence consumers' evaluations and behavioural intentions, we conducted three separate analyses of covariances (ANCOVAs) with ITR, GS and PCE as the dependent variables, e-BEP conditions as an independent variable, and GPB as a covariate. When the covariate was not significant, we removed it from the ANCOVAs. The assumption of homogeneity of variances was violated for ITR and PCE. The bootstrap method was therefore used for non-parametric analyses as it does not make any assumptions about the sampling distributions (Preacher & Hayes, 2008). The current study used 5000 bootstrapped samples with a 95% confidence interval to provide robust estimates (Banjanovic & Osborne, 2016). After controlling for GPB, there were no significant differences in ITR between the different e-BEP conditions (F (3, 271) = .37, p = .78). We compared means and standard deviations (SD) of each dependent variable in the studied conditions. As can be seen in **Table 8**, participants have positive ITR in all conditions (all means > 4.00). Besides, there was no significant difference in GS between (F (3, 271) = 2.06, p = .11) and PCE (F (3, 271) = 1.11, p = .35) between the different e-BEP conditions. These results do not support **H1**, **H2** and **H3**, suggesting that e-BEP conditions did not significantly impact any of these three dependent variables. As there was no significant effect found, we did not further examine the hypothesis of the serial mediation of GS and PCE (**H4**).

Table 8. Descriptive statistics of dependent variables for all conditions in the main analysis

	Absent e-BEP (N=70)	Low e-BEP 5 times (N=70)	Medium e-BEP 25 times (N=68)	High e-BEP 45 times (N=68)
Intention to reuse (ITR)[a]	4.90 (1.51)	4.74 (1.64)	4.65 (1.80)	4.66 (1.95)
Green scepticism (GS)[a]	2.90 (1.40)	2.97 (1.48)	3.24 (1.48)	3.46 (1.78)
Perceived consumer effectiveness (PCE)[a]	5.03 (1.33)	4.88 (1.60)	5.04 (1.49)	4.69 (1.83)

[a] Means are reported (constructs measured on scales 1 to 7), standard deviations in brackets.

4.4.3 Reuse frequency and lifespan of packaging

4.4.3.1 Quantitative analysis of numerical estimations

The results of numerical estimations showed that the reuse frequency and lifespan of each packaging varied greatly from 0 to 100, with mean values of 14.13 reuses per year and 6.77 years in usage. This resulted in the total number of reuses of one packaging varied from 0 to 10000 with a mean value of 159.27 times. To ensure the accuracy of our analysis, we did an outlier test to exclude extreme values. Specifically, we excluded values above the upper quartile plus three times the interquartile range - the number of reuses above 302 (N=23). Subsequently, one-way ANOVA analyses were performed on the remaining samples (N=253). The results revealed that the total reuse times did

not statistically differ between the e-BEP conditions (M_{absent} = 52.43 vs. M_{low} = 39.51 vs. M_{medium} = 38.59 vs. M_{high} = 41.37, p = .51)[1].

4.4.3.2 Qualitative analysis of the rationale for the estimations

The qualitative responses were collected from all participants (N=276) and coded using Atlas.ti, a qualitative analysis software. We followed an inductive procedure that intended to group conceptually similar topics into more general codes, resulting in 53 codes across eight categories (**Appendix B**). Most findings aligned closely with previous qualitative interview research on RPSs (see Miao et al., 2023b). For this study, our analysis primarily focused on elaborating the five categories relevant to consumer responses to the e-BEPs, thereby seeking additional insights for the main study.

General optimism towards the concept of reuse

Overall, most participants expressed a strong sense of optimism towards reuse. Some consumers considered RPSs a permanent practice and a future mainstream. Many participants believed they could continue reusing packaging until it was broken or lost. In addition, some participants anticipated that reusing packaging could demonstrate their environmental responsibility to the planet and contribute to waste reduction.

> (50 years) If they're around for the rest of my life, and it works, then I would use it for the rest of my life. (P98)

The lack of references to make quantitative estimations of reusable packaging

Despite positive anticipations, participants struggled to make quantitative estimations of reusable packaging without references or physically experiencing the RPS. Their estimations about the reuse frequency primarily relied on several factors, such as grocery shopping frequency, packaging size, and product demands.

> (12 times per year) This is a vague estimate, and the realistic number greatly depends on the product. Some products I need to rebuy nearly every week, while other products only once or twice a year. (P175)

Estimating the lifespan of each reusable packaging was even more difficult. Some participants expressed a lack of knowledge regarding packaging durability and emphasised the need for additional information to make accurate assessments. Perceptions of plastic packaging varied, with some participants viewing plastic as long-

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[1] To verify that the removal of the outliers did not influence the findings, we also performed a non-parametric Kruskal-Wallis test on the full dataset (N=276). The results corroborated the findings of the one-way ANOVA, showing no significant differences in the estimation of total reuse times among the four conditions (H (3) = 5.203, p = .157). This consistency across different statistical methods ensures a correct interpretation and enhances the validity of our findings.

lasting while others considered it non-durable. Participants tended to refer to their prior experience with similar plastic containers to make a guess.

> (3 years) It's a complete guess, no way to tell without trying it. (P17)

> (1 year) I can't really estimate the durability of a product that I've never used. (P105)

Diverse interpretations of the e-BEP

Most participants who were informed of e-BEPs generally recognised that increased reuse times of packaging could amplify positive environmental impacts. However, some participants in the high e-BEP condition reported that this number was too high and would not start using this packaging at all (i.e. total reuse time equals 0). This suggested that a high e-BEP could be viewed as a potential barrier that demotivated the initial adoption.

> (0 years) Too much hassle, especially as it states that it takes 45 uses before it lowers the environmental impact. (P280)

It is worth noting that two participants wrongly interpreted the e-BEP as the lifespan of packaging, mistakenly using it as a reference for judging the durability of packaging. Consequently, their estimations of reuse times and packaging lifespan were also counted according to this e-BEP.

> (2 years) The life expectancy of the containers is 45 uses. (P233)

Low involvement in reusable packaging

Packaging is seen as a low-involvement item. Several participants reported that packaging is always sold at an affordable price and easily makes its money worthy. Therefore, these participants usually make purchase decisions without considering the number of reuses. Some participants expressed that they would initially adopt the RPS for fun but failed to repeat this behaviour in the long term due to boredom. As a result, participants can put the packaging aside or purchase a new one.

> (1 time) I think this idea would be fun for the first time but is not realistic for long-term use. (P64)

Besides, some participants mentioned that plastic packaging can generate scratches or superficial damage, which makes it less desirable. Participants preferred to use neat-looking packaging to store food and tended to replace their worn-out reusable packaging. Additionally, several participants reported they only paid little attention to their reusable packaging and sometimes expected that they would lose or break it as a result.

> (6 years) Things like this are liable to be left behind sometimes, maybe they break, but I wouldn't be so attached to them and not mind buying a new one. So, I probably wouldn't prioritise looking after it. (P196)

Forgetfulness in reusing packaging

Many participants acknowledged that remembering to bring their reusable packaging requires additional mental effort. People admitted that they could easily forget their reusable packaging and would obtain new ones or temporarily switch to buying single-use packaging, especially during spontaneous shopping trips. The negative consequences noted included reusable packaging being excessively purchased, accumulated at home, and left unused in storage, which would eventually hinder its role in waste reduction.

> (2 times per year) I would maybe use it once or twice and then forget about it. It will just become another jar in the kitchen. (P132)

4.4.3.3 Summary

The qualitative results reveal that many participants had a limited understanding of the implications of e-BEPs and found it difficult to make quantitative estimations without physically using reusable packaging. Given the limited availability of RPSs in the market (Steinhorst & Beyerl, 2021), consumers may never have engaged with RPSs before participating in the study. Existing literature suggests that people might be overly optimistic about adopting socially desirable behaviours but tend to forget or encounter inconvenience in unfamiliar routines (Gollwitzer & Sheeran, 2006). A recent qualitative study highlights consumers who had prior experience with reusable packaging reported more practical barriers in habit changes than inexperienced consumers (De Temmerman et al., 2023a). Therefore, we assumed that consumers who have never reused packaging may not fully recognise the barriers to changing their habits and may not believe it would be hard to embed reusable packaging in their grocery routines.

In light of these considerations, we posited that the lack of experience may contribute to a general sense of optimism, which could explain the non-significant differences in ITR, GS and PCE across e-BEP conditions. Consequently, we decided to further explore the effects of the e-BEP conditions on the dependent variables under the distinction between experienced and inexperienced consumers with reusable offerings.

4.4.4 Post-test and analysis

For the post-test, we revisited all participants of the main study to inquire about their prior experience with reusable packaging. It was executed by asking an additional question: 'Have you ever used any reusable packaging similar to the one showcased in the study?' We incorporated several reusable packaging examples that can be viewed as 'similar' experiences, including but not limited to reusable coffee cups on the go, products delivered in returnable containers, private refillable containers, and freshly squeezed orange juice in refillable bottles.

Out of the initial 276 participants in the main study, we received 208 responses in our post-test. We examined whether the subset of the sample included in this post-analysis (N=208) was comparable to the full sample analysed in the main study (N=276). Results

of T-tests showed that there were no significant differences in terms of the means of ITR (M_{subset} = 4.78 vs. M_{full} = 4.74, p = .82), GS (M_{subset} = 3.17 vs. M_{full} = 3.14, p = .81) and PCE (M_{subset} = 4.93 vs. M_{full} = 4.91, p = .82). Furthermore, demographics were also similar (ages all ranges between 18 and 75 years, M_{subset} = 42.35 vs. M_{full} = 41.46, p = .49, female: 54% and 53%, respectively). These results demonstrate that the subset of the sample and the full sample are comparable, demonstrating that the post-test data was not biased towards any particular subgroup. Based on the responses to our additional question, we created a dummy variable for prior experience with reusable offerings using 0 for inexperienced participants (N=120) and 1 for experienced participants (N=88).

4.4.4.1 The main effect of experience on intention to reuse, green scepticism and perceived consumer effectiveness

We conducted three ANCOVAs with experience (0 and 1) as the independent variable, and ITR, GS and PCE as the dependent variables. GPB was included as a covariate. Our results revealed no significant effect of experience on either ITR ($M_{experienced}$ = 4.65 vs. $M_{inexperienced}$ = 4.87, p = .35) or the total number of reuses ($M_{experienced}$ = 37.03 vs. $M_{inexperienced}$ = 37.48, p = .95). However, experience had a notable effect on both GS (F (1, 205) = 6.09, p < .05) and PCE (F (1, 205) = 5.18, p < .05). Participants with prior experience in general report higher GS ($M_{experienced}$ = 3.48 vs. $M_{inexperienced}$ = 2.95) and lower PCE ($M_{experienced}$ = 4.65 vs. $M_{inexperienced}$ = 5.13) compared to inexperienced participants. This result indicates that experienced consumers tend to be more critical in their evaluations of RPSs than inexperienced consumers. Descriptive statistics are presented in **Table 9**, and the results are illustrated in **Figure 18**. Subsequent analyses were performed separately for the inexperienced and experienced groups.

Table 9. Descriptive statistics of dependent variables for all conditions in the post-analysis

	Inexperienced groups (N=120)				Experienced groups (N=88)			
	Absent (N=33)	Low (N=29)	Medium (N=32)	High (N=26)	Absent (N=21)	Low (N=21)	Medium (N=21)	High (N=25)
Intention to reuse (ITR)[a]	4.83 (1.71)	4.53 (1.64)	4.66 (1.85)	4.84 (1.85)	5.14 (1.26)	5.43 (1.33)	4.68 (1.73)	4.29 (2.09)
Green scepticism (GS)[a]	2.93 (1.29)	2.93 (1.32)	3.11 (1.42)	3.10 (1.43)	2.81 (1.64)	2.85 (1.22)	3.55 (1.63)	4.20 (1.63)
Perceived consumer effectiveness (PCE)[a]	5.24 (1.30)	4.91 (1.46)	5.02 (1.67)	4.78 (1.77)	4.90 (1.60)	5.45 (1.12)	5.05 (1.24)	4.05 (1.94)

[a] Means are reported (constructs measured on scales 1 to 7), standard deviations in brackets.
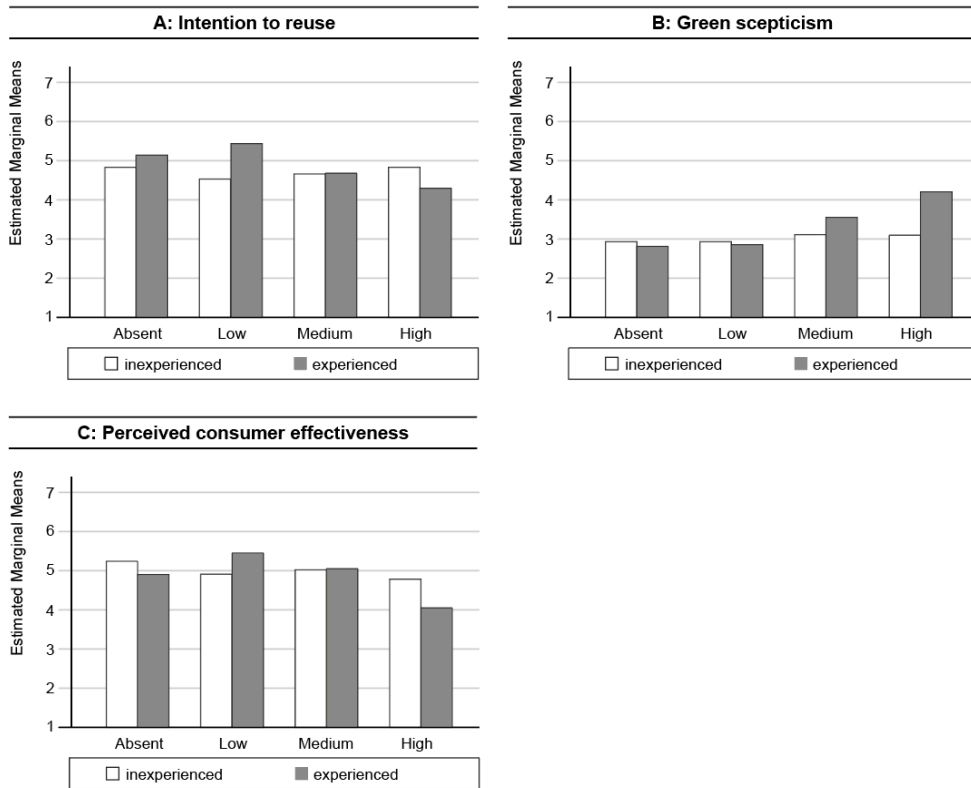
Figure 18. Bar charts showing the differences in the intention to reuse (A), green scepticism (B) and perceived consumer effectiveness (C) of inexperienced participants and experienced participants for all conditions in the post-analysis

4.4.4.2 The effect of e-BEP conditions on intention to reuse, green scepticism and perceived consumer effectiveness of inexperienced and experienced consumers

First, we conducted three ANCOVAs for the inexperienced group (N=120) with e-BEP conditions as an independent variable, and ITR, GS and PCE as dependent variables while controlling for GPB as a covariate. No significant effects of e-BEP conditions on dependent variables were observed in the inexperienced group (all p values > .10), consistent with the results of our main study.

Next, we performed three ANCOVAs for the experienced group (N=88). When the results were significant, we conducted post-hoc tests adjusted with the Bonferroni correction for pairwise comparisons to determine where the differences occurred between the conditions. The assumption of homogeneity of variances was violated for ITR and PCE, and bootstrap methods were applied using 5000 generated samples with a 95% confidence interval.

Intention to reuse (ITR). Bootstrap analysis indicated no main effect of e-BEP conditions on ITR for the experienced group (F (3, 83) = 1.78, p = .16). A marginal effect of e-BEP conditions on ITR was identified between the low and high e-BEP condition (B = .94, SE = .50, p = .07, 95% CI: [-.07, 1.89]). Specifically, experienced consumers exhibit higher ITR when a low e-BEP is communicated compared to when a high e-BEP is communicated (M_{low} = 5.43 vs. M_{high} = 4.29, p = .07). This is in line with the direction of **H1** but for experienced consumers only.

Green scepticism (GS). The results of ANCOVA demonstrated a significant main effect of e-BEP conditions on GS (F (3, 83) = 4.24, p < .01). Specifically, experienced consumers have significantly lower GS for reusable packaging with a low e-BEP than that has a high e-BEP (M_{low} = 2.85 vs. M_{high} = 4.20, p = .05). This aligns with **H2** but for experienced consumers only. Additionally, GS for reusable packaging with a high e-BEP was significantly higher than that without an e-BEP (M_{high} = 4.20 vs. M_{absent} = 2.81, p < .05). No significant difference was found between the low and absent e-BEP conditions (M_{low} = 2.85 vs. M_{absent} = 2.81, p > .10). These findings suggest that communicating a high e-BEP may increase GS in the experienced group.

Perceived consumer effectiveness (PCE). Bootstrap analysis indicated a significant main effect of e-BEP conditions on PCE for the experienced group (p = .05). Specifically, the mean difference between the low e-BEP condition and the high e-BEP condition (B = -1.17, SE = .47, p < .05, 95% CI: [-2.10, -.25]) reached statistical significance whereas the mean difference between the low e-BEP and absent e-BEP conditions (B = .37, SE = .39, p = .35, 95% CI: [-.37, 1.13]) did not. These results suggest that experienced consumers are more likely to have higher PCE when a low e-BEP is communicated, in comparison to when a high e-BEP is communicated (M_{low} = 5.45 vs. M_{high} = 4.05, p < .05). This aligns with **H3** but for experienced consumers only.

4.4.4.3 Mediating effect

The results of ANCOVAs indicated that experienced participants were in general more sensitive to the increasing e-BEP levels, whereas the inexperienced participants were not. As we found significant differences, we further tested whether the relationship between levels of e-BEPs and ITR is serially mediated by GS and PCE for the experienced group.

We performed a serial mediation test (PROCESS macro, model 6 with 5000 bootstrapped samples; Hayes, 2013) with e-BEP levels (including low, medium and high levels) as a three-condition independent variable, GS and PCE as mediators (in that order), and ITR as the dependent variable. The PROCESS results showed a negative and significant indirect effect (B = -.22; SE = .14; 95%CI: [-.55; -.02]) and an insignificant direct effect of e-BEP levels on ITR (p = .94), supporting the mechanism

described in this model[2] presented in **Figure 19**. Therefore, we concluded that for experienced participants, the GS and PCE serially mediate the effect of e-BEP levels on the ITR, aligning with **H4** but for experienced consumers only.
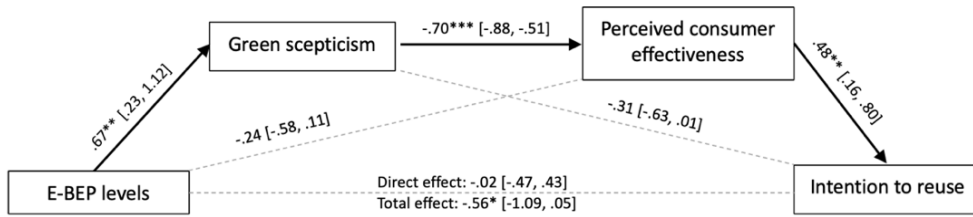
Figure 19. Serial multiple mediation of e-BEP conditions relationship to intention to reuse, including green scepticism as the first mediator and perceived consumer effectiveness as the second mediator (n=67). Green purchase behaviour is included as a covariate.
*p < .05. **p < .01. ***p < .001. The values shown are unstandardised coefficients.

4.5 General discussion

The current shift from single-use packaging to reusable alternatives presents an attractive opportunity to reduce environmental impacts. RPSs are often marketed with innovative features (e.g., financial incentives and smart technologies) and environmental benefits (e.g., reduction of food and packaging waste) (Beitzen-Heineke et al., 2017; Matthews & Webb, 2023), yet we should note that these positive attributes can trigger consumers' optimism towards RPSs and result in insufficient reuse in practice. This study examined the role of e-BEPs in shaping consumers' intention to use the packaging. Below, we draw theoretical and practical implications from our findings.

4.5.1 Theoretical implications

Overall, our study advances the understanding of consumer perceptions regarding the environmental break-even point (e-BEP) of reusable packaging. We move beyond e-BEPs based on LCA and frame e-BEPs as consumer-oriented goals to investigate subjective consumer responses. This approach aims to link consumer reuse behaviour directly with the environmental impact of RPSs, promoting more informed decision-making and conscious reuse, while considering the potential drawbacks of presenting such e-BEPs.

First, while prior studies on reusable packaging mainly focused on exploring consumer preferences for RPSs (Greenwood et al., 2021; Noëth et al., 2024), their adoption drivers and potential barriers (Long et al., 2022; Miao et al., 2023b), we contribute to the literature by examining the effects of different e-BEPs as a specific intervention within

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[2] We also examined for a reversed causality, estimating a serial mediation model in which perceived consumer effectiveness was an antecedent to green scepticism. This serial mediation path mediational model was not significant (B = -.15; SE = .12; 95%CI: [-.42; .04]).

RPSs. By investigating variations in e-BEP conditions, we revealed that consumers consistently expressed a high intention to reuse the packaging, low green scepticism about the intrinsic sustainability of reusable packaging and high perceived consumer effectiveness about their reuse behaviour. Although these findings contradict our initial hypotheses, they align with other research on RPSs, which demonstrates great consumer optimism towards RPSs. For instance, a cross-country study discovered that the drivers (e.g., positive attitudes and subjective norms) of reusable packaging generally outweigh practical barriers (e.g., situational constraints and hygienic concerns) in influencing consumer intention to avoid single-use plastics (Herweyers et al., 2023); and a study on digital reuse systems found that presenting information about the traceability of containers or technology used does not influence consumers' willingness to engage in these systems, and suggested a potential ceiling effect where consumers are willing to engage with reuse systems regardless of their descriptions (Matthews & Webb, 2023). Our study extends these findings by showing that even when presented with high e-BEPs that will be challenging to reach for many FMCGs, consumer responses towards RPSs under different e-BEP conditions remain positive and stable. On the one hand, this is positive as it will encourage many consumers to adopt a wide range of RPSs when these are introduced to the market. On the other hand, there is a big risk associated with such optimism. Consumers' optimism about their future behaviour is likely to be unrealistic because these thoughts are constructed around an ideal behaviour (Tanner & Carlson, 2009). This could lead to a discrepancy between their initial optimism and actual reuse behaviours over time. More research is needed to explore how consumers use RPS with different e-BEPs and to uncover if consumers can achieve different e-BEPs in practice.

Next, our study demonstrates that consumers with and without reuse experience significantly differentiate in their e-BEP perceptions. These findings contribute to prior literature on the importance of consumer segmentation for the adoption of new RPSs. However, while previous studies have suggested that consumers who have performed reuse behaviours are more likely to adopt reusable packaging (Greenwood et al., 2021; Miao et al., 2023b), our findings demonstrate that experienced consumers can also be more critical towards reuse. Specifically, our study found that experienced participants are more sensitive to RPSs with relatively higher e-BEP, which is reflected in increased green scepticism and decreased perceived consumer effectiveness. This aligns with a study showing that experienced consumers prioritise practical issues in the retail environment (De Temmerman et al., 2023a). Prior experience with reuse may lead to more deliberate reflections on the ease of the behaviour and greater attention to the e-BEP communicated on the packaging. Additionally, we uncovered a significant serial mediation path among experienced consumers, where e-BEP levels can indirectly influence the intention to reuse through green scepticism and perceived consumer effectiveness. This finding extends the existing literature about how green scepticism and perceived consumer effectiveness influence behaviour intentions (van der Waal et al., 2022). Drawing on the diffusion of innovation theory, experienced consumers are often early adopters with high environmental knowledge and awareness (Thøgersen et al., 2010) and may use e-BEP information to make purchase decisions. While it is important to increase the total number of consumers engaged in RPSs, the challenge

also emerges in retaining existing adopters. It is therefore crucial to enhance the satisfaction of adopters as they appear more open to a wide range of product categories for RPSs (De Temmerman et al., 2023a), and can act as opinion leaders, spread positive word-of-mouth, and accelerate the diffusion of reusable packaging innovations (Perez-Castillo & Vera-Martinez, 2020).

Furthermore, our study uncovered diverse consumer comprehension of e-BEPs. We found that some consumers can misinterpret an e-BEP as the lifespan of the packaging, judging the durability of the packaging and estimating their total reuse times based on the e-BEP. This underscores the potential risks associated with displaying e-BEP information on packaging, as it may inadvertently trigger premature disposal or replacement of reusable items once the e-BEP is met. Moreover, many consumers in the high e-BEP condition reported they will not use this reusable packaging at all, suggesting that a high e-BEP can deter consumers' initial adoption of RPSs. These insights emphasise the need for effective consumer education about the meaning of e-BEP displayed on packaging, and highlight the need for clear, transparent communication to prevent misconceptions.

4.5.2 Practical implications

Our study implies that simply presenting an e-BEP on packaging is insufficient to encourage consumers to effectively use RPSs and gain environmental benefits. Consumers need a better understanding of what the e-BEP entails and the negative environmental consequences of insufficient reuse of RPSs. Stakeholders across the board should collaborate to tackle the challenges of the e-BEP of RPSs, making RPSs environmentally beneficial for the transition to a Circular Economy.

To raise awareness about the potential problems of not sufficiently reusing RPSs and the role of e-BEPs in this respect, governments can launch educational campaigns. These campaigns could explain the concept of the e-BEP, emphasise the environmental and social benefits of reusable packaging, and provide practical tips for maximising reuse. Furthermore, governments can support the reuse programs in collaboration with local companies that offer reusable packaging options. These reuse programs can list reuse opportunities and highlight specific e-BEPs reported by companies, motivating consumers to compare different options, and fostering conscious consumption.

To encourage the widespread application of the e-BEP, policymakers could establish regulations requiring e-BEP information to be included in RPSs, as well as set standards and certifications for reusable packaging to verify its durability and sustainability. This would improve the overall credibility of e-BEPs.

In the marketing context, retailers could communicate e-BEPs of RPSs through various techniques to enhance accessibility and information richness. Recent qualitative research has indicated that both experienced and inexperienced consumers are willing to check online information for RPSs (De Temmerman et al., 2023a), suggesting the potential to convey e-BEPs in a digital format (e.g., QR codes, RFID and barcodes) (Ellsworth-Krebs et al., 2022; Matthews & Webb, 2023). Additionally, a digital product

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passport has been suggested to support the traceability of each packaging unit, which ensures better monitoring and management throughout its lifecycle (Ellsworth-Krebs et al., 2022). This initiative requires collaboration in the supply chain, especially when the same reusable packaging is used across different brands. Nevertheless, the use of digital technologies will also negatively contribute to the overall environmental impact of the whole system, which should be accounted for when deciding if this type of e-BEP is worthwhile for RPSs.

While communicating the e-BEP can provide certain benefits, promoting RPSs with a high e-BEP may encounter challenges and require efforts from different stakeholders. First of all, manufacturers need to ensure the packaging materials are durable enough to meet the high e-BEPs. Consumers can deem packaging with damages unacceptable due to contamination risks, safety concerns and perceived decreased quality of the product (Magnier & Gil-Pérez, 2021; White et al., 2016). To tackle consumer green scepticism, manufacturers could communicate the production process and provide additional information about material attributes and quality. To prevent consumers from replacing the packaging more or less directly after passing its e-BEP, we advise retailers to communicate e-BEP as a milestone rather than an ultimate goal. Some innovative strategies can be implemented, such as gamification design with goal-setting features that allow consumers to unlock progressive reuse challenges or set personalised goals beyond the e-BEP of RPSs; or tailored feedback mechanisms that enable consumers to monitor the impact of their continued adoption of the RPS. These may infuse a sense of excitement and achievement, thereby encouraging long-term adoption of the RPS. Additionally, to foster the development of a new habit of reuse, providing consumers with convenient services and infrastructures (e.g., subscription models and deposit return schemes) can establish a long-term commitment to the RPS, due to which surpassing a high e-BEP may feel less effortful.

Overall, the e-BEP is recognised as a robust metric for evaluating the effectiveness of RPSs in reducing environmental impact (Bradley & Corsini, 2023; Thomassen et al., 2024). While developing durable reusable packaging remains necessary to support long-term reuse practice, it is equally crucial to cut down on the environmental impact of the system. This can be done by selecting materials with a lower environmental impact for refillable packaging, optimal packaging design for transportation, efficient collection schemes and centralised cleaning processes for returnable packaging (Greenwood et al., 2021; Thomassen et al., 2024), and finally ensuring end-of-life recycling of each packaging.

4.5.3. Limitations and avenues for future research

Although this study provides interesting results, several limitations open avenues for future research.

First, our study employed an experimental setting with hypothetical scenarios presented through online questionnaires. While this approach enabled us to compare consumer responses with high internal validity, participants may give socially desirable answers

without following these behaviours in real-life situations. Future research could employ field studies in a retailing context, thereby obtaining behavioural data regarding RPSs with different e-BEPs. Another opportunity for future research is to conduct longitudinal studies that track changes in consumer responses to RPSs with different e-BEPs over time. Besides, we did not provide participants with the option to select single-use packaging and cannot predict their preference when both options are available. Further research could explore how consumers respond to e-BEPs when they make actual purchase decisions between single-use packaging and reusable packaging for the same products.

Second, our study specifically examined plastic packaging within a single product category (i.e., rice). This narrow focus may limit the generalisability of our findings to other product categories. Future research could replicate our results across various product categories, or experiment with reusable packaging made of other materials (e.g., metal, glass, or recycled materials) with more challenging e-BEPs. Notably, calculating e-BEPs for standardised packaging may pose challenges considering that it can contain various products and replace different types of initial packaging. This requires additional support from future LCA studies to provide trustworthy references for those e-BEPs.

Third, we conducted the post-test after the main study and encountered limitations in reaching the entire sample. The reduced sample size may hamper the robustness and generalisation of the results presented in the post-analysis. Future research could recruit more diverse participants at different stages of engagement with reusable packaging. Additionally, it would be interesting to investigate at which engagement stage green scepticism and perceived consumer effectiveness are the most prominent in influencing intention to reuse. Reflecting on the samples, we used standard samples in Prolific with selection based on several demographic criteria. Even though this enabled us to obtain a wide variety of participants, the sample was not necessarily representative of the full population. Future studies could recruit representative samples from different countries to capture the trend of the target population and enhance the generalisability of results.

Lastly, even though we explicitly mentioned in the survey that reusable packaging may exhibit traces of usage due to multiple cleaning and transportation actions, our scenarios showed flawless packaging. Changes in the appearance of packaging can influence consumers' willingness to use it, and consumers are unlikely to accept reusable packaging worn out above a certain level (Baird et al., 2022; Magnier & Gil-Pérez, 2023). Future research could explore scenarios incorporating usage traces for different e-BEPs. This would offer additional insights about whether e-BEP conditions with a used appearance may influence consumer acceptance and optimism towards reusable packaging.

4.6 Conclusion

To conclude, communicating an e-BEP can prompt consumers to have a more deliberate reflection on reusable packaging. Our study suggests that for reusable packaging to achieve a positive environmental impact through consumer engagement,

the challenge may not only emerge in attracting new consumers but also in bridging the gap between consumers' initial optimism towards reuse and corresponding reuse behaviours in the long run. Our findings offer insights for the management and design of future RPSs. Effective RPSs should promote conscious purchase and encourage a sufficient number of reuses without raising consumers' green scepticism about the intrinsic sustainability of reusable packaging or weakening perceived consumer effectiveness about reuse behaviour. By addressing these challenges, RPSs can facilitate broader adoption and realise environmental benefits in the long run.

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/ *Chapter 5* /

Out of sight, out of mind? Investigating how concealing patterns mitigate consumer negative perceptions of reusable packaging with signs of use

While reusable packaging systems (RPSs) offer a sustainable alternative to single-use packaging, their success relies on consumer long-term adoption. The previous chapter addressed one key challenge of encouraging sufficient reuses through the communication of an environmental break-even point (e-BEP) on packaging. However, with repeated use, another barrier emerges: the appearance of visible signs of use - such as scratches, stains, or minor damage generated over multiple uses. These imperfections can negatively influence consumer perceptions of reusable packaging and lead to rejections.

Chapter 5 investigates how such signs of use influence consumer evaluations of reusable packaging and explores whether concealing patterns can mitigate negative effects. Through three studies integrating quantitative experiments and qualitative insights, this research offers an initial understanding of how concealment strategies may improve consumer acceptance of reusable packaging with signs of use, ultimately supporting the goals of a circular economy.

5.1 Introduction

The massive production and throwaway habit of single-use packaging for fast-moving consumer goods (FMCGs) have led people to expect pristine packaging and to view imperfections as problematic (Collis et al., 2023). Consumers are likely to prevent buying products with packaging that has even superficial damage (White et al., 2016), and are in general unwilling to use food and drink containers that exhibit signs of prior use (Baird et al., 2022; Collis et al., 2023; Hoseini et al., 2024). Such aversions to imperfect packaging pose a challenge for consumer adoption of reusable packaging systems (RPSs).

From an environmental perspective, reusable packaging only offers a more sustainable alternative to single-use packaging when it is reused a sufficient number of times to offset its environmental footprint (Cottafava et al., 2021; Miao et al., 2024a; Zimmermann & Bliklen, 2020). However, as reusable packaging typically undergoes repeated cleaning, transportation, and refilling processes, it inevitably generates noticeable signs of use, such as abrasion, discolouration, stains or dents (Baird et al., 2022; Collis et al., 2023; Magnier & Gil-Pérez, 2021). While these changes in packaging appearance do not necessarily compromise functionality, they are consistently recognised as a barrier to consumer acceptance and adoption of RPSs (Collis et al., 2023; Hoseini et al., 2024; Magnier & Gil-Pérez, 2021; Miao et al., 2023b).

In light of this challenge, it becomes crucial to explore design strategies that can mitigate the negative consumer perceptions associated with signs of use. This raises an important question for designers and practitioners: How can reusable packaging be designed to retain consumer appeal after multiple cycles of use?

This chapter contributes to the literature on consumer behaviour and design innovation for RPSs by exploring the use of concealing patterns as a potential solution. The following section outlines how signs of use influence consumer perceptions, and why concealing patterns may offer a promising solution. To assess their effectiveness, we conducted three complementary studies. We first tested the effect of concealing patterns and signs of use on consumer perception through two experimental studies, with a particular focus on aesthetic appeal, contamination concerns, and purchase intention. Then we explored consumer perceptions, reasoning, and preferences regarding concealing patterns in a choice-based experiment with open-ended questions. Together, these studies integrate quantitative and qualitative insights to generate theoretical and practical implications for the design and implementation of concealing patterns on reusable packaging. Limitations and directions for future research are also discussed.

5.2 Theoretical background

5.2.1 The influence of signs of use on consumer responses to reusable packaging

The presence of signs of use on reusable packaging is often associated with reduced desirability, leading to lower purchase intentions (Collis et al., 2023; Magnier & Gil-Pérez, 2021; Miao et al., 2023b; Tenhunen-Lunkka et al., 2024). When consumers are presented with multiple packaging options, they tend to compare and select the neatest-looking packaging (Baird et al., 2022; Miao et al., 2023b). This avoidance of worn packaging could be attributed to two psychological mechanisms: diminished aesthetic appeal and heightened contamination concerns associated with visible signs of use.

The "What is beautiful is good" principle is widely acknowledged in the literature and suggests that people generally associate aesthetically appealing objects with desirability and quality (Dion et al., 1990). This phenomenon is also observed in consumer preferences for packaging, where consumers are more inclined to purchase, use and reuse (or repurpose) packaging when they perceive it as aesthetically pleasing (Granato et al., 2022b; Lindh et al., 2016). Aesthetic appeal has also been identified as a motivator for consumers to adopt reusable packaging (Herweyers et al., 2024; Miao et al., 2023b). However, when reusable packaging starts to show signs of usage, its aesthetic appeal significantly declines (Baird et al., 2022; Collis et al., 2023; Magnier & Gil-Pérez, 2021; Tenhunen-Lunkka et al., 2024). One possible explanation could be that signs of use disrupt visual harmony, drawing consumer attention directly to imperfections, which in turn overshadow the original aesthetic qualities of the packaging. While designing aesthetic reusable packaging remains crucial for encouraging consumer adoption, it is equally important to consider its "aesthetic durability" – its ability to retain aesthetic appeal over multiple reuse cycles. Enhancing aesthetic durability may help increase the longevity of packaging use, increasing the total cycles of reuse, and maximising the sustainability of reusable packaging.

In addition to diminishing aesthetic appeal, signs of use may trigger contamination concerns (Herweyers et al., 2024; Miao et al., 2023b; White et al., 2016). Contamination, in a psychological sense, can be understood as the process by which the quality, meaning, or value of an object changes due to interaction with someone or something (Baxter et al., 2016). Baxter et al. (2017) identified three mechanisms that drive contamination perceptions - hygiene, utility, and territory. The three mechanisms can hinder consumers from engaging with previously used objects, including reusable packaging (Miao et al., 2023b). Hygiene concerns arise when signs of use, such as stains or scratches, are interpreted as indicators of unsanitary conditions, which may trigger feelings of disgust and associations of a higher probability of pathogen (Baird et al., 2022; Miao et al., 2023b; Pott et al., 2024). Utility contamination occurs when signs of use lead to a perceived decrease in value or functionality (Collis et al., 2023; Pott et al., 2024), such as a cracked container may raise concerns about food leakage. Territorial contamination refers to the discomfort consumers feel about reusing the packaging that

is previously handled by strangers (Miao et al., 2023b). This might be a particular concern in returnable packaging systems, in which ownership is shared across multiple consumers who access the same packaging in its lifetime (Muranko et al., 2021).

5.2.2 The potential of concealing patterns to hide signs of use

Design has the potential to improve packaging resistance to visible signs of use. In addition to preventing signs of use through enhanced material durability (Collis et al., 2023; Greenwood et al., 2021; Tenhunen-Lunkka et al., 2024), design can conceal signs of use on a surface level. One promising direction is the use of concealing patterns, an effective technique applied to products that are frequently used by different users in the public setting, such as transport seat covers and airport carpets (See examples in **Figure 20**). These concealing patterns are designed to hide signs of use and make any minor imperfections less noticeable, maintaining the overall visual harmony of the products.

Figure 20. Applying patterns to conceal signs of use (Photos captured by the author)

The potential of concealing patterns also aligns with the principle of camouflage patterns, which has been widely studied in visual perception, evolutionary biology, and military applications (Lin et al., 2019; Mondal, 2022; Stevens & Merilaita, 2009; Troscianko et al., 2017). Camouflage reduces the visibility of an object through techniques such as background matching, which blends objects into their surroundings, and disruptive colouration, which breaks up its outline to obscure shape recognition. In nature, animals use camouflage as an adaptive strategy to avoid predation (Stevens & Merilaita, 2009), while in military applications, camouflage patterns help soldiers and equipment visually merge with their environment, making them harder to detect or target (Baumbach, 2012; Lin et al., 2019). Similarly, concealing patterns on reusable packaging may mask different types of signs of use, such as scratches, stains, or little dents, preventing them from drawing consumers' attention. By leveraging this design-driven approach, concealing patterns may serve as an effective solution to address signs of use without requiring major structural or material modifications to reusable

packaging. However, despite the theoretical potential of this intervention, empirical research on consumer responses to the effectiveness of concealing patterns in mitigating the negative effect of signs of use remains unexplored.

5.3 Study 1

The purpose of study 1 is twofold: 1) to examine whether adding concealing patterns to scratched packaging improves consumer responses on aesthetic appeal, contamination concerns and purchase intention, and 2) to explore whether different concealing patterns elicit the same effect.

5.3.1 Study design and stimuli

We conducted a between-subject design with a single factor consisting of three conditions (packaging appearance: plain vs. marble pattern vs distressed pattern). Signs of use (e.g., scratches and small dents) were intentionally created by the researcher on the packaging for all conditions. Hand soap was selected as the target product because it is a familiar and widely used product in most households, so that participants can make relatable evaluations. To make the stimuli realistic while avoiding brand-related biases, we selected an existing product not available in the UK, where the participants were recruited from. To further eliminate brand-related influences, we replaced the original brand name with a fictitious one and removed irrelevant packaging elements (e.g., vegan labels, pH indicators). In the plain condition, no concealing pattern was applied, allowing signs of use to be fully visible. In the two patterned conditions, marble patterns and distressed patterns were respectively added. The marble pattern was selected due to its variation in colour and irregular shapes. As signs of use also exhibit these two features, they are likely to be blended into the overall aesthetic of the marble pattern. The distressed pattern was chosen because it intentionally mimics the look of subtle scratches, scuffs and abrasions that often accumulate on packaging over time. Its 'imperfect' appearance may help integrate real signs of use into its aesthetics. Moreover, both patterns can be found in familiar products. Marble patterns are widely applied in furniture and tableware, while distressed patterns are often used for jeans and leather goods. These real-world applications ensure both patterns are feasible for reusable packaging design. The photo was taken for a physical hand soap package and then edited to different versions in the digital graphic software Adobe Photoshop 2024. The parts with visible signs of use were enlarged for clear observation across all conditions. **Figure 21** illustrates the final design of the stimuli used in study 1.

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Figure 21. Visual stimuli of Study 1: plain (A), marble pattern (B), and distressed pattern (C)

5.3.2 Data collection and sample

The online survey was created using Qualtrics and distributed to 123 participants recruited via Prolific, a UK-based platform renowned for its diverse participant pool (Peer et al., 2017). Pre-screening ensured participants met the following criteria: aged 18–75, primary shopper in the household, fluent in English, and residing in the UK (where the selected brand is not available). This approach minimised brand bias while ensuring participants could engage meaningfully with the scenarios presented.

Each participant was randomly assigned to one of the three experimental conditions. They were presented with a scenario in which they considered buying hand soap in reusable packaging. After reading the scenario and examining the packaging image, participants completed a series of questions about the assigned packaging and individual characteristics. Each participant received £1.20 for completing the survey in approximately 10 minutes. The research (including all three studies) was approved by the Human Research Ethics Committee of Delft University of Technology (reference number: 4255).

5.3.3 Measures

The measurement scales used in these studies were mainly adapted from previously validated instruments to suit the context of reusable packaging. Items in each scale were displayed in a random order. The reliability of all the scales was adequate with Cronbach's alpha, with all scores above 0.70 indicating good internal consistency (Mackison et al., 2010). All construct items of the measurements are presented in **Appendix C**.

First, we asked participants to rate the aesthetic appeal of the packaging using the following five items: "How do you evaluate the appearance of this reusable packaging?" (1 = Not very aesthetically pleasing / Flawed / Unattractive / Unappealing / Bad looking; 7 = Very aesthetically pleasing / Perfect / Attractive / Appealing / Good looking) (adapted from Magnier & Schoormans, 2015; $\alpha = 0.96$). Following this, their contamination concerns were measured using the following five items: "I feel this reusable packaging is…" (1= Is not at all dirty/Is not at all unsanitary/ Is not at all contaminated/ Was definitely not touched by other people; 7= Is very dirty/Is very unsanitary/ Is very contaminated/ Was definitely touched by other people) (adapted from White et al., 2016; $\alpha = 0.82$). Next, participants rated their purchase intention using the following two items: "I am likely/willing to purchase this reusable packaging of hand soap." (1 = strongly disagree; 7 = strongly agree) (adapted from Mugge et al., 2017; $\alpha = 0.97$). In addition, we asked participants to rate their reuse behaviour using nine items including "I carry a reusable water bottle every time that I leave home." (1 = never; 7 = always) (adapted from Ertz et al., 2017b; $\alpha = 0.81$) and included it as a covariate to control for individual differences, as consumers' prior experiences of reuse can influence their perceptions toward RPSs (Miao et al., 2024a). Lastly, to check our manipulation, we asked participants to rate the noticeability of traces using the following three items: "Based on the picture with details, the signs of wear and tear on this

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reusable packaging are…" (1= Unnoticeable / Hidden / Subtle; 7 = Noticeable / Evident / Striking) (self-developed scales; α = 0.93). An attention check item "To show you are still paying attention, please select 'strongly disagree'" was randomly inserted in the questionnaire to detect participants who did not pay sufficient attention to the questionnaire. The questionnaire ended with several demographic questions, including age, gender, and education level.

5.3.4 Results

5.3.4.1 Attention check and manipulation check

Two responses were excluded from the analysis for failing the attention check, leaving a total of 121 valid responses (age range: 21 - 71 years, M_{age} = 42.02, SD_{age} = 13.27; 29.8% male, 67.7% female, 1.7% other, 0.8% prefer not to say).

Due to a violation of homogeneity of variances for the noticeability of traces, we conducted a Kruskal-Wallis test for the manipulation check, with packaging appearance as the independent variable and noticeability of traces as the dependent variable. The results revealed a significant effect of packaging appearance on the noticeability of traces ($H (2)$ = 37.47, $p < .001$). Post-hoc analyses with Bonferroni corrections indicated that the marble pattern significantly reduced the noticeability of traces compared to the plain condition (mean $rank_{marble}$ = 37.70 vs mean $rank_{plain}$ = 61.21, $p < .001$). However, to our surprise, the distressed pattern significantly increased the noticeability of traces compared to the plain condition (mean $rank_{distressed}$ = 84.67 vs M_{plain} = 61.21, $p < .001$).

These findings suggest that while marble patterns effectively concealed signs of use, distressed patterns unintentionally enhanced their noticeability. Despite this unexpected outcome, we kept the distressed condition in subsequent analyses of dependent variables in Study 1. Including it allowed us to understand how different pattern designs influence perceptions of aesthetics and contamination concerns, offering more insights into concealing pattern designs.

5.3.4.2 The effect of packaging appearance on consumer responses

A series of analyses of covariance (ANCOVAs) were conducted with packaging appearance as the independent variable, aesthetic appeal, contamination concerns and purchase intention as the dependent variables, and reuse behaviour as a covariate.

The results indicated a significant effect of packaging appearance on aesthetic appeal ($F (2, 117)$ = 14.33, $p < .001$). Planned contrast further revealed that marble-patterned packaging was perceived as significantly more aesthetically appealing than plain packaging (M_{marble} = 4.58 vs M_{plain} = 3.37, $p < .001$). However, the distressed pattern did not significantly differ from the plain condition ($M_{distressed}$ = 3.05 vs M_{plain} = 3.37, p = .29). Next, no significant effect of packaging appearance was found on contamination concerns ($F (2, 117)$ = 1.72, p = .18). For purchase intention, there was a marginal significant effect of packaging appearance ($F (2, 117)$ = 2.40, $p < .10$). Planned contrasts further showed that participants had marginally higher purchase intention for marble-

patterned packaging compared to plain packaging (M_{marble} = 4.96 vs M_{plain} = 4.16; p = .10).

Descriptive statistics for all variables are presented in **Table 10**.

Table 10. Descriptive statistics of study 1

	1 Plain (N=38)	2 Marble pattern (N=42)	3 Distressed pattern (N=41)	Statistics	Planned Contrasts
Aesthetic appeal	3.37 (1.25)	4.58 (1.25)	3.05 (1.46)	$F_{(2, 117)}$ = 14.33***	1<2***
Contamination concerns	3.96 (1.29)	3.79 (1.21)	4.36 (1.29)	$F_{(2, 117)}$ = 1.72	/
Purchase intention	4.16 (2.17)	4.96 (2.03)	3.83 (2.06)	$F_{(2, 117)}$ = 2.40 [a]	1<2 [a]
Noticeability of traces	4.96 (1.13)	3.78 (1.47)	5.86 (1.07)	$H_{(2)}$ = 37.47***	1>2***, 1<3***

Note: Means are reported (constructs measured on scales 1 to 7); Standard deviations in brackets.
The F statistics correspond to the results of the ANCOVAs, with pairwise comparisons based on mean values.
The H statistics correspond to the Kruskal-Wallis tests, which were conducted when the assumptions for parametric tests were violated, with pairwise comparisons based on mean ranks.
[a] p<.10 (marginal); * p<.05; ** p<.01; *** p<.001

5.3.5 Discussion Study 1

The findings of Study 1 suggest that the marble pattern can serve as an effective design intervention for reusable packaging with signs of use[3], particularly by improving aesthetic appeal and marginally increasing purchase intention.

Nevertheless, although both patterns were intended to reduce the noticeability of signs of use, only the marble pattern achieved this goal. In contrast, the distressed pattern unintentionally reinforced the noticeability of traces. One possible explanation is that participants were confused with distressed patterns as an intentional design on the packaging. Or, they may have misinterpreted distressed patterns as real signs of use when viewing the pictorial stimuli in the online setting. This implies that not all patterns are equally effective in concealing signs of use, highlighting the importance of pattern selection.

Moreover, although the marble pattern enhanced aesthetic appeal, its effect on purchase intention was only marginally significant. This suggests that while visual improvements may positively influence consumer perception, additional factors likely contribute to purchasing decisions.

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[3] To rule out potential confounding effects of the marble pattern itself, we conducted an independent-sample T-test to compare plain packaging and marble-patterned packaging in two between-subject conditions (N=80), in which no visible signs of use were present. The results showed no significant differences in aesthetic appeal, perceived contamination, and purchase intention (all p values > .05). This suggests that the observed effects in Study 1 were due to the interaction between the marble pattern and the presence of signs of use, rather than by the marble pattern itself.

Notably, contamination concerns remained unaffected by concealing patterns, suggesting that simply hiding signs of use may not be sufficient to address consumer contamination concerns about reusable packaging. This could be due to contamination perception stemming from a complex mechanism that can go beyond visual cues on the packaging surface, such as the association of prior ownership or uncertainty about hygiene conditions (Miao et al., 2023b). However, it worth noting that the mean values of contamination concerns for both the plain and marble pattern conditions were below the midpoint of the scale, suggesting that consumers did not perceive contamination risks as particularly severe in these cases.

Given the promising results of the marble pattern, we selected it as the design intervention to mitigate signs of use in subsequent studies, referred to as "Patterned Packaging".

5.4 Study 2

Study 2 aimed to build upon and validate the findings of Study 1 by examining both the independent effects of signs of use and patterns, as well as their interaction on consumer evaluations of reusable packaging. By introducing signs of use as an additional factor, Study 2 sought to determine under which conditions concealing patterns are most effective in mitigating negative perceptions.

5.4.1 Study design and stimuli

Study 2 employed a 2 (signs of use: absent vs. present) × 2 (packaging appearance: plain vs. patterned) between-subjects experimental design. We used the stimuli consisting of four images of hand soap packaging identical to Study 1 (see **Figure 22**).

5.4.2 Participants and Procedure

A total of 160 participants were recruited from Prolific with the same pre-screening criteria used for Study 1. Each participant was randomly assigned to one of the four experimental conditions and completed an online survey. The scenario and procedure were identical to those used in Study 1, where participants considered buying hand soap in reusable packaging and evaluated the packaging image they received in an online survey. To ensure participants clearly observe the images, we asked participants to access the survey using their desktop computers.

5.4.3 Measures

Participants rated their responses on several measurement scales identical to those used in Study 1. Specifically, participants were asked to rate aesthetic appeal ($\alpha = 0.96$), contamination concerns ($\alpha = 0.83$) of the packaging and their purchase intention ($\alpha = 0.97$). Then we asked participants to rate their reuse behaviour ($\alpha = 0.78$) as a covariate. To check our manipulation, we asked participants to rate the noticeability of traces ($\alpha = 0.94$). An attention check item "To show you are still paying attention, please select

'strongly disagree'" was randomly inserted in the questionnaire. The questionnaire ended with several questions about demographic characteristics (age, gender, and education level).

Plain packaging	Patterned packaging
Signs of use absent	
Signs of use present	
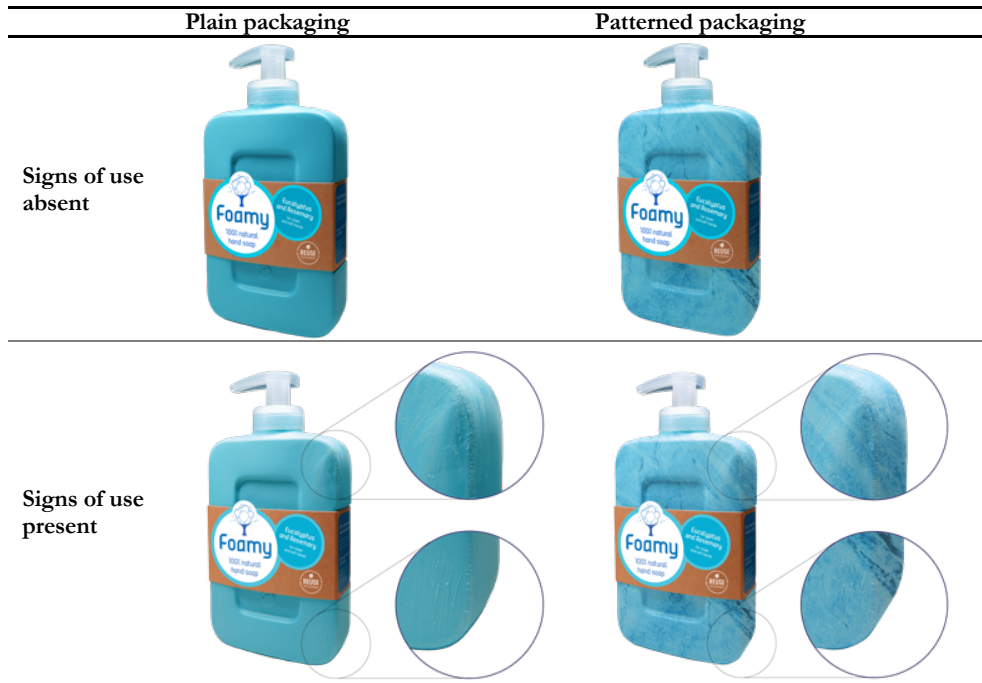
Figure 22. Four conditions in Study 2

5.4.4 Results

5.4.4.1 Attention check and manipulation check

Six respondents were excluded from the analysis due to failing the attention check, leaving a total of 154 valid responses (age range: 21 - 71 years, M_{age} = 43.50, SD_{age} = 13.64; 29.2% males, 69.5% females, 0.65% other, 0.65% prefer not to say).

Due to a violation of homogeneity of variances for the noticeability of traces, we conducted a Kruskal-Wallis test for the manipulation check, with packaging appearance as the independent variable and noticeability of traces as the dependent variable. The results revealed a significant difference in noticeability of traces among the four conditions (H (3) = 64.15, p < .001). Mann-Whitney test confirmed that signs of use were significantly more noticeable when present than when absent (mean rank$_{present}$ = 104.70 vs. mean rank$_{absent}$ = 48.85, p < .001). Additionally, between two conditions where signs of use were present, signs of use were rated as more noticeable on plain packaging than on patterned packaging (mean rank$_{plain}$ = 46.15 vs. mean rank$_{patterned}$ = 34.00, p < .05), which aligned with the result in Study 1. We therefore concluded that our manipulation check was successful.

5.4.4.2 The effect of packaging appearance and signs of use on consumer responses

To examine the effects of packaging appearance (plain vs. patterned) and signs of use (present vs. absent), three univariate ANCOVAs were conducted with aesthetic appeal, contamination concerns and purchase intention as dependent variables, and reuse behaviour as a covariate. The results showed that signs of use had a significant main effect on aesthetic appeal (F (1,149) = 23.68, p < .001), with packaging rated as more aesthetically appealing when signs of use were absent than present (M_{absent} = 5.05 vs. $M_{present}$ = 3.98, p < .001). Signs of use also had a significant main effect on contamination concerns (F (1,149) = 13.89, p < .001), with packaging perceived as more contaminated when signs of use were present than absent (M_{absent} = 2.88 vs. $M_{present}$ = 3.73, p < .001). No significant main effect was found on purchase intention (F (1, 149) = 1.22, p = .27).

In addition, packaging appearance had no significant main effects on any of the three dependent variables (all p values > .05), suggesting that adding patterns did not in general influence consumer perceptions of reusable packaging. No significant interaction effects of packaging appearance and signs of use were found on any of the three dependent variables (all p values > .05).

To examine whether the results of Study 2 validated the findings of Study 1, we conducted an independent samples t-test comparing the effect of packaging appearance (plain vs. patterned) on aesthetic appeal, contamination concerns, and purchase intention, under conditions where signs of use were present. The results indicated that packaging appearance had no significant effect on any of the three dependent variables. Specifically, there was no significant difference in aesthetic appeal between patterned and plain packaging (M_{plain} = 3.78 vs $M_{patterned}$ = 4.18; t (77) = -1.30, p = .20). Similarly, no significant difference was found for contamination concerns (M_{plain} = 3.72 vs $M_{patterned}$ = 3.74; t (77) = -0.08, p = .94) or purchase intention (M_{plain} = 4.47 vs $M_{patterned}$ = 4.53; t (77) = -0.11, p = .92). These findings suggest that the patterned packaging did not mitigate the negative effects of signs of use on consumer responses. While contamination concerns remained unaffected, consistent with the results of Study 1, the findings for aesthetic appeal and purchase intention deviated from Study 1. In Study 1, the marble patterns enhanced aesthetic appeal and (marginally) increased purchase intention, yet this effect was not replicated in Study 2.

Descriptive statistics for each variable are provided in **Table 11**, and the results are illustrated in **Figure 23**.

Table 11. Descriptive statistics of Study 2

Signs of use	Absent (N=75)		Present (N=79)	
Packaging appearance	Plain (N=36)	Patterned (N=39)	Plain (N=39)	Patterned (N=40)
Aesthetic appeal	4.92 (1.28)	5.19 (1.41)	3.78 (1.35)	4.18 (1.40)
Contamination concerns	2.95 (1.22)	2.81 (1.33)	3.72 (1.36)	3.74 (1.56)
Purchase intention	4.96 (1.76)	4.86 (1.75)	4.47 (2.08)	4.53 (2.11)
Noticeability of traces	2.14 (1.82)	2.05 (1.36)	4.80 (0.96)	4.04 (1.58)

*Note: Means are reported (constructs measured on scales 1 to 7); standard deviations in brackets
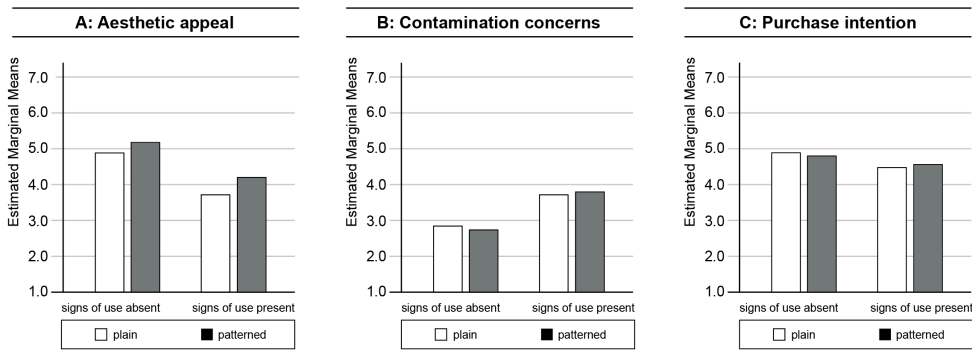
Figure 23. Bar charts showing differences in aesthetic appeal (A), contamination concerns (B) and purchase intention (C)

5.4.5 Discussion Study 2

The findings of Study 2 suggest that the presence of signs of use significantly reduced aesthetic appeal and increased contamination concerns of reusable packaging for hand soap, aligning with previous research about signs of use on food packaging (Magnier & Gil-Pérez, 2021). However, unlike previous studies that found signs of use strongly influence purchase intention, Study 2 revealed that signs of use did not influence the overall purchase intention. One possible explanation is that prior studies largely focused on ingested products (e.g., food and beverages), where signs of use could be linked to the safety and health of consuming products (Baird et al., 2022; White et al., 2016). The higher risks associated may contribute to a decreased purchase intention.

Notably, while concealing patterns were still effective in reducing the noticeability of signs of use, consistent with the results of Study 1, their ability to enhance aesthetic appeal and purchase intention appeared to be weaker in Study 2. This challenges the initial assumption that incorporating concealing patterns would serve as an effective design intervention to mitigate consumers' negative perceptions of reusable packaging with signs of use. Although the setup and conditions were identical, the reduced impact in Study 2 suggests some external factors might be unintentionally introduced to influence consumer evaluations. One reason could be the variations in device usage to access the online survey. In Study 2, we explicitly asked participants to complete the survey on a desktop computer, whereas in Study 1, device usage was not specified. Differences in screen resolution, display size, and image clarity may have influenced how signs of use were perceived. Larger images on desktops might have heightened the visual salience of signs of use, making them more noticeable and diminishing the effectiveness of pattern concealment. In contrast, smaller screens on mobile devices (which might be used in Study 1) could have softened the signs of use, allowing concealing patterns to play a stronger role.

Given the inconclusive findings regarding the effectiveness of concealing patterns in mitigating the negative perception of signs of use, further investigation is necessary to better understand the underlying consumer perceptions.

5.5 Study 3

Unlike Study 1 and Study 2, which quantitively assessed packaging in isolation, Study 3 aimed to understand consumer perceptions and preferences in a comparative context by allowing participants to directly compare plain and patterned packaging side by side, under different conditions of signs of use. This approach better reflects real-world retail environments, where consumers often see multiple packaging options before making a purchase decision. By integrating choice with qualitative reasoning, Study 3 sought to uncover the underlying thought processes behind consumer evaluations, offering deeper insights into how concealing patterns influence consumer responses to reusable packaging.

5.5.1 Study design and stimuli

Each participant in Study 3 evaluated packaging in one of the two experimental conditions, based on the presence or absence of signs of use (see **Figure 24**). In condition 1, participants were presented with both plain and patterned packaging, with no signs of use. In condition 2, participants were shown both plain and patterned packaging, with signs of use. Each condition combined a choice task with several open-ended questions to capture both quantitative preferences and qualitative reasoning. The stimuli were identical to Study 2, ensuring consistency across studies.

5.5.2 Participants and procedure

A total of 197 participants recruited from Prolific took part in Study 3, with random assignment to one of two conditions: signs of use absent (N = 97) or signs of use present (N = 100). To ensure participants clearly observe the images, we asked participants to access the survey using their desktop computers.

Participants were first presented with a scenario like previous studies, in which they considered buying hand soap in reusable packaging. Differently, Study 3 presented them with two side-by-side packaging images. An additional explanation was provided: "The company has launched two packaging versions for the same product: one version features a plain design, while the other incorporates patterns". After observing the two packaging images, participants were asked to choose their preferred packaging and respond to several open-ended questions, including (1) rationale for their choice (using the question "Why did you choose this option?"), (2) positive attributes of the chosen packaging (using the question "What do you like about this reusable packaging?"), and (3) potential concerns or drawbacks (using the question "What are the potential problems that hinder you from using this reusable packaging?").

This mixed-method approach provided both quantitative and qualitative insights, allowing for a richer interpretation of consumer perceptions. The open-ended responses explained and complemented the findings from Study 1 and Study 2, helping to clarify the role of concealing patterns in shaping consumer responses to reusable packaging.

Figure 24. Condition 1: signs of use absent (above); Condition 2: signs of use present (below)

5.5.3 Results and discussion

5.5.3.1 The effect of signs of use on consumer packaging preference

A Chi-Square test of independence was conducted to examine whether the presence of signs of use influenced participants' preference for patterned packaging over plain packaging. The results indicated no significant differences in choice under the two

conditions ($\chi 2(1) = 0.52$, p = .47). Participants consistently selected patterned packaging, with 85.6% choosing it when signs of use were absent and 89.0% choosing it when signs of use were present.

This preference contrasted with Study 2, where no significant effect was observed in consumer evaluations between patterned and plain packaging. A key difference between the two studies is that Study 3 allowed participants to make direct comparisons between two packaging options, whereas participants in Study 2 saw only one packaging image. The discrepancy suggests that patterned packaging may be perceived as more favourable when consumers can directly contrast it with a plain alternative, highlighting its relative advantages. However, when evaluated individually (as in Study 2), the advantages of patterned packaging may not have been immediately apparent.

Furthermore, the consistent preference for patterned packaging across both conditions suggests that there might be other positive perceptions associated with this marble pattern in addition to its ability to conceal signs of use, which may have contributed to consumer preference.

5.5.3.2 Qualitative insights regarding concealing patterns and signs of use

The qualitative responses from all participants (N = 197) were analysed using Atlas.ti, a qualitative analysis software. The coding process followed an inductive approach, identifying key themes related to concealing patterns and signs of use. This process resulted in 28 codes across eight categories (**Appendix C**). Most responses about general considerations of reusable packaging aligned with our prior findings presented in Chapter 3, such as durability of materials, transparency of packaging, ease of packaging label removals, and scepticism about the environmental impact of reusable packaging. The analysis of Study 3 specifically focused on consumer perceptions of concealing patterns, their effectiveness in mitigating signs of use, and their broader implications for reusable packaging design. Below, we elaborated on the key qualitative insights, complementing the quantitative findings from Study 1 and Study 2.

Concealing signs of use. In both conditions, many participants acknowledged that patterned packaging effectively concealed signs of use, making them less noticeable than on plain packaging. Specifically, participants perceived concealing patterns to preserve an "as-new" appearance over time: "The signs of use blended in better with the pattern, so it looked newer (than the plain one)" (P167, signs of use present). Even when signs of use were absent, some participants noted that patterned designs can act as a visual distraction from imperfections that may occur in the future: "The nice design would distract from the fact that the packaging is damaged" (P54, sings of use absent). Moreover, several participants expressed a preference to buy packaging that looked new and a tendency to avoid visual reminders of prior use: "The less obvious it is that this product has been reused, the more inclined I would be to buy it" (P75, signs of use absent).

In addition to the ability to conceal signs of use and make packaging stay "new" to consumers, the specific concealing pattern – the marble pattern itself – seemed to have additional values that positively influenced participants' preferences.

Enhancing aesthetic appeal of packaging. Participants reported they preferred aesthetically appealing designs and described patterned packaging as more aesthetically pleasing than plain packaging. Throughout the responses, participants frequently used terms like "appealing", "modern", "stylish", "eye-catching", "interesting" and "unique" to describe patterned packaging. This suggests that in direct comparison, beyond concealment, patterns could add a level of visual engagement that plain designs may lack. This enhanced aesthetic appeal seemed to influence consumer preference, as some participants believed that attractive packaging might encourage adoption: "…it encourages me to use this product as it looks attractive" (P122, signs of use present). Besides, participants considered not only the moment of purchase but also the integration of this packaging in their living environments, such as how the packaging would fit into their bathrooms or kitchens. As participants remarked, "The design of the (patterned) packaging is more appealing and would look better in my bathroom" (P22, signs of use absent), and "When considering a hand soap, I think about how it will look in my bathroom on the sink, and it has to look somewhat nice" (P177, signs of use present).

Additional positive associations and symbolic meanings of marble patterns. Beyond their aesthetic benefits, the marble patterns used in this study seemed to evoke additional positive associations and carried symbolic meanings related to sustainability, luxury, and durability. Specifically, some participants felt that marble patterns reinforced a sustainable image, making the packaging appear more natural and environmentally friendly: "It looks very natural and fits the theme of being eco-friendly" (P16, signs of use absent), and "I think textured/patterned packaging tends to imply eco-friendliness" (P160, signs of use present). Others perceived the marble pattern as luxury and high quality, elevating the perceived value of the packaging. "Packaging looks nicer and higher end with the marble effect" (P27, signs of use absent). Some participants associated the marble pattern with material durability and robustness, even though it was purely a design feature: "Marble gives a solid and quality appearance" (P31, signs of use absent).

Shifting consumer mindsets towards signs of use. Interestingly, a perspective emerged regarding how concealing patterns could reshape consumer attitudes toward imperfections. Some participants perceived patterns to normalise imperfections, rather than just hide them: "It's a nice way of acknowledging that things don't have to be perfect to be aesthetically pleasing" (P48, sings of use absent), and "…people will come to understand that packaging does not need to look pristine" (P179, signs of use present). Furthermore, some participants viewed signs of use as blending into patterns as intentional design elements. This positive frame seemed to trigger the aesthetic appreciation of imperfections: "It looks interesting and adds character - it also makes the wear and tear on the packaging look purposeful" (P187, signs of use present).

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Consumer expectations for thoughtful design. Several participants believed patterned packaging reflected greater care and thoughtfulness in manufacturing and design, positively influencing their preferences: "It also looks like more thought was put into the design" (P29, signs of use absent). An interesting misconception emerged, where some participants believed that patterns were a result of using recycled materials: "The marbling of the packaging almost makes it clear that the bottle has been recycled, making it seem authentic" (P48, signs of use present). Although this assumption was incorrect, it suggests a potential opportunity for designers - integrating patterns that align with the material's properties may reinforce a sense of sustainability and authenticity in reusable packaging.

Despite the merits of concealing signs of use, participants raised several specific challenges regarding concealing patterns.

Concerns about pattern durability and quality. Some participants questioned the durability and quality of the patterns, expressing concerns that they might fade, wear off, or degrade over time, reducing their effectiveness in concealing signs of use. As one participant noted: "The marbling effect might rub off after repeated washing" (P66, signs of use present). Aligning with this, some participants highlighted the need for high-quality material and durable printing techniques to ensure that concealing patterns maintain their aesthetic and functional effectiveness over multiple reuse cycles. If patterns begin to deteriorate, they may not only lose their ability to hide signs of use but could also become visually unappealing, which might discourage consumers from engaging with patterned packaging.

Concealing patterns are insufficient to address contamination concerns. As we stated before, participants acknowledged that concealing patterns could make signs of use less noticeable. However, this did not necessarily translate into confidence in the cleanliness or hygiene of reusable packaging. Contamination concerns were likely to extend beyond visual cues: "My main issue would be regarding the hygiene aspects of the scheme, which is unrelated to the bottle's visual design" (P82, signs of use absent). Even when no signs of use were visible, some participants still expressed discomfort merely at the thought of prior ownership: "…just knowing that someone else used it before, even though it has been cleaned, that would be at the back of my mind constantly" (P53, signs of use absent). Additionally, some participants reported the disgust associated with cross-contamination and the risk of receiving germs from previous users: "The design of the soap was nice, but the thought of someone else having used the same bottle after they use the toilet (even though they say it is cleaned) really grosses me out!" (P100, signs of use absent). These findings suggest that concealing patterns alone were insufficient to fully address contamination concerns of reusable packaging, which could also be triggered by psychological barriers, such as the mental associations of prior use.

The qualitative findings complement the quantitative results by providing deeper insights into how consumers perceived concealing patterns. Overall, concealing patterns were again shown to hide signs of use, consistent with the results of Study 1

and Study 2. Besides, the marble pattern used in this study seemed to enhance the overall aesthetic appeal of reusable packaging in comparison to a plain version. It also provided additional symbolic meanings, such as being perceived as natural, eco-friendly, luxurious, and robust, which may reinforce a positive image of reusable packaging and contribute to consumer preference. However, concealing patterns did not inherently reduce contamination concerns, which could be partially driven by psychological barriers beyond visual cues of signs of use. Interestingly, we also found concealing patterns may have the potential to help normalise imperfections by shifting consumer expectations of reusable packaging.

5.6 General discussion

Increasing the adoption of RPSs presents a critical challenge: ensuring that packaging remains acceptable to consumers over multiple life cycles. Prior research has shown that visible signs of use—such as scratches, stains, and discolouration—can reduce consumer acceptance (Baird et al., 2022; Collis et al., 2023; Magnier & Gil-Pérez, 2021; White et al., 2016). This chapter examines whether concealing patterns can serve as an effective strategy to mitigate signs of use and improve consumer evaluations of reusable packaging with signs of use. Below, we elaborate on the theoretical and practical implications of our findings, followed by an acknowledgment of limitations and directions for future research.

5.6.1 Theoretical implications

5.6.1.1 The negative effect of signs of use on consumer evaluations

Our research extends prior research about the negative effects of signs of use on aesthetic appeal and contamination concerns, which discourage consumer adoption of RPSs (Baird et al., 2022; Collis et al., 2023; Magnier & Gil-Pérez, 2021; White et al., 2016). The findings (in Study 2) showed that even minor signs of use significantly reduce aesthetic appeal and increase contamination concerns. However, our results did not support the assumption that signs of use necessarily decrease purchase intention. A possible explanation is that prior studies largely focused on ingested products (e.g., food and beverages), where signs of use could be linked to the safety and health risks of consuming these products (Baird et al., 2022; White et al., 2016). Our studies investigated hand soap packaging, which is used externally, where risks associated with signs of use are likely to be perceived as less critical and do not necessarily influence purchase intention.

5.6.1.2 The role of concealing patterns in mitigating signs of use

Our research complements the literature on consumer perception of signs of use in reusable packaging (Collis et al., 2023). While previous studies have primarily focused on preventing visible signs of use through enhanced material durability (Greenwood et al., 2021; Tenhunen-Lunkka et al., 2024), we propose that preserving aesthetic durability is equally important for maintaining consumer acceptance. Instead of eliminating signs

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of use entirely, we drew inspiration from camouflage principles and explored the concealment strategy in reusable packaging design. Across three studies, our findings provide empirical evidence that concealing patterns could make signs of use less noticeable. However, their downstream effects on consumer perceptions were not always consistent, suggesting that concealment is an inconclusive solution.

5.6.1.3 The influence of concealing patterns on aesthetic appeal

There are notable inconsistencies in our results concerning the impact of concealing patterns on aesthetic appeal and purchase intentions. In Study 1, participants perceived (marble) patterned packaging as significantly more aesthetically appealing and reported marginally higher purchase intention than plain packaging when signs of use were present. However, this effect was not replicated in Study 2, where patterned packaging and plain packaging were rated similarly. In contrast, Study 3 revealed a stable preference for patterned packaging in a comparative setting, regardless of signs of use. The qualitative responses suggested that marble patterns may add intrinsic aesthetic value to reusable packaging, and their ability to conceal signs of use and maintain aesthetic durability over time was also well recognised by consumers.

Combining these results, we can only conclude that (marble) patterned packaging for this hand soap is more likely to be preferred when being directly compared to its plain counterpart. The discrepancies between Study 2 and Study 3 could be attributed to distinction bias (Hsee & Zhang, 2004), which suggests that preferences shift depending on whether options are evaluated separately (single evaluation) or side by side (joint evaluation). The comparative setting in Study 3 could have made the relative advantages in the aesthetic appeal of patterned packaging more salient than plain packaging. This finding is relevant for physical retail environments, where multiple packaging options are likely to be displayed side by side. Consumers naturally engage in comparative evaluations, and the patterned packaging has the potential to be seen as more attractive than its plain counterpart.

5.6.1.4 The influence of concealing patterns on contamination concerns

Although concealing patterns are effective in reducing the noticeability of traces, they do not directly address contamination concerns. In both Study 1 and Study 2, contamination concerns remained unaffected by concealing patterns. Qualitative insights from Study 3 suggest that contamination concerns are not solely driven by what consumers can see. Instead, these concerns appear to stem from psychological barriers—such as associations with prior ownership and uncertainty about hygiene practices. Even when participants acknowledged that patterns effectively concealed signs of use, they continued to question the hygienic condition of the packaging. This aligns with the concept of territorial contamination (Baxter et al., 2017), where objects previously used by others are perceived as contaminated. These concerns may be exacerbated if there is a lack of clear communication about hygiene conditions (Long et al., 2022; Miao et al., 2023b). In this sense, concealing patterns may filter contamination cues out of sight, but they do not eliminate concerns from consumers'

minds. This suggests that concealment strategies are insufficient to address contamination concerns and should be complemented with additional interventions.

5.6.2 Practical implications

While this research provides empirical insights into whether concealing patterns have a potential to mitigate the negative effects of signs of use on reusable packaging, the findings across studies were not entirely consistent. As such, the practical implications could be limited and should be considered with caution. Rather than presenting a conclusive solution, we want to offer several considerations for implementing concealing patterns in reusable packaging design.

5.6.2.1 Selection and implementation of concealing patterns

Our results suggest that not all patterns are equally effective in concealing signs of use. Study 1 demonstrated that certain patterns, such as marble, effectively reduced the noticeability of signs of use, whereas the distressed patterns unintentionally emphasised that. Therefore, designers should pre-test pattern effectiveness before implementation, ensuring that selected patterns can effectively make signs of use less noticeable.

Beyond their functional role in concealing wear, patterns can also carry symbolic meanings that influence consumer perceptions of reusable packaging. For instance, the marble pattern used in our study was associated with naturalness, durability, and a premium aesthetic, which may have contributed to consumer preferences. This suggests that when selecting patterns, designers should not only consider their ability to conceal wear but also whether their symbolic meanings align with consumer expectations for reusable packaging. Additionally, the context of usage of the target product should be considered to ensure that the overall appearance of patterned packaging fits.

Interestingly, some participants appreciated but misinterpreted the patterns as being due to the use of recycled materials. While this was a misunderstanding, it presents an opportunity to integrate unique patterns derived from recycled materials into reusable packaging, which aligns with consumer preference for reusable packaging made from sustainable materials, as suggested by our previous study (Miao et al., 2023b). One recent study has shown that incorporating distinct patterns that reflect recycled content can enhance perceived sustainability and improve purchase intention (Polyportis et al., 2024).

5.6.2.2 Ensuring the quality and durability of concealing patterns

Although patterns were generally well received in the studies, some participants expressed concerns about their long-term durability, fearing that patterns might fade or wear off over time. This highlights the importance of ensuring that pattern application techniques—whether printed, embossed, or integrated into the material structure—are robust enough to withstand repeated use and cleaning.

Importantly, visual interventions, such as concealing patterns, should not be used as a cover-up for poor durability of reusable packaging or insufficient cleanliness of the system. Instead, these fundamental aspects must be rigorously ensured by manufacturers and suppliers.

5.6.2.3 Addressing contamination concerns associated with reusable packaging

Simply hiding signs of use is insufficient to address contamination concerns, and additional interventions might be needed to reassure consumers. For instance, providing information about the cleaning processes of packaging (e.g., sterilisation methods and sanitation standards) and hygiene assurances of the system (e.g., informing consumers that RPSs are well-maintained) might further help to mitigate contamination concerns. However, a recent study suggests that, while providing such reassurances can reduce self-reported contamination concerns, this does not effectively increase consumer willingness to use packaging with signs of use (Pott et al., 2024). Therefore, consumer avoidance of packaging with signs of use may be driven more by affective responses than cognitive deliberation about contamination concerns. Increasing consumer acceptance may require efforts not only in practical assurances but also a shift in consumer mindset about signs of use.

5.6.2.4 Beyond concealment: Valorising imperfections in reusable packaging

An emerging insight from our qualitative findings was that patterns may not only conceal signs of use but also have the potential to reframe them as intentional design elements. Some participants perceived signs of use as blending into the aesthetic of patterned packaging, adding character and visually integrating imperfections. This perspective aligns with research on embracing imperfections and graceful ageing as strategies to enhance product longevity (Lilley et al., 2019; Pedgley et al., 2018; Rognoli & Karana, 2014). These studies suggest that visible signs of use, under certain conditions, can enhance the aesthetic appeal of products. While our research did not test this concept, it introduces an interesting approach to implement patterns - instead of merely hiding signs of use, patterns could be strategically designed to integrate signs of use generated over time, shifting consumer perceptions from viewing traces as damage to seeing them as a natural aspect of reusable packaging.

5.6.3 Limitations and future research

While this research provides novel insights into the role of concealing patterns in mitigating the negative perception of signs of use on reusable packaging, several limitations must be acknowledged. These limitations highlight the need for further research to validate and expand upon these initial findings.

First, a key limitation of this research is the inconsistencies in findings across studies, particularly regarding the effects of concealing patterns on aesthetic appeal and purchase intention in Study 1 and Study 2. A possible explanation is that the subtlety of the signs

of use employed in our stimuli (minor scratches and dents) may not have been visually prominent enough in digital images used in an online setting. Besides, technical factors such as device types, screen sizes and screen resolutions were not consistently controlled across studies. Participants may have accessed the survey through different devices, which may have influenced the display of signs of use and packaging appearance. To enhance ecological validity, future studies could move beyond static digital stimuli and invite participants to physically examine damaged packaging in real-world retail or laboratory settings. This would enable more realistic consumer assessments.

Second, this research primarily examined a single pattern design (marble) and cannot generalise findings to other pattern designs. The findings from Study 1 and Study 3 imply that different patterns may carry distinct aesthetic and symbolic meanings, which could influence consumer perceptions. Future research should explore a broader range of pattern designs to determine whether alternative designs can contribute to the concealment of signs of use, therefore providing comprehensive guidance to designing effective concealing patterns.

Third, the generalisability of the findings is also limited by sample size and demographic composition. Across all three studies, the sample was relatively small, reducing statistical power. Additionally, the sample was female-dominant, which was likely due to the study's screening criteria (primary household shoppers). While this aligns with traditional consumer roles in many households, it may limit the applicability of findings to a broader demographic. Future research should aim for a larger and more gender-balanced sample to improve representativeness and ensure broader generalisability.

Fourth, across studies, concealing patterns did not reduce contamination concerns or improve purchase intention for reusable packaging. Future research should explore alternative design strategies, such as reframing signs of use as desirable or meaningful to change consumers' mindsets. Some real-world designs already adopt this approach and demonstrate how signs of use can be integrated into the design to enhance rather than diminish product value. For instance, the Heineken FOBO beer bottle features a large, embossed logo that scuffs through repeated use and becomes whiter and more attractive (**Figure 25**).

Figure 25. Packaging design that incorporates signs of use (©Heineken FOBO bottle)

5.7 Conclusion

The widespread adoption of RPS is promising to reduce packaging waste and advance the packaging sector toward a circular economy. However, achieving this vision is not only a technical challenge of designing durable packaging, but also demands a fundamental shift in consumer behaviour and perceptions.

For decades, consumers have been conditioned to associate pristine packaging with quality, cleanliness, and desirability. This default expectation poses a key challenge: any visible signs of use on reusable packaging may be interpreted as a loss of value or increased risk, leading to negative evaluations. This challenge also extends beyond RPSs to all products that may carry signs of previous ownership. Yet, consumers' pursuit of perfect products conflicts with the principles of a circular economy, which encourages reuse, repair, and prolonged product lifespans.

This research explored whether concealing patterns could help address this challenge by reducing the noticeability of traces generated on reusable packaging, thereby maintaining an "as new" appearance. While concealment may serve as a potential strategy, achieving widespread consumer adoption of reusable packaging ultimately requires a shift in mindset.

For a circular economy to thrive, we need more innovative solutions to encourage consumers to accept or even appreciate products that continue to serve their purpose, even though they no longer appear new. In this way, small imperfections will no longer be seen as flaws but as natural and meaningful markers of product longevity, sustainability and responsibility.

5

PART III

PROVIDING

DESIGN STRATEGIES

Part III provides actionable design strategies for RPSs and addresses SRQ3:

What design strategies can support the development and redesign of RPSs in design practice?

/ *Chapter 6* /

Design strategies for consumers' continued usage of reusable packaging systems

In the previous chapters, we indicated that consumers generally are positive towards reuse and have a high willingness to adopt RPSs. However, in practice, their adoption may encounter various challenges, which can lead to insufficient reuse, unintentionally undermining sustainability efforts. Design has the potential to address the challenges of RPSs. Yet, existing research lacks design strategies tailored for RPSs.

In Chapter 6, we conduct four creative workshops and generate a large number of potential design ideas, which are developed through thematic analysis into 20 design strategies for consumers' continued usage of RPSs. These findings could inspire future research and RPS development.

6.1 Introduction

Reusable packaging systems (RPSs) are emerging in the fast-moving consumer goods (FMCGs) sector to reduce packaging waste (Bradley & Corsini, 2023; Coelho et al., 2020; Greenwood et al., 2021). Despite their potential, consumer engagement in RPSs remains low due to various challenges, as discussed in the previous chapters. These challenges include practical barriers, such as limited availability and product variety, system complexity, and the additional effort and time required for reuse. Moreover, consumers may not necessarily adopt RPSs just for the sake of pursuing sustainability, and they often lack the awareness regarding the actual environmental impacts of RPSs.

Beyond initial adoption, maintaining long-term adoption with RPSs remains a challenge. A significant drop-off rate has been observed, with consumers failing to consistently refill or return reusable packaging (Kunamaneni et al., 2019). For example, some consumers may acquire multiple reusable packaging for similar purposes (Bethurem et al., 2021; Tassell & Aurisicchio, 2023), while forgetting to use some and end up leaving them in drawers unused (Lofthouse & Prendeville, 2018). Others may temporarily abandon reusables, switch to single-use alternatives, or use both reusable and single-use packaging in parallel (Tassell & Aurisicchio, 2023). Additionally, heavy signs of usage or growing boredom with reusable packaging can lead to premature disposal and replacement (Changwichan & Gheewala, 2020). These unintended behaviours result in insufficient reuse and undermine the positive environmental and societal benefits of RPSs.

Despite the growing interest from academic research and industry practice, the innovation potential within RPSs remains largely underexplored. A design-driven approach presents opportunities to tackle consumer behaviour challenges (Bhamra et al., 2011; Lockton et al., 2010), making RPSs more desirable and feasible. However, much of the existing research has primarily focused on understanding consumer preferences for well-established solutions, such as returnable bottles for beverages and reusable coffee cups (Greenwood et al., 2021; Herweyers et al., 2024; Novoradovskaya et al., 2021), rather than exploring new design possibilities. While some studies have identified barriers and enablers of consumer adoption across various product categories (De Temmerman et al., 2023b; Fogt Jacobsen et al., 2022; Long et al., 2022; Miao et al., 2023b; Noëth et al., 2024), few have translated these insights into structured design strategies to guide innovation. Notable exceptions include studies that introduced digital product passports to improve supply chain transparency (Ellsworth-Krebs et al., 2022), explored the effect of environmental information on consumers' willingness to reuse (Tonikidou & Webb, 2024) and investigated digital reuse systems across different shopping contexts (e.g., online, in-store, and on the go) (Matthews & Webb, 2023). While these explorations have demonstrated the potential of design interventions to influence consumer behaviour, many more design opportunities remain unexplored.

To date, the design strategies tailored to influencing consumer behaviour with RPSs are limited. Given that consumer acceptance and continued engagement are essential to unlocking the long-term sustainability of RPSs (e.g., Bradley & Corsini, 2023; Matthews

& Webb, 2023), there is a need to develop design strategies tailored for RPSs. These strategies should not only address adoption challenges but also spark novel solutions.

This chapter aims to address this gap by (1) creating a large number of design ideas that can stimulate continued use of reusable packaging, and (2) categorising them into structured design strategies. To guide this process, we investigate the following research question: **What design strategies can designers utilise to ensure consumers' continued usage of reusable packaging?**

6.2 Theoretical background

6.2.1 Design for sustainable behaviour

As global environmental concerns continue to rise, researchers and practitioners have increasingly recognised the potential of design as an approach to facilitate behaviour change and promote sustainable choices (Bhamra et al., 2011; Ceschin & Gaziulusoy, 2016). Within this domain, Design for Sustainable Behaviour (DfSB) has emerged as a multidisciplinary field that integrates insights from design, psychology, and social sciences to influence consumer behaviours towards more sustainable outcomes (Bhamra et al., 2011). Initially, DfSB focused on designing products that positively impact consumer behaviours, and then it has expanded to include designing strategies to address emerging challenges and establishing sustainable behaviours (De Medeiros et al., 2018). While design inherently seeks to solve problems through creative solutions, it is usually informed by established theories that explain why people act in certain ways and how interventions can influence those actions.

Over the past few decades, design researchers have drawn on behavioural theories from disciplines such as psychology, social sciences, and marketing to guide sustainable design. For example, the Fogg Behavior Model (FBM), originally developed in human-computer interaction and persuasive technology, explains how motivation, ability, and triggers influence user actions (Fogg, 2009). It has been applied to design studies that develop strategies for encouraging product care (Ackermann, 2018), improve interactive energy visualisation to prompt energy conservation (Rist & Masoodian, 2019), and understand how product design can support repair behaviour (Nazlı, 2021). Similarly, the COM-B Model (Capability, Opportunity, Motivation – Behaviour) (Michie et al., 2011), originally from health psychology, has been used for behaviour analysis and design intervention in areas such as food waste recycling (Allison et al., 2022). Nudge Theory (Thaler & Sunstein, 2008), originating in behavioural economics, has been widely used to encourage pro-environmental behaviour through subtle interventions without restricting freedom of choice, such as reducing meat consumption and promoting low-carbon travel choices (Lehner et al., 2016).

While each of these frameworks or models offers valuable insights, they are often discipline-specific, targeting narrowly defined behavioural constructs or intervention types. For example, FBM focuses on designing persuasive triggers but offers limited guidance on long-term behaviour change. Similarly, COM-B provides a strong

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diagnostic structure for identifying behavioural barriers but may limit the generation of diverse and creative strategies. Nudge theory excels in low-effort interventions but has been critiqued for downplaying user autonomy and engagement over time.

6.2.2 The SHIFT framework

In response to these limitations, White et al. (2019) introduced the SHIFT framework – a comprehensive and integrative model developed through a literature review that synthesises numerous theories from behaviour science and marketing. It identifies five psychological drivers of sustainable consumer behaviour: social influence, habit formation, individual self, feelings and cognition, and tangibility (White et al., 2019). These five themes represent both internal and external drivers, offering a holistic view of factors influencing consumer behaviour. Besides, it has been specifically developed for encouraging sustainable consumer behaviour change, making it directly relevant to the challenges of RPS adoption. Translating these overarching themes to an RPS context will help generalising design strategies from diverse perspectives and foster a mindset open to novel solutions. Each of the five psychological drivers within the SHIFT framework provides a distinct lens for developing design strategies:

- **Social influence** can affect and shift consumers to be more sustainable through strengthening the presence, behaviours, and expectations of others.

- **Habit formation** refers to the process by which sustainable behaviours become automatic and enduring through repeated actions.

- **Individual self** includes individual factors that align with individual interest or desire to maintain a positive self-image, which can be reflected through their consumption behaviours.

- **Feelings and cognition** shape consumers' decision-making through two routes - an intuitive, affective route and a rational, deliberative route.

- **Tangibility** addresses the challenges that sustainable actions often require individuals to make sacrifices in the present for outcomes that seem abstract, vague, or distant from the self.

Overall, the comprehensive structure and sustainability focus of the SHIFT framework makes it suitable for developing targeted strategies to promote consumer acceptance and continued engagement with RPSs. Therefore, we adopt the SHIFT framework as our theoretical foundation to guide the development of design strategies.

6.3 Development of design strategies

To generate a diverse range of design ideas, we conducted four workshops: (1) two workshops with industry practitioners, and (2) two creative sessions with design students. The workshops with industry practitioners provided insights from experts working in circular design, packaging, and sustainable innovation. These participants

brought real-world experience and practical considerations, helping to ground the design strategies in practice. The creative sessions with design students allowed a more exploratory ideation process with fresh perspectives and openness to creative thinking.

6.3.1 Two design workshops with practitioners

6.3.1.1 Participants

Two design workshops were organised as part of an event organised by the Circular Design Forum (CDF) at Dutch Design Week 2023. CDF is a collaborative initiative where knowledge, ideas and practices in circular design are shared. Fifteen participants were recruited via email and voluntarily applied to our design workshop. Participants were members of CDF who came from manufacturers, design firms, universities, or research institutes. They all have design experience ranging from 4 to 32 years and have either interest or expertise in the circular economy.

6.3.1.2 Procedure

The workshop consisted of one physical session with ten participants and one online session with five participants. The two sessions were facilitated by two researchers in parallel. Both sessions lasted 90 minutes including 15 minutes of introduction, 45 minutes of brainstorming and ideation, 20 minutes of idea clustering and interpretations of the rationale behind design strategies, and 10 minutes of results sharing. The purpose of the workshop was to generate ideas for design interventions that could encourage consumers' continued usage of RPSs.

Brainstorming was selected as the primary workshop activity as it allowed participants to freely express their thoughts without criticism of others. To structure this ideation, we used the "How Might We" (HMW) technique — a widely adopted method in human-centred design that reframes design challenges into open-ended, opportunity-driven questions (IDEO.org, 2015). HMW prompts are intentionally broad to invite diverse ideas yet specific enough to anchor thinking in a defined behavioural challenge. To guide the brainstorming while encouraging breadth and variety, we preidentified four themes for HMW questions based on the five behavioural themes from the SHIFT framework (White et al., 2019) and insights from existing behavioural and design literature:

(1) **HMW use (digital) technologies to build a long-term relationship with reusable packaging?** This question explored the role of digital interventions, such as smart tracking systems, mobile applications, or embedded technology, in improving the usability and convenience of RPSs (Kuzmina et al., 2019; Matthews & Webb, 2023).

(2) **HMW add social values to enhance the social desirability of reusable packaging?** This question encouraged participants to consider ways to motivate packaging reuse in the social context (Babader et al., 2016).

(3) **HMW use packaging appearance design to evoke positive consumer emotions over time?** This question aimed to stimulate ideas about packaging design beyond functionality, focusing on aesthetics, materiality, and sensory appeal that may foster emotional attachment and long-term use (Haines-Gadd et al., 2018).

(4) **HMW communicate the environmental impacts of sustained use of reusable packaging?** This question considered the current lack of environmental communication about RPSs (Miao et al., 2023b), and that making environmental benefits more tangible could reinforce sustainable behaviours (Krah et al., 2019; Mugge et al., 2019).

The physical session was held in a spacious room, with four large tables and chairs around the edge. Four A1 fillable templates containing the HMW questions, some tool cards, markers and post-it notes were placed on the tables (**Figure 26**, left). The workshop started with an introduction explaining the objective of the workshop - designing RPSs that consumers keep using over an extended period. Participants were also introduced to the key barriers to reuse and examples of existing design strategies. Participants were then asked to make groups of 2-3 persons and undertake the brainstorming together (**Figure 26**, right). Each group started from one of the four HMW questions. Every ten minutes, all groups moved to the next HMW question and repeated the brainstorming process, as well as built on the ideas of others. This process, known as the carousel brainstorming strategy, encourages diverse ideas by exposing participants to fresh perspectives. After four brainstorming rounds of all HMW questions, participants went back to their initial templates. In the following 20 minutes, they clustered these ideas into interpretations of design strategies and had 10 minutes to share results with all participants in the room.
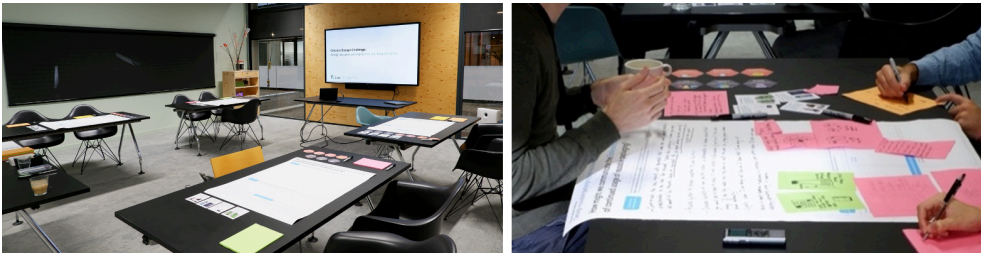
Figure 26. Setup (left) and brainstorming session (right) of the offline workshop

The online session was conducted in parallel via Microsoft Teams. Teams provides an encrypted, secure audio and video communication platform that can be easily accessed from home using a link provided by the researcher. It also allowed the researcher to share the screen and use Miro, an online collaborative whiteboard platform, to interact with and collect ideas from participants. The online workshop followed the same procedure as the offline one. The only difference was that online participants did silent brainwriting rather than verbal brainstorming on the Miro board (**Figure 27**). Brainwriting is a structured idea generation technique where participants write down their ideas individually, rather than expressing them verbally. This approach is

particularly beneficial in the online setting as it minimises common challenges such as audio delays, connection issues, and multiple participants speaking at the same time, which can hinder the flow of verbal brainstorming. Using Miro boards, participants have equal opportunities to contribute and review others' ideas. To make the session interactive, the researcher selected participants to elaborate on or clarify their ideas during the brainwriting.
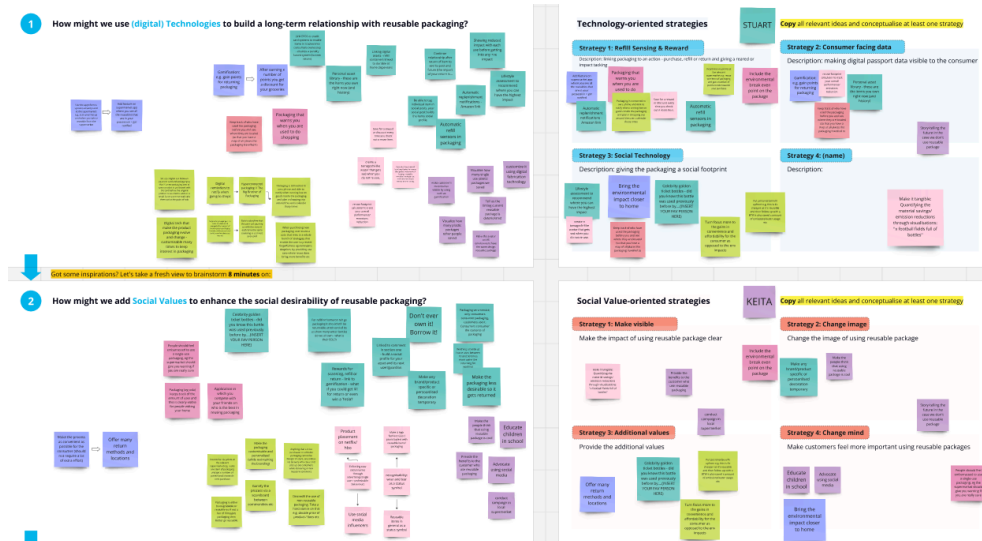
Figure 27. Brainwriting on the Miro board in the online workshop

6.3.2 Two creative sessions with design students

6.3.2.1 Participants

To broaden and enrich our findings, we conducted two creative sessions with four design students each. Participants had at least a bachelor's degree in industrial design or a similar design field. While the workshops with industry practitioners focused on generating a broad range of practical design strategies, the sessions with design students aimed to explore more imaginative and unconventional ideas that were less constrained by existing business or technological limitations.

6.3.2.2 Procedure

To encourage creative thinking, we adopted creative problem-solving techniques proposed by Heijne and van der Meer (2019), which emphasise divergent thinking and associative ideation methods. Each creative session lasted two hours and was guided by the question: **How can we encourage consumers to use reusable packaging systems continuously?** Rather than narrowing down exploration too early, the single-question approach could maintain creative freedom and allow unexpected connections to emerge, encouraging students to challenge conventional assumptions and generate novel ideas for RPS design.

Participants started with a mind-mapping exercise centred on RPSs from a consumer perspective (**Figure 28**, left). This activity helped them delve into diverse aspects of the problem. After that, the word chain association technique was used to stimulate divergent thinking. Specifically, participants were asked to construct several 5X5 matrices (**Figure 28**, right), each starting with a word related to the session question. The remaining cells were filled with random words extracted from different domains, encouraging lateral thinking and unexpected associations. This method helped participants break away from conventional problem-solving patterns and led to novel design directions. To push ideation further, two random words from each association matrix were selected and 'forced fit' to the original problem statement. This forced association technique helped participants establish connections between unrelated concepts, leading to creative solutions.

After generating ideas, participants engaged in brief discussions to evaluate and refine their ideas. Participants then indicated their preferred ideas and eliminated those deemed insufficiently novel or impactful for further development. Finally, participants paired up to create sketches of the selected ideas. Each pair then switched the partner to further refine and expand on the concepts. This collaborative sketching allowed ideas to evolve from diverse perspectives and increased the novelty of the concepts generated (**Figure 29**).

6.3.3 Data analysis

Participants' ideas collected on templates were all transcribed for analysis. A total of 251 raw ideas were extracted from the four workshops. To systematically organise and interpret the data, we conducted a thematic analysis following a mixed inductive and deductive approach.

First, we applied an inductive approach to refine the ideas and generate initial codes. This exploratory approach ensured an open-ended examination of the data, allowing a broad range of creative ideas to be captured without immediate comparative evaluation. To maintain a design-focused perspective, irrelevant ideas (e.g., policy regulations) were excluded from the analysis, and overlapping ideas were combined.

Next, we applied a deductive approach to categorise conceptually similar codes into subthemes. In this phase, we actively consulted relevant literature and consumer insights to enhance the scientific rigour of our categorisation. This iterative process resulted in a final set of 20 subthemes, each representing a design strategy. These strategies were then mapped onto the five overarching themes proposed by the SHIFT framework (White et al., 2019).

To ensure credibility and avoid misinterpretation of the data, the organisation of the codes and subthemes was discussed and iterated within the research team.
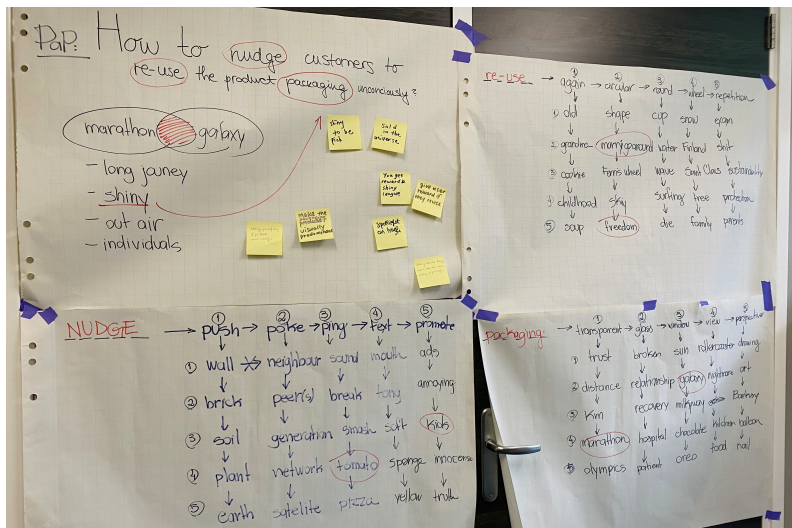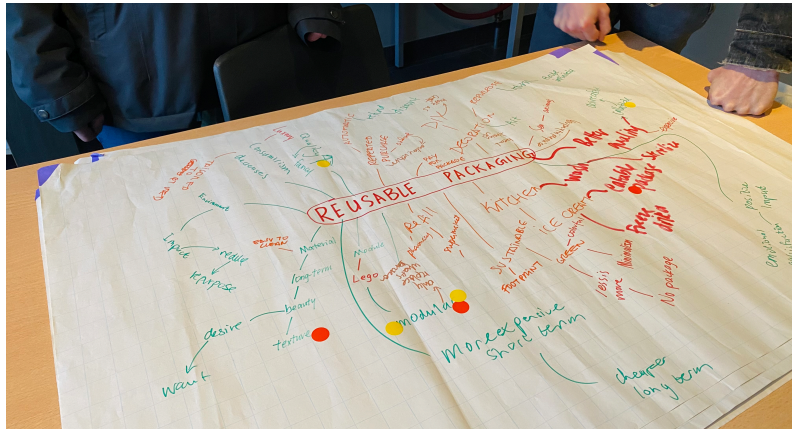
Figure 28. Mind mapping (above) and word chain association (below)

Figure 29. Collaborative sketching

6.4 Results: Design strategies for RPSs

Table 12 shows an overview of design strategies for RPSs. Below, we elaborate on each design strategy with examples to demonstrate how they can be implemented in RPSs.

Table 12. Design strategies for RPSs within the SHIFT framework

Themes (5)	Design strategy (20)
Social Influence	Making reuse socially desirable
	Expressing social identity
	Enabling social interaction
Habit Formation	Stimulating first reuse
	Bridging context and reuse
	Prompting reuse action
	Making reuse practical
Individual Self	Empowering individual reuse
	Matching with self-interest
	Enhancing responsibility and commitment
Feelings and Cognition	Recognisability
	Playfulness
	Uniqueness
	Novelty
	Familiarity
Tangibility	Providing feedback
	Proximity and concreteness
	Positive appearance change
	Intentional imperfection
	Intrinsic sustainability

6.4.1 Social influence

Social influence has been shown to foster consumer engagement in sustainable behaviours, such as adopting reusable packaging (Dorn & Stöckli, 2018). The effect of social influence is based on the idea that people have an urge to align their behaviour to the words and actions of others. Using reusable packaging is a social practice as consumers must (1) bring the packaging to a public space (e.g., supermarkets) and (2) expose their packaging choice to others when they refill or return the packaging. The presence of others can induce a desire to manage one's impression (White & Dahl, 2006), making it crucial to generate design strategies that leverage social influence.

Making reuse socially desirable. Participants proposed displaying real-time collective efforts (e.g., live updates on packaging waste reductions) and public campaigns to increase the social awareness of reuse options. This suggests that a social atmosphere where reusable packaging is a socially preferred option may stimulate consumers to pursue it. This also aligns with previous research showing that consumers often seek to align their actions with social desirability in a public context to create a positive impression on others (Green & Peloza, 2014).

Expressing social identity. Participants suggested designing packaging with an eco-statement, such as "I Choose Reuse" or incorporating green labels to signal

sustainability. These elements allow consumers to visually express their environmental values to others, reinforcing one's self-perception as a sustainable consumer. This corresponds to previous research showing that individuals seek to align their consumption choices with the norms of their reference groups (the social group they identify with) (van der Werff et al., 2013).

Enabling social interaction. Beyond individual expressions, participants also emphasised the role of social interactions in reinforcing reuse behaviours. They recommended creating online platforms or reuse communities where consumers can showcase reuse achievements, share experiences, and inspire others. Engaging in social interactions strengthens perceived belonging to a pro-environmental group (van der Werff et al., 2014). Additionally, participants suggested integrating public reward mechanisms (e.g., collecting points, ranking systems, or reuse milestones) to gamify sustainable actions.

6.4.2 Habit formation

Consumers' purchase of FMCGs is largely habitual but not in line with notions of sustainable behaviour and consumption. Habits form slowly over time through repeated action and are likely to recur automatically without much conscious controlled process or effort in stable contexts, such as the same location or time of day (White et al., 2019). To use RPSs, consumers need to alter existing routines of buying products in single-use packaging and develop new shopping patterns with reusable packaging. Making the new habit effortless requires a stable and effective context that allows unobstructed and fast performance, as well as encourages repetition over time (Verplanken & Whitmarsh, 2021).

Stimulating first reuse. Participants highlighted the importance of making the first attempt at reusing packaging attractive and effortless, such as providing free trials or offering discounted refill bundles. Indeed, many studies have indicated that while consumers expressed a willingness to engage in reuse, they often hesitate to invest extra money or effort in obtaining reusable packaging (De Temmerman et al., 2023b; Keller et al., 2021; Miao et al., 2023b). Therefore, providing easy entry points may help break the old habit, as the first step to establishing a new one.

Bridging context and reuse. To reinforce reuse habits, participants proposed embedding contextual cues that link packaging reuse to consumers' daily routines. One approach involves incorporating visible indicators on the packaging, such as a supermarket logo on a reusable shopping bag. This visual cue can build mental associations between reusable packaging and its intended context (e.g., grocery shopping). Research on habit formation suggests that behaviours become automatic and intuitive when they are consistently repeated in the presence of stable cues (Verplanken & Wood, 2006).

Prompting reuse action. Participants emphasised that they might not know where to find RPSs or forget to bring packaging for reuse. They proposed introducing prompts at different stages of the user journey. First, awareness of available reuse infrastructures

and products offered in RPSs could be raised during the planning stage, such as informing these through supermarket apps or brochures to prompt consideration of reuse options. Second, reuse infrastructures, such as refill and return points, should be strategically placed in accessible locations with clear signage. This exposure reduces the mental effort in locating reuse options and supports spontaneous engagement. Third, reminders were seen as useful in triggering reuse actions. Participants suggested push notifications, replenishment alerts, or tips for carrying containers. Such prompts encourage consumers to actively explore reuse options and reduce the chances of forgetfulness in their grocery shopping.

Making reuse practical. To establish the repetition of reuse behaviour, participants stressed that reusable packaging must be practical and convenient, aligning with previous studies that uncovered consumer preference for reusable packaging (Herweyers et al., 2024; Miao et al., 2023b). Participants suggested several design features to improve the practicality of reusable packaging. Examples encompass portability, making packaging foldable or stackable for efficient space utilisation during transportation; adaptability, addressing versatility by replacing certain components (e.g., caps) to accommodate different product uses, or expanding packaging volume to suit individual needs; attachability, enabling the packaging to be conveniently attached to clothing or accessories for on-the-go use; modularity, allowing consumers to replace or customise parts of the packaging when they cannot satisfy consumers' demand anymore.

6.4.3 Individual self

While sustainable consumption is often framed as a collective effort, consumers may feel that their individual actions have a limited impact on addressing environmental challenges. Many are reluctant to sacrifice the perceived benefits of single-use packaging—such as affordability, convenience, and hygiene—unless they also see individual benefits through adopting RPSs.

Empowering individual reuse. Participants emphasised the importance of helping consumers feel confident and assured about the value of their reuse behaviour. For instance, participants suggested goal-setting tools and personalised progress updates, such as weekly summaries showing the number of single-use packages avoided through RPSs in their daily shopping. Participants also mentioned the potential of communicating break-even points, which clarify how many reuses are needed for reusable packaging to become more sustainable than its single-use counterpart. This suggestion closely aligns with our earlier findings presented in Chapter 4 (also see Miao et al., 2024a). These interventions are designed to instil a sense of accomplishment, convincing consumers that their consistent actions have a meaningful impact. This also aligns with previous studies suggesting that consumers are more inclined to adopt sustainable behaviour when they believe their actions can yield positive outcomes (Kim & Choi, 2005). By making progress actionable and goal achievable, such design ideas can empower consumers to stay engaged and take ownership of their contribution to sustainability.

Matching with self-interest. Participants suggested that consumers are more likely to adopt RPSs if they offer personal gains beyond sustainability. They proposed emphasising convenience features such as home delivery, customisable portion sizes, and widespread availability of refill stations. Monetary incentives were also recommended, such as lower prices for refills compared to pre-packaged products or rewards for long-term reuse. Additionally, some participants highlighted that the upfront cost of reusable containers might deter adoption. To address this, they suggested demonstrating a pay-back period of investment and showing consumers their investment in reusable packaging would result in cost savings in the long term. These ideas suggest that communications about RPSs should go beyond environmental benefits, such as personal gain, making it more attractive to consumers.

Enhancing responsibility and commitment. Participants suggested that to encourage consumers to commit to continued reuse, designers can develop loyalty programs that allow consumers to track their reuse history, receive rewards for consistent participation, and manage their current packaging possessions. Besides, they also recommended explicit commitment mechanisms, such as signing up for a "reuse pledge" or registering for a membership program to encourage long-term engagement. This seems to align with self-concept and preference for consistency (Christner et al., 2022), which suggests that when people commit to a certain behaviour, they are likely to act in ways consistent with that commitment to maintain a stable self-concept, leading to long-term behaviour change.

6.4.4 Feelings and cognition

Consumers' adoption of reusable packaging can be driven by two primary psychological processes: feelings, which are intuitive and emotion-based, and cognition, which involve more deliberate, rational evaluations. To trigger consumers' reuse actions, it is important to understand consumers' perceptions, emotional responses, and appraisals of different design elements of reusable packaging.

Recognisability. Participants emphasised the importance of making reusable packaging recognisable, both in retail settings and at home. A distinct and recognisable appearance not only differentiates reusable packaging from single-use alternatives to ease cognition but also guide appropriate handling and reuse. Potential interventions include integrating iconic design features, or consistent labelling systems to signal reusability. This aligns with findings from the research on sustainable product perception, where recognisability has been shown to increase purchase intention or willingness to pay a price premium for products made from recycled materials (Magnier et al., 2019; Polyportis et al., 2024).

Playfulness. Participants proposed incorporating playful design elements to stimulate curiosity and create emotional engagement with reusable packaging. A specific example discussed was anthropomorphic design, where packaging can be given human-like attributes, such as facial expressions, names, or gestures. Participants mentioned a well-known design, Henry vacuum cleaner, whose smiling face, hat-like dome, and name

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create a sense of character and charm. Such features not only make the product more enjoyable to use but also develop an emotional bond, which may support long-term use. Previous studies have shown that anthropomorphic product design fosters stronger consumer attachment (Wan & Chen, 2021), which could be leveraged in RPSs to promote long-term adoption.

Interestingly, the idea of anthropomorphic design echoes the image shared in the foreword of this dissertation (**Figure 1**) - there is an M&M's container saved from my childhood. I did not throw it away at a young age simply because it had a smirking face and felt like a friend. Perhaps, if reusable packaging could evoke this kind of delight and personality, consumers would be more inclined to keep them in use.

Uniqueness. Making reusable packaging unique was another recurring theme in participant discussions. They suggested personalisation features, such as allowing consumers to co-design packaging through customisable prints, patterns, or engravings. The participatory effort put into the design process enhances the emotional attachment to packaging and makes it a scarce resource that is less likely to be abandoned. Additionally, participants proposed embedding memory markers—such as a timestamp or location print on the packaging—to create a tangible record of personal experiences, leading consumers to keep it for a longer period.

Novelty. To maintain consumer interest and engagement, participants suggested that reusable packaging should infuse a sense of novelty and incorporate continuous innovation over time. Some technologies were suggested to assist innovations in RPSs, such as digital fabrication (e.g., 3D printing) that enables customisation to suit evolving consumer preferences and built-in sensors (e.g., radio frequency identification (RFID) chips) that facilitate smart interactions. These ideas align with prior studies that highlight the potential of technological integration in RPSs to reflect consumer use behaviour of the products and offer tailored service to individual needs (Coelho et al., 2020; Ellsworth-Krebs et al., 2022; Kuzmina et al., 2019).

Familiarity. While some participants expressed a preference for novelty, others emphasised novelty sometimes introduces additional cognitive effort, making the transition from single use to reuse more challenging. Instead, they highlighted the importance of familiarity to ease the transition. For example, they proposed retaining iconic branding features in packaging design while adding reuse-specific features (e.g., resealable caps). This approach allows consumers to continue their habitual product choices while seamlessly adapting to reuse. This perspective aligns with findings from our previous study, which revealed that consumers seek familiar aspects to reduce perceived complexity when adopting a novel reuse offering (Miao et al., 2023b).

6.4.5 Tangibility

Sustainable consumer behaviours usually involve putting aside more proximal, immediate, individual interests in place of actions that confer benefits that are more remote, future-focused, and other-oriented. Therefore, sustainable outcomes usually seem psychologically distant, abstract, and difficult for consumers to grasp and measure

(Trope & Liberman, 2010). Thus, making the packaging pollution crisis and solutions very clear and tangible is important for encouraging consumers' continued usage of reusable packaging.

Providing feedback. Participants emphasised the need for tangible and quantifiable feedback mechanisms to communicate the environmental benefits of reuse. Suggestions included physical or digital tracking systems that provide real-time updates on waste reduction, carbon savings, or the number of single-use packages avoided. This aligns with prior research indicating that consumers often lack sufficient knowledge to evaluate the environmental benefits of RPSs, which can reduce their motivation to participate (Miao et al., 2023b). On the other hand, feedback has been widely recognised as effective in promoting sustainable behaviour by providing immediate and tailored information, and motivating long-term engagement (Abrahamse et al., 2007; Bhamra et al., 2011).

Proximity and concreteness Participants highlighted that the environmental impact of packaging waste often feels distant in time and space from when and where the consumption takes place, which makes it difficult to assess the actual impact or perceive the urgency of reuse. They suggested making the environmental impact more proximal and concrete to consumers' context. For example, highlighting local pollution statistics or depicting the potential consequences of waste accumulation in nearby communities can make environmental impacts more tangible. Another example was using interactive media, such as augmented reality, to simulate a worse future scenario if reusable packages are not used, addressing present-focused biases, and enhancing the urgency to act. This is supported by construal level theory (Trope & Liberman, 2010), which posits that people are more likely to act on issues perceived as immediate and concrete rather than distant and abstract.

Positive appearance change. Participants suggested that packaging should visually evolve in a positive way that reflects and rewards continued use. One example mentioned was Bethan Laura Wood's teacups, which reveal an enhanced pattern through repeated use, creating a sense of progress and personal engagement. Accordingly, participants suggested applying similar principles to reusable packaging, such as incorporating designs that gradually emerge, textures that improve with handling, or colour-changing materials that react to usage. These positive appearance changes could make reuse a more interactive and rewarding experience. This perspective aligns with research on "graceful ageing" as a strategy to enhance product longevity, highlighting the idea that signs of use can be an indicator of product value rather than deterioration (Lilley et al., 2019; Rognoli & Karana, 2014). Another practical example can be found in the Heineken FOBO bottle we discussed in Chapter 5, which features a large, embossed logo that gradually scuffs, and becomes whiter and more attractive through repeated use (see **Figure 25** in Chapter 5).

Intentional imperfection. Besides positive appearance changes, participants also recognised that reusable packaging typically becomes worn after multiple lifecycles and proposed reframing signs of use generated on reusable packaging. In line with previous

studies, signs of use have been constantly recognised as a barrier to consumer acceptance and adoption of reusable packaging (Collis et al., 2023; Hoseini et al., 2024; Magnier & Gil-Pérez, 2021; Miao et al., 2023b). Participants suggested incorporating imperfections resulting from signs of use into the packaging appearance as an inherent part of reusable packaging may help normalise and even celebrate them. For example, creating a "worn effect" or retaining imperfections in the material to visualise the product's history of use. Some participants also suggested using narratives to explain the meaning behind these imperfections, emphasising the environmental benefits of multiple lifecycles. By reframing imperfections as a natural or meaningful part of the reuse experience, this approach encourages consumers to view worn packaging positively.

Intrinsic sustainability. Participants emphasised that for RPSs to gain consumer trust, their sustainability must be evident throughout the entire lifecycle, from material sourcing and production to disposal. One key suggestion was to prioritise materials that are widely recognised as environmentally responsible, such as biodegradable, recycled, or recyclable options, as these materials enhance the perceived sustainability of the packaging. Participants also highlighted the importance of clear communication regarding these sustainable attributes to help them assess whether a reusable packaging solution is more sustainable than its single-use counterpart. Additionally, participants stressed the need for explicit guidance on responsible end-of-life disposal, such as on-pack messaging, QR codes, or digital platforms that direct them to reuse schemes, proper recycling pathways, or repurposing options. Providing such information enhances transparency and reduces consumer uncertainty about what to do with the packaging once it reaches the end of its usability.

6.5 General discussion

This chapter presents the development of 20 design strategies developed through four workshops and structured using the SHIFT framework, aiming to support consumer adoption and continued use of RPSs for FMCGs.

6.5.1 Theoretical implications

While many existing design tools focus on general behaviour change models (e.g., Michie et al., 2011) or circular economy business strategies (e.g., Konietzko et al., 2020; Rexfelt & Selvefors, 2021), they often lack specificity for direct application in real-world RPS innovation. In contrast, our design strategies build on evidence-based consumer behaviour insights and are structured within the SHIFT framework (White et al., 2019). This integration demonstrates the framework's adaptability to new domains and its value in guiding tailored design strategies for promoting sustainable behaviour.

By translating theoretical constructs into concrete and actionable strategies, this study contributes to the growing body of literature on design for sustainability. It also contributes to methodological discourse by showcasing exploratory methods that can be effectively combined with established theoretical models. This approach enhances

the credibility of the resulting strategies, providing a replicable approach for applying behavioural frameworks to other sustainability-focused design challenges.

6.5.2 Practical implications

This study adopted an exploratory approach without restricting strategies to specific product categories. While this broad applicability is beneficial for generalising design strategies across different RPSs, their effectiveness may depend on target products. For instance, strategies such as responsibility and commitment may be more effective for frequently consumed products (e.g., milk or coffee) than slowly consumed items (e.g., detergent) as higher reuse frequency may foster stronger consumer engagement and habit formation.

Although we focused on explaining individual strategies, combining multiple design strategies in practice may address different aspects of consumer behaviour and enhance the effectiveness of the solution. For example, integrating prompts with social interactions (e.g., a digital app that provides reuse reminders, availability updates, and an online community for shared experiences) could motivate long-term engagement. This highlights the potential synergistic effects of design strategies when applied in practice. However, some strategies may contradict or dilute each other. For example, pairing social desirability (e.g., public recognition or comparison) with strategies rooted in self-interest may unintentionally discourage participation. If consumers feel pressured to act for public approval rather than intrinsic motivation, they may experience discomfort or inconsistency in their behaviour. Further research could explore strategy pairings that maximise positive behavioural outcomes.

Importantly, the temporal effectiveness of certain strategies should be considered in design practice. Strategies such as playfulness and novelty may work best in the early adoption phase but lose their motivational impact as consumers become accustomed to the packaging. In contrast, strategies like positive appearance change only yield benefits through repeated reuse cycles. Designers should anticipate these temporal effects and effectively implement strategies to maintain consumer engagement.

6.5.3 Limitations and future research

Although this study contributes valuable insights into design strategies for promoting continued usage of RPSs, several limitations should be acknowledged.

First, the method used for idea generation in this research tends to prioritise quantity over quality, meaning ideas are often generated quickly without much critical reflection or elaboration. As a result, some of the ideas may appear conceptually appealing but lack depth or systemic considerations when examined more closely. Future research could complement structured design methods, such as co-design or scenario building, to foster deeper ideation and refine promising concepts.

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Second, although the participants in this study had relevant backgrounds in circular economy or design, they were not experts in behavioural science or working in the packaging industry. As such, they may not have had a full understanding of the current trends and technological advancements that could enable or constrain RPS innovations. Future research could engage expert stakeholders, such as packaging engineers, supply chain specialists, or retail partners, to contribute deeper industry insights and help evaluate which strategies hold promise for innovation.

Third, these design strategies were developed through four workshops and thematic analysis. While this process enabled a rich, exploratory examination of design opportunities, it lacks empirical validation. Future research should move beyond ideation and seek to evaluate these strategies through experimental studies, consumer testing, or real-world pilot interventions. For instance, controlled experiments could assess consumer responses to specific strategies, and longitudinal studies could explore their effectiveness over time and potential rebound effects.

Finally, although the strategies were conceptually grounded and structured using the SHIFT framework, their translation into practical design guidance remains a work in progress. Practitioners may require more structured, visual, and practical tools to apply these strategies in concrete projects. As a next step, we develop and evaluate a card-based design toolkit in Chapter 7 that builds on these strategies and facilitates their application in design practice.

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/ *Chapter 7* /

Let's RePacKit! Development and evaluation of a design toolkit to support consumers' sustained use of reusable packaging systems

Chapter 7 builds on the 20 design strategies developed in Chapter 6 and translates them into a card-based design toolkit, aiming to support the development of new reusable packaging systems (RPSs). This chapter details the iterative development of this design toolkit to ensure its clarity, usability, and alignment with the design process. After several iterations, the toolkit is demonstrated and evaluated in two workshops with design students. This approach allows us to examine how it facilitates ideation and supports participants in generating novel RPS concepts. Through qualitative analysis of workshop data, we identify strengths of this design toolkit and areas for improvement. Based on the insights collected from workshops, we refine and finalise the toolkit to enhance its usability and practical application.

7.1 Introduction

It is well-recognised that designers play a critical role in shaping consumer interactions with products and services, thus creating positive impacts on society and the environment (Bhamra et al., 2011; Ceschin & Gaziulusoy, 2016). As industries transition toward sustainability, design has become an essential driver in creating solutions that reduce environmental impact and encourage more sustainable consumer behaviours. However, designing for sustainability presents significant challenges, as it requires interdisciplinary knowledge, systems thinking, and expertise that extend beyond traditional design skills (Wiek et al., 2011). For many designers, particularly those without formal training in sustainability, tackling sustainability challenges can be seen as complex and overwhelming (Ceschin & Gaziulusoy, 2016; Ræbild & Hasling, 2019). In the context of reusable packaging systems (RPSs), while existing research has explored factors influencing consumer adoption of RPSs (Herweyers et al., 2024; Long et al., 2022; Miao et al., 2023b), practical tools that help designers apply scientific knowledge in RPS development remain scarce.

In Chapter 6, we developed 20 design strategies aimed at fostering consumer acceptance and long-term adoption of RPSs. These design strategies were structured within the SHIFT framework (White et al., 2019), covering social influence, habit formation, individual self, feelings and cognition, and tangibility. Although these design strategies can serve as valuable inspiration, their current textual presentation poses several limitations when it comes to real-world design practice.

Unlike researchers accustomed to analysing paper-based knowledge, designers typically engage in visual workflows and utilise interactive or physical design tools rather than dense textual descriptions (Ackermann et al., 2021). Translating design strategies into a more visual and interactive format can enhance their usability, making them easier to explore and apply in creative sessions. Moreover, the disconnect between design research and design practice often hinders the application of research findings in real-world innovation (Dorst, 2016). Much of the knowledge surrounding RPS adoption and sustainable design is often scattered throughout academic literature, making it challenging and time-consuming for practitioners to locate and interpret relevant insights. Designers and practitioners work in fast-paced, iterative environments where they need to quickly interpret, synthesise, and apply insights into practical solutions. A structured, practical design toolkit can spread scientific knowledge to a broader audience, enabling quick reference and application.

Given these considerations, this chapter introduces the development and evaluation of a design toolkit for RPSs, which is envisioned as a resource of inspiration for future RPS development. The research question guiding this work is:

How can designers be supported to develop or redesign RPSs that foster consumer acceptance and long-term adoption?

To answer this question, we employ an iterative design research approach comprising three key phases: (1) Toolkit development: We translate 20 design strategies developed in Chapter 6 into a card-based toolkit and add additional components to support their usage. These cards are refined through multiple internal iterations within the research team, ensuring clarity and usability in the design processes. (2) Demonstration and evaluation: We conduct two workshops with thirteen design students, introducing them to the toolkit and observing how they apply it to generate new RPS concepts. These sessions allow us to examine how different components in the toolkit facilitate the ideation process, and whether they effectively guide participants to generate novel design solutions for RPSs. Through qualitative analysis of workshop data, including participant reflections, discussions, and generated design outcomes, we identify the strengths of this toolkit and areas for improvement. (3) Refinement and finalisation: Based on feedback received from the workshops, we further refine and finalise the design toolkit to enhance its usability and practical application.

In the following sections, we elaborate on each phase. This chapter concludes with a general discussion, limitations, and future directions to further validate the toolkit and explore its application in the real-world design practice of RPSs.

7.2 Toolkit development

The development of the toolkit was an explorative and iterative process within the research team, which was also informed by existing toolkit research.

Among various tool formats, card-based design tools have gained popularity as effective means for communicating research insights in design practice (Wölfel & Merritt, 2013; Yoon et al., 2016). Examples include: Design with Intent, which presents a range of techniques for understanding context and influencing behaviours (Lockton et al., 2013); Design for Happiness Deck, which encourages designers to consider the emotional well-being dimension in product design (Delft Institute of Positive Design, 2017); Use2Use design toolkit, consisting of five tools to integrate user perspective into the circular design (Rexfelt & Selvefors, 2021); Circularity Deck, which helps firms analyse, ideate and develop the circularity potential of their innovation ecosystems (Konietzko et al., 2020); and Product Care Kit, which supports the development of products and services that encourage care, repair, and maintenance of products (Ackermann, 2018).

The general advantages of these card-based tools are clear and concise descriptions, and visualised examples. Designers can easily browse the cards, gain insights, and collaboratively generate ideas within their teams (Wölfel & Merritt, 2013). Given these advantages, we chose to translate our design strategies and five SHIFT themes into a card-based design toolkit.

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7.2.1 Structure and key components

The toolkit is structured around four components: theme cards, strategy cards, journey cards, and an instructional guide, each serving a distinct yet complementary role in the design practice.

Theme cards are based on the five factors in the SHIFT framework and tailored to the context of RPSs. These cards can be used at the beginning of the ideation process, helping designers to identify factors influencing consumer behaviour, stimulate discussions about current challenges and opportunities, and establish initial design directions.

Strategy cards are drawn from 20 design strategies outlined in **Table 12** (Chapter 6), acting as practical prompts. These cards can be used flexibly during ideation sessions to spark creativity or refine design concepts.

Journey cards help structure the user journey, mapping key interactions in the RPS. These cards encourage designers to think systematically about the user experience and identify opportunities at different stages to facilitate long-term adoption.

Instructional guide allows users to navigate the toolkit independently without requiring additional facilitation. This ensures that our design toolkit can be effectively used across different design settings, whether in workshops, team discussions, or individual brainstorming sessions.

To enhance usability and aid comprehension, each theme card and strategy card features visual illustrations, making key information immediately accessible. This reduces reliance on lengthy texts, minimises cognitive overload, and ensures that the toolkit remains user-friendly for designers.

7.2.2 Iterations

The development of the design toolkit followed an iterative, explorative process within the research team, incorporating continuous improvement to ensure clarity, practicality, and usability. Throughout multiple iterations, our goal was to create a design toolkit that supports designers in generating ideas for developing new RPSs or improving existing RPSs.

A critical aspect of this process involved crafting illustrations that clearly and meaningfully represent each theme and strategy. The illustrations were developed collaboratively by a researcher and a professional graphic designer with a master's degree in product design. To achieve a strong visual representation, we conducted several brainstorming sessions, drawing inspiration from various sources, and sketched multiple conceptual ideas for each strategy. Each illustration underwent rounds of discussion and refinement to ensure it accurately captures the intended concept while remaining simple and engaging. **Figure 30** and **Figure 31** show illustrations for the five themes and 20 design strategies for RPSs, respectively.

Social Influence   **Habit Formation**   **Individual Self**   **Feelings and Cognition**   **Tangibility**
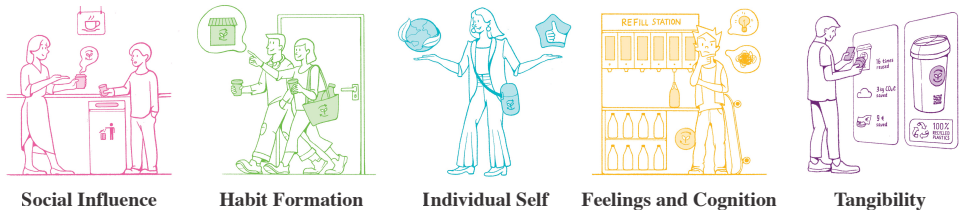
Figure 30. Illustrations for the five themes

Making Reuse Socially Desirable   **Stimulating First Reuse**   **Empowering Individual Reuse**   **Recognisability**   **Providing Feedback**

Expressing Social Identity   **Bridging Context and Reuse**   **Matching with Self-Interest**   **Playfulness**   **Proximity and Concreteness**

Enabling Social Interaction   **Prompting Reuse Action**   **Enhancing Responsibility and Commitment**   **Uniqueness**   **Positive Appearance Change**

Making Reuse Practical   **Novelty**   **Intentional Imperfection**

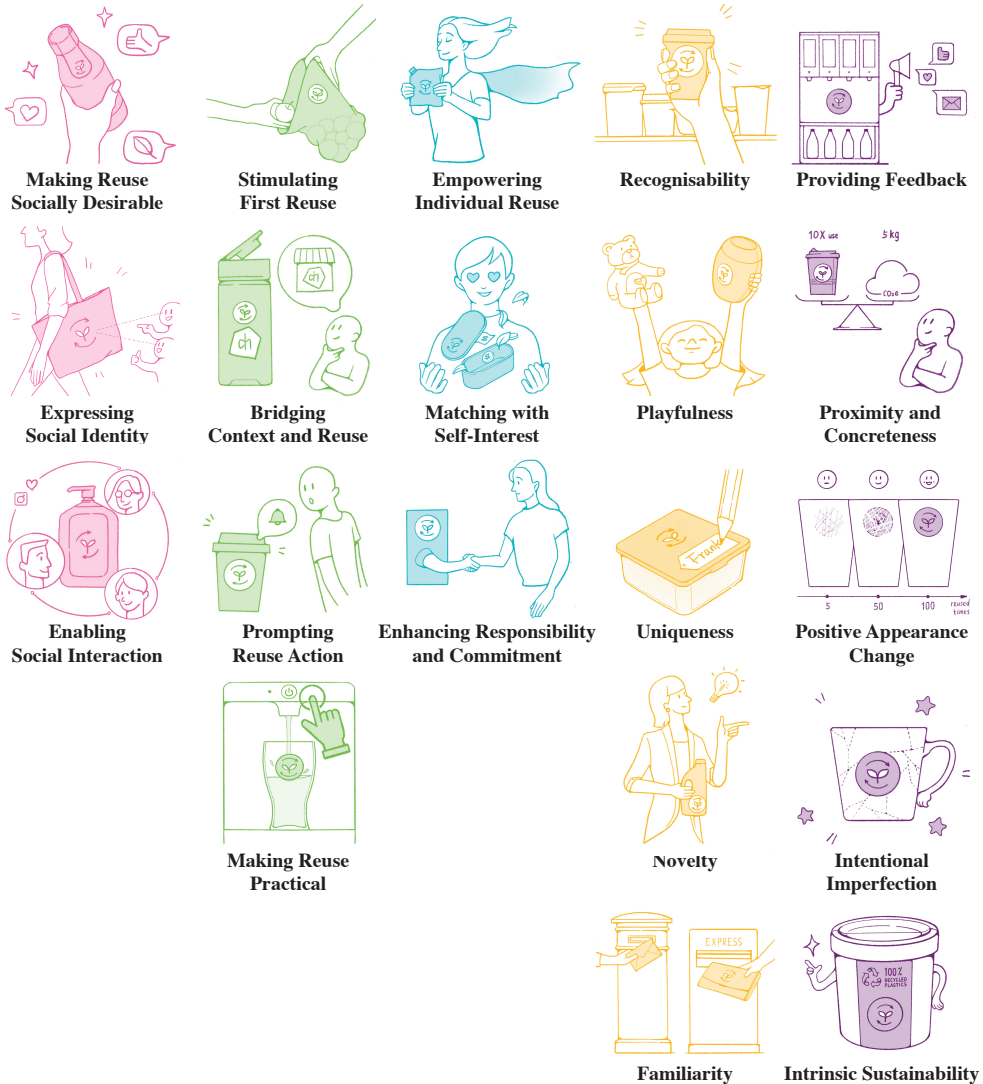**Familiarity**   **Intrinsic Sustainability**

Figure 31. Illustrations for the 20 design strategies

The design toolkit evolved through three iterations, each incorporating feedback from discussions within the research team. Earlier versions (1.0 and 2.0) can be found in the **Appendix D**. The prototype used in the demonstration and evaluation workshops is described in detail below.

7.2.3 Results: Design toolkit for reusable packaging systems

The final iteration of the toolkit comprises: 5 Theme cards, 20 Strategy cards, 12 Journey cards and a foldable instructional guide.

Theme cards. Five theme cards that are double-sided and colour-coded, each representing one of the five themes from the SHIFT framework (social influence, habit formation, individual self, feelings and cognition, and tangibility). The front side displays the theme name and an illustration that depicts a relevant scenario. The reverse side includes a description related to RPSs and an inspirational question, along with several associated design strategies (see an example in **Figure 32**).
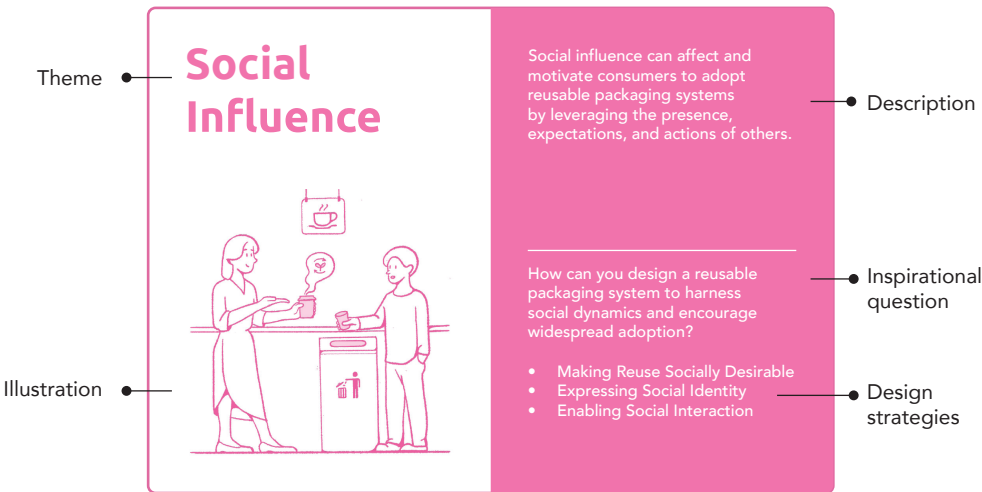
Figure 32. An example of the theme card (left: front side, right: reverse side)

Strategy cards. Twenty strategy cards that are double-sided and colour-coded, aligning with the themes they belong to. The front side presents the strategy name, a brief description and an illustration that depicts the scenario this strategy wants to achieve. The reverse side offers consumer insights, an inspirational question with suggested design ideas as hints. An illustrated example with a description shows how the strategy can be applied to reusable packaging (see an example in **Figure 33**). While many examples were inspired by existing sustainable product designs, others were developed through brainstorming sessions.
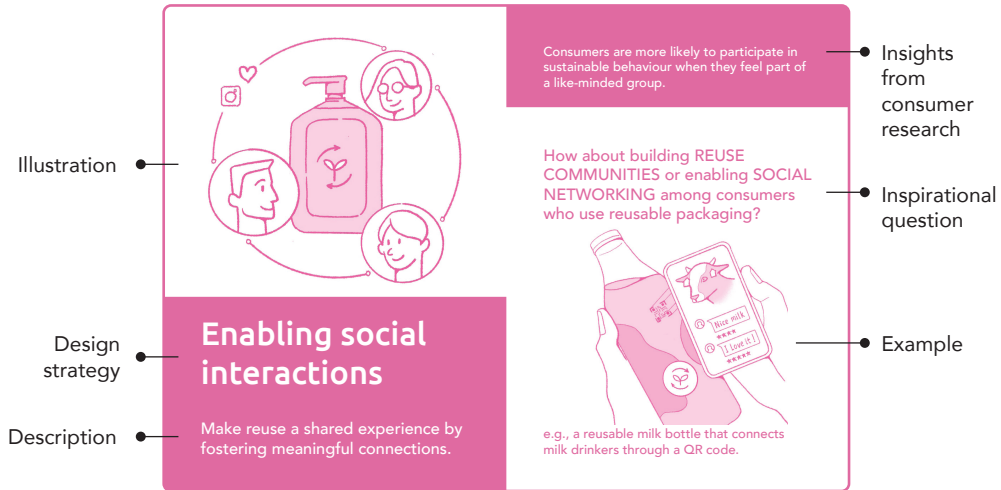
Figure 33. An example of the design strategy card (left: front side, right: reverse side)

Journey cards. Twelve journey cards that are small and single-sided. Each card features an action-oriented verb (see an example in **Figure 34**). These 12 verbs are selected from common activities in consumer interactions with RPSs, including: search or discover, select or order, obtain, use the product, clean, store, sort and collect, dispose, return on the go, return from home, refill at home, and refill on the go. These cards enable designers to map out a user journey, describe consumer interactions with an RPS and identify critical challenges. The goal is to encourage designers to approach their ideas from a system perspective to develop solutions that support not just initial adoption but also long-term use.

Figure 34. An example of the journey card

Instructional guide. A guide introduces how to use this design toolkit and provides an overview of the toolkit's components and their functions. To make the toolkit adaptable to diverse design goals, the guide does not define fixed rules. Instead, it offers four ways to use it in design practice: (1) Trigger new ideas in the development of an RPS; (2) Transform single-use packaging into an RPS; (3) Spark reflection and discussion around an RPS; or (4) Support experimentation to enhance an RPS. Prior

research on design toolkits suggests that users, particularly those unfamiliar with structured ideation tools, may struggle to get started (Konstanti et al., 2022). To address this, we also included a suggested step-by-step procedure to help users initiate the process. Ideally, the guide will ensure that designers can independently navigate the toolkit without requiring external facilitation. This ensures that the toolkit can be effectively used across different design settings, whether in workshops, team discussions, or individual brainstorming sessions. Additionally, the guide is foldable to match the compact format of the design toolkit, making it easy to store and carry.

7.3 Demonstration and evaluation

The design toolkit was demonstrated and evaluated in two workshops involving design students. During these sessions, we introduced the toolkit to participants and invited them to apply it to generate new RPS concepts. Workshops are widely used in design research to test tools because they can simulate natural settings where participants actively engage with the tools (Yoon et al., 2016). Workshop sessions allowed us to examine how different components of the toolkit facilitated the ideation process, and whether they effectively supported participants in generating novel RPS concepts.

In this section, we first present how we demonstrated and evaluated the toolkit, then elaborate on the feedback received from the workshop participants.

7.3.1 Participants

Design master's students from Delft University of Technology were recruited using purposive and opportunity sampling. A recruitment poster was distributed to attract students who were interested in sustainable design and available for participation. A total of 13 students took part in two workshop sessions (workshop 1: N=8 and workshop 2: N=5). To ensure familiarity with design practices, all participants had prior educational or professional design experience, ranging from 1 to 9 years with an average of 5.8 years. This ensured that participants had sufficient expertise to evaluate the toolkit's relevance and usability in a design practice.

7.3.2 Procedure

Both workshops were held in a university meeting room and lasted approximately 90 minutes. At the beginning of each workshop, participants were provided informed consent forms and asked to review and sign them.

After a welcome and an introduction to the toolkit's development and the workshop agenda, participants were asked to work in small groups of 2-3. Each group selected one object from a range of fast-moving consumer goods (FMCGs) (e.g., fast food, meat, small fruits, coffee, detergents, etc) as the basis for developing an RPS concept. This took around 10 minutes. For the next 50 minutes, participants explored the design toolkit within their groups and generated concepts for their chosen object (see **Figure 35**). No additional guidance was provided by the researcher to allow natural interaction

with the toolkit. Additionally, participants were encouraged to note their thoughts on post-it notes, highlighting aspects they found useful, frustrating, or interesting about the toolkit.

Figure 35. Testing the design toolkit in the workshop

Following the exploration, a semi-structured focus group discussion took place with all participants. This discussion lasted for around 30 minutes and was audio recorded for analysis. Specifically, participants were asked to reflect on their experiences with the toolkit and discuss its overall impact on their ideation process, usefulness, and ease of use. The focus group concluded with participants giving suggestions for improvement and potential applications of this design toolkit.

The workshop ended with a brief thank-you, and each participant received a €15 voucher as compensation for their participation. A detailed procedure of the workshop is provided in **Appendix E.**

7.3.3 Data collection and analysis

The qualitative approach was employed to generate insights into how designers interacted with the toolkit, what aspects supported ideation, and where challenges emerged. The qualitative data was collected during the workshops through three key sources: (1) Observations. Researchers took field notes during the workshops to capture participants' reactions to the toolkit, including how they navigated the cards, discussed ideas, and structured their design process; (2) Audio recordings and transcriptions. Focus group discussions were audio-recorded and transcribed for qualitative analysis to identify recurring patterns in participants' insights; and (3) Generated design outcomes. Participants' written notes, sketches, and concept ideas were collected to understand how the toolkit influenced their ideation.

7.3.4 Results

Through combining the insights from these data sources, we identified key strengths and areas for improvement in the design toolkit.

7.3.4.1 Strengths

Active engagement and adaptability

Overall, participants actively engaged with the toolkit, exploring various cards to support their ideation process. None of the five groups reported difficulties in applying the cards to their cases. This demonstrates the feasibility and adaptability of the toolkit for designing RPSs across different FMCG product categories. Summaries of the concepts generated by each group can be found in **Appendix E.**

Flexible use of the toolkit

During the ideation process, we observed diverse approaches to using the toolkit. Some groups began by identifying problems and selecting themes that resonated most with their design challenges, then focused only on the related strategies. Others spread all the cards on the table, browsing through them and picking strategies based on their visual appeal or relevance. Once satisfied with the selection, participants used this card set as the basis for the next steps in developing concepts. Notably, all groups tended to combine multiple strategies into one concept. This highlights the flexibility of this toolkit in guiding ideation and supporting multi-dimensional design thinking.

Generating concrete and feasible ideas

In the focus group discussion, participants highlighted that the context-specific nature of the toolkit helped them quickly generate concrete and feasible ideas. They perceived it as more actionable compared to broader sustainability-focused toolkits, which are often abstract and difficult to apply directly to the specific case. As one group remarked:

> "Most design toolkits for sustainability are quite broad and vague, this one is very specific. I feel the specific tool is more inspiring for ideations, because it helps you come up with concrete ideas" (group 5).

Additionally, participants felt confident in their design outcomes within a short timeframe:

> "It's only a quick prototype, but still in one hour we come up with something that we were already proud of" (group 3).

Illustrations enhancing understanding and engagement

The illustrations on the front side of the cards were particularly helpful for comprehending the themes and strategies quickly, as one group noted:

> "The drawings are useful for understanding what the card was about" (group 5).

Beyond comprehension, the illustrations added enjoyment to the process, making ideation more engaging and playful. Some participants compared it to an interactive board game:

"It was fun to use, I feel like playing a board game" (group 5)

"…it makes the toolkit playful in a good way" (group 3)

Facilitating structured and efficient discussions

In addition, the linkage between different card types and visual content also facilitated group discussions in a structured and interactive way. Selected theme and strategy cards served as focal points for the group to develop ideas around it, which kept the ideation focused and efficient, ensuring groups stayed aligned with a core design direction. As some groups mentioned:

"It was a very guided method, there was some help, and we could discuss and move ahead with it" (group 2).

"We picked a few cards from the deck as top values to guide our design" (group 5).

7.3.4.2 Areas for improvements

Despite its strengths, participants also identified areas for improvement, particularly regarding the examples, journey cards, and instructional guide.

Balancing inspiration with creative freedom

While the illustrated examples on the strategy cards helped participants formulate ideas, they may have constrained imagination and lead to fixation. As one group commented:

"The examples are nice but very straightforward to the solutions. It is difficult to come up with crazy ideas with these examples" (group 4).

A potential improvement is to design a stage where participants can ideate first using only the strategy information on the front side, flipping the card for inspiration only if needed. In this way, designers could be free from the possible constraints that specific examples might impose.

Clarifying journey card usage

Participants valued the journey cards for prompting consideration of system-level aspects. However, their usage seems to be ambiguous due to the ordered layout in the instructions. Some groups spent much time figuring out how and when to use them. Some participants were uncertain whether to use all cards or only select relevant ones to their object:

"We were confused whether we should take the entire cards from the deck or only select some relevant ones." (group 5).

Additionally, several terms on the journey cards were confusing, for example, some participants initially interpreted "store" as a noun rather than a verb. Participants

suggested adding more elaborate explanations in the instructions or on the journey cards themselves, considering the current version only contains keywords. Some participants also proposed to provide some blank cards for creating additional actions:

"Maybe leave some of them blank so you can fill in" (group 1).

Improving the instructional guide

Some participants relied heavily on the instructional guide and indicated that practical information should be more prominent in the guide, while introductory content about the background of this toolkit could be minimised. This suggests restructuring the layout of instructions and making the practical information more prominent could enhance its effectiveness as a guide.

7.4 Refinement and finalisation

The research team discussed these findings internally and implemented several refinements to enhance the usability and effectiveness of the toolkit. The modifications primarily focused on three key areas: the strategy cards, journey cards, and instructional guide. These refinements ensured that the toolkit is both structured and flexible, inspiring without imposing constraints on the ideation process.

First, we refined the strategy card usage to allow for greater creative freedom while still offering practical inspiration when needed. Participants highlighted that the illustrated examples on the back of the cards, while useful, sometimes led to fixation, limiting the exploration of more unconventional ideas. To address this, we adjusted the recommended usage sequence shown in the instructional guide — encouraging designers to ideate first using only the strategy descriptions on the front side and flip the card to view the example only when needed.

Second, improvements were made to clarify the journey card functionality, which had been perceived as ambiguous in the workshops. To improve usability, explanations were added to the backside of each journey card, offering a reference to its intended meaning. Additionally, blank journey cards were included, allowing designers to define additional actions if the existing set did not fully align with their specific RPS context.

Finally, the instructional guide was restructured to enhance its clarity. The layout was reorganised so that step-by-step instructions on how to use the toolkit were prioritised. This ensures that users can quickly grasp how to apply the toolkit without feeling overwhelmed by theoretical explanations.

Besides, we named our toolkit *RePacKit* to reflect its core focus on reuse, packaging, and toolkit design. Phonetically, it also reads as 'repack it', making it intuitively linked to reusing the packaging.

The refined design toolkit can be found in **Appendix F**. To encourage a broader range of innovations in RPSs across both research and practice, a digital version of the design toolkit is available as a free template on the Miroverse platform.

7.5 General discussion

In this chapter, we presented the development and evaluation of a card-based design toolkit for RPSs. This design toolkit was developed through an iterative process and evaluated in two workshops involving 13 design students. During the evaluation, the toolkit was described as inspiring, informative, and enjoyable to use, demonstrating its potential as a valuable resource for design practice in RPS innovation. This study primarily contributes to design research in terms of the toolkit's accessibility, flexibility, and its role as a collaborative ideation tool.

First, one of the key contributions of this study is transforming scientific knowledge into a practical tool accessible and actionable for academics, designers, industry practitioners, and innovators working on RPSs. This aligns with prior studies emphasising the role of design tools in making sustainability knowledge more usable for practitioners (Ackermann, 2018; Bocken et al., 2016). Prior research has highlighted that many tools developed in academic research fail to gain traction in industry settings due to their complexity, limited usability, or lack of practical relevance (Baumann et al., 2002; Blomsma & Tennant, 2020; Bocken et al., 2016; Tyl, 2015). To address these challenges and enhance uptake in practice, our design toolkit incorporated empirical consumer insights from literature, real-world examples, iterative refinements to ensure its clarity and usability, and evaluations through simulating design practice.

Second, this study contributes to the discourse on how design toolkits should balance structure with flexibility to accommodate diverse design needs. Prior research suggests that design processes should be adaptable based on project constraints and objectives (Rexfelt & Selvefors, 2021). In the context of RPSs, the toolkit enabled designers to generate concrete ideas within a short ideation session, demonstrating both efficiency and practical relevance. To support flexible usage, we avoided prescribing rigid rules for applying the toolkit. Instead, we provided example applications in the instructional guide, allowing designers to naturally integrate the toolkit into their workflow and align it with their specific project requirements. Evaluation workshops showed that participants engaged with the toolkit in varied ways, showing its ability to support both structured and open-ended ideation. Additionally, the visual presentation, particularly the illustrations, was highly valued for enhancing comprehension and engagement. However, while clear examples aid comprehension, they may inadvertently constrain creativity by leading users towards fixed interpretations. To mitigate this risk, it may be more effective to provide abstract or transferable examples, encouraging divergent thinking.

Third, beyond its role in supporting designers, the toolkit also has the potential to serve as a collaborative tool that facilitates communication and alignment across different stakeholders. Developing RPSs typically requires multidisciplinary expertise involving designers, engineers, suppliers, and retailers—each with different priorities and constraints. This can create barriers to implementing effective RPS solutions in the consumer market. This design toolkit can thus serve as a shared reference to foster collaboration, ideation, and problem-solving within multidisciplinary teams working on

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RPS innovations. While our workshops primarily simulated early-stage ideation, the toolkit is aimed at broader applications, as stated in the instructional guide, including concept refinement, experimentation, and design reflection across various phases of RPS development.

Lastly, we see the toolkit holding educational value. Sustainability challenges require a new generation of designers to integrate behavioural insights into circular design. Therefore, incorporating this toolkit in design education and professional training programs could help designers embed consumer behaviour insights into sustainability-driven innovation.

7.6 Limitations and future research

While this study provides promising initial insights, several limitations highlight areas for further research and development.

One key limitation is that we tested this design toolkit only with design students in a research setting. Although participants had several years of design education, they may lack the real-world constraints and priorities faced by industry practitioners. The way professional designers use the toolkit to develop RPSs, especially in collaborative environments, could differ from design students' approach. Future research could extend the demonstration and evaluation to industry settings. This would provide broader insights into whether the toolkit aligns with real-world constraints, such as time pressure, team dynamics, and project objectives. Additionally, assessing how multiple stakeholders, including designers, engineers, marketers, and policymakers, engage with the toolkit could help refine its effectiveness in fostering communication, ideation, and decision-making within multidisciplinary teams working on RPS innovation.

Additionally, while the card-based format was well-received in workshops, it may not be practical for all design settings. In professional contexts, designers increasingly rely on digital tools, collaborative platforms, and AI-assisted design software. To address this, we have also developed a digital version of this toolkit, but we have not yet tested it. Future research could explore its use in online collaboration environments, helping to better align the toolkit with the workflows and needs of different teams.

Moreover, the toolkit's focus on consumer behaviour is both a strength and a limitation. While it offers valuable guidance on fostering consumer adoption of RPSs, it does not explicitly address other critical dimensions of RPS innovation, such as technical feasibility or business viability. Since effective RPS design often requires interdisciplinary collaboration, future research could explore ways to integrate this consumer-focused toolkit into broader innovation processes or provide additional guidance on aligning this toolkit with engineering, marketing, and business considerations.

Lastly, our evaluation primarily focused on the usability of the toolkit in ideation, rather than assessing the quality and impact of the design outcomes it produces. As a result, we cannot determine whether RePacKit produces more promising RPS concepts

compared to other design tools. Future research could develop evaluation metrics to measure the impact of design outcomes or compare the toolkit's effectiveness with other general design tools applicable to RPS innovations.

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/ *Chapter 8* /

Discussion and Conclusion

This dissertation advances the understanding of reusable packaging systems (RPSs) through the lens of consumer behaviour and design approaches. It examines the factors influencing consumer adoption, tests design interventions to encourage long-term adoption, and proposes actionable design strategies to inform the development and redesign of RPSs in practice.

This final chapter synthesises the main findings and contributions of this research, structured around the research questions introduced in Chapter 1. It then outlines the theoretical and practical implications, offering insights for researchers, designers, businesses, and policymakers. Finally, the chapter reflects on the limitations of this research and highlights opportunities for future research. Chapter 8 concludes with some final reflections on the role of RPSs in promoting sustainable consumption in a circular economy.

8.1 Main findings and research contributions

The central research question addressed by this dissertation is:

How can design foster consumer acceptance and long-term adoption of new reusable packaging systems (RPSs)?

To answer this question, the research is structured around three sub-questions, each corresponding to a specific part of the dissertation. A diverse set of methods is employed across chapters, including qualitative interviews, quantitative online surveys, experimental studies, and creative workshops. This mixed-method approach enables a comprehensive exploration of the topic, yielding multifaceted insights into new RPSs designed for consumer markets. In the following sections, we discuss the key findings and research contributions corresponding to each sub-question.

8.1.1 What are the key factors influencing consumer acceptance and adoption of different RPSs?

Part I (Chapter 2 and Chapter 3) introduces the factors influencing consumer acceptance and adoption of RPSs.

Chapter 2 examines whether consumers perceive RPSs as desirable alternatives to the single-use packaging, which they are accustomed to. The findings show that consumers evaluate both types of RPSs more favourably than single-use packaging, demonstrating their desirability in the consumer market. Specifically, three key benefits are recognised for RPSs: environmental benefits, anticipated conscience, and enjoyment, highlighting their relative advantages over single-use packaging. Notably, while environmental benefits are acknowledged, they have no direct influence on the purchase intention of RPSs. Instead, anticipated conscience and enjoyment positively predict the purchase intention of both refillable and returnable packaging systems. This suggests that enhancing the experiential and emotional aspects of RPSs may be an effective strategy for increasing consumer adoption. Despite these positive evaluations, two major risks emerge — complexity and contamination. Consumers perceive RPSs as more complex to use compared to single-use packaging. Refillable packaging systems present a higher perceived contamination risk than returnable packaging systems. Although neither risk is considered severe, the negative impact of contamination risk on purchase intention for refillable packaging systems underscores the need for targeted design interventions to mitigate them.

While Chapter 2 provides an initial understanding of consumer evaluations of different packaging solutions, it focuses on a limited set of factors and relies on consumers' responses to hypothetical scenarios. In practice, adopting RPSs could be a more complex and dynamic process, involving a broader range of influencing factors that may affect consumer perception and behaviour at different stages.

To capture consumer responses in a more realistic setting, **Chapter 3** extends the analysis by conducting semi-structured interviews with consumers who physically interacted with an RPS. The findings uncover a spectrum of influencing factors (**Figure 36**) and provide insights into consumers' underlying thoughts across different stages of the consumption process.
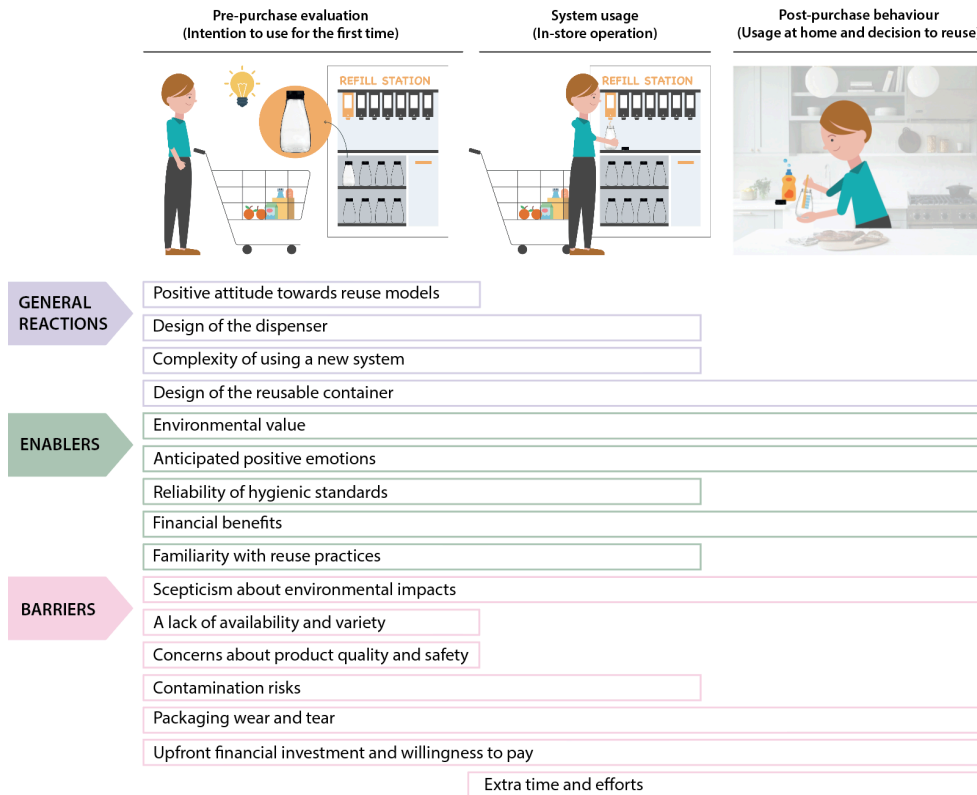

Figure 36. Influencing factors across different stages of the consumption process

Chapter 3 suggests that consumers are primarily motivated by the desire to reduce domestic packaging waste and positive emotions associated with contributing to environmental protection. However, the actual environmental impact of RPSs remains unclear as consumers struggle to quantify the resources saved through RPSs. Meanwhile, various challenges occur across different stages of the consumption process. For instance, barriers such as limited availability, accessibility, and concerns about product quality and safety emerge during the pre-purchase stage. Long-term challenges, such as visible signs of use (e.g., scratches), are anticipated from repeated use, which may lead to a suboptimal number of reuse cycles and early replacement of the packaging. In addition, Chapter 3 highlights the critical role of design. On the positive side, design features such as sensory interactions (e.g., smell and sound) and practical considerations (e.g., stackability) can enhance consumer experiences and encourage reuse. On the negative side, poorly designed systems (e.g., unclear digital instructions and product

spillages) can complicate the reuse process, increase learning costs, evoke contamination concerns, and thereby discourage continued use. These insights further confirm the concerns regarding complexity and contamination risk identified in Chapter 2, underscoring the critical role of thoughtful design in addressing these barriers.

It is important to reflect on the diverging insights observed across studies in Part I, particularly regarding perceived environmental benefits, enjoyment, and contamination concerns. For instance, Chapter 2 suggested that RPSs are generally perceived as enjoyable and environmentally beneficial, with only limited concern about contamination. However, Chapter 3 revealed that enjoyment tends to diminish over time, environmental benefits of RPSs are often perceived as vague or difficult to assess, and contamination occurs at different stages of the reuse process. These discrepancies can be attributed to differences in both methodological approach and behavioural stage assessed. The surveys used in Chapter 2 tended to elicit fast, evaluative responses based on hypothetical scenarios. In contrast, the interviews in Chapter 3 fostered reflective dialogue grounded in personal experience and offered deeper insights. Moreover, Chapter 2 focused on early-stage attitudes and intentions, whereas Chapter 3 investigated later-stage reflections after using a real RPS. Rather than treating these differences as contradictions, they should be viewed as complementary. Together, they offer a more holistic understanding of consumer adoption of RPSs. This mixed-method approach is particularly valuable when investigating sustainable practices that may appear conceptually appealing but encounter resistance in practice.

Part I concludes that while consumers perceive RPSs positively and express a high intention to adopt them, multiple practical and psychological challenges hinder their long-term adoption. Furthermore, Part I underscores the critical role of design in shaping consumer perceptions and behaviours. These insights lay the foundation for Part II, which focuses on developing targeted design interventions to address specific challenges and foster long-term adoption of RPSs.

8.1.2 How can specific design interventions address challenges in the long-term adoption of RPSs?

Part II (Chapter 4 and Chapter 5) tests two targeted design interventions aimed at addressing challenges in the long-term adoption of RPSs.

Chapter 4 explored the communication of the environmental break-even point (e-BEP) of reusable packaging as a design intervention to encourage conscious reuse. Reusable packaging is typically made from durable materials to support extended use. Thus, achieving sufficient reuse cycles is essential to realising the environmental benefits of RPSs (Baird et al., 2022). Through a mixed-method approach consisting of online experiments with open-ended questions, this chapter examines how communicating varying levels of e-BEP influences consumer responses to reusable packaging. The findings indicate that consumers are generally optimistic about RPSs regardless of the e-BEP level presented. Nevertheless, this response varies depending on consumers' prior experience with reusable packaging. Experienced consumers demonstrate

increased green scepticism and reduced perceived consumer effectiveness when exposed to high e-BEP levels. In contrast, inexperienced consumers remain unaffected by variations in e-BEP. Additionally, among experienced consumers, e-BEP levels can indirectly influence the intention to reuse through green scepticism and perceived consumer effectiveness. These findings indicate the importance of tailoring the communication of e-BEPs to different consumer groups, ensuring that such interventions encourage rather than hinder continued engagement with RPSs.

Chapter 5 focuses on another challenge to long-term RPS adoption: signs of use generated on reusable packaging through repeated uses. As identified in Chapter 3 and supported by existing literature, signs of use can undermine consumer perceptions of reusable packaging (Collis et al., 2023; Hoseini et al., 2024; Magnier & Gil-Pérez, 2021; Miao et al., 2023b), leading to avoidance or premature disposal of reusable packaging. This chapter introduces concealing patterns to reduce the visibility of signs of use on reusable packaging, thereby mitigating consumers' negative perceptions related to aesthetic appeal and contamination. Across three studies, our findings provide empirical evidence that concealing patterns make signs of use less noticeable. However, their downstream effects on consumer perceptions are not always consistent, suggesting that concealment is not a conclusive solution. While such patterns may help maintain aesthetic appeal when directly compared to plain packaging, they do not fully eliminate contamination concerns. The qualitative findings further suggest that contamination concerns can stem from complex psychological mechanisms beyond visual cues, such as mental associations with prior use. These findings suggest that addressing contamination concerns requires alternative or complementary design strategies beyond visual concealment.

In summary, Part II demonstrates that design interventions, such as e-BEPs and concealing patterns, influence consumer perceptions and behaviours in terms of long-term RPS adoption. However, they are not universally effective and may lead to unintended consequences. Further research is needed to refine these solutions, explore complementary strategies, and assess their effectiveness in real-world settings.

8.1.3 What design strategies can support the development and redesign of RPSs in design practice?

Despite the growing interest in RPSs, tailored design strategies to support their development and redesign remain underexplored. Part III addresses this gap by proposing specific design strategies for RPSs and translating them into a practical design toolkit to spark innovation in this field.

Chapter 6 develops 20 design strategies for RPSs from a large number of ideas generated in four workshops. These strategies are grouped under five overarching themes based on the SHIFT framework: social influence, individual self, habit formation, feelings and cognition, and tangibility (White et al., 2019). By developing these design strategies, this chapter highlights the role of design in RPS innovation. Researchers can build on these design strategies to assess their effectiveness across

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various contexts, while designers can utilise them as a starting point for developing tailored interventions that address specific challenges or create novel RPS solutions to foster consumer acceptance and long-term adoption.

- Making reuse socially desirable
- Expressing social identity
- Enabling social interaction
- Stimulating first reuse
- Bridging context and reuse
- Prompting reuse action
- Making reuse practical
- Empowering individual reuse
- Matching with self-interest
- Enhancing responsibility and commitment
- Recognisability
- Playfulness
- Uniqueness
- Novelty
- Familiarity
- Providing feedback
- Proximity and concreteness
- Positive appearance change
- Intentional imperfection
- Intrinsic sustainability

To facilitate the application of these design strategies in practice, **Chapter 7** introduces and evaluates a card-based design toolkit, consisting of theme cards, strategy cards, journey cards, and an instructional guide. The full version of this design toolkit can be found in **Appendix F**. This toolkit provides designers with a structured yet flexible source of inspiration for RPS development. During the evaluation workshops conducted with 13 design students, the toolkit was described as inspiring, informative, and enjoyable. Its specificity to RPSs effectively stimulated discussions about real-world design challenges, enabling designers to break down complex problems into manageable and relevant opportunities. The integration of actionable design strategies and consumer insights within the toolkit was perceived as a valuable approach, as it enabled designers to generate novel ideas while addressing challenges identified in scientific research. Furthermore, the illustrative and visual format of the toolkit makes its content easy to understand while fostering a playful and engaging ideation experience.

8.2 Theoretical implications

This dissertation contributes to the theoretical understanding of consumer behaviour, environmental psychology, and design for sustainability by offering an in-depth

exploration of how design can foster consumer acceptance and long-term adoption of RPSs.

This dissertation adopts an empirical, design-led approach to generating new insights into consumer behaviour. Unlike other studies on RPS adoption (Chen & Miao, 2024; Ertz et al., 2017b; Rapp et al., 2017), which often rely on behavioural science models such as the Theory of Planned Behaviour (Ajzen, 1991), Innovation Diffusion Theory (Rogers, 1995), or Practice Theory (Reckwitz, 2002), this dissertation does not adopt a singular theoretical framework as its foundation. We integrate the decision-making model (EKB model, Engel et al., 1968) to understand benefits and risks and use the SHIFT framework (White et al., 2019) as an organising structure for the development of design strategies. However, we leave the exploration of specific design interventions with an open-ended frame. While behavioural science models usually offer useful explanatory power, this dissertation primarily takes exploratory, design-driven approaches to understanding consumer adoption of RPSs, which may not be fully captured by established theories.

8.2.1 Consumer behaviour: Optimism towards RPSs and challenges in the long-term adoption

This dissertation enriches consumer behaviour literature by deepening the understanding of engagement, optimism, and challenges in RPS adoption.

While much of the existing literature approaches RPSs from a systemic perspective emphasising business models and supply chain management (Babader et al., 2016; Mahmoudi & Parviziomran, 2020; Tenhunen-Lunkka et al., 2024), this dissertation focuses on consumer perspective, exploring how consumers respond, adopt and experience RPSs. Purchase decisions for fast-moving consumer goods (FMCGs) are highly habitual, automatic, and driven by immediate convenience and personal benefits (Fuentes et al., 2019; Kunamaneni et al., 2019). Although RPSs aim to deliver environmental benefits, consumers' initial adoptions are not necessarily driven by a rational evaluation of their environmental outcomes. This dissertation contributes to the literature by suggesting that affective factors, such as enjoyment and anticipated conscience, may serve as effective entry points to disrupt the entrenched single-use habit and encourage initial trials of RPSs. This finding aligns with and empirically supports the growing consumer-centric perspective in sustainability research that highlights the role of intrinsic motivations and hedonic pleasure in driving sustainable consumption (Choi & Johnson, 2019; Hartmann et al., 2018; Tezer & Bodur, 2020). However, it is worth noting that the long-term influence of these affective factors on consumer behaviour change remains uncertain.

This dissertation also raises critical pitfalls of consumer optimism towards RPSs. Across multiple chapters, consumers consistently exhibit high motivations and positive evaluations of RPSs, confirming and extending prior findings (Herweyers et al., 2024; Lofthouse et al., 2009; Magnier & Gil-Pérez, 2023). While it might be beneficial in stimulating initial adoption, it may blind consumers to the effort, time, and behavioural

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adjustments required for sustained reuse. Over time, challenges, such as inconvenience, forgetfulness, accumulation of containers, and boredom, may discourage consumers from effectively integrating RPSs into their routines. Additionally, signs of use generated on reusable packaging can diminish its aesthetic appeal and raise contamination concerns (Collis et al., 2023; Magnier & Gil-Pérez, 2021). This may lead to premature disposal and insufficient reuse cycles, ultimately undermining or even backfiring the environmental advantages of RPSs. While some of these challenges have been mentioned in prior studies (Baird et al., 2022; Collis et al., 2023; Herweyers et al., 2024; Lofthouse et al., 2009; Long et al., 2022), this dissertation demonstrates when and where these barriers emerge in the adoption phases of RPSs and provides practical insights into mitigating these challenges through design. By testing several targeted design interventions, this dissertation emphasises that a successful transition to RPSs not only involves attracting new consumers but also bridging initial consumer optimism with sustained reuse behaviour in the long term, ensuring that RPSs fulfil the intended environmental benefits.

8.2.2 Environmental psychology: Perceived environmental benefits and green scepticism of RPSs

Although life cycle assessments (LCA) have demonstrated that RPSs can reduce the overall environmental footprint of packaging consumption (Blanca-Alcubilla et al., 2020; Caspers et al., 2023; Cottafava et al., 2021), this largely depends on whether consumers reuse them sufficiently. The extent to which consumers perceive and act upon environmental benefits based on their understanding remains underexplored. This dissertation contributes to environmental psychology by examining how consumers interpret the sustainability of RPSs and how these perceptions shape their adoption and reuse behaviours. Specifically, we uncovered psychological barriers, such as green scepticism and low perceived consumer effectiveness associated with reuse practice, that may hinder long-term adoption of RPSs.

A fundamental challenge in encouraging sustainable behaviour is the psychological distance of environmental benefits. Sustainable outcomes, such as waste reduction and lower carbon emissions, are often abstract, and distant in time and space from daily consumption, making them difficult for consumers to assess (Trope & Liberman, 2010; White et al., 2019). While reducing packaging waste appears to be an intuitive benefit, many consumers struggle to quantify the overall impact of RPSs. This uncertainty can lead them to question whether their reuse efforts are truly impactful or whether RPSs genuinely serve as sustainable alternatives to single-use packaging.

Current RPS designs do not adequately address these psychological barriers. When discussing the sustainability of RPSs, it is necessary to acknowledge the environmental investment associated with their manufacture, distribution, and operation processes (Jiménez Romanillos et al., 2024). Counteracting these investments relies on packaging durability, system efficiency and, critically, consistent consumer engagement. While technical innovations can enhance material durability and system efficiency, the success of RPSs ultimately depends on sustained consumer engagement (Cottafava et al., 2021;

Jiménez Romanillos et al., 2024). When consumers believe RPSs truly deliver environmental benefits, and that their participation in RPSs contributes to broader environmental goals, they are more likely to maintain consistent reuse behaviours in the long term.

To bridge this gap, this dissertation empirically explores the communication of e-BEPs on reusable packaging. This information serves as a design intervention that translates abstract environmental benefits into a tangible metric, helping consumers understand the number of uses required to offset the environmental costs. This aligns with the notion that quantifiable and relatable environmental data enhances engagement in sustainable practices (Gleim et al., 2013; White et al., 2019). Additionally, this dissertation proposes other design-driven strategies, such as providing feedback and utilising proximity and concreteness cues, to help consumers better understand their contributions. Furthermore, it underscores the need to explore the effect of different formats of sustainability information on consumer decision-making and the long-term adoption of RPSs.

8.2.3 Design for sustainability: Design toolkit for RPS innovation

This dissertation contributes to the design for sustainability literature by introducing consumer-centred design strategies tailored for RPS innovation. While many existing design tools focus on general behaviour change (e.g., Michie et al., 2011) or circular economy strategies (e.g., Konietzko et al., 2020), they often lack the specificity needed to address the unique challenges associated with RPS adoption. By utilising the SHIFT framework (White et al., 2019) as an organising structure, this research develops evidence-based design strategies that are both theoretically robust and practically actionable. At the same time, this research also extends the applicability of the SHIFT framework beyond its original psychological and marketing contexts, establishing its relevance within sustainable design.

Furthermore, this dissertation bridges the gap between sustainability research and design practice by developing a design toolkit that translates insights from scientific research into actionable strategies. Many academic design tools fail to gain traction in industry settings due to their complexity, limited accessibility, or lack of practical relevance (Baumann et al., 2002; Tyl et al., 2015). To address these challenges and enhance uptake in practice, the design toolkit was developed through a multi-faceted approach, integrating empirical consumer insights from existing literature, exploratory workshops with industry practitioners and design students, real-world examples through desk research, and usability tests through design tasks. Additionally, to ensure accessibility and encourage broader adoption, the design toolkit is made freely available as a template on the Miroverse platform. This provides an inspirational resource for academics, designers, industry practitioners, and innovators seeking to contribute to RPS development and implementation.

Beyond its application for the direct users mentioned above, this dissertation also positions this design toolkit as a collaborative instrument that facilitates cross-disciplinary engagement in sustainability transitions. For instance, the successful implementation of RPS requires systemic coordination among diverse stakeholders, including designers, engineers, suppliers, and retailers – each operating within distinct priorities, constraints, and decision-making framework (Bradley & Corsini, 2023; Ellsworth-Krebs et al., 2022).

8.3 Practical implications

8.3.1 Implications for designers

In a transition toward a circular economy, packaging must be reimagined to contribute to sustainability. Designers are at the forefront of this trend and should actively explore innovative solutions to accelerate adoption. This section discusses the role of design in shaping the future of RPSs, supported by real-life examples.

First, designers should create a smooth user experience for consumers. RPSs introduce new forms and consumption models that differ from conventional single-use packaging to which consumers are accustomed. Although reuse is not a novel concept, designers should ensure that new RPS features align with consumers' expectations regarding packaging usability, accessibility, and interactions with fast-moving consumer goods. For instance, one key challenge is the separation of product information from packaging. Unlike single-use packaging, which typically conveys rich on-pack information, RPSs often rely on separate labels, dispensers, or digital interfaces, potentially leading to confusion. Digital technologies offer solutions to bridge this gap. For example, RFID tags, QR codes, and connected apps can provide product details in digital formats (Mahmoudi & Parviziomran, 2020; Miao et al., 2024b). Digital Product Passports (DPPs) presents a promising solution for tracking individual packaging units throughout their lifecycle, from production to the end of life (Ellsworth-Krebs et al., 2022). For instance, Dopper has created DPPs for reusable water bottles, offering transparency on material usage and carbon footprint (**Figure 37**). Similarly, RPSs can leverage DPPs to store and update reuse cycles, cleaning history, and environmental performance. By offering consumers access to such detailed information, DPPs enable consumers to make informed purchase decisions and encourage them to explore sustainable options.

Figure 37. Digital product passport for reusable water bottles (©Dopper)

Second, RPS designs should address practical concerns, such as ease of use and convenience. Innovative design solutions, like Lidl's refillable detergent pouch, features a smart cap that can be recognised by the refill station (**Figure 38**). This cap ensures accurate refilling and prevents spillage, thereby reducing the risks of contamination and improving the consumer's reuse experience.

Figure 38. Lidl's refillable detergent pouch with a smart cap (©Lidl, refill station)

Beyond individual packaging design, infrastructure design plays a crucial role in making reuse more accessible. Refilling and return infrastructures should be designed to align with consumer needs and diverse business scales. Modular solutions, such as Tomra's reverse vending machines as reuse collection points (**Figure 39**), exemplify how adaptable infrastructure can accommodate different consumer needs and business scales, facilitating widespread participation across various retail formats, ranging from small convenience stores to large hypermarkets.

Figure 39. RPS modules that suit different business scales and consumer needs (©Tomra)

Next, RPS design should maintain the aesthetic appeal and functionality over time. Since reusable packaging undergoes multiple use cycles, wear and signs of use can lead to negative perceptions. Designers should thus carefully consider materials, finishes, and structural durability to ensure packaging retains both aesthetic and functional durability over time (Greenwood et al., 2021; Miao et al., 2023b). However, material selection must also align with sustainability goals. For instance, while glass containers are usually aesthetically appealing and durable, they also come with high initial environmental footprints in the production phase (Stefanini et al., 2021). Thus, designers must strike a balance between durability, material efficiency, and aesthetic longevity to maximise sustainability benefits. Another approach is to shift consumer perception of signs of use to extend its perceived durability. Drawing inspiration from Freitag's backpack made from recycled truck tarps, the Japanese art of kintsugi, and Govaligo's crash baggage (see **Figure 40**), designers can shift consumer mindsets of signs of use by reframing these imperfections as a desirable aesthetic feature or a symbol of sustainability and longevity. This approach will inspire consumers to reconsider their relationship with reused objects, fostering an appreciation of signs of use and long-term adoption of RPSs.

Figure 40. Examples of product designs that incorporate signs of use. (©Freitag, Kintsugi, and Govaligo)

Moreover, achieving true sustainability requires ensuring that RPSs are reused sufficiently to offset their environmental costs. Beyond the communication of e-BEP via labelling as we tested in Chapter 4, designers can incorporate gamification, goal setting, and real-time feedback mechanisms into RPSs to sustain consumer engagement. For example, '999 Bottles' tracks the number of plastic bottles a consumer has saved and offers relatable environmental feedback through an app (**Figure 41**). Such approaches instil a sense of achievement and excitement, making reuse an engaging and rewarding experience rather than a mere obligatory.

Figure 41. A reusable water bottle that tracks environmental contributions (©999 bottles)

8.3.2 Implications for stakeholders in the supply chain

The successful transition to RPSs requires collaboration across the supply chain, particularly when packaging is shared among multiple brands or retailers. Each stakeholder must adapt to new roles and responsibilities to ensure that RPSs are efficient, scalable and widely adopted (Bradley & Corsini, 2023; Kleine Jäger & Piscicelli, 2021). While this dissertation primarily focuses on consumer behaviour, the results also highlight the implications for other stakeholders within the supply chain.

Manufacturers play a crucial role in ensuring the viability of RPSs by producing durable, high-quality packaging capable of withstanding multiple use cycles. The selection of material is critical, as reusable packaging must endure repeated handling, washing and transportation while remaining lightweight and resource efficient. Manufacturers are also responsible for testing packaging performance to ensure compliance with safety, durability, and environmental standards. Furthermore,

manufacturers should carefully balance standardisation with brand differentiation. In the design of RPSs, standardised packaging enhances compatibility and improves operational efficiency across reuse schemes. However, consumers often associate products with brand identity. Manufacturers should also provide opportunities for brands to retain their visual identity while still participating in reusable packaging schemes. For instance, Loop's RPS primarily utilises glass and metal containers but allows FMCG brands to incorporate distinctive design elements to maintain product recognisability and consumer familiarity (**Figure 42**).

Figure 42. Reusable packaging enables brand identity (©Loop)

Distributors include logistics providers, distribution centres and cleaning companies, who are responsible for the collection, transportation, sanitisation, and redistribution of reusable packaging, ensuring that each packaging meets hygiene standards while keeping operations cost-effective. To optimise RPS logistics, distributors can establish centralised collection and cleaning hubs to streamline operations and minimise transportation emissions. Additionally, traceability systems can help monitor packaging lifecycles, improve operational efficiency, and ensure compliance with regulatory standards.

Retailers serve as the direct communicator of RPS infrastructure to consumers. They have the power to normalise reuse practices by making RPSs accessible, convenient, and attractive in retail environments. However, RPSs currently represent an alternative and often coexist with single-use packaging, constituting only a relatively small portion of the overall store offerings. This limited presence fails to disrupt consumers' habitual reliance on single-use packaging. To increase consumer engagement, retailers should gradually integrate reuse infrastructures into mainstream shopping environments, such as expanding in-store refill stations and offering pre-filled reusable packaging alongside single-use alternatives; positioning RPSs in high-traffic areas to attract consumer attention and encourage trial; and partnering with suppliers to offer best-selling items in RPSs that align with consumers current demands. Collaborative efforts among

retailers also accelerate the widespread adoption of RPSs. For instance, in 2025, Albert Heijn, Aldi, Carrefour, Colruyt, Delhaize, and Lidl in Belgium initiated a six-month pilot program introducing reusable mushroom trays in their stores (**Figure 43**). While this initiative is commendable, expanding such applications beyond specific product categories is essential to achieve a broader impact. Moreover, the rise of service-based consumption models presents new opportunities for RPSs. Retailers can introduce packaging-as-a-service models, such as subscription-based systems, where consumers receive daily essentials in reusable containers via home delivery. Upon their next scheduled delivery, empty packaging is collected, reducing the effort required for returns. Additionally, deposit return schemes are seen as an essential element for incentivising consumer participation (Bradley & Corsini, 2023; De Temmerman et al., 2023a; Mahmoudi & Parviziomran, 2020). Finally, clear guidance on waste management at the end of the packaging lifecycle is necessary to prevent reusable packaging from being improperly discarded. Retailers should provide explicit instructions on how to return obsolete or damaged packaging for recycling, ensuring circularity within the system and reinforcing consumer trust in the intrinsic sustainability of RPSs.
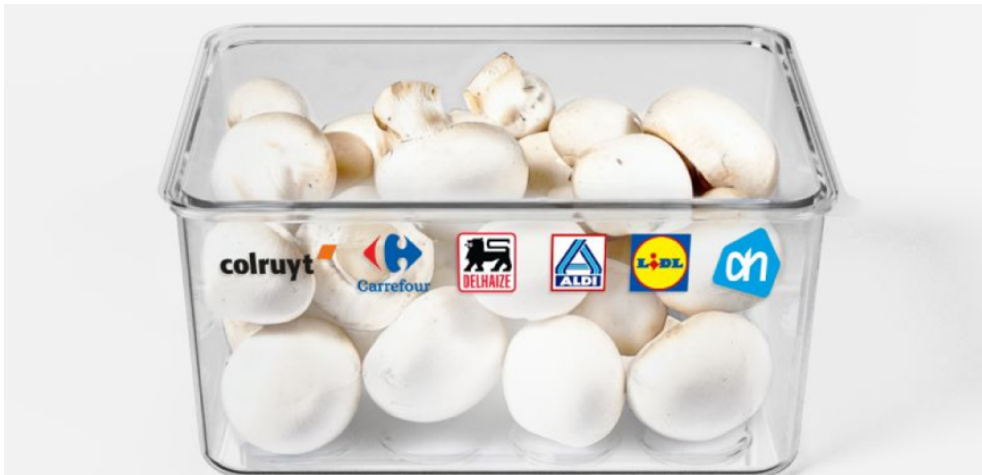

Figure 43. Reusable packaging for mushrooms in partnership with multiple retailers (©Evmi)

8.3.3 Implications for policymakers

Policy and legislation play a crucial role in accelerating the transition toward a circular economy (Hartley et al., 2020). Policymakers can establish industry-wide standards and incentivise businesses, retailers, and consumers in the uptake of RPSs (Bradley & Corsini, 2023; Camps-Posino et al., 2021; Ertz et al., 2017b).

One of the most direct and effective policy interventions is the implementation of economic incentives and disincentives to encourage the adoption of RPSs. Countries such as Denmark and the Netherlands have already introduced bans on giving single-use packaging for free, while Belgium and Finland have implemented taxation schemes to discourage single-use packaging (Bradley & Corsini, 2023). Compulsory deposit

return schemes, widely used in Germany and the Netherlands for beverage bottles, metal cans and glass containers, provide financial incentives for consumers to return reusable packaging (Bradley & Corsini, 2023; De Temmerman et al., 2023a; Mahmoudi & Parviziomran, 2020). More ambitious policies, such as outright bans on certain types of single-use packaging (e.g., disposable cutlery in France and the Netherlands), can create strong demand for reusable alternatives and drive systemic change. Furthermore, waste taxation schemes that account for reuse can more accurately reflect the true environmental cost of single-use packaging, further incentivising businesses, and consumers to prioritise reusable alternatives.

To ensure credibility and consumer trust, regulations and certification frameworks should be implemented to establish clear sustainability standards for RPSs. For instance, mandating the inclusion of e-BEP information on reusable packaging (as studied in Chapter 4) can encourage businesses to demonstrate their commitment to sustainability and enable consumers to make informed purchase decisions. Additionally, certifications and eco-labels that define durability, material safety, and environmental performance criteria would ensure that RPSs meet verifiable sustainability standards.

Beyond regulatory measures, public education and awareness campaigns are useful for shaping consumer perceptions (Thoresen et al., 2015). Governments can initiate consumer education through targeted campaigns explaining key sustainability concepts such as e-BEPs and the importance of sustained reuse over time. These campaigns should also address green scepticism by providing transparent information on how RPSs compare to single-use packaging regarding resource consumption, emissions, waste reduction, and overall environmental impact.

Finally, governments can support local reuse initiatives by funding pilot projects, creating publicly accessible databases of RPS locations, and facilitating collective return schemes—such as centralised drop-off points similar to recycling bins—to make participation more convenient and familiar for consumers.

8.4 Limitations and future research

While this dissertation offers valuable insights into consumer behaviour and design strategies for RPSs, several limitations highlight opportunities for future research. The following subsections discuss these key limitations and propose directions for advancing knowledge in this field.

8.4.1 Addressing social desirability and improving ecological validity

Most of the empirical insights in this dissertation were derived from online experiments, surveys, and controlled interview studies. While these methods ensured high internal validity, they also introduced limitations related to ecological validity, as they may not fully capture actual consumer behaviour in real-world settings. For instance, controlled studies often introduce social desirability bias and hypothetical decision-making

(Ahmad et al., 2014; Entem et al., 2022). In interview studies, participants may present more environmentally conscious responses in the presence of a researcher to align with social expectations, even if these responses do not accurately reflect their real-life behaviours. Similarly, in experimental settings, consumers may express strong intentions to use reusable packaging but fail to account for practical barriers such as inconvenience, forgetfulness, or contamination concerns that arise in daily life.

To enhance ecological validity, future research should incorporate field studies in retail environments to capture consumer behaviour in naturalistic settings. In-store observations, ethnographic studies, and behavioural tracking methods could offer deeper insights into how consumers engage with RPSs beyond self-reported intentions. For instance, conducting post-purchase interviews with consumers actively using RPSs in supermarkets or refill stations could provide a more nuanced understanding of adoption drivers and practical barriers. Additionally, design interventions tested in online experiments could be replicated in physical settings, allowing consumers to interact with the packaging and provide direct evaluations. These approaches would provide a more realistic assessment of consumer adoption patterns and inform strategies for improving RPSs.

8.4.2 Expanding insights on long-term adoption challenges

Although this research aims to develop strategies for fostering long-term RPS adoption, its findings are limited by the use of cross-sectional data, which captures consumer responses at a single point in time. As a result, barriers that may arise after multiple reuse cycles may not have been fully identified. For instance, while this dissertation identifies signs of use as a potential barrier that emerges in the long term, other factors, such as diminishing novelty effects, evolving risk perceptions, habit formation challenges, or fatigue, warrant further investigation.

To address this limitation, future research could employ longitudinal study designs to track consumer engagement with RPSs over extended periods. Such approaches would provide valuable insights into how consumer attitudes, behaviours, and motivations evolve across multiple reuse cycles. To support this, collaborations with retailers, digital reuse platforms, or smart packaging technologies could facilitate continuous tracking of consumer behaviour. These partnerships would allow researchers to monitor retention rates, identify drop-off points, and evaluate the long-term effectiveness of design interventions in sustaining engagement with RPSs.

8.4.3 Broadening the scope of product categories and packaging materials

This dissertation investigates RPSs across various FMCGs, including dry food (e.g., rice, cookies, lentils, coffee beans, etc), liquid food (i.e. ketchup) and personal care products (i.e. shampoo, hand soap). However, to ensure controlled comparisons in each experimental study, only one or two product categories were selected for investigation at a time. While this approach enhances internal validity, it may limit the generalisability

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of findings in each study to diverse product categories. Future research should expand the scope by investigating consumer perceptions across diverse product categories, especially those not yet sold in RPSs. Academic research should take a more radical approach and explore the more sensitive product categories. For example, recent studies suggest that consumer responses to perishable products (e.g., meat, fruit and dairy) and frozen food delivered in reusable packaging may introduce heightened concerns regarding freshness and contamination (Magnier & Gil-Pérez, 2023; Noëth et al., 2024). Exploring how RPSs can be effectively implemented for these sensitive products may yield interesting insights.

In addition, this dissertation primarily focuses on reusable packaging made of plastics. This choice is out of the consideration that plastic is the most widely used material for FMCG packaging, and one of the most challenging materials to recycle. Therefore, addressing issues related to plastic packaging is particularly relevant to the development of RPSs. Nevertheless, other materials also hold significant potential for reusable packaging, and material choice may greatly influence consumer acceptance. Given the trade-offs associated with different materials (e.g., glass for premium feel but increased weight, stainless steel for durability but sensitive to dents) (Greenwood et al., 2021; Jetten et al., 1999), future research could investigate how material selection influences packaging reusability, consumer perceptions of sustainability, and willingness to reuse RPSs in the long-term.

8.4.4 Expanding research to diverse consumer segments and cultural contexts

Across all studies presented in this dissertation, participants were recruited from the Netherlands and the United Kingdom, where environmental awareness tends to be relatively high (Magnier et al., 2019). Therefore, our findings may not be generalisable to populations with varying socio-cultural backgrounds, regulatory environments, and economic constraints.

For example, in low-income countries, reusable packaging may be widely accepted due to resource shortage, whereas in fast-growing economies (e.g., China and India), convenience and efficiency often take precedence over sustainability concerns. Research suggests that Asian consumers (in comparison to Western consumers) generally exhibit a more interdependent self-construal, meaning their motivation to adopt reusable packaging is more likely influenced by subjective norms and perceived behavioural control, rather than attitudes (Ertz et al., 2017b). Encouraging a shift towards sustainable practices in these regions may require a greater emphasis on raising awareness of packaging-related issues and fostering a social context in which reusable packaging is positively valued.

8.4.5 Investigating alternative RPS formats

This dissertation primarily focuses on the RPSs within in-store settings, while other formats may present different challenges and opportunities. For instance, online RPSs

with delivery services offer a different consumer experience, with possible benefits such as convenience due to the elimination of technical barriers and effort associated with in-store RPSs (e.g., packaging refilling, returning, or transports) (Jiménez Romanillos et al., 2024). Meanwhile, mobile refill or return stations, which have been rarely explored in academic research, could offer greater accessibility and flexibility to consumers.

Exploring consumer perceptions, drivers, and barriers to alternative RPS formats can provide relevant insights into why some consumers prefer these options over in-store experiences. Additionally, such research can illuminate the challenges and opportunities associated with different RPS formats, contributing to a more nuanced understanding of their adoption.

8.4.6 Evaluating the quality and effectiveness of proposed design strategies

This dissertation develops various evidence-based design strategies aimed at fostering consumer adoption of RPSs. The primary purpose of creating these strategies was to serve as a source of inspiration for practitioners in designing new RPS solutions, rather than providing prescriptive guidelines. However, while these strategies are theoretically grounded and supported by consumer insights, their quality and actual effectiveness in shaping consumer behaviour remain untested. Understanding which strategies are most effective, for whom, and in what contexts is essential for refining their application and ensuring they contribute meaningfully to RPS innovation.

Future research could assess the quality and effectiveness of these design strategies through empirical consumer studies. One approach would be to conduct interviews with consumers to understand their perceptions and reactions to the proposed strategies. A face-to-face setting would allow for a more detailed explanation of strategies that may otherwise seem abstract, ensuring that participants fully understand their intent. Additionally, in-depth discussions would enable participants to articulate why certain strategies resonate with them, while others may be perceived as ineffective or impractical in their daily routines. A complementary approach could involve survey-based studies to quantitatively evaluate consumer preferences and the perceived effectiveness of different design strategies. By testing multiple strategies across different FMCG categories, researchers could identify which interventions are universally effective in encouraging adoption and which are dependent on specific product characteristics. Besides, identifying boundary conditions - when and where RPSs may not yield environmental or practical benefits - is crucial for guiding responsible innovation and avoiding unintended consequences.

8.5 Final reflections and perspectives of RPSs in CE

In 2019, the Ellen MacArthur Foundation published its influential report, Reuse: Rethinking Packaging (Ellen MacArthur Foundation, 2019), igniting a global call to action on promoting reuse options. Since then, the discourse surrounding RPSs has expanded, with businesses, researchers, and policymakers increasingly exploring how

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RPSs can address the packaging waste crisis. However, despite growing interest and emerging initiatives, RPSs have yet to transition from niche experiments to a mainstream solution.

Over the past four years of conducting this research in the Netherlands, I have witnessed the ongoing progress of real-world reuse initiatives (**Figure 44**). In 2022, Albert Heijn introduced a packaging-free shopping concept, enabling consumers to refill dry goods in reusable containers or linen bags (Albert Heijn, 2022). Despite initial enthusiasm, it was discontinued in 2025 due to low consumer uptake, with many consumers perceiving the system as inconvenient (RTL Nieuws, 2025). Similarly, Lidl and Ecover have actively experimented with refillable detergent stations but struggle to gain traction beyond pilot scales. Meanwhile, Pieter Pot, the first online supermarket operating with returnable glass jars, initially faced financial and logistical challenges that led to its bankruptcy in 2023. Yet, its crowdfunding-enabled comeback in 2024 demonstrates consumers' desirability of reuse models and the significant hurdles that must be overcome to scale them effectively (Pieter Pot, 2024).

Figure 44. Packaging-free shopping at Albert Heijn XL (left) and Ecover refill station (right) (Photos captured by the author)

This dissertation takes a consumer perspective, identifying enablers and barriers to RPSs while proposing actionable design strategies to foster the long-term adoption of RPSs. From the findings of this dissertation, the slow pace of transition is not due to a lack of consumer interest - many consumers are increasingly open to reuse. However, expecting them to integrate RPSs into daily consumption practices while still being surrounded by a system that overwhelmingly favours single-use packaging creates an uneven playing field. Currently, RPSs are often positioned as an "alternative" to disposable packaging. However, a true circular economy is built on designing out waste and pollution, keeping products and materials in use, and regenerating natural systems, in which reuse is prioritised as one of the highest-value strategies for resource efficiency (Ellen MacArthur Foundation, 2022). Without a fundamental shift toward systemic reuse, RPSs will never fully fit into this vision.

As we move further into an era of ecological and resource constraints, RPSs are about more than rethinking packaging; they are about reshaping consumption patterns. The responsibility now falls on businesses, particularly large FMCG companies and retailers, who are responsible for most of the packaging on the market. It is no longer sufficient to conduct isolated pilot projects or small-scale trials. The systemic change requires setting RPSs as the new norm, integrated seamlessly into mainstream retail and consumer habits.

Looking ahead, paving the way toward reuse will require constant and coordinated efforts across academia, industry, and policy. The key question is no longer whether reusable packaging can work, but rather how quickly and effectively we can overcome the adoption barriers standing in its way. Future research, industry practices, and policy frameworks must continue to push the boundaries of what is possible, ensuring that RPSs truly deliver environmental benefits at scale.

This dissertation marks a step toward that future. By unpacking the influencing factors, investigating design interventions, and providing actionable strategies, we hope it offers valuable insights for those committed to making RPSs viable, feasible and desirable. Yet, this is just the beginning. As we stand at the crossroads between business as usual and a future free from packaging waste, we must ask ourselves: Are we ready to embrace the systemic shift that a circular economy demands, or will we continue clinging to the linear economy until our planet can no longer bear the cost?

At the end of the day, the path forward is ours to shape. We hope the insights shared in this dissertation inspire both reflection and action.

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References

Abrahamse, W., Steg, L., Vlek, C., & Rothengatter, T. (2007). The effect of tailored information, goal setting, and tailored feedback on household energy use, energy-related behaviors, and behavioral antecedents. *Journal of Environmental Psychology*, *27*(4), 265–276. https://doi.org/10.1016/j.jenvp.2007.08.002

Accorsi, R., Baruffaldi, G., & Manzini, R. (2020). A closed-loop packaging network design model to foster infinitely reusable and recyclable containers in food industry. *Sustainable Production and Consumption*, *24*, 48–61. https://doi.org/10.1016/j.spc.2020.06.014

Ackermann, L. (2018). Design for Product Care: Enhancing Consumers' Repair and Maintenance Activities. *Design Journal*, *21*(4), 543–551. https://doi.org/10.1080/14606925.2018.1469331

Ackermann, L., Tuimaka, M., Pohlmeyer, A. E., & Mugge, R. (2021). Design for Product Care—Development of Design Strategies and a Toolkit for Sustainable Consumer Behaviour. *Journal of Sustainability Research*, *3*(2). https://doi.org/10.20900/jsr20210013

Adjei, M. T., Noble, S. M., & Noble, C. H. (2010). The influence of C2C communications in online brand communities on customer purchase behavior. *Journal of the Academy of Marketing Science*, *38*(5), 634–653. https://doi.org/10.1007/s11747-009-0178-5

Ağlargöz, O., & Ağlargöz, F. (2024). Toward a Packaging-Free Society: A Historical Journey of Institutionalization and the Way Forward. In K. Bäckström, C. Egan-Wyer, & E. Samsioe (Eds.), *The Future of Consumption* (pp. 127–143). Springer International Publishing. https://doi.org/10.1007/978-3-031-33246-3_8

Ahmad, S. A., Ismail, I. S., Azmi, N. A., & Zakaria, N. B. (2014). Methodological Issues in Whistle-blowing Intentions Research: Addressing the Social Desirability Bias and Order Effect Bias. *Procedia - Social and Behavioral Sciences*, *145*, 204–210. https://doi.org/10.1016/j.sbspro.2014.06.028

Ajzen, I. (1991). The Theory of Planned Behavior Organizational Behavior and Human. *Organizational Behavior and Human Decision Processes*, *50*(2), 179–211.

Albert Heijn. (2022, April 5). *Albert Heijn introduceert verpakkingsvrij boodschappen doen*. Albert Heijn Nieuws. https://nieuws.ah.nl/albert-heijn-introduceert-verpakkingsvrij-boodschappen-doen/

Ali, T., & Bodur, H. O. (2020). The Greenconsumption Effect: How Using Green Products Improves Consumption Experience. *Journal of Consumer Research*, *47*, 25–39. https://doi.org/10.1093/jcr/ucz045

Allison, A. L., Lorencatto, F., Michie, S., & Miodownik, M. (2022). Barriers and Enablers to Food Waste Recycling: A Mixed Methods Study amongst UK Citizens. *International Journal of Environmental Research and Public Health*, *19*(5), 2729. https://doi.org/10.3390/ijerph19052729

Amienyo, D., Gujba, H., Stichnothe, H., & Azapagic, A. (2013). Life cycle environmental impacts of carbonated soft drinks. *The International Journal of Life Cycle Assessment*, *18*(1), 77–92. https://doi.org/10.1007/s11367-012-0459-y

Andor, M. A., & Fels, K. M. (2018). Behavioral Economics and Energy Conservation – A Systematic Review of Non-price Interventions and Their Causal Effects. *Ecological Economics*, *148*(November 2017), 178–210. https://doi.org/10.1016/j.ecolecon.2018.01.018

Argo, J. J., Dahl, D. W., & Morales, A. C. (2006). Consumer contamination: How consumers react to products touched by others. *Journal of Marketing*, *70*(2), 81–84. https://doi.org/10.1509/jmkg.70.2.81

Babader, A., Ren, J., Jones, K. O., & Wang, J. (2016). A system dynamics approach for enhancing social behaviours regarding the reuse of packaging. *Expert Systems with Applications*, *46*, 417–425. https://doi.org/10.1016/j.eswa.2015.10.025

Baird, H. M., Meade, K., & Webb, T. L. (2022). This has already been used! A paradigm to measure the point at which people become unwilling to use reusable containers. *Journal of Cleaner Production*, *363*(April), 132321. https://doi.org/10.1016/j.jclepro.2022.132321

Banjanovic, E. S., & Osborne, J. W. (2016). Confidence intervals for effect sizes: Applying bootstrap resampling. *Practical Assessment, Research and Evaluation*, *21*(5).

Baumann, H., Boons, F., & Bragd, A. (2002). Mapping the green product development field: Engineering, policy and business perspectives. *Journal of Cleaner Production*, *10*(5), 409–425. https://doi.org/10.1016/S0959-6526(02)00015-X

Baumbach, J. (2012). Colour and camouflage: Design issues in military clothing. In *Advances in Military Textiles and Personal Equipment* (pp. 79–102). Elsevier. https://doi.org/10.1533/9780857095572.1.79

Baxter, W., Aurisicchio, M., Mugge, R., & Childs, P. R. N. (2017). *Positive and negative contamination in user interactions*. *8*(August), 509–518.

Baxter, W. L., Aurisicchio, M., & Childs, P. R. N. (2016). Materials, use and contaminated interaction. *Materials and Design*, *90*, 1218–1227. https://doi.org/10.1016/j.matdes.2015.04.019

R

References

Becker, L., van Rompay, T. J. L., Schifferstein, H. N. J., & Galetzka, M. (2011). Tough package, strong taste: The influence of packaging design on taste impressions and product evaluations. *Food Quality and Preference*, *22*(1), 17–23. https://doi.org/10.1016/j.foodqual.2010.06.007

Beitzen-Heineke, E. F., Balta-Ozkan, N., & Reefke, H. (2017). The prospects of zero-packaging grocery stores to improve the social and environmental impacts of the food supply chain. *Journal of Cleaner Production*, *140*, 1528–1541. https://doi.org/10.1016/j.jclepro.2016.09.227

Ben-David, I. (2024). From anecdotes to insights: Streamlining the research idea generation process. *Financial Review*, *59*(4), 835–844. https://doi.org/10.1111/fire.12412

Bethurem, M., Choate, B., & Bramwell, S. (2021). Stop Piling on: Assessing Efforts to Reduce Single-Use Water Bottles at Allegheny College. *Sustainability*, *13*(16), 8864. https://doi.org/10.3390/su13168864

Betts, K., Gutierrez-Franco, E., & Ponce-Cueto, E. (2022). Key metrics to measure the performance and impact of reusable packaging in circular supply chains. *Frontiers in Sustainability*, *3*, 910215. https://doi.org/10.3389/frsus.2022.910215

Billeter, D., Zhu, M., & Inman, J. J. (2012). Transparent packaging and consumer purchase decisions. *ACR North American Advances*.

Bhamra, T., Lilley, D., & Tang, T. (2011). Design for Sustainable Behaviour: Using products to change consumer behaviour. *Design Journal*, *14*(4), 427–445. https://doi.org/10.2752/175630611X13091688930453

Blanca-Alcubilla, G., Bala, A., de Castro, N., Colomé, R., & Fullana-i-Palmer, P. (2020). Is the reusable tableware the best option? Analysis of the aviation catering sector with a life cycle approach. *Science of the Total Environment*, *708*, 135121. https://doi.org/10.1016/j.scitotenv.2019.135121

Bocken, N. M. P., De Pauw, I., Bakker, C., & Van Der Grinten, B. (2016). Product design and business model strategies for a circular economy. *Journal of Industrial and Production Engineering*, *33*(5), 308–320. https://doi.org/10.1080/21681015.2016.1172124

Bocken, N. M. P., Harsch, A., & Weissbrod, I. (2022). Circular business models for the fastmoving consumer goods industry: Desirability, feasibility, and viability. *Sustainable Production and Consumption*, *30*, 799–814. https://doi.org/10.1016/j.spc.2022.01.012

Boesen, S., Bey, N., & Niero, M. (2019). Environmental sustainability of liquid food packaging: Is there a gap between Danish consumers' perception and learnings from life cycle assessment? *Journal of Cleaner Production*, *210*, 1193–1206. https://doi.org/10.1016/j.jclepro.2018.11.055

Bradley, C. G., & Corsini, L. (2023). A literature review and analytical framework of the sustainability of reusable packaging. *Sustainable Production and Consumption*, *37*, 126–141. https://doi.org/10.1016/j.spc.2023.02.009

Bradu, C., Orquin, J. L., & Thøgersen, J. (2014). The Mediated Influence of a Traceability Label on Consumer's Willingness to Buy the Labelled Product. *Journal of Business Ethics*, *124*(2), 283–295. https://doi.org/10.1007/s10551-013-1872-2

Camilleri, A. R., Larrick, R. P., Hossain, S., & Patino-Echeverri, D. (2019). Consumers underestimate the emissions associated with food but are aided by labels. *Nature Climate Change*, *9*(1), 53–58. https://doi.org/10.1038/s41558-018-0354-z

Camps-Posino, L., Batlle-Bayer, L., Bala, A., Song, G., Qian, H., Aldaco, R., Xifré, R., & Fullana-i-Palmer, P. (2021). Potential climate benefits of reusable packaging in food delivery services. A Chinese case study. *Science of the Total Environment*, *794*. https://doi.org/10.1016/j.scitotenv.2021.148570

Carrington, M.J., Neville, B.A., Whitwell, G.J., 2014. Lost in translation: exploring the ethical consumer intention-behavior gap. J. Bus. Res 67, 2759–2767. https://doi. org/10.1016/j.jbusres.2012.09.022

Casarejos, F., Bastos, C. R., Rufin, C., & Frota, M. N. (2018). Rethinking packaging production and consumption vis-à-vis circular economy: A case study of compostable cassava starch-based material. *Journal of Cleaner Production*, *201*, 1019–1028. https://doi.org/10.1016/j.jclepro.2018.08.114

Caspers, J., Süßbauer, E., Coroama, V. C., & Finkbeiner, M. (2023). Life Cycle Assessments of Takeaway Food and Beverage Packaging: The Role of Consumer Behavior. *Sustainability*, *15*(5), 4315. https://doi.org/10.3390/su15054315

Celhay, F., & Trinquecoste, J. F. (2015). Package Graphic Design: Investigating the Variables that Moderate Consumer Response to Atypical Designs. *Journal of Product Innovation Management*, *32*(6), 1014–1032. https://doi.org/10.1111/jpim.12212

Ceschin, F., & Gaziulusoy, I. (2016). Evolution of design for sustainability: From product design to design for system innovations and transitions. *Design Studies*, *47*, 118–163. https://doi.org/10.1016/j.destud.2016.09.002

Chandrashekaran, R. (2004). The influence of redundant comparison prices and other price presentation formats on consumers' evaluations and purchase intentions. *Journal of Retailing*, *80*(1), 53–66. https://doi.org/10.1016/j.jretai.2004.01.004

Chang, C. (2011). Feeling ambivalent about going green: Implications for green advertising processing. *Journal of Advertising*, *40*(4), 19–31. https://doi.org/10.2753/JOA0091-3367400402

Changwichan, K., & Gheewala, S. H. (2020). Choice of materials for takeaway beverage cups towards a circular economy. *Sustainable Production and Consumption*, *22*, 34–44. https://doi.org/10.1016/j.spc.2020.02.004

Chen, R., & Miao, X. (2024). Understanding a SPSS-aided packaging-free shopping practice. *Proceedings of the Design Society*, *4*, 1229–1238. https://doi.org/10.1017/pds.2024.125

Choi, D., & Johnson, K. K. P. (2019). Influences of environmental and hedonic motivations on intention to purchase green products: An extension of the theory of planned behavior. *Sustainable Production and Consumption*, *18*, 145–155. https://doi.org/10.1016/j.spc.2019.02.001

Choi, Y., Lee, G., & Rodgers, P. (2021). *Understanding roles of care in the design process for sustainable behaviour: Commitment and responsibility in packaging reuse*. University of Limerick. https://doi.org/10.31880/10344/10202

Christner, N., Pletti, C., & Paulus, M. (2022). How does the moral self-concept relate to prosocial behaviour? Investigating the role of emotions and consistency preference. *Cognition and Emotion, 36*(7), 1427–1444. https://doi.org/10.1080/02699931.2022.2067133

Claudy, M. C., Garcia, R., & O'Driscoll, A. (2015). Consumer resistance to innovation—A behavioral reasoning perspective. *Journal of the Academy of Marketing Science*, *43*(4), 528–544. https://doi.org/10.1007/s11747-014-0399-0

Coelho, P. M., Corona, B., ten Klooster, R., & Worrell, E. (2020). Sustainability of reusable packaging–Current situation and trends. *Resources, Conservation and Recycling: X*, *6*(November 2019), 100037. https://doi.org/10.1016/j.rcrx.2020.100037

Collis, B., Baxter, W., Baird, H. M., Meade, K., & Webb, T. L. (2023). Signs of Use Present a Barrier to Reusable Packaging Systems for Takeaway Food. *Sustainability*, *15*(11), 8857. https://doi.org/10.3390/su15118857

Cooper, T. (1994). *Beyond recycling: The longer life option*. New Economics Foundation.

Cottafava, D., Costamagna, M., Baricco, M., Corazza, L., Miceli, D., & Riccardo, L. E. (2021). Assessment of the environmental break-even point for deposit return systems through an LCA analysis of single-use and reusable cups. *Sustainable Production and Consumption*, *27*, 228–241. https://doi.org/10.1016/j.spc.2020.11.002

Council of the European Union. (2024, March 4). Packaging: Council and Parliament strike a deal to make packaging more sustainable and reduce packaging waste in the EU. https://www.consilium.europa.eu/en/press/press-releases/2024/03/04/packaging-council-and-parliament-strike-a-deal-to-make-packaging-more-sustainable-and-reduce-packaging-waste-in-the-eu/

Council of the European Union. (2024, December 16). Sustainable packaging: Council signs off on new rules for less waste and more re-use in the EU. https://www.consilium.europa.eu/en/press/press-releases/2024/12/16/sustainable-packaging-council-signs-off-on-new-rules-for-less-waste-and-more-re-use-in-the-eu/

Dabholkar, P. A., & Spaid, B. I. (2011). Service failure and recovery in using technology-based self-service: effects on user attributions and satisfaction. *The Service Industries Journal*, *32*(9), 1415–1432. https://doi.org/10.1080/02642069.2011.600518

Das, A., Konietzko, J., Bocken, N., & Dijk, M. (2023). The Circular Rebound Tool: A tool to move companies towards more sustainable circular business models. *Resources, Conservation & Recycling Advances*, *20*, 200185. https://doi.org/10.1016/j.rcradv.2023.200185

Delft Institute of Positive Design (2017). *Design for Happiness Deck*. Delft, Delft University of Technology. ISBN: 978-94-92516-86-2

De Medeiros, J. F., Da Rocha, C. G., & Ribeiro, J. L. D. (2018). Design for sustainable behavior (DfSB): Analysis of existing frameworks of behavior change strategies, experts' assessment and proposal for a decision support diagram. *Journal of Cleaner Production*, *188*, 402–415. https://doi.org/10.1016/j.jclepro.2018.03.272

De Temmerman, J., Slabbinck, H., & Vermeir, I. (2023a). The full package of package-free retail environments: A mixed methods study on multiple stakeholder perspectives of package-free shopping. *Sustainable Production and Consumption*, *41*(April), 404–417. https://doi.org/10.1016/j.spc.2023.08.020

De Temmerman, J., Slabbinck, H., & Vermeir, I. (2023b). The wrap-less revolution: Consumer segmentation by facilitators of and barriers to package-free shopping. *Resources, Conservation and Recycling*, *199*(May), 107265. https://doi.org/10.1016/j.resconrec.2023.107265

Dorn, M., & Stöckli, S. (2018). Social influence fosters the use of a reusable takeaway box. *Waste Management*, *79*, 296–301. https://doi.org/10.1016/j.wasman.2018.07.027

Dorst, K. (2016). Design practice and design research: Finally together? In *Proceedings of DRS 2016 International Conference: Future-Focused Thinking* (pp. 2670–2683). Design Research Society. https://doi.org/10.21606/drs.2016.212

DS Smith. (2019, January). *The history of packaging*. https://www.dssmith.com/tecnicarton/about/newsroom/2019/1/the-history-of-packaging

R

References

Du Rietz, S., & Kremel, A. (2024). Consumer Behavior as a Challenge and Opportunity for Circular Food Packaging—A Systematic Literature Review. *Circular Economy and Sustainability*, *4*(1), 413–438. https://doi.org/10.1007/s43615-023-00290-1

Ellen MacArthur Foundation. (2022). Global commitment 2022: Overview. https://www.ellenmacarthurfoundation.org/global-commitment-2022/overview

Ellen MacArthur Foundation. (2019). Reuse: Rethinking packaging. https://www.ellenmacarthurfoundation.org/reuse-rethinking-packaging

Ellen, P. S., Wiener, J. L., & Cobb-Walgren, C. (1991). The Role of Perceived Consumer Effectiveness in Motivating Environmentally Conscious Behaviors. *Journal of Public Policy & Marketing*, *10*(2), 102–117. https://doi.org/10.1177/074391569101000206

Ellsworth-Krebs, K., Rampen, C., Rogers, E., Dudley, L., & Wishart, L. (2022). Circular economy infrastructure: Why we need track and trace for reusable packaging. *Sustainable Production and Consumption*, *29*, 249–258. https://doi.org/10.1016/j.spc.2021.10.007

Engel, J. F., Kollat, D. T., & Blackwell, R. D. (1968). Consumer behavior. Holt, Rinehart and Winston.

Entem, A., Lloyd-Smith, P., Adamowicz, W. V. L., & Boxall, P. C. (2022). Using inferred valuation to quantify survey and social desirability bias in stated preference research. *American Journal of Agricultural Economics*, *104*(4), 1224–1242. https://doi.org/10.1111/ajae.12268

Ertz, M., François, J., & Durif, F. (2017). How Consumers React to Environmental Information: An Experimental Study. *Journal of International Consumer Marketing*, *29*(3), 162–178. https://doi.org/10.1080/08961530.2016.1273813

Ertz, M., Huang, R., Jo, M. S., Karakas, F., & Sarigöllü, E. (2017). From single-use to multi-use: Study of consumers' behavior toward consumption of reusable containers. *Journal of Environmental Management*, *193*(January), 334–344. https://doi.org/10.1016/j.jenvman.2017.01.060

Eurostat (2022). Packaging waste statistics. European Commission. https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Packaging_waste_statistics

FBR Sustainable Chemistry & Technology, Thoden Van Velzen, E. U., & Brouwer, M. T. (2022). *Reusable packaging in Europe: Between facts and fiction – an informed opinion for Metal Packaging Europe*. Wageningen Food & Biobased Research. https://doi.org/10.18174/568438

Fernqvist, F., Olsson, A., Spendrup, S. (2015). What's in it for me? Food packaging and consumer responses, a focus group study. Br. Food J. 117, 1122–1135. https://doi. org/10.1108/BFJ-08-2013-0224

Ferrara, C., Zigarelli, V., & De Feo, G. (2020). Attitudes of a sample of consumers towards more sustainable wine packaging alternatives. *Journal of Cleaner Production*, *271*, 122581. https://doi.org/10.1016/j.jclepro.2020.122581

Fetner, H., & Miller, S. A. (2021). Environmental payback periods of reusable alternatives to single-use plastic kitchenware products. *International Journal of Life Cycle Assessment*, *26*(8), 1521–1537. https://doi.org/10.1007/s11367-021-01946-6

Fogg, B. (2009). A behavior model for persuasive design. *ACM International Conference Proceeding Series*, *350*. https://doi.org/10.1145/1541948.1541999

Fogt Jacobsen, L., Pedersen, S., & Thøgersen, J. (2022). Drivers of and barriers to consumers' plastic packaging waste avoidance and recycling – A systematic literature review. *Waste Management*, *141*(January), 63–78. https://doi.org/10.1016/j.wasman.2022.01.021

Foteinis, S. (2020). How small daily choices play a huge role in climate change: The disposable paper cup environmental bane. *Journal of Cleaner Production*, *255*, 120294. https://doi.org/10.1016/j.jclepro.2020.120294

Frederick, S., & Loewenstein, G. (1999). Hedonic adaptation. In D. Kahneman, E. Diener, & N. Schwarz (Eds.), *Well-being: The foundations of hedonic psychology* (pp. 302–329). Russell Sage Foundation.

Fuentes, C., Enarsson, P., & Kristoffersson, L. (2019). Unpacking package free shopping: Alternative retailing and the reinvention of the practice of shopping. *Journal of Retailing and Consumer Services*, *50*, 258–265. https://doi.org/10.1016/j.jretconser.2019.05.016

Gallego-Schmid, A., Mendoza, J. M. F., & Azapagic, A. (2018). Improving the environmental sustainability of reusable food containers in Europe. *Science of The Total Environment*, *628–629*, 979–989. https://doi.org/10.1016/j.scitotenv.2018.02.128

Gallego-Schmid, A., Mendoza, J. M. F., & Azapagic, A. (2019). Environmental impacts of takeaway food containers. *Journal of Cleaner Production*, *211*(2019), 417–427. https://doi.org/10.1016/j.jclepro.2018.11.220

Gleim, M. R., Smith, J. S., Andrews, D., & Cronin, J. J. (2013). Against the Green: A Multi-method Examination of the Barriers to Green Consumption. *Journal of Retailing*, *89*(1), 44–61. https://doi.org/10.1016/j.jretai.2012.10.001

Golding, A. (1999). *Reuse of primary packaging: Final report*. Abfallberatung Müllvermeidung & Recycling. https://ec.europa.eu/environment/pdf/waste/studies/packaging/reuse_main.pdf

Gollwitzer, P. M., & Sheeran, P. (2006). Implementation Intentions and Goal Achievement: A Meta-analysis of Effects and Processes. In *Advances in Experimental Social Psychology* (Vol. 38, pp. 69–119). Elsevier. https://doi.org/10.1016/S0065-2601(06)38002-1

Granato, G., Fischer, A. R. H., & van Trijp, H. C. M. (2022a). A meaningful reminder on sustainability: When explicit and implicit packaging cues meet. *Journal of Environmental Psychology*, *79*(November 2021), 101724. https://doi.org/10.1016/j.jenvp.2021.101724

Granato, G., Fischer, A. R. H., & van Trijp, H. C. M. (2022b). The price of sustainability: How consumers trade-off conventional packaging benefits against sustainability. *Journal of Cleaner Production*, *365*(June), 132739. https://doi.org/10.1016/j.jclepro.2022.132739

Grebmer, C., & Diefenbach, S. (2020). The challenges of green marketing communication: Effective communication to environmentally conscious but skeptical consumers. *Designs*, *4*(3), 1–16. https://doi.org/10.3390/designs4030025

Green, T., & Peloza, J. (2014). Finding the Right Shade of Green: The Effect of Advertising Appeal Type on Environmentally Friendly Consumption. *Journal of Advertising*, *43*(2), 128–141. https://doi.org/10.1080/00913367.2013.834805

Greenwood, S. C., Walker, S., Baird, H. M., Parsons, R., Mehl, S., Webb, T. L., Slark, A. T., Ryan, A. J., & Rothman, R. H. (2021). Many Happy Returns: Combining insights from the environmental and behavioural sciences to understand what is required to make reusable packaging mainstream. *Sustainable Production and Consumption*, *27*, 1688–1702. https://doi.org/10.1016/j.spc.2021.03.022

Gupta, S., Ogden, D.T. (2009). To buy or not to buy? A social dilemma perspective on green buying. J. Consum. Mark. 26, 378–393. https://doi.org/10.1108/ 07363760910988201.

Haines-Gadd, M., Chapman, J., Lloyd, P., Mason, J., & Aliakseyeu, D. (2018). Emotional Durability Design Nine—A Tool for Product Longevity. *Sustainability*, *10*(6), 1948. https://doi.org/10.3390/su10061948

Hakola, L., Hakola, E., Palola, S., Tenhunen-Lunkka, A., & Lahtinen, J. (2024). Durable and sustainable smart tags for identity management and condition monitoring: Case study for reusable packaging and recyclable data carriers. *Packaging Technology and Science*, *37*(2), 107–121. https://doi.org/10.1002/pts.2781

Hartley, K., Van Santen, R., & Kirchherr, J. (2020). Policies for transitioning towards a circular economy: Expectations from the European Union (EU). *Resources, Conservation and Recycling*, *155*, 104634. https://doi.org/10.1016/j.resconrec.2019.104634

Hartmann, P., Apaolaza, V., & D'Souza, C. (2018). The role of psychological empowerment in climate-protective consumer behaviour: An extension of the value-belief-norm framework. *European Journal of Marketing*, *52*(1/2), 392–417. https://doi.org/10.1108/EJM-01-2017-0080

Hayes, A. F. (2013). Introduction to mediation, moderation, and conditional process analysis: A regression-based approach. (pp. xvii, 507). Guilford Press.

Hazée, S., Van Vaerenbergh, Y., Delcourt, C., & Warlop, L. (2019). Sharing Goods? Yuck, No! An Investigation of Consumers' Contamination Concerns About Access-Based Services. *Journal of Service Research*, *22*(3), 256–271. https://doi.org/10.1177/1094670519838622

Heeremans, E. (2025). *Packaging the future: Determinants of use intentions and incentive structures of reusable packaging systems*.

Heidbreder, L. M., Bablok, I., Drews, S., & Menzel, C. (2019). Tackling the plastic problem: A review on perceptions, behaviors, and interventions. *Science of the Total Environment*, *668*, 1077–1093. https://doi.org/10.1016/j.scitotenv.2019.02.437

Heijne, K., & van der Meer, H. (2019). *Road map for creative problem-solving techniques: Organizing and facilitating group sessions*. Boom uitgevers Amsterdam.

Herrmann, C., Rhein, S., & Sträter, K. F. (2022). Consumers' sustainability-related perception of and willingness-to-pay for food packaging alternatives. *Resources, Conservation and Recycling*, *181*(February). https://doi.org/10.1016/j.resconrec.2022.106219

Herweyers, L., Du Bois, E., & Moons, I. (2024). Use—Clean—Repeat: Understanding user, product, and context to design for long-term reuse. *Resources, Conservation and Recycling*, *204*(September 2023), 107511. https://doi.org/10.1016/j.resconrec.2024.107511

Herweyers, L., Du Bois, E., & Moons, I. (2023). TRASH TALK: WHO USES WHICH REUSABLE PRODUCT? USER INSIGHTS AND DESIGN OPPORTUNITIES FOR SINGLE-USE ALTERNATIVES. *Proceedings of the Design Society*, *3*, 3641–3650. https://doi.org/10.1017/pds.2023.365

Herweyers, L., Du Bois, E., & Moons, I. (2024). Unravelling experiences, barriers, and design strategies for encouraging reusable takeaway cup usage. *Proceedings of the Design Society*, *4*, 995–1004. https://doi.org/10.1017/pds.2024.102

R

References

Herweyers, L., Moons, I., Barbarossa, C., De Pelsmacker, P., & Du Bois, E. (2023). Understanding who avoids single-use plastics and why: A cross-country mixed-method study. *Journal of Cleaner Production*, *414*, 137685. https://doi.org/10.1016/j.jclepro.2023.137685

Hitt, C., Douglas, J., & Keoleian, G. (2023). Parametric life cycle assessment modeling of reusable and single-use restaurant food container systems. *Resources, Conservation and Recycling*, *190*(November 2022), 106862. https://doi.org/10.1016/j.resconrec.2022.106862

Hoseini, M., Greenwood, S. C., Eman, S., Mattinson, P., Baird, H. M., Beswick-Parsons, R., Fairclough, J. P. A., Webb, T. L., Ryan, A. J., & Rothman, R. H. (2024). Integrating behavioural, material and environmental science to inform the design and evaluation of a reuse system for takeaway food. *Resources, Conservation and Recycling*, *209*, 107815. https://doi.org/10.1016/j.resconrec.2024.107815

Hsee, C. K., & Zhang, J. (2004). Distinction Bias: Misprediction and Mischoice Due to Joint Evaluation. Journal of Personality and Social Psychology, 86(5), 680–695. https://doi.org/10.1037/0022-3514.86.5.680

IDEO.org. (2015). *The field guide to human-centered design*. IDEO.

Jain, P., & Hudnurkar, Dr. M. (2022). Sustainable packaging in the FMCG industry. *Cleaner and Responsible Consumption*, *7*, 100075. https://doi.org/10.1016/j.clrc.2022.100075

James, A. M., Reitsma, L., & Aftab, M. (2019). Bridging the double-gap in circularity. Addressing the intention-behaviour disparity in fashion. *The Design Journal*, *22*(sup1), 901–914. https://doi.org/10.1080/14606925.2019.1595407

Jetten, J., De Kruijf, N., & Castle, L. (1999). Quality and safety aspects of reusable plastic food packaging materials: A European study to underpin future legislation. *Food Additives and Contaminants*, *16*(1), 25–36. https://doi.org/10.1080/026520399284299

Jiang, X., Dong, M., He, Y., Shen, J., Jing, W., Yang, N., & Guo, X. (2020). Research on the design of and preference for collection modes of reusable takeaway containers to promote sustainable consumption. *International Journal of Environmental Research and Public Health*, *17*(13), 1–17. https://doi.org/10.3390/ijerph17134764

Jiménez Romanillos, E., Williams, H., & Wever, R. (2024). Unpacking Behaviours: A Literature Study and Research Agenda on Consumer Behaviour in Packaging-Free Systems. *Packaging Technology and Science*, pts.2825. https://doi.org/10.1002/pts.2825

Kanay, A., Hilton, D., Charalambides, L., Corrégé, J. B., Inaudi, E., Waroquier, L., & Cézéra, S. (2021). Making the carbon basket count: Goal setting promotes sustainable consumption in a simulated online supermarket. *Journal of Economic Psychology*, *83*(January). https://doi.org/10.1016/j.joep.2020.102348

Karmarkar, U. R., & Bollinger, B. (2015). BYOB: How Bringing Your Own Shopping Bags Leads to Treating Yourself and the Environment. *Journal of Marketing*, *79*(4), 1–15. https://doi.org/10.1509/jm.13.0228

Keh, H. T., & Pang, J. (2010). Customer reactions to service separation. *Journal of Marketing*, *74*(2), 55–70. https://doi.org/10.1509/jmkg.74.2.55

Keller, A., Köhler, J. K., Eisen, C., Kleihauer, S., & Hanss, D. (2021). Why consumers shift from single-use to reusable drink cups: An empirical application of the stage model of self-regulated behavioural change. *Sustainable Production and Consumption*, *27*, 1672–1687. https://doi.org/10.1016/j.spc.2021.04.001

Kim, Y., & Choi, S. M. (2005). Antecedents of Green Purchase Behavior: An Examination of Collectivism, Environmental Concern, and Perceived Consumer Effectiveness. *Advances in Consumer Research*, *32*(August), 592–599.

King Mongkut's Institute of Technology Ladkrabang, Katephap, N., Limnararat, S., & King Mongkut's Institute of Technology Ladkrabang. (2017). The Operational, Economic and Environmental Benefits of Returnable Packaging Under Various Reverse Logistics Arrangements. *International Journal of Intelligent Engineering and Systems*, *10*(5), 210–219. https://doi.org/10.22266/ijies2017.1031.23

Kirchherr, J., Reike, D., & Hekkert, M. (2017). Conceptualizing the circular economy: An analysis of 114 definitions. *Resources, Conservation and Recycling*, *127*, 221–232. https://doi.org/10.1016/j.resconrec.2017.09.005

Kleine Jäger, J., & Piscicelli, L. (2021). Collaborations for circular food packaging: The set-up and partner selection process. *Sustainable Production and Consumption*, *26*, 733–740. https://doi.org/10.1016/j.spc.2020.12.025

Konietzko, J., Bocken, N., & Hultink, E. J. (2020). A Tool to Analyze, Ideate and Develop Circular Innovation Ecosystems. *Sustainability*, *12*(1), 417. https://doi.org/10.3390/su12010417

Konstanti, C., Karapanos, E., & Markopoulos, P. (2022). The Behavior Change Design Cards: A Design Support Tool for Theoretically-Grounded Design of Behavior Change Technologies. *International Journal of Human-Computer Interaction*, *38*(13), 1238–1254. https://doi.org/10.1080/10447318.2021.1990519

Krah, S., Todorovic, T., & Magnier, L. (2019). Designing for packaging sustainability. The effects of appearance and a better eco-label on consumers' evaluations and choice. *Proceedings of the International Conference on Engineering Design, ICED*, *2019-Augus*(August), 3251–3259. https://doi.org/10.1017/dsi.2019.332

Kunamaneni, S., Jassi, S., & Hoang, D. (2019). Promoting reuse behaviour: Challenges and strategies for repeat purchase, low-involvement products. *Sustainable Production and Consumption*, *20*, 253–272. https://doi.org/10.1016/j.spc.2019.07.001

Kuzmina, K., Prendeville, S., Walker, D., & Charnley, F. (2019). Future scenarios for fast-moving consumer goods in a circular economy. *Futures*, *107*(April 2018), 74–88. https://doi.org/10.1016/j.futures.2018.12.001

Lehner, M., Mont, O., & Heiskanen, E. (2016). Nudging – A promising tool for sustainable consumption behaviour? *Journal of Cleaner Production*, *134*, 166–177. https://doi.org/10.1016/j.jclepro.2015.11.086

Leonidou, C. N., & Skarmeas, D. (2017). Gray Shades of Green: Causes and Consequences of Green Skepticism. *Journal of Business Ethics*, *144*(2), 401–415. https://doi.org/10.1007/s10551-015-2829-4

Lilley, D., Bridgens, B., Davies, A., & Holstov, A. (2019). Ageing (dis)gracefully: Enabling designers to understand material change. *Journal of Cleaner Production*, *220*, 417–430. https://doi.org/10.1016/j.jclepro.2019.01.304

Lin, C. J., Prasetyo, Y. T., Siswanto, N. D., & Jiang, B. C. (2019). Optimization of color design for military camouflage in CIELAB color space. *Color Research & Application*, *44*(3), 367–380. https://doi.org/10.1002/col.22352

Lindh, H., Williams, H., Olsson, A., & Wikström, F. (2016). Elucidating the Indirect Contributions of Packaging to Sustainable Development: A Terminology of Packaging Functions and Features. *Packaging Technology and Science*, *29*(4–5), 225–246. https://doi.org/10.1002/pts.2197

Liu, W., Zhu, Z., & Ye, S. (2023). A Framework Towards Design for Circular Packaging (DfCP): Design Knowledge, Challenges and Opportunities. *Circular Economy and Sustainability*, *3*(4), 2109–2125. https://doi.org/10.1007/s43615-023-00264-3

Lo, C. J., Tsarenko, Y., & Tojib, D. (2019). To tell or not to tell? The roles of perceived norms and self-consciousness in understanding consumers' willingness to recommend online secondhand apparel shopping. *Psychology and Marketing*, *36*(4), 287–304. https://doi.org/10.1002/mar.21179

Locke, E. A. (1996). Motivation through conscious goal setting. *Applied and Preventive Psychology*, *5*(2), 117–124. https://doi.org/10.1016/S0962-1849(96)80005-9

Locke, E. A., & Latham, G. P. (2002). Building a practically useful theory of goal setting and task motivation: A 35-year odyssey. *American Psychologist*, *57*(9), 705–717. https://doi.org/10.1037/0003-066X.57.9.705

Lockton, D., Harrison, D., & Stanton, N. A. (2010). The Design with Intent Method: A design tool for influencing user behaviour. *Applied Ergonomics*, *41*(3), 382–392. https://doi.org/10.1016/j.apergo.2009.09.001

Lockton, D., Harrison, D., & Stanton, N. A. (2013). Exploring Design Patterns for Sustainable Behaviour. *The Design Journal*, *16*(4), 431–459. https://doi.org/10.2752/175630613X13746645186124

Löfgren, M., & Witell, L. (2005). Kano's Theory of Attractive Quality and Packaging. *Quality Management Journal*, *12*(3), 7–20. https://doi.org/10.1080/10686967.2005.11919257

Lofthouse, V. A. (2007). A creative approach to investigating refillable packaging systems. *Ciwm 2007*, *June*.

Lofthouse, V. A., Bhamra, T. A., & Trimingham, R. L. (2009). Investigating customer perceptions of refillable packaging and assessing business drivers and barriers to their use. *Packaging Technology and Science*, *22*(6), 335–348. https://doi.org/10.1002/pts.857

Lofthouse, V., & Bhamra, T. (2006). Investigation into the drivers and barriers affecting refillable packaging. *Waste 2006*, 1–8.

Lofthouse, V., & Prendeville, S. (2018). Human-Centred Design of Products And Services for the Circular Economy – A Review. *The Design Journal*, *21*(4), 451–476. https://doi.org/10.1080/14606925.2018.1468169

Long, Y., Ceschin, F., Harrison, D., & Terzioğlu, N. (2022). Exploring and Addressing the User Acceptance Issues Embedded in the Adoption of Reusable Packaging Systems. *Sustainability*, *14*(10), 6146. https://doi.org/10.3390/su14106146

Long, Y., Ceschin, F., Mansour, N., & Harrison, D. (2020). Product–Service Systems Applied to Reusable Packaging Systems: A Strategic Design Tool. *Design Management Journal*, *15*(1), 15–32. https://doi.org/10.1111/dmj.12057

Louis, D., Lombart, C., & Durif, F. (2021). Packaging-free products: A lever of proximity and loyalty between consumers and grocery stores. *Journal of Retailing and Consumer Services*, *60*(January), 102499. https://doi.org/10.1016/j.jretconser.2021.102499

Mackison, D., Wrieden, W. L., & Anderson, A. S. (2010). Validity and reliability testing of a short questionnaire developed to assess consumers' use, understanding and perception of food labels. *European Journal of Clinical Nutrition*, *64*(2), 210–217. https://doi.org/10.1038/ejcn.2009.126

Madria, W., Tangsoc, J. (2019). Factors to consider in the design of plastic packaging intended for reuse of consumers. In: 2019 IEEE 6th Int. Conf. Ind. Eng. Appl. ICIEA 2019, pp. 877–882. https://doi.org/10.1109/IEA.2019.8715074.

R

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References

Magnier, L., & Crié, D. (2015). Communicating packaging eco-friendliness: An exploration of consumers' perceptions of eco-designed packaging. *International Journal of Retail and Distribution Management*, *43*(4–5), 350–366. https://doi.org/10.1108/IJRDM-04-2014-0048

Magnier, L., & Gil-Pérez, I. (2021). Reviving the milk man: Consumers' evaluations of circular reusable packaging offers. *4th PLATE 2021 Virtual Conference*, *May*. http://hdl.handle.net/10344/10227

Magnier, L., & Gil-Pérez, I. (2023). Should the milkman return? The effect of a reusable packaging on product perceptions and behavioural intentions. *Food Quality and Preference*, *112*, 105037. https://doi.org/10.1016/j.foodqual.2023.105037

Magnier, L., Mugge, R., & Schoormans, J. (2019). Turning ocean garbage into products – Consumers' evaluations of products made of recycled ocean plastic. *Journal of Cleaner Production*, *215*, 84–98. https://doi.org/10.1016/j.jclepro.2018.12.246

Magnier, L., & Schoormans, J. (2015). Consumer reactions to sustainable packaging: The interplay of visual appearance, verbal claim and environmental concern. *Journal of Environmental Psychology*, *44*, 53–62. https://doi.org/10.1016/j.jenvp.2015.09.005

Magnier, L., Schoormans, J., & Mugge, R. (2016). Judging a product by its cover: Packaging sustainability and perceptions of quality in food products. *Food Quality and Preference*, *53*, 132–142. https://doi.org/10.1016/j.foodqual.2016.06.006

Mahmoudi, M., & Parviziomran, I. (2020). Reusable packaging in supply chains: A review of environmental and economic impacts, logistics system designs, and operations management. *International Journal of Production Economics*, *228*(March), 107730. https://doi.org/10.1016/j.ijpe.2020.107730

Maleki, R. A., & Meiser, G. (2011). Managing Returnable Containers Logistics—A Case Study.

Marken, G. H., & Hörisch, J. (2019). Purchasing unpackaged food products. *Sustainability Management Forum | NachhaltigkeitsManagementForum*, *27*(3–4), 165–175. https://doi.org/10.1007/s00550-020-00490-5

Matthews, M., & Webb, T. L. (2023). Understanding Consumer's Willingness to Engage with Digital Reuse Systems. *Sustainability*, *15*(19), 14560. https://doi.org/10.3390/su151914560

Mazar, A., Tomaino, G., Carmon, Z., Wood, W. (2021). Habits to save our habitat: using the psychology of habits to promote sustainability. Behav. Sci. Policy 7, 75–89. https://doi.org/10.1353/bsp.2021.0014.

Miao, X., Magnier, L. B. M., & Mugge, R. (2023a). Developing Reusable Packaging for FMCG: Consumers' Perceptions of Benefits and Risks of Refillable and Returnable Packaging Systems. In: Fukushige, S., Kobayashi, H., Yamasue, E., Hara, K. (eds) EcoDesign for Sustainable Products, Services and Social Systems I. Springer, Singapore. https://doi.org/10.1007/978-981-99-3818-6_2

Miao, X., Magnier, L., & Mugge, R. (2023b). Switching to reuse? An exploration of consumers' perceptions and behaviour towards reusable packaging systems. *Resources, Conservation and Recycling*, *193*, 106972. https://doi.org/10.1016/j.resconrec.2023.106972

Miao, X., Magnier, L., & Mugge, R. (2024a). How Many Times Should I Use My Reusable Packaging? Exploring the Role of an Environmental Break-Even Point in Shaping Consumers' Intention to Reuse. *Circular Economy and Sustainability*. https://doi.org/10.1007/s43615-024-00437-8

Miao, X., Magnier, L., & Mugge, R. (2024b). Design strategies for consumers' continued usage of reusable packaging systems (RPSs). Proceedings of the Design Society, 4, 1379–1388. https://doi.org/10.1017/pds.2024.140

Michie, S., Van Stralen, M. M., & West, R. (2011). The behaviour change wheel: A new method for characterising and designing behaviour change interventions. *Implementation Science*, *6*(1), 42. https://doi.org/10.1186/1748-5908-6-42

Mitchell, V.-W. (1992). Understanding consumers' behaviour: Can perceived risk theory help? *Management Decision, 30*(3), 26–31. https://doi.org/10.1108/00251749210013050

Mohr, L. A., Eroǧlu, D., & Ellen, P. S. (1998). The development and testing of a measure of skepticism toward environmental claims in marketers' communications. Journal of Consumer Affairs, 32(1), 30–55. https://doi.org/10.1111/j.1745-6606.1998.tb00399.x

Mondal, A. (2022). Camouflage design, assessment and breaking techniques: A survey. *Multimedia Systems*, *28*(1), 141–160. https://doi.org/10.1007/s00530-021-00813-6

Monnot, E., Parguel, B., & Reniou, F. (2015). Consumer responses to elimination of overpackaging on private label products. *International Journal of Retail and Distribution Management*, *43*(4–5), 329–349. https://doi.org/10.1108/IJRDM-03-2014-0036

Moretti, C., Hamelin, L., Jakobsen, L. G., Junginger, M. H., Steingrimsdottir, M. M., Høibye, L., & Shen, L. (2021). Cradle-to-grave life cycle assessment of single-use cups made from PLA, PP and PET. *Resources, Conservation and Recycling*, *169*(December 2020). https://doi.org/10.1016/j.resconrec.2021.105508

Mugge, R., Dahl, D.W. (2013). Seeking the ideal level of design newness: consumer response to radical and incremental product design. J. Prod. Innov. Manag. 30, 34–47. https://doi.org/10.1111/jpim.12062.

Mugge, R., Jockin, B., & Bocken, N. (2017). How to sell refurbished smartphones? An investigation of different customer groups and appropriate incentives. *Journal of Cleaner Production*, *147*, 284–296. https://doi.org/10.1016/j.jclepro.2017.01.111

Mugge, R., Magnier, L., & Schoormans, J. (2019). Using proximity in sustainable product design. *Conference Proceedings of the Academy for Design Innovation Management*, *1*(1). https://doi.org/10.33114/adim.2017.110

Muranko, Ż., Tassell, C., van der Laan, A. Z., & Aurisicchio, M. (2021). Characterisation and environmental value proposition of reuse models for fast-moving consumer goods: Reusable packaging and products. *Sustainability (Switzerland)*, *13*(5), 1–35. https://doi.org/10.3390/su13052609

Navas, R., Chang, H. J., Khan, S., & Chong, J. W. (2021). Sustainability transparency and trustworthiness of traditional and blockchain ecolabels: A comparison of generations x and y consumers. *Sustainability (Switzerland)*, *13*(15). https://doi.org/10.3390/su13158469

Nazlı, T. (2021). Repair motivation and barriers model: Investigating user perspectives related to product repair towards a circular economy. *Journal of Cleaner Production*, *289*. https://doi.org/10.1016/j.jclepro.2020.125644

Nemeroff, C., & Rozin, P. (1994). The contagion concept in adult thinking in the United States: Transmission of germs and of interpersonal influence. *Ethos, 22*(2), 158–186. https://doi.org/10.1525/eth.1994.22.2.02a00020

Nguyen, T. T. H., Yang, Z., Nguyen, N., Johnson, L. W., & Cao, T. K. (2019). Greenwash and green purchase intention: The mediating role of green skepticism. *Sustainability (Switzerland)*, *11*(9), 1–16. https://doi.org/10.3390/su11092653

Nihart, A. J., Garcia, M. A., El Hayek, E., Liu, R., Olewine, M., Kingston, J. D., Castillo, E. F., Gullapalli, R. R., Howard, T., Bleske, B., Scott, J., Gonzalez-Estrella, J., Gross, J. M., Spilde, M., Adolphi, N. L., Gallego, D. F., Jarrell, H. S., Dvorscak, G., Zuluaga-Ruiz, M. E., … Campen, M. J. (2025). Bioaccumulation of microplastics in decedent human brains. *Nature Medicine*. https://doi.org/10.1038/s41591-024-03453-1

Noëth, E., Van Opstal, W., & Du Bois, E. (2024). Introducing reusable food packaging: Customer preferences and design implications for successful market entry. *Business Strategy and the Environment*, bse.3820. https://doi.org/10.1002/bse.3820

Novoradovskaya, E., Mullan, B., Hasking, P., & Uren, H. V. (2021). My cup of tea: Behaviour change intervention to promote use of reusable hot drink cups. *Journal of Cleaner Production*, *284*, 124675. https://doi.org/10.1016/j.jclepro.2020.124675

Numata, D., & Managi, S. (2012). Demand for refilled reusable products. *Environmental Economics and Policy Studies*, *14*(4), 421–436. https://doi.org/10.1007/s10018-012-0037-3

Orth, U. R., Campana, D., & Malkewitz, K. (2010). Formation of Consumer Price Expectation Based on Package Design: Attractive and Quality Routes. *Journal of Marketing Theory and Practice*, *18*(1), 23–40. https://doi.org/10.2753/MTP1069-6679180102

Patton, M.Q. (2002). Qualitative Research & Evaluation Methods. SAGE Publications, Thousand Oaks

Pedgley, O., Şener, B., Lilley, D., & Bridgens, B. (2018). Embracing material surface imperfections in product design. *International Journal of Design*, *12*(3), 21–33.

Peer, E., Brandimarte, L., Samat, S., & Acquisti, A. (2017). Beyond the Turk: Alternative platforms for crowdsourcing behavioral research. *Journal of Experimental Social Psychology*, *70*, 153–163. https://doi.org/10.1016/j.jesp.2017.01.006

Perez-Castillo, D., & Vera-Martinez, J. (2020). Green behaviour and switching intention towards remanufactured products in sustainable consumers as potential earlier adopters. *Asia Pacific Journal of Marketing and Logistics*, *33*(8), 1776–1797. https://doi.org/10.1108/APJML-10-2019-0611

Pettinico, G., & Milne, G. R. (2017). Living by the numbers: Understanding the "quantification effect". *Journal of Consumer Marketing*, *34*(4), 281–291. https://doi.org/10.1108/JCM-06-2016-1839

Pieter Pot. (2024). *Heropening: Pieter Pot 2.0 halverwege maart!* Pieter Pot. https://pieter-pot.nl/blogs/artikelen/heropening-pieter-pot-2-0-halverwege-maart-2

Polyportis, A., Magnier, L., & Mugge, R. (2022). Guidelines to Foster Consumer Acceptance of Products Made from Recycled Plastics. *Circular Economy and Sustainability*, *0123456789*. https://doi.org/10.1007/s43615-022-00202-9

Polyportis, A., Mugge, R., & Magnier, L. (2024). To see or not to see: The effect of observability of the recycled content on consumer adoption of products made from recycled materials. *Resources, Conservation and Recycling*, *205*, 107610. https://doi.org/10.1016/j.resconrec.2024.107610

Poole, J. (2019). Refill and reuse: unilever launches Cif ecorefill, removing 1.5 million plastic spray bottles from shelves. Packag. Insights. URL https://www.packaginginsights.com/news/refill-and-reuse-unilever-launches-cif-ecorefill-removing-15million-plastic-spray-bottles-from-shelves.html (accessed February 2023).

R

References

Pott, S. L., Baird, H. M., Eman, S., Ciocirlan, A.-B., Foster, K., Green, G., Grobien, M., & Webb, T. L. (2024). Does Providing Information about Cleaning Increase People's Willingness to (Re)Use Bowls That Show Signs of Previous Use? *Sustainability*, *16*(3), 1322. https://doi.org/10.3390/su16031322

Potting, J., Hekkert, M., Worrell, E., & Hanemaaijer, A. (n.d.). *CIRCULAR ECONOMY: MEASURING INNOVATION IN THE PRODUCT CHAIN*.

Preacher, K. J., & Hayes, A. F. (2008). Asymptotic and resampling strategies for assessing and comparing indirect effects in multiple mediator models. *Behavior Research Methods*, *40*(3), 879–891. https://doi.org/10.3758/BRM.40.3.879

Ræbild, U., & Hasling, K. M. (2019). Experiences of the Sustainable Design Cards: Evaluation of Applications, Potentials and Limitations. *Fashion Practice*, *11*(3), 417–442. https://doi.org/10.1080/17569370.2019.1664026

Rapp, A., Marino, A., Simeoni, R., & Cena, F. (2017). An ethnographic study of packaging-free purchasing: Designing an interactive system to support sustainable social practices. *Behaviour & Information Technology*, *36*(11), 1193–1217. https://doi.org/10.1080/0144929X.2017.1365170

Reckwitz, A. (2002). Toward a Theory of Social Practices: A Development in Culturalist Theorizing. *European Journal of Social Theory*, *5*(2), 243–263. https://doi.org/10.1177/13684310222225432

Rexfelt, O., & Selvefors, A. (2021). The Use2Use Design Toolkit—Tools for User-Centred Circular Design. *Sustainability*, *13*(10), 5397. https://doi.org/10.3390/su13105397

Rezvani, Z., Jansson, J., & Bengtsson, M. (2017). Cause I'll Feel Good! An Investigation into the Effects of Anticipated Emotions and Personal Moral Norms on Consumer Pro-Environmental Behavior. *Journal of Promotion Management*, *23*(1), 163–183. https://doi.org/10.1080/10496491.2016.1267681

Rijksoverheid (2024). *Regels voor wegwerpplastic*. https://www.rijksoverheid.nl/onderwerpen/afval/regels-voor-wegwerpplastic

Risch, S. J. (2009). Food Packaging History and Innovations. *Journal of Agricultural and Food Chemistry*, *57*(18), 8089–8092. https://doi.org/10.1021/jf900040r

Rist, T., & Masoodian, M. (2019). Promoting Sustainable Energy Consumption Behavior through Interactive Data Visualizations. *Multimodal Technologies and Interaction*, *3*(3), 56. https://doi.org/10.3390/mti3030056

Rognoli, V., & Karana, E. (2014). Toward a New Materials Aesthetic Based on Imperfection and Graceful Aging. In *Materials Experience* (pp. 145–154). Elsevier. https://doi.org/10.1016/B978-0-08-099359-1.00011-4

Rogers, E. M. (2003). *Diffusion of innovations* (5th ed.)

Rokka, J., & Uusitalo, L. (2008). Preference for green packaging in consumer product choices – Do consumers care? *International Journal of Consumer Studies*, *32*(5), 516–525. https://doi.org/10.1111/j.1470-6431.2008.00710.x

RTL Nieuws. (2025, February 19). Te veel gedoe, te weinig animo: AH stopt met verpakkingsvrij tappen. https://rtl.nl/nieuws/economie/artikel/5495256/te-veel-gedoe-te-weinig-animo-ah-stopt-met-verpakkingsvrij-tappen

Rundh, B. (2005). The multi-faceted dimension of packaging: Marketing logistic or marketing tool? *British Food Journal*, *107*(9), 670–684. https://doi.org/10.1108/00070700510615053

Sang, Y., Yu, H., & Han, E. (2022). Understanding the Barriers to Consumer Purchasing of Zero-Waste Products. *Sustainability*, *14*(24), 16858. https://doi.org/10.3390/su142416858

Schuitema, G., Anable, J., Skippon, S., & Kinnear, N. (2013). The role of instrumental, hedonic and symbolic attributes in the intention to adopt electric vehicles. *Transportation Research Part A: Policy and Practice*, *48*, 39–49. https://doi.org/10.1016/j.tra.2012.10.004

Scott, M., Barreto, M., Quintal, F., & Oakley, I. (2011). Understanding goal setting behavior in the context of energy consumption reduction. *Lecture Notes in Computer Science (Including Subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics)*, *6946 LNCS*(PART 1), 129–143. https://doi.org/10.1007/978-3-642-23774-4_13

Silva, S. C., Santos, A., Duarte, P., & Vlačić, B. (2021). The role of social embarrassment, sustainability, familiarity and perception of hygiene in second-hand clothing purchase experience. *International Journal of Retail and Distribution Management*, *49*(6), 717–734. https://doi.org/10.1108/IJRDM-09-2020-0356

Simmonds, G., Spence, C. (2017). Thinking inside the box: how seeing products on, or through, the packaging influences consumer perceptions and purchase behaviour. Food Qual. Prefer. 62, 340–351. https://doi.org/10.1016/j.foodqual.2016.11.010.

Singh, J., & Cooper, T. (2017). Towards a Sustainable Business Model for Plastic Shopping Bag Management in Sweden. *Procedia CIRP*, *61*, 679–684. https://doi.org/10.1016/j.procir.2016.11.268

Singh, P., Wani, A.A., & Langowski, H.-.C. (2016). Food Packaging Materials: Testing & Quality Assurance, 1st ed. CRC Press. https://doi.org/10.4324/9781315374390

Steenis, N. D., van Herpen, E., van der Lans, I. A., Ligthart, T. N., & van Trijp, H. C. M. (2017). Consumer response to packaging design: The role of packaging materials and graphics in sustainability perceptions and product evaluations. *Journal of Cleaner Production*, *162*, 286–298. https://doi.org/10.1016/j.jclepro.2017.06.036

Stefanini, R., Borghesi, G., Ronzano, A., & Vignali, G. (2021). Plastic or glass: A new environmental assessment with a marine litter indicator for the comparison of pasteurized milk bottles. *The International Journal of Life Cycle Assessment*, *26*(4), 767–784. https://doi.org/10.1007/s11367-020-01804-x

Steinhorst, J., & Beyerl, K. (2021). First reduce and reuse, then recycle! Enabling consumers to tackle the plastic crisis – Qualitative expert interviews in Germany. *Journal of Cleaner Production*, *313*(May), 127782. https://doi.org/10.1016/j.jclepro.2021.127782

Stevens, M., & Merilaita, S. (2009). Animal camouflage: Current issues and new perspectives. *Philosophical Transactions of the Royal Society B: Biological Sciences*, *364*(1516), 423–427. https://doi.org/10.1098/rstb.2008.0217

Straughan, R. D., & Roberts, J. A. (1999). Environmental segmentation alternatives: A look at green consumer behavior in the new millennium. *Journal of Consumer Marketing*, *16*(6), 558–575. https://doi.org/10.1108/07363769910297506

Sweeney, J. C., & Soutar, G. N. (2001). Consumer perceived value: The development of a multiple item scale. *Journal of Retailing*, *77*(2), 203–220. https://doi.org/10.1016/S0022-4359(01)00041-0

Tanner, R. J., & Carlson, K. A. (2009). Unrealistically Optimistic Consumers: A Selective Hypothesis Testing Account for Optimism in Predictions of Future Behavior. *Journal of Consumer Research*, *35*(5), 810–822. https://doi.org/10.1086/593690

Tassell, C., & Aurisicchio, M. (2023). Refill at home for fast-moving consumer goods: Uncovering compliant and divergent consumer behaviour. *Sustainable Production and Consumption*, *39*, 63–78. https://doi.org/10.1016/j.spc.2023.04.018

Tate, K., Stewart, A. J., & Daly, M. (2014). Influencing green behaviour through environmental goal priming: The mediating role of automatic evaluation. *Journal of Environmental Psychology*, *38*, 225–232. https://doi.org/10.1016/j.jenvp.2014.02.004

Tenhunen-Lunkka, A., Balatsas-Lekkas, A., Mouazan, E., Palola, S., Ngo, T., Salo, M., Hylkilä, E., Sundqvist, H., Luomala, H., Pennanen, K., Sorvari, K., Petänen, P., & Lahtinen, J. H. (2024). Implementing a circular business model for reusable packaging: Multidisciplinary learnings from reusable pizza packaging. *Sustainable Production and Consumption*, *48*, 62–83. https://doi.org/10.1016/j.spc.2024.05.006

Tezer, A., & Bodur, H. O. (2020). The Greenconsumption Effect: How Using Green Products Improves Consumption Experience. *Journal of Consumer Research*, *47*(1), 25–39. https://doi.org/10.1093/jcr/ucz045

Thaler, R. H., & Sunstein, C. R. (2008). *Nudge: Improving decisions about health, wealth, and happiness.* Yale University Press.

Thøgersen, J., Haugaard, P., & Olesen, A. (2010). Consumer responses to ecolabels. *European Journal of Marketing*, *44*(11/12), 1787–1810. https://doi.org/10.1108/03090561011079882

Thomassen, G., Peeters, E., Van Hee, N., Noëth, E., Du Bois, E., Boone, L., & Compernolle, T. (2024). The environmental impacts of reusable rice packaging: An extended comparative life cycle assessment. *Sustainable Production and Consumption*, *45*(January), 333–347. https://doi.org/10.1016/j.spc.2024.01.014

Thoresen, V. W., Didham, R. J., Klein, J., & Doyle, D. (2015). Responsible living: Concepts, education and future perspectives. *Responsible Living: Concepts, Education and Future Perspectives*, 1–283. https://doi.org/10.1007/978-3-319-15305-6

Tonikidou, A., & Webb, T. L. (2024). Does Providing Information about the Environmental Benefits of Reusable Packaging Systems for Consumer Products Increase Consumers' Willingness to Use Them? *Sustainability*, *16*(15), 6599. https://doi.org/10.3390/su16156599

Trattner, A., Hvam, L., Forza, C., & Herbert-Hansen, Z. N. L. (2019). Product complexity and operational performance: A systematic literature review. In *CIRP Journal of Manufacturing Science and Technology* (Vol. 25, Issue February). https://doi.org/10.1016/j.cirpj.2019.02.001

Trope, Y., & Liberman, N. (2010). Construal-level theory of psychological distance. *Psychological Review*, *117*(2), 440–463. https://doi.org/10.1037/a0018963

Troscianko, J., Skelhorn, J., & Stevens, M. (2017). Quantifying camouflage: How to predict detectability from appearance. *BMC Evolutionary Biology*, *17*(1), 7. https://doi.org/10.1186/s12862-016-0854-2

Twede, D. (2016). *History of packaging.* In D. G. B. Jones & M. Tadajewski (Eds.), The Routledge companion to marketing history (pp. 115–130). Routledge.

Tyl, B., Vallet, F., Bocken, N. M. P., & Real, M. (2015). The integration of a stakeholder perspective into the front end of eco-innovation: A practical approach. *Journal of Cleaner Production*, *108*, 543–557. https://doi.org/10.1016/j.jclepro.2015.07.145

R

References

van der Waal, N. E., Folkvord, F., Azrout, R., & Meppelink, C. S. (2022). Can Product Information Steer towards Sustainable and Healthy Food Choices? A Pilot Study in an Online Supermarket. *International Journal of Environmental Research and Public Health*, *19*(3). https://doi.org/10.3390/ijerph19031107

van der Werff, E., Steg, L., & Keizer, K. (2013). The value of environmental self-identity: The relationship between biospheric values, environmental self-identity, and environmental preferences, intentions, and behaviour. *Journal of Environmental Psychology, 34*, 55–63. https://doi.org/10.1016/j.jenvp.2012.12.006

van der Werff, E., Steg, L., & Keizer, K. (2014). Follow the signal: When past pro-environmental actions signal who you are. *Journal of Environmental Psychology*, *40*, 273–282. https://doi.org/10.1016/j.jenvp.2014.07.004

van Rompay, T. J. L., Deterink, F., & Fenko, A. (2016). Healthy package, healthy product? Effects of packaging design as a function of purchase setting. *Food Quality and Preference*, *53*, 84–89. https://doi.org/10.1016/j.foodqual.2016.06.001

Vaughan, P., Cook, M., & Trawick, P. (2007). A sociology of reuse: Deconstructing the milk bottle. *Sociologia Ruralis*, *47*(2), 120–134. https://doi.org/10.1111/j.1467-9523.2007.00432.x

Venhoeven, L. A., Bolderdijk, J. W., & Steg, L. (2020). Why going green feels good. *Journal of Environmental Psychology*, *71*(August), 101492. https://doi.org/10.1016/j.jenvp.2020.101492

Verghese, K., Lewis, H., Lockrey, S., & Williams, H. (2015). Packaging's Role in Minimizing Food Loss and Waste Across the Supply Chain: PACKAGING'S ROLE IN MINIMIZING FOOD WASTE ACROSS THE SUPPLY CHAIN. *Packaging Technology and Science*, *28*(7), 603–620. https://doi.org/10.1002/pts.2127

Verplanken, B., & Whitmarsh, L. (2021). Habit and climate change. *Current Opinion in Behavioral Sciences*, *42*, 42–46. https://doi.org/10.1016/j.cobeha.2021.02.020

Verplanken, B., & Wood, W. (2006). Interventions to Break and Create Consumer Habits. *Journal of Public Policy & Marketing*, *25*(1), 90–103. https://doi.org/10.1509/jppm.25.1.90

Wallner, T. S., Snel, S., Magnier, L., & Mugge, R. (2023). Contaminated by Its Prior Use: Strategies to Design and Market Refurbished Personal Care Products. *Circular Economy and Sustainability*, *3*(2), 1077–1098. https://doi.org/10.1007/s43615-022-00197-3

Wan, E. W., & Chen, R. P. (2021). Anthropomorphism and object attachment. *Current Opinion in Psychology, 39*, 88–93. https://doi.org/10.1016/j.copsyc.2020.08.009

Wang, Q., Zhang, W., Tseng, C. P. M. L., Sun, Y., & Zhang, Y. (2021). Intention in use recyclable express packaging in consumers' behavior: An empirical study. *Resources, Conservation and Recycling, 164*(August 2020), 105115. https://doi.org/10.1016/j.resconrec.2020.105115

Webster, K. (2015). *The circular economy: A wealth of flows*. Ellen MacArthur Foundation Publishing.

Welsch, H., & Kühling, J. (2011). Are pro-environmental consumption choices utility-maximizing? Evidence from subjective well-being data. *Ecological Economics*, *72*, 75–87. https://doi.org/10.1016/j.ecolecon.2011.04.015

White, K., & Dahl, D. W. (2006). To Be or *Not* Be? The Influence of Dissociative Reference Groups on Consumer Preferences. *Journal of Consumer Psychology, 16*(4), 404–414. https://doi.org/10.1207/s15327663jcp1604_11

White, K., Habib, R., & Hardisty, D. J. (2019). How to SHIFT consumer behaviors to be more sustainable: A literature review and guiding framework. *Journal of Marketing*, *83*(3), 22–49. https://doi.org/10.1177/0022242919825649

White, K., Lin, L., Dahl, D. W., & Ritchie, R. J. B. (2016). When do consumers avoid imperfections? Superficial packaging damage as a contamination cue. *Journal of Marketing Research*, *53*(1), 110–123. https://doi.org/10.1509/jmr.12.0388

Wiek, A., Withycombe, L., & Redman, C. L. (2011). Key competencies in sustainability: A reference framework for academic program development. *Sustainability Science*, *6*(2), 203–218. https://doi.org/10.1007/s11625-011-0132-6

Williams, H., Wikström, F., Otterbring, T., Löfgren, M., & Gustafsson, A. (2012). Reasons for household food waste with special attention to packaging. *Journal of Cleaner Production*, *24*, 141–148. https://doi.org/10.1016/j.jclepro.2011.11.044

Wölfel, C., & Merritt, T. (2013). Method Card Design Dimensions: A Survey of Card-Based Design Tools. In P. Kotzé, G. Marsden, G. Lindgaard, J. Wesson, & M. Winckler (Eds.), *Human-Computer Interaction – INTERACT 2013* (Vol. 8117, pp. 479–486). Springer Berlin Heidelberg. https://doi.org/10.1007/978-3-642-40483-2_34

Wright, S. L., & Kelly, F. J. (2017). Plastic and Human Health: A Micro Issue? *Environmental Science & Technology*, *51*(12), 6634–6647. https://doi.org/10.1021/acs.est.7b00423

Yoon, J., Desmet, P. M. A., & Pohlmeyer, A. E. (2016). Developing Usage Guidelines for a Card-Based Design Tool. *Archives of Design Research*, *29*(4), 5. https://doi.org/10.15187/adr.2016.11.29.4.5

Zaid, S. (2020). *The role of familiarity in increasing repurchase intentions in online shopping. Journal of Economics, Business, and Accountancy Ventura*, 23(1), 12–18. https://doi.org/10.14414/jebav.v23i1.2132

R

Zaman, A., & Newman, P. (2021). Plastics: Are they part of the zero-waste agenda or the toxic-waste agenda? *Sustainable Earth*, *4*(1), 4. https://doi.org/10.1186/s42055-021-00043-8

Zeng, T., & Durif, F. (2019). The influence of consumers' perceived risks towards eco-design packaging upon the purchasing decision process: An exploratory study. *Sustainability (Switzerland)*, *11*(21), 10–13. https://doi.org/10.3390/su11216131

Zhu, Z., Liu, W., Ye, S., & Batista, L. (2022). Packaging design for the circular economy: A systematic review. *Sustainable Production and Consumption*, *32*, 817–832. https://doi.org/10.1016/j.spc.2022.06.005

Zimmermann, T., & Bliklen, R. (2020). Single-use vs. reusable packaging in e-commerce: Comparing carbon footprints and identifying break-even points. *GAIA - Ecological Perspectives for Science and Society*, *29*(3), 176–183. https://doi.org/10.14512/gaia.29.3.8

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Appendices

Appendix A – Chapter 2 Measurement scales

Environment benefits (adapted from Chang, 2011) Using this shampoo/ketchup… (1) Is bad for the environment/ (7) Is good for environment. (1) Accelerates the deterioration of the environment/ (7) Slows the deterioration of the environment. (1) Increase pollution/ (7) Reduces pollution.	α=0.95
Anticipated conscience (adapted from Bradu et al., 2014) (1 = strongly disagree, 7 = strongly agree) - It would give me a good conscience to buy shampoo/ketchup in this packaging. - I would feel good about buying shampoo/ketchup in this packaging.	α=0.95
Enjoyment (adapted from Sweeney & Soutar, 2001) This shampoo/ketchup packaging… (1 = strongly disagree, 7 = strongly agree) - Is the one that I would enjoy. - Would make me want to use it. - Is the one that I would feel relaxed about using. - Would make me feel good. - Would give me pleasure.	α=0.95
Performance risk (adapted from Keh & Pang, 2010) (1 = strongly disagree, 7 = strongly agree) - There is a chance that there would be something wrong with this shampoo/ketchup packaging. - There is a chance that I would suffer some loss because this shampoo/ketchup packaging would not perform well. - This shampoo/ketchup packaging is risky in terms of how it would perform.	α=0.89
Contamination risk (adapted from Argo et al., 2006) (1 = strongly disagree, 7 = strongly agree) - I believe this shampoo/ketchup packaging is very unsanitary. - I think this shampoo/ketchup packaging is contaminated. - In my opinion, this shampoo/ketchup is dirty.	α=0.90
Complexity (adapted from Rogers, 2003) (1 = not much at all, 7 = Very much) or (1 = not many at all, 7 = a lot) - How much instruction do you think you need in learning how to use this packaging? - How much knowledge is needed to use this packaging? - How much help is needed in taking this packaging into use? - How much effort do you think it costs to learn how to use this packaging? - How many people do you think will find use of this packaging complicated?	α=0.90
Purchase intention (adapted from Mugge et al., 2017) Given the information above… (1 = strongly disagree, 7 = strongly agree) - I am likely to buy shampoo/ketchup in this packaging. - I am willing to buy shampoo/ketchup in this packaging.	α=0.97
Environmental concern (adapted from Kim & Choi, 2005) (1 = strongly disagree, 7 = strongly agree) - I make a special effort to buy products that are made from recycled materials. - I have switched products for ecological reasons. - When I have a choice between two equal products, I purchase the one less harmful to other people and environment - I have avoided buying a product because it had potentially harmful environmental effects.	α=0.81
Involvement (adapted from Chandrashekaran, 2004) (1 = strongly disagree, 7 = strongly agree) - I am particularly interested in shampoo/ketchup. - Overall, I am quite involved when I am purchasing shampoo/ketchup for my personal use.	α=0.71

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Appendix B – **Chapter 4 Measurement scales**

Use complexity (adapted from Adjei et al., 2010) Compared to buying conventional pre-packaged products from the shelf, taking all steps into account, I think this reusable packaging system… (1) is simple to use (7) is complicated to use (1) is easy to use (7) is difficult to use (1) requires low effort to use (7) requires high effort to use	α=0.89
Product availability (adapted from Sang et al., 2022) (1 = strongly disagree, 7 = strongly agree) - I think this reusable packaging system will only propose a narrow range of products. - The variety or range of product types will be poor in this reusable packaging system. - Not all product variants will be available in this reusable packaging system.	α=0.82
Value barriers (adapted from Sang et al., 2022) I think this reusable packaging… (1 = strongly disagree, 7 = strongly agree) - Has no advantages compared to single-use packaging. - Has lower quality than single-use packaging. - Is not helpful for environmental protection in reducing single-use packaging.	α=0.74
Intention to reuse (repurchase) (adapted from Leonidou & Skarmeas, 2017) To what extent will you reuse this packaging to purchase rice again? (1) highly unlikely (7) highly likely (1) highly improbable (7) highly probable (1) highly uncertain (7) highly certain (1) no chance at all (7) very good chance	α=0.98
Perceived consumer effectiveness (adapted from Kim & Choi, 2005) (1 = strongly disagree, 7 = strongly agree) - I can have a positive effect on the environment by adopting this reusable packaging system. - I feel I can help solve natural resource problems by adopting this reusable packaging system. - I can protect the environment by adopting this reusable packaging system. - I feel capable of helping solve environmental problems by adopting this reusable packaging system.	α=0.95
Green scepticism (adapted from Leonidou & Skarmeas, 2017) Based on the video and the information on the label, it is… (1) Doubtless to (7) Doubtful that this packaging is environmentally friendly. (1) Certain to (7) Uncertain that this packaging is less damaging to the environment. (1) Sure to (7) Unsure that this packaging meets high environmental standards. (1) Unquestionable to (7) Questionable that this packaging is better for the natural environment.	α=0.95
Information meaningfulness (adapted from Pettinico & Milne, 2017) This label on the packaging … (1 = strongly disagree, 7 = strongly agree) - provides meaningful information on the minimum times this packaging should be reused to decrease the negative environmental impact. - provides useful information on the minimum times this packaging should be reused to decrease the negative environmental impact. - helps increase my understanding of the minimum times this packaging should be reused to decrease the negative environmental impact.	α=0.98
Perceived effort to achieve the BEP (self-developed) How easy do you think it will be to reach the required minimum times of reuse to decrease the negative environmental impact of packaging? (1) It will require low effort to reach (7) It will require high effort to reach (1) It will take a short time to reach (7) It will take a long time to reach (1) It will be easy to reach (7) It will be difficult to reach (1) It will be very possible to reach (7) It will be impossible at all to reach	α=0.92
Green purchase behaviour (Kim & Choi, 2005) (1 = strongly disagree, 7 = strongly agree) - I make a special effort to buy products made from sustainable materials. - I have switched products for sustainability-related reasons. - When I have a choice between two equal products, I purchase the one that is less harmful to the environment. - I have avoided buying a product because it has potentially harmful environmental effects.	α=0.90

A

List of categories and codes

Categories (8)	Codes (53)
General optimism towards the concept of reuse	Using packaging until it is broken or lost
	Contributing to waste prevention
	Future mainstream
	Lifelong practice
	Environmental responsibility to the planet
The lack of references to make quantitative estimations of reusable packaging	Physical usage is necessary to make quantitative estimations
	Grocery shopping frequency
	Packaging size
	Demands for specific products
	A lack of knowledge about the durability of packaging
	Desires for additional information
	The durability of plastic is controversial: long-lasting vs. degradable over time
	Referring to prior experience with similar containers
Diverse interpretations of the e-BEP	Associations between reuse times and environmental impacts
	High e-BEPs demotivate the initial use due to the perceived effort required
	Confusion between lifespan and e-BEPs
	Using e-BEP as a reference for judging packaging durability
	E-BEPs influence the estimations of packaging lifespan
Low involvement in reusable packaging	Packaging is low-involved and easily worth the money
	No expectations about packaging lifespan
	Making purchase decisions without considering reuse times
	Short-term effect of hedonic pleasure
	Boredom with the same packaging and desire for newness
	Wear and tear and superficial damages make packaging less desirable
	Regular replacement due to the desire for neat-looking packaging
	Limited attention
	Unconscious loss
Forgetfulness in reusing packaging	Remembering to bring it required additional mental effort
	Excessive purchase of reusables
	Temporally switch to buying single-use packaging
	Being unused in storage and accumulation
	Spontaneous shopping
Scepticism about the environmental impact of reusable packaging	Sustainability of the packaging material
	Extra resources and energy consumption in manufacturing packaging and systems
	Tangible environmental impact
Cost related to reusable packaging	Upfront deposit
	Multiple packaging purchases
	Expensive product offerings
Usability and practicality of reusable packaging	Availability of the system and products
	Dissatisfaction with the product offerings
	Extra effort in washing
	Transferring residue
	The complexity of the system and performance risks
	Spillage triggers hygienic concerns
	Sticking to the status quo
	Product freshness loss
	More space is required for storage
	Disability in using the system
	Preference for private containers or paper bags
	Time-consuming in the shop (e.g., waiting in a queue, operating the system)
	A lack of online options
	Habitual purchase behaviour towards products
	Recycling packaging is easier than reusing it

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Appendix C – Chapter 5 Measurement scales in Study 1 and Study 2

Aesthetic appeal (adapted from Magnier & Schoormans, 2015) How do you evaluate the appearance of this reusable packaging? (1) Not very aesthetically pleasing (7) Very aesthetically pleasing (1) Flawed (7) Perfect (1) Unattractive (7) Attractive (1) Unappealing (7) Appealing (1) Bad looking (7) Good looking	Study 1: α=0.96 Study 2: α=0.96
Contamination concerns (adapted from White et al., 2016) Based on the picture and description of this reusable packaging of hand soap, I feel this reusable packaging... (1) Is not at all dirty. (7) Is very dirty. (1) Is not at all unsanitary. (7) Is very unsanitary. (1) Is not at all contaminated. (7) Is very contaminated. (1) Was definitely not touched. (7) Was definitely touched by other people.	Study 1: α=0.82 Study 2: α=0.83
Purchase Intention (adapted from Mugge et al., 2017) Assuming that the quality and price of the product are satisfying, please indicate how much you agree with each of the following statement. (1 = strongly disagree, 7 = strongly agree) - I am likely to purchase this reusable packaging of hand soap. - I am willing to purchase this reusable packaging of hand soap.	Study 1: α=0.97 Study 2: α=0.97
Noticeability of traces (self-developed) Based on the picture with details, the signs of wear and tear on this reusable packaging are… (1) Unnoticeable (7) Noticeable (1) Hidden (7) Evident (1) Subtle (7) Striking	Study 1: α=0.93 Study 2: α=0.94
Reuse Behaviour (Ertz et al., 2017b) Please indicate to what extent you reuse packaging in other domains. (1 = Never, 7 = Always) - I avoid purchasing drinks in plastic bottles. - I carry a reusable water bottle every time that I leave home. - I wash and refill disposable plastic bottles. - I avoid purchasing takeaway hot drinks in disposable cups. - I use a reusable coffee cup every time I buy a takeaway hot drink. - I purchase a reusable coffee cup if I forget to bring my own when I buy a takeaway hot drink. - I avoid using plastic and paper bags at the grocery. - I bring reusable shopping bags every time I do grocery shopping. - I purchase reusable shopping bags if I forget to bring my own when I do grocery shopping.	Study 1: α=0.81 Study 2: α=0.78

A

List of categories and codes

Categories (8)	Codes (28)
Concealing signs of use	Preserving an "as-new" appearance over time
	Visual distractions from imperfections
	Reducing visual reminders of prior use
	Preference for packaging that looks new
Enhancing aesthetic appeal of packaging	Increased visual engagement at the purchase
	Suitability in the usage environment
Positive associations and symbolic meanings of marble patterns	Perceived connection to nature and eco-friendliness
	Associations with material durability and robustness
	Perceptions of luxury and high-quality
Shifting consumer mindsets towards signs of use	Normalised imperfections
	Signs of use as intentional elements
	Aesthetic appreciation of imperfections
Consumer expectations for thoughtful design	Perceived effort in manufacturing and design
	Aligning patterns with material's properties
	Enhancing perceptions of sustainability and authenticity
Concerns about pattern quality	Worries about pattern fading or deterioration over time
	Need for high-quality materials and durable printing techniques
	Ensuring patterns maintain both aesthetic and functional effectiveness
Concealing patterns were insufficient to address contamination concerns	Contamination concerns extended beyond visual cues
	Discomfort with prior ownership
	Concerns and disgust about potential cross-contamination
General considerations of reusable packaging	Durability and functional longevity of each component to support reuse
	Ease of label removal to maintain a clean appearance
	Transparency of packaging
	Scepticism about the environmental impact of reusable packaging
	Perceived inconvenience of returning packaging
	Lack of clear information about hygienic standards
	Concerns about additional monetary costs

A

Appendix D – Chapter 7 Toolkit development

Iterations - Version 1.0

The preliminary version of the toolkit consists of the following components:

- **Theme cards.** Five double-sided cards explaining why these themes introduced by the SHIFT framework are important to leverage, and describing how they encourage consumer behaviour change in the context of RPSs.
- **Design strategy cards**. Twenty double-sided cards presenting distinct strategies. Each card features several design ideas for improving consumer acceptance and long-term adoption of RPSs.
- **Example cards.** Ten single-sided cards showing real-world photo examples that correspond with specific design strategies (indicated by icons).
- **One-page instructional guide.** A step-by-step guide to help designers navigate the ideation process with different tools.
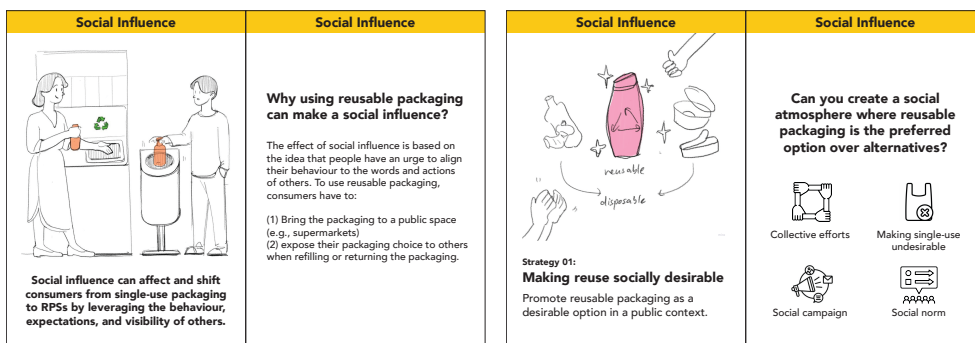
This preliminary version was printed and reviewed internally by the research team and the graphic designer to assess its clarity and logical flow. Several key arguments affected the next iteration:

- The current rigid, linear process indicated in the instruction may restrict designers' creativity, making ideation feel more like a task than an exploratory activity. It is better to accommodate flexible approaches to using this toolkit in the instruction.
- The text on the back side of the theme cards was dense yet provided limited practical information. This will not help broaden perspectives or encourage deeper discussions about the current situation.
- There was no linkage between different card types, which could cause confusion on how to use them. For instance, theme and strategy cards were disconnected, and example cards were not easily associated with specific themes or strategies. The separation of example cards was found to be more distracting than beneficial and added unnecessary complexity to the toolkit.
- While the strategies were practical, they appeared somewhat arbitrary without supporting evidence.
- Using icons to represent design interventions was found to obscure their meanings and lead to confusion. The presence of multiple icons could lead to information overload.
- The cards were not categorised by visuals, making them difficult to distinguish from each other when they were spread out on the table.

Iterations - Version 2.0

The second iteration of the design toolkit consists of the following components:

- **Theme cards.** Five double-sided and colour-coded cards describing how these factors encourage consumer behaviour change toward RPSs and associated design strategies.

- **Design strategy cards.** Twenty double-sided and colour-coded cards presenting distinct strategies. The back of each card includes insights from consumer studies to explain why the strategy may be effective, accompanied by an inspirational question and a real-world example of how to apply the strategy in packaging design.

- **One-page instructional guide.** This guide explains the functions of each card type and provides application examples. The process of working with this design toolkit is flexible, with no strict rules or steps to be followed and not all cards have to be used each time.

This digital version was presented at a design conference, where informal conversations with experts in sustainable design provided some initial feedback. After engaging in in-depth discussions within the research team, the following insights guided the next iteration:
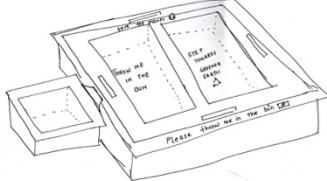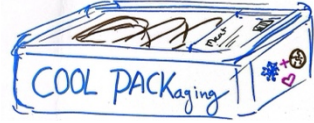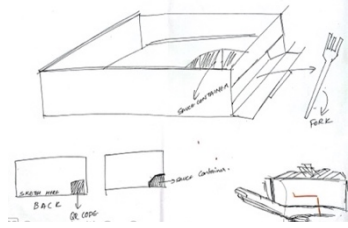
- The levels of abstraction of illustrations on the strategy cards were inconsistent. Some illustrations depicted concrete solutions (e.g., "Prompting to reuse" indicates reminders as a prompt), while others remained more abstract (e.g., "Empowering individual reuse").
- Real-world photo examples on the strategy card were thought to limit creativity, as they might steer designers toward similar solutions rather than encouraging novel ones.
- The font size for strategy names was too small, making it difficult to read during ideation sessions. The layout needed to attract attention to key messages and present the strategy in a clear way.
- These cards predominantly inspire packaging design addressing initial consumer preferences. Additional tools might be useful to help designers consider consumer behaviour at all stages of the consumption process.

Appendix E – **Chapter 7 Demonstration and Evaluation**

Procedure of workshops

|	
Welcome and Introduction	5 min
• Participants sign the informed consent.	
• Brief introduction of the research and researcher	
Participants select an example object to work on	5 min
Example objects provided in the workshop:	
• Perishable food: Strawberry, Egg, Meat, Salad	
• Long shelf-life food: Coffee beans, Tea, Chips, Vitamin & Supplements	
• Fast food & Street food: Kibbeling, Pizza, Dutch fries, Burgers	
• Non-food products: cleaning products, home and body products	
Participants explore and utilise the Design Toolkit within their groups	50 min
Focus group discussion: Reflection and Discussion (audio-recorded)	30 min
Questions:	
1. (Overall effect) How did this toolkit affect your overall ideation process?	
2. (Usefulness) Which aspects of the toolkit did you find most useful? Which were not useful?	
3. (Ease of use) What was easy to use? Why? What was difficult to use, and how to make it easier?	
4. (Reflections on the experience) What did you find enjoyable, and why? What did you dislike or find frustrating, and how can we improve it?	
5. (Takeaways and application suggestions) How do you think we can apply this toolkit in a real design practice?	

Ideas generated through workshops

Objects explored	Strategies used	Main concept and Sketches	
Group 1 (N=2) Small fruit: Strawberry	- Familiarity - Recognisability - Playfulness - Stimulating first reuse - Making reuse practical	- Sturdy, portable plastic container with a familiar look. - Stackable and foldable. Easy to store in the backpack to carry around. - Get the first one for free with a membership card.	
Group 2 (N=3) Street food: Kibbeling	- Making reuse practical - Prompting to reuse	- Redesign the packaging format and materials. - Provide consumers with hints for proper return segregation after usage.	
Group 3 (N=3) Perishable food: Beef	Expressing social identity Matching with self-interest - Novelty - Familiarity - Playfulness	- Add new features and benefits to packaging (e.g., changeable size and personalised portion, cooling system, and multifunction-can be used in the microwave). - Add icons on the packaging to show its superiority and eco-friendliness - Introduce this solution at the butcher or a pop-up market.	
Group 4 (N=2) Street food: Dutch Fries	- Stimulating first behaviour - Making reuse practical - Novelty - Uniqueness - Recognisability - Playfulness	- Unique street art collaborations. - Interactive packaging (QR code) to introduce the history of Dutch Fries - Eliminate single-use alternatives and force reuse behaviour.	
Group 5 (N=3) Non-food: Home cleaning products	- Stimulating first reuse - Making reuse practical - Recognisability	- Reusable bottle and refill packs are designed with the same unit, colour, vibe, and shape. - Add a sign or symbol for "reuse" on the bottle. - Indicate how to refill on packaging. - Sell the refillable bottle and refill packs in a bundle.	

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Appendix F – Design toolkit for RPSs

Theme cards (double-sided)

Social Influence
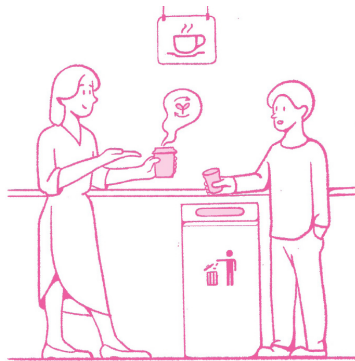
Social influence can affect and motivate consumers to adopt reusable packaging systems by leveraging the presence, expectations, and actions of others.

How can you design a reusable packaging system to harness social dynamics and encourage widespread adoption?

- Making Reuse Socially Desirable
- Expressing Social Identity
- Enabling Social Interaction

Habit Formation

Habit formation is a gradual process built through repeated actions in stable contexts. Once reuse becomes habitual, consumers are more likely to engage with reusable packaging systems automatically and with minimal conscious effort.

How can you design a reusable packaging system that supports the formation of reuse habits and integrates them into consumers' daily routines?

- Stimulating First Reuse
- Bridging Context and Reuse
- Prompting Reuse Action
- Making Reuse Practical

A

Individual Self

Individual self refers to the personal motivations that shape consumer behaviour, such as personal values, perceived efficacy, self-interest, and the desire for behavioural consistency. When a reusable packaging system supports (one of) these motivations, consumers are more likely to sustain reuse behaviour over time.

How can you design a reusable packaging system that resonates with individual users?

- Empowering Individual Reuse
- Matching with Self-Interest
- Enhancing Responsibility and Commitment

Feelings and Cognition

Feelings and cognition influence behaviour through two routes: one intuitive and emotional, the other rational and analytical. By evoking the right emotions and promoting clear understanding, reusable packaging systems can better encourage consumer adoption.

How can you design a reusable packaging system that feels emotionally appealing and is easy to understand?

- Recognisability
- Familiarity
- Playfulness
- Uniqueness
- Novelty

A

Tangibility

Tangibility relates to the physical and perceptible outcomes of sustainable actions. Improving tangibility can make the impact of reusable packaging systems more concrete, relatable, and easy to grasp.

How can you design a reusable packaging system to help consumers see or feel the results of their reuse behaviour?

- Providing Feedback
- Proximity and Concreteness
- Positive Appearance Change
- Intentional Imperfection
- Intrinsic Sustainability

A

Strategy cards (double-sided)

Consumers may choose sustainable options to create a positive impression on others.

How about promoting reusable packaging through SOCIAL CAMPAIGNS that frame it as the more desirable choice?

e.g., a notice board in the café encouraging consumers to choose reusable coffee cups.

Making Reuse Socially Desirable

Promote reusable packaging as a preferred option in public contexts.

Consumers express social identity by aligning their product choices with the groups they identify with.

How about adding an ECO-STATEMENT or a GREEN IDENTITY marker to reusable packaging?

e.g., a returnable food container printed with "We choose reuse".

Expressing Social Identity

Position reusable packaging as a symbol of group belonging.

A

Enabling Social Interaction

Make reuse a shared experience by fostering meaningful connections.

Consumers are more likely to participate in sustainable behaviour when they feel part of a like-minded group.

How about building REUSE COMMUNITIES or enabling SOCIAL NETWORKING among consumers who use reusable packaging?

e.g., a reusable milk bottle that connects milk drinkers through a QR code.
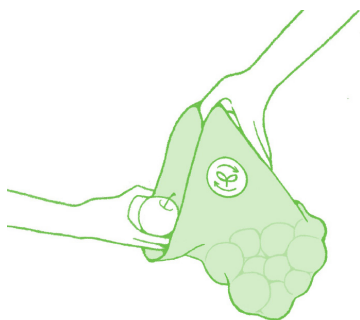
Stimulating First Reuse

Make the first reuse attempt attractive and effortless.

Consumers may hesitate to invest extra effort or money in reusable packaging if the benefits are not immediate.

How about offering FREE TRIALS or REFILL BUNDLES to encourage first-time use and spark a new habit?
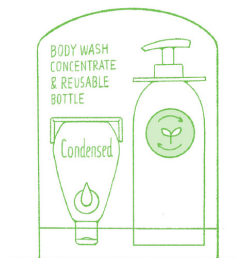
e.g., a refill bundle that includes a free reusable bottle, offered at the launch of a new product.

A

Consumers can easily forget to bring reusable packaging because it requires extra mental effort.

Bridging Context and Reuse

Establish a mental connection between the context of usage and reuse behaviour.

How about using a CONTEXTUAL CUE to support a new ROUTINE CREATION?

e.g., a reusable shopping bag that serves as a membership card to unlock discounts or collect points.

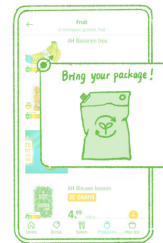Consumers may own reusables but forget to use them due to inattention or forgetfulness.

Prompting Reuse Action

Provide timely cues or reminders to encourage reuse.

How about highlighting the ACCESSIBILITY and sending timely REMINDERS to prompt reuse actions?

e.g., a supermarket app that promotes reuse options and reminds consumers to bring their packaging.

A

Making Reuse Practical

Enhance functionality and convenience to support daily reuse.
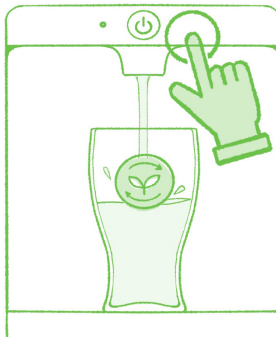
Consumers may find reusable packaging inconvenient to carry or difficult to use.

How about designing with PORTABILITY, FOLDABILITY or MODULARITY to fit daily routines?

e.g., a foldable egg container that allows bulk purchases while offering protection and easy storage.

Empowering Individual Reuse

Highlight the impact of individual actions to boost user confidence.

Consumers may feel their individual efforts don't make a meaningful difference to the environment.

How about communicating the BREAK-EVEN POINT or enabling GOAL SETTING to reinforce the value of repeated use?

16/20 REUSES

e.g., a reusable coffee cup that reaches its environmental break-even point after 20 uses.

A
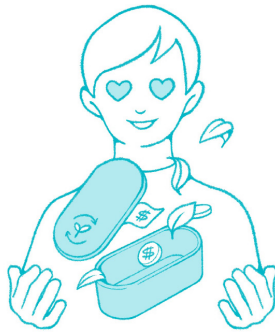
Consumers often seek personal benefits in addition to environmental benefits in sustainable actions.

How about offering CASHBACK or REWARDS to consumers who reuse their packaging?

Matching with Self-Interest

Create added value that is aligned with personal goals and motivations.

e.g., using reusable packaging to earn discounts on future purchases.

Consumers are more likely to engage if they feel responsible for the reuse behaviour or have made a commitment to it.

How about introducing a LOYALTY PROGRAM to support long-term engagement?

Enhancing Responsibility and Commitment

Strengthen a sense of ownership and encourage consistent reuse.

SIGN UP
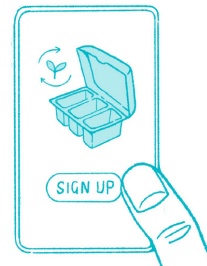
e.g., registering with a local reuse system to manage packaging through a personal account.

A

Recognisability

Design packaging to clearly signal its reusability.

Consumers may overlook reuse options or mistakenly dispose of reusable packaging.

How about incorporating clear REUSE CUES or REUSE LOGOS into the packaging design?

RETURN ME TO REUSE

RETURN ME TO REUSE

e.g., returnable e-commerce packaging with folding lines and a Velcro closure to make folding and resealing intuitive.

Playfulness

Spark curiosity through fun and emotionally engaging design.

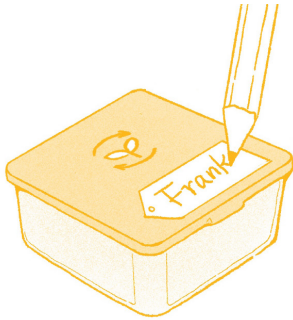Consumers are often drawn to packaging that surprises or entertains them, making them more likely to adopt and reuse it.

How about applying ANTHROPOMORPHISM or GAMIFICATION in packaging design?
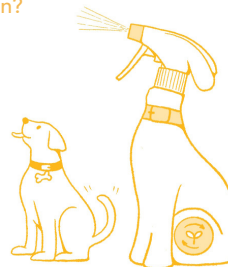
e.g., a reusable spray bottle shaped like a dog that turns a boring task into a fun experience.

A

Consumers are more likely to keep a product longer when it carries personal meaning, memories, or their creative input.

How about enabling DIY, offering CUSTOMISATION, or adding MEANINGFUL MARKS to foster a sense of connection?

Uniqueness

Design packaging that invites creative input or highlights the distinctiveness.

e.g., a reusable water bottle that consumers can customise with their own design.

Consumers may become disengaged when reusable packaging lacks variety or feels repetitive, leading to innovation fatigue.
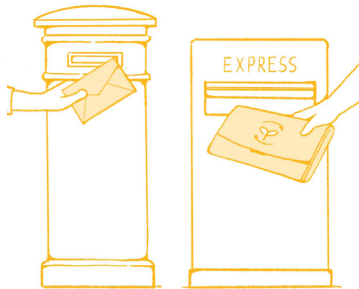
How about incorporating NEW FEATURES or TRANSFORMATIVE DESIGNS that depart from conventional solutions?

Novelty

Introduce innovative features or new technologies to create a refreshed user experience.
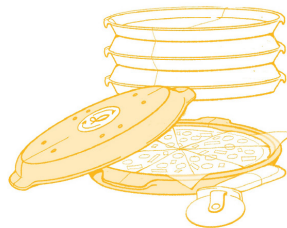
e.g., a reusable pizza box with a stackable structure for efficient transport and a vented, resealable lid to preserve food quality.

A

Consumers look for familiar aspects in a new system to reduce perceived complexity and lower cognitive effort.

How about retaining the ICONIC BRAND FEATURES of original packaging that consumers are familiar with?

Familiarity

Embed familiarity in new design to align with consumers' existing knowledge and habits.
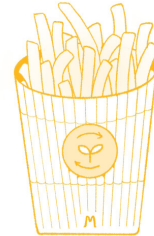
e.g., reusable packaging for French fries that matches the aesthetic of its iconic disposable version.

Consumers often lack a clear understanding of how their reuse behaviour contributes positively to the environment.

How about developing a physical or digital TRACK AND TRACE system to provide personalised feedback on reuse and its impact?

16 times reused

3 kg CO₂e saved

9 € saved
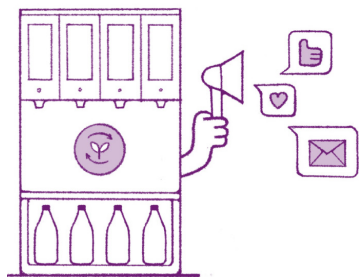
Providing Feedback
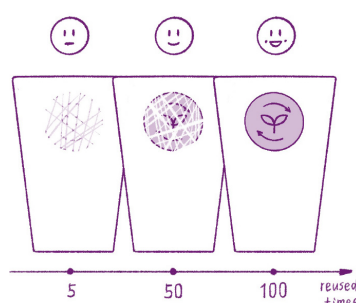
Implement feedback mechanisms to communicate the environmental impact of reuse behaviour.
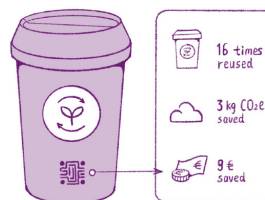
e.g., smart technology that tracks packaging usage and provides real-time feedback to consumers.

A

Consumers may consider reusable packaging unacceptable for further use due to wear and tear or visible traces of prior use.

How about incorporating GRACEFUL AGEING into the design, making traces an intentional and desirable feature?

e.g., a reusable glass bottle that develops scuffs on its embossing over time, enhancing its character and appeal.

Positive Appearance Change

Improve the visual appeal or quality of packaging through proper reuse.

Consumers often associate wear and tear with contamination or reduced value.

How about embedding a WORN-EFFECT into packaging and using NARRATIVES to reframe these traces as part of its character?

e.g., a reusable ice cream container with distressed patterns that frame traces as an expected feature rather than a flaw.

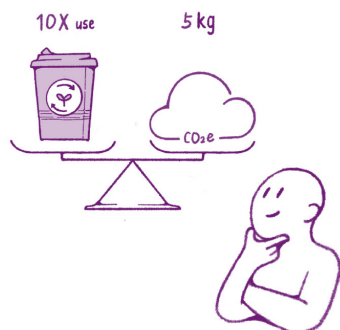## Intentional Imperfection

Incorporate imperfections into packaging design to encourage consumer acceptance and adoption.

A

Consumers often struggle to grasp environmental benefits because they are abstract, vague, or distant in time and space.

How about using RELATABLE EQUIVALENTS or LOCAL CONSEQUENCES to make the impact relatable and immediate?

e.g., a reusable water bottle that compares its impact to relatable equivalents.

Proximity and Concreteness

Communicate environmental impact in a way that feels tangible and relevant to consumers.

Consumers seek tangible proof that reusable packaging is genuinely sustainable.

How about using SUSTAINABLE MATERIALS and ensuring the packaging is RECYCLABLE at end of life?

e.g., a refillable hand wash bottle made from recycled ocean plastic.

Intrinsic Sustainability

Make the sustainability of reusable packaging tangible and trustworthy across its entire lifecycle.

A

Journey cards (double-sided)

SEARCH OR DISCOVER	Learn about the packaging through online research, peer recommendations, advertisements, or in-store browsing.	**SELECT OR ORDER**	Select the packaging based on personal needs or preferences, and purchase it either online or in-store.
OBTAIN	Access the packaging through in-store purchases, vending machines, or home delivery.	**DAILY USE**	Consume the product in the packaging as intended in everyday contexts.
CLEAN	Wash, wipe, or maintain the packaging to prepare it for the next use.	**STORE**	Keep the packaging in a convenient place for future reuse, such as at home, at work, or on the go.
SORT AND COLLECT	Separate and gather empty packaging for return, refill, or recycling.	**DISPOSE**	Recycle or discard the packaging appropriately when it is no longer usable, following relevant instructions.
RETURN FROM HOME	Return the packaging for reuse via home pickup or mail-back services.	**RETURN ON THE GO**	Drop off empty packaging at designated public return points, such as stores or collection stations.
REFILL AT HOME	Refill the product at home using bulk purchases or refill packs.	**REFILL ON THE GO**	Refill the product at public refill stations, in stores, or at kiosks.

A

Instructional Guide (double-sided)

How to Organise an Ideation Session?

Start: Define a Clear Goal	Clarify the design objectives for your session.	
Step 1: Explore the Theme Cards	Spread out the **Theme Cards**, read through them, and select those that align with your design objective.	
Step 2: Apply the Strategy Cards	Select the **Strategy Cards** that inspire you. Discuss, brainstorm, and sketch ideas. Flip the card only if you need an example.	
Step 3: Create a User Journey	Use the **Journey Cards** to map out how users interact with the system. Discuss behaviours and actions across different stages.	
Step 4: Refine & Iterate	Review and refine your ideas. Adjust the user journey accordingly.	

RePacKit

Design Toolkit to Support Consumers'
Sustained Use of Reusable Packaging Systems

TUDelft

FOLD LINE

Adapt to Your Case

RePacKit is designed to support and inspire your ideation process for reusable packaging systems (RPSs). There is no fixed order or method for using the cards. Instead, they can be adapted to suit different contexts and design objectives.

Here are a few ways your team can use this toolkit.

1) Transform existing single-use product packaging into an RPS

Your team wants to redesign existing single-use packaging into an RPS, which requires changes in consumer behaviour. This toolkit can help identify key changes and guide the development of solutions to support the transition.

2) Trigger new ideas in the development of an RPS

Your team is brainstorming an RPS and looking for novel solutions beyond existing ones. This toolkit provides out-of-the-box ideas that not only challenge conventions but also resonate with consumer needs and preferences.

3) Spark reflection and discussion around an RPS

Your team has already launched an RPS but is facing low consumer engagement, indicating possible overlooked barriers. This toolkit helps uncover those barriers and stimulates team discussion around strategies to address them.

4) Support experimentation to enhance an RPS

Your team aims to improve the performance of an existing RPS through experimental interventions. This toolkit serves as inspiration for generating new ideas, which can then be refined and tested in pilots or experiments.

Theme Cards

Guide your focus and inspire potential directions to explore.

Strategy Cards

Offer prompts to generate or refine ideas.

Journey Cards

Map the user journey to explore how consumers interact with RPSs. If the provided cards don't fully capture the actions you want to describe, use the blank ones to add your own.

SELECT
OR
ORDER

Write by
Yourself

A

Card Explanation

RePacKit includes three types of cards to serve as inspiration.

5 Theme Cards

These cards highlight five key psychological factors identified by White et al. (2019) for shifting consumer behaviour towards sustainability. These themes have been adapted to the context of RPSs.

White, K., Habib, R., & Hardisty, D. J. (2019). How to SHIFT consumer behaviours to be more sustainable: A literature review and guiding framework. Journal of Marketing, 83(3), 22–49.

FRONT

BACK

Theme

Social Influence

Illustration

Social influence can affect and motivate consumers to adopt reusable packaging systems by leveraging the presence, expectations, and actions of others. — Description

How can you design a reusable packaging system to harness social dynamics and encourage widespread adoption? — Inspirational question

- Making Reuse Socially Desirable
- Expressing Social Identity
- Enabling Social Interaction

— Design strategies

20 Strategy Cards

These cards present a wide range of innovative strategies for designing RPSs. They were developed through four creative workshops, drawing on insights from consumer research. Each strategy is linked to one of the five themes.

FRONT

BACK

Illustration

Consumers are more likely to participate in sustainable behaviour when they feel part of a like-minded group. — Insights from consumer research

How about building REUSE COMMUNITIES or enabling SOCIAL NETWORKING among consumers who use reusable packaging? — Inspirational question

Design strategy

Enabling social interactions

Description

Make reuse a shared experience by fostering meaningful connections.

— Example

e.g., a reusable milk bottle that connects milk drinkers through a QR code.

12 Journey Cards

These cards depict common consumer activities when interacting with RPSs, based on practices and scientific studies around RPSs.

FRONT

Activity name

SEARCH OR DISCOVER

BACK

Explanation

Learn about the packaging through online research, peer recommendations, advertisements, or in-store browsing.

A

Acknowledgement

Standing at the end of my PhD and looking back, I truly appreciate this invaluable journey. These five years have taught me how to transform vague ideas into rigorous scientific investigations, how to sustain curiosity for science while keeping a passion for life, and how to live with uncertainty, eventually turning it into concrete outcomes. Besides, this journey has also been packed with personal growth, expanded horizons, deep friendships and cherished memories. I want to thank all those who have accompanied me on this journey, regardless of distance or stage.

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ways to stay closely connected. Your gentle yet active involvement in my life has been a constant source of strength and warmth. Every trip home was an exciting and refreshing experience, filled with your endless care and delicious meals. I feel incredibly fortunate to be your child. To my parents-in-law, **Lihong** and **Xu**, thank you for your encouragement and support, for taking care of me, and for visiting me in Delft! To my dear dog **V**, you are the cutest and clingiest Chihuahua in the world. Thank you for always greeting me with your wet kisses and warm paws whenever I returned home. Most importantly, you have kept mom and dad company, bringing them joy and comfort when I was far away.

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While writing this acknowledgement at home in China, I came across a childhood notebook, in which little me once wrote down a bright dream at 10 years old:

> "长大以后，我想当一名老师或者科学家。"
>
> *(I wish to be a teacher or a scientist when I grow up)*

I think it is now time to take the next step forward.

About the Author

Xueqing Miao was born on January 16, 1995, in Henan Province, China. She completed her high school education in her hometown, Zhengzhou. With a curiosity for design and its impact on everyday life, she pursued a Bachelor of Engineering in Industrial Design at Dalian University of Technology from 2013 to 2017.

Eager to expand her horizons in design and explore different cultures beyond her home country, Xueqing continued her academic journey to Europe. From 2017 to 2019, she enrolled at Politecnico di Milano in Italy, where she pursued a master's degree in Product-Service System Design. During this time, she developed a keen interest in understanding human behaviour and designing products and services for a sustainable future. Her master's thesis explored reusable packaging in logistics to tackle the growing issue of e-commerce packaging waste.

From September 2020 to September 2025, Xueqing lived in the Netherlands, undertaking her PhD at Delft University of Technology, in the department of Design, Strategy & Organisation at the Faculty of Industrial Design Engineering (IDE). Her PhD research explored consumer perception and behaviour towards reusable packaging systems designed for fast-moving consumer goods, aiming to promote sustainable consumption through design-driven solutions. Beyond research, she was involved in teaching, coaching bachelor and master students in courses, and supervising graduation projects.

Looking ahead, Xueqing envisions herself continuing to contribute to sustainability research while growing in creative, harmonious and international communities. She is passionate about designing and investigating solutions that balance innovation, environmental responsibility, and human behaviour, and she hopes to build a career that fosters collaboration, curiosity, and meaningful impact.

List of Publications

Peer-Reviewed Journal Articles

Miao, X., Magnier, L., & Mugge, R. (2024). How Many Times Should I Use My Reusable Packaging? Exploring the Role of an Environmental Break-Even Point in Shaping Consumers' Intention to Reuse. *Circular Economy and Sustainability*. https://doi.org/10.1007/s43615-024-00437-8

Miao, X., Magnier, L., & Mugge, R. (2023). Switching to reuse? An exploration of consumers' perceptions and behaviour towards reusable packaging systems. *Resources, Conservation and Recycling*, *193*, 106972. https://doi.org/10.1016/j.resconrec.2023.106972

(submitted) **Miao, X**., Magnier, L., & Mugge, R. RePacKit: A design toolkit to support consumers' sustained use of reusable packaging systems. *International Journal of Design*.

Peer-Reviewed Conference Proceedings

Miao, X., Magnier, L., & Mugge, R. (2024). Design strategies for consumers' continued usage of reusable packaging systems (RPSs). *Proceedings of the Design Society*, *4*, 1379–1388. http://dx.doi.org/10.1017/pds.2024.140

Chen, R., & **Miao, X**. (2024). Understanding a SPSS-aided packaging-free shopping practice. *Proceedings of the Design Society*, *4*, 1229–1238. http://dx.doi.org/10.1017/pds.2024.125

Miao, X., Magnier, L. B. M., & Mugge, R. (2023). Engaging consumers in reusable packaging systems: An exploration of factors influencing the adoption. In Proceedings of 5th Product Lifetimes and the Environment Conference (PLATE) (pp. 680-685). (Aalto University publication series ART + DESIGN + ARCHITECTURE, 3/2023).

Miao, X., Magnier, L., Mugge, R. (2023). Developing Reusable Packaging for FMCG: Consumers' Perceptions of Benefits and Risks of Refillable and Returnable Packaging Systems. In: Fukushige, S., Kobayashi, H., Yamasue, E., Hara, K. (eds) EcoDesign for Sustainable Products, Services and Social Systems I. Springer, Singapore. https://doi.org/10.1007/978-981-99-3818-6_2

Wang, T., Xiao, D., **Miao, X**., Zhang, Y., Lan, X., Yan, C. (2023). A Sustainable Product-Service System (PSS) Design for Retail Food Loss and Waste: Research Through Design. In: Fukushige, S., Kobayashi, H., Yamasue, E., Hara, K. (eds) EcoDesign for Sustainable Products, Services and Social Systems I. Springer, Singapore. https://doi.org/10.1007/978-981-99-3818-6_30

Yao X., **Miao, X**., Song, Y., & Vink, P. (2023). Service type and timing to optimize in-flight comfort experience. International Comfort Congress, 2023.
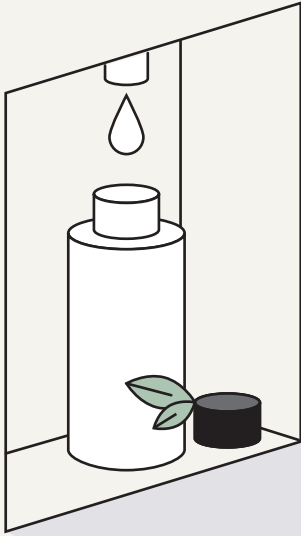
As packaging waste continues to pollute the environment, moving away from single-use packaging is no longer optional but a necessity. Reusable packaging systems (RPSs) have emerged as a promising solution to reduce the waste generated by everyday consumption. Yet, consumer acceptance and long-term adoption remain significant challenges.

This dissertation takes a consumer-centred perspective, exploring what motivates and hinders consumers from choosing RPSs over single-use packaging, which strategies can encourage sustained use, and how design can foster future innovation in this field.

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