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Increasing Participatory Engagement through Technology and Design

New Approaches for Participation

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A Case Study of Reusable Takeaway
Bowls in Airports

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Conny Bakker, Jo van Engelen, and Rita Jonyer*

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10 Designing for Green Transitions

A Case Study of Reusable Takeaway Bowls in Airports

*Elisabeth Tschavгова, Sonja van Dam,
Conny Bakker, Jo van Engelen, and Rita Jonyer*

Introduction

Given the urgency of the climate crisis, the European Commission has identified the circular economy (CE) as a key priority in achieving sustainability (European Commission, 2018). Transitioning to a CE is seen as an effective strategy for reducing environmental impacts across various sectors (Pizzi et al., 2022), including aviation. In response, Norwegian airports, part of the Avinor group, are working towards achieving circularity (Avinor, 2023). For instance, Oslo Airport aims to halve its residual waste from daily operations by 2030 through various zero-waste projects (Avinor, 2023). These ambitions are not only driven by internal goals but also by compliance with external regulations, such as the European Green Deal. A key regulation in this transition is the EU Packaging and Packaging Waste Regulation (PPWR), which aims to minimise packaging waste and reduce reliance on primary raw materials. In alignment with this, Oslo Airport is exploring the adoption of reusable takeaway packaging through a pilot of reusable bowls combined with emerging technologies for payment and smart return machines. Based on this pilot, the study aims to explore driving green transitions within a complex organisational setting using participatory engagement. The following research questions guide this study:

RQ1: “What are the key enablers and obstacles to employee and passenger engagement in the case study, taking operational feasibility into account?”

RQ2: “What broader learnings on interventions advancing green transitions in complex environments, such as an airport, can be drawn from this case study?”

This research contributes to the broader field of sustainability transitions by addressing the limited empirical studies on the implementation of reusable takeaway packaging systems (Bradley & Corsini, 2023). In doing so, it also fills a gap in the operationalisation of CE principles within the airport contexts (Van Der Tuin-Rademakers et al., 2024). By following a systemic design (SD) approach based on combining participatory action research and a causal-loop diagram (CLD) to synthesise findings, this chapter offers insights into how system dynamics, particularly consumer and employee engagement, influence circular transitions in complex environments.

The chapter is organised as follows: First, a literature review of academic contributions on the adoption of CE principles in airports and the implementation of reusable packaging to position this study is conducted. Next, the methodology of the pilot is introduced, followed by the synthesised findings presented in the CLD that highlight insights regarding passenger

and employee engagement. Finally, the discussion reflects on the pilot and broader learnings, addressing the challenges and opportunities associated with adopting reusable packaging.

Literature Review

Airports encounter unique challenges in adopting sustainable practices. Therefore, this literature review explores the complexities of implementing reusable packaging systems in these environments and identifies empirical gaps in current research. By examining two critical themes – **airports as complex environments for implementing CE principles** and **existing research gaps regarding reusable packaging** – this study aims to establish its theoretical foundation.

Airports as Complex Environments for Implementing CE Principles

As circular transitions require a systemic approach (Guzzo et al., 2022), airports function as complex systems characterised by interconnected relationships among various actors, technologies, and processes (Aarikka-Stenroos et al., 2021). However, stakeholders often operate in silos, leading to inefficiencies across the airport system (Parra, 2023) and limited adoption of CE concepts due to diverse stakeholder interests (Van Der Tuin-Rademaker et al., 2024). Stakeholder management is further complicated as their goals may not always align with those of the airport management (Schaar & Sherry, 2010). Thus, collaboration and effective resource management are fundamental for a CE transition (Sassanelli & Terzi, 2023), as is the engagement of a range of stakeholders, including employees, passengers, and industry partners (Van Der Tuin-Rademaker et al., 2024). While the literature found contributes to advancing CE principles in aviation by discussing obstacles and opportunities, much of the research remains theoretical, with limited description of real-life interventions. Studies such as those by Tjahjono et al. (2024), Baxter (2022), and Özbay and Gokceviz (2022) have laid out conceptual frameworks and models for waste management and CE transitions in airport settings. However, these studies do not explore the practical implementation of their suggested approaches, focusing instead on theoretical constructs and potential strategies without real-world application or case study evidence. This gap underscores the need for more empirical research to translate theoretical suggestions into actionable interventions within the complexity of the airport environment. Thus, to navigate the airport complexities and their system actors to develop a feasible intervention, an SD approach, which integrates systems thinking and design (Bijl-Brouwer & Malcolm, 2020), offers a promising method. Due to its co-creative nature (Jones, 2018), SD provides a promising approach to facilitate systemic interventions through engagement, which is crucial for diverse organisational activities such as value creation, innovation, and sustainability (Kujala et al., 2022), while collaboratively addressing challenging issues (Oberholzer & Sachs, 2023). Therefore, this study defines engagement as the participatory collaboration of various stakeholders – employees, passengers, and industry partners – in the development of SD interventions to advance green transitions.

Empirical Gaps in Reusable Packaging Research

A recent literature review by Bradley and Corsini (2023) reveals that most research on reusable packaging relies on quantitative methods, such as life cycle assessment, which, while providing measurable indicators of success, lacks empirical validation through case studies. This aligns with Tenhunen-Lunkka et al. (2024), who noted the scarcity of empirical field studies and limited research on consumer attitudes toward reuse. Ertz et al. (2017) further highlights the

absence of consumer perspectives on reusable packaging as a significant oversight. In addition to a stronger focus on consumer attitudes, research on reusable takeaway packaging requires interdisciplinary collaboration among various stakeholders (Pålsson & Olsson, 2023). Bradley and Corsini (2023) emphasise the need for multidisciplinary perspectives, as current research is predominantly technical and neglects social sciences, user experience, and service design. Despite the recognised importance of stakeholder collaboration (Chan, 2007), existing research remains fragmented across fields. Therefore, to advance the field, a comprehensive multi-stakeholder approach, involving retailers, manufacturers, logistics companies, policymakers, and consumers (Bradley & Corsini, 2023) is needed. The reviewed literature suggests an empirical gap in the implementation of reusable packaging, particularly a need for studies that adopt a multidisciplinary perspective with a focus on design.

To ensure that no relevant case studies or empirical research that could offer insights into the adoption of reusable packaging alternatives within airport environments were overlooked, a search string based on the six key concepts of this study was developed:

(“Circular Economy” OR “Sustainable practices” OR “Green transitions”)
 AND
 (“Airports” OR “Aviation industry” OR “Airport management”)
 AND
 (“Engagement” OR “Participatory design” OR “Stakeholder collaboration”)
 AND
 (“Reusable Packaging” OR “Sustainable packaging” OR “Reusable containers” OR “Packaging waste reduction”)
 AND
 (“Case Study” OR “Case Studies” OR “Empirical research”)
 AND
 (“Systemic Design” OR “Systemic approach” OR “Systems thinking” OR “Systemic intervention”)

When applying this search string with a preference for English articles and no restriction on the time period, very limited results were found. Databases such as Web of Science and Scopus indicated no matching literature, and Google Scholar suggested 109 results (excluding citations). Upon reviewing the titles and abstracts of found articles, no literature was identified that constituted a case study adopting reusable packaging within an airport context. This lack of matching case studies indicates a gap concerning reusable packaging within airports. It underscores the need for more empirical studies on real-world applications of reusable packaging systems in complex environments. Therefore, the limited case studies reinforce this research’s empirical aim to achieve a systematic and design-oriented perspective. To the best of our knowledge, this chapter represents one of the first efforts to fill in the gap in empirical implementation of reusable packaging in complex environments like airports, while integrating multi-stakeholder perspectives.

Methodology

The research employs a case study following an action research approach to assess the impact of reusable takeaway packaging at the airport and identify key engagement enablers and obstacles. The case study follows the plan-act-observe-reflect cycle of action research (Interaction Design Foundation [IxDF], 2015), as shown in Figure 10.1.

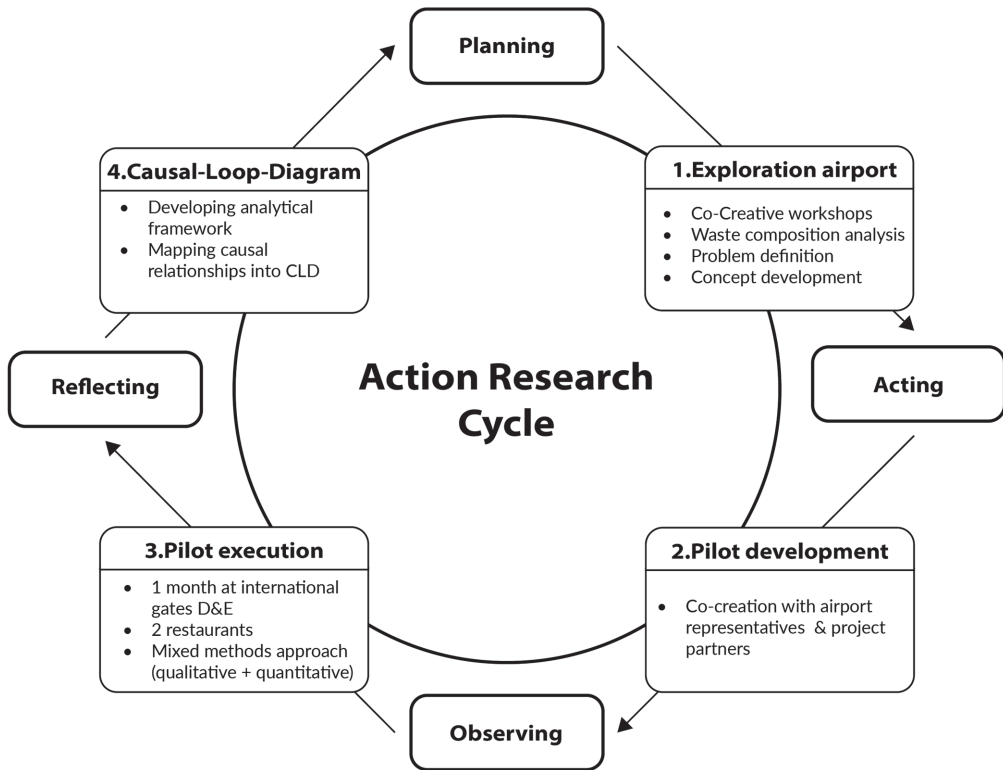


Figure 10.1 Action research process embedded in case study.

Source: Adapted from Interaction Design Foundation (IxDF), 2015.

Exploration Airport

To gain insights into the current airport waste management system, co-creative workshops were conducted with various airport representatives, and a waste composition analysis was performed, including mapping material flow and examining resource stream compositions based on weight, volume, and treatment methods, while also verifying the treatment processes (Van Der Tuin-Rademakers et al., 2024). These activities provided a comprehensive overview of the waste generated as well as insights into the composition of the residual waste stream. This stream represents the largest portion of waste generated by internal processes and currently goes straight into incineration for energy recovery. Several scoping sessions and student projects were conducted to develop sustainable interventions aimed at reducing residual waste. One project focused on dishwashing-as-a-service as an alternative to single-use takeaway. This led to the reusable takeaway packaging system “Green Circles” (Falcón, 2024).

Pilot Development

To test “Green Circles”, a single case study approach was adopted as defined by Yin (2014). This case study was selected for its ability to capture real-world interactions, identify systemic

barriers, and provide contextually grounded insights that can inform both academic discourse and practical decision-making regarding CE transitions.

The case study was conducted at Oslo Airport, with the objective of testing a fully operational infrastructure for reusable packaging. The pilot was conducted over the course of one month at the airport's international D and E gates and involved two participating restaurants. The development of this infrastructure was carried out iteratively, in collaboration with Avinor (including the circularity team, restaurants, and cleaning facilities) and external stakeholders (smart return machine provider, payment system provider, and reusable bowl provider). The pilot featured QR-coded reusable bowls integrated with a point-of-sale (POS) system, smart return machines, a centralised dishwashing service, and promotional materials (Figure 10.2). The design of the promotional materials and the machines was developed collaboratively, ensuring consistency with Avinor's brand style. The promotional materials consisted of A5 and A4 posters, which adhered to the same visual language as the machines. The posters were placed in table stands, with one side in English and the other in Norwegian, and were placed on all tables and next to the registers of both restaurants. The posters provided a brief visual explanation of the reusable bowl and a QR code link to a subpage on avinor.no for further details. Online promotion materials also extended to internal communication channels for employees and social media posts on LinkedIn.

Customers who purchased food from these restaurants could opt for a reusable bowl, equipped with a unique QR code for traceability. At checkout, customers tapped their payment cards at the POS, which followed a novel “tap-and-reuse” approach. When a customer tapped their card, no deposit was withdrawn from their bank account. They had one week to return the bowl to one of the six designated smart return machines at the international gates D and E. Only if a customer failed to return the bowl within this timeframe was a fee of 70 NOK automatically deducted from their account. Returned bowls were collected from the smart return machines by airport cleaning staff and transported to the central dishwashing facility within the airport, where they were cleaned and redistributed to the participating restaurants (Figure 10.3).

Pilot Execution

To capture the various perspectives and realities of transitions within a complex environment, this study utilised a mixed-method approach, combining both quantitative and qualitative data sources. Surveys that focused on passengers' perceptions of reusable packaging ($n = 59$) provided quantitative data. These surveys were conducted by engaging passengers after they

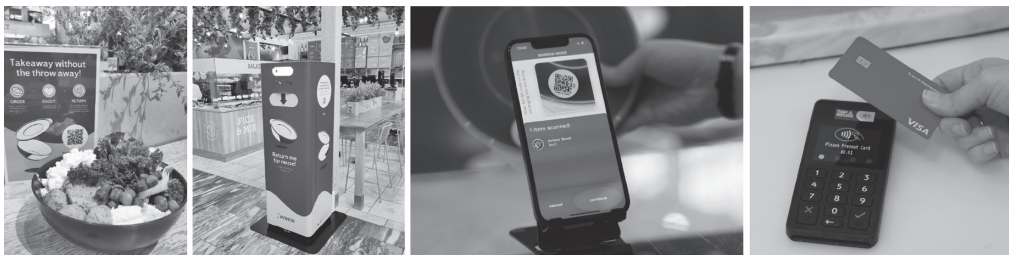


Figure 10.2 (a) Promotion material and reusable bowl; (b) Smart return machine; (c) Scanning QR code of reusable bowl by employee to activate POS; (d) Customer tapping with card at POS to activate the deposit-free borrowing system.

Source: Photos @Rita Jonyer.

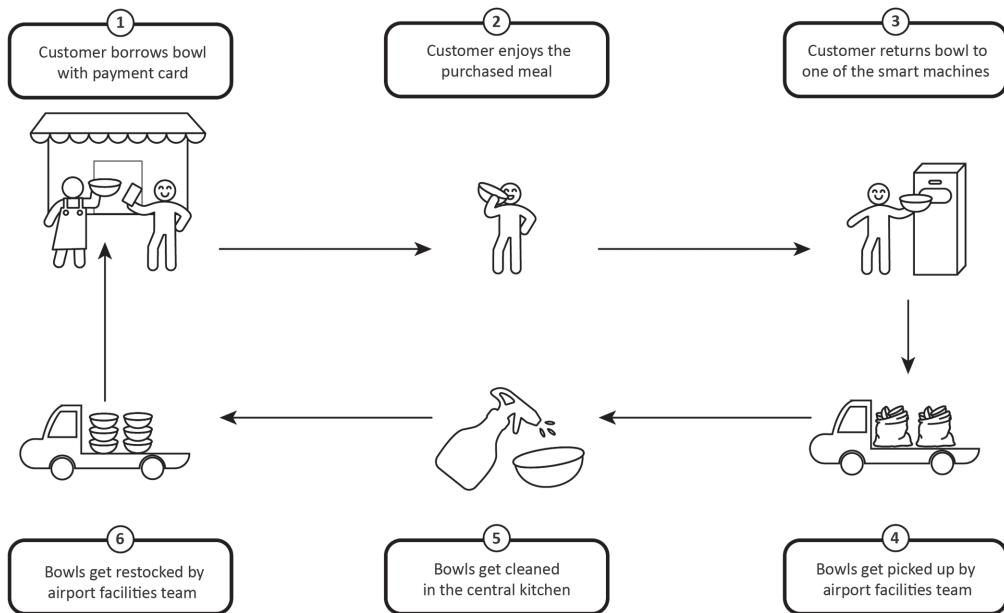


Figure 10.3 Process of the pilot: Steps 1–3 show the front end of the bowl borrowing process, and steps 4–7 show the backend in terms of pick up, cleaning, and redistribution of the bowls.

purchased a takeaway meal at one of the two participating restaurants. Participants were asked where they planned to eat their meal, whether they were aware of a reusable packaging alternative, and if so, why they were (not) choosing it. Qualitative data was collected through various means, including interviews ($n = 9$) with a diverse group of system actors, such as employees, project partners, and industry experts. These interviews offered a multi-stakeholder perspective on engagement with reusable takeaway packaging. Furthermore, on-site observations (50 hours over one month) were conducted at key locations, such as restaurants, smart return machines, and seating areas. Informal conversations were conducted with employees, passengers, and other airport staff interested in the reusable packaging. A field diary (Couvinhas et al., 2015) was kept throughout the pilot, documenting observations, insights, and informal conversations with various system actors. The survey questions and semi-structured interview guides can be found online in appendix A (full appendix link supplied at the end of the chapter).

Causal-Loop-Diagram

The final phase of the research involved synthesising the data collected to extract key insights, identify patterns, and develop a conceptual model illustrating the dynamics influencing the transition to reusable takeaway packaging in the complex environment of an airport. An analysis framework based on the research questions was created to structure and guide the analysis, ensuring alignment between the study's objectives and emergent themes. The framework (Figure 10.4) revolves around eight key themes. The four themes of RQ1 were recurring topics throughout the entire pilot, raised by internal and external stakeholders. "Communication and information flow" and "consumer engagement" were frequently discussed with the internal

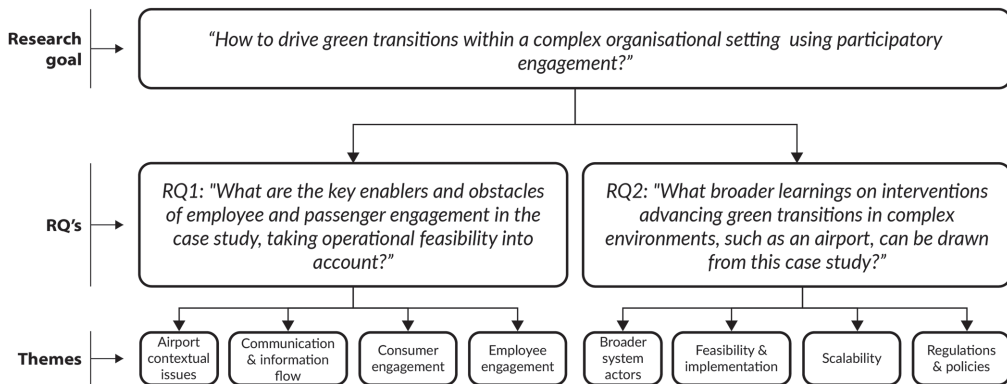


Figure 10.4 Conceptual framework based on the thematic analysis.

stakeholders during the pilot preparations to ensure that the system was functioning and viable. Discussions with external stakeholders, who provided the return machines and POS, addressed “airport contextual issues” and emphasised “employee engagement” to promote the reusable bowls. The themes “Broader System Actors” and “Regulations & Policies” of RQ2 emerged from interviews with industry experts as key enablers for promoting reusable packaging. Subsequent coding and clustering of relevant quotes led to the final topics: “Feasibility & Implementation” and “Scalability”.

The interview transcripts, relevant observational notes, and researcher reflections were digitised and imported into Atlas.ti. The textual insights were systematically coded, and the eight key themes were refined through iteration. To go beyond a siloed representation of individual themes, a CLD was developed to visualise the recurring patterns and causal relationships between the diverse insights (Bala et al., 2017). While the analytical framework helped categorise the findings thematically, the CLD reveals how these themes influence one another through feedback loops and interdependencies.

Results

The results present the case study findings, structured to address the two research questions through the lens of the eight analytical themes. First, findings on the airport’s organisational context are described to establish the spatial, behavioural, and operational characteristics that make it a uniquely challenging environment for reusable bowls. This contextual understanding of the airport provides the foundation for many of the barriers and enablers discussed throughout this chapter. Next, the results from the pilot execution are presented, particularly the limited borrowing rate and the interdependence of employee and consumer engagement. These findings are essential to understanding how certain behaviours and operational routines hindered the implementation of the reusable bowl. These results also serve as the basis for several of the eight analytical themes, particularly those related to engagement, feasibility, and contextual barriers. Finally, the CLD is introduced, which embeds the dynamic interrelations across all eight themes.

Defining the Airport Environment

The case study highlights a unique challenge for implementing reusable packaging in the airport environment with its transient, high-pressure nature. Unlike traditional food service locations, where customers return frequently and can gradually establish new habits, airports cater to a constantly changing flow of passengers. Each traveller must learn about reusable packaging from scratch, yet many leave without returning, making it a semi-open-loop environment with difficulties in creating lasting behavioural change. The stressful nature of air travel further complicates engagement. Passengers are often preoccupied with boarding procedures, navigating security, and reaching their gates on time, leaving little room for learning and adopting a new behaviour. This fast-paced environment also puts pressure on employees, who face stressful passenger peak hours, where explaining the reusable packaging adds to the already intense workload. The international nature of the airport also introduces language and cultural barriers, adding another layer of complexity to the adoption of a reusable system. Overall, various unique airport-specific constraints became evident when integrating reusable takeaway packaging during the pilot (Figure 10.5).

Pilot Execution

The pilot resulted in the low borrowing rate of 35 reusable bowls within one month. The average return time for a bowl varied, with passengers returning them on the same day, while some airport employees keeping the bowl for up to five working days. Additionally, the pilot faced several technical challenges, such as internet connectivity, POS device malfunction, currency errors and smart return machines being disconnected by passengers.

The primary reason for the low turnout was that most of the takeaway food was pre-packaged in disposable packaging, leaving passengers with no reusable alternatives. Of the 59 passengers surveyed after purchasing meals at the participating restaurants, 44% received their meals pre-packaged in disposable packaging, making the availability of reusable options irrelevant in those cases. Further 49% reported having no awareness of the reusable packaging option. Interviews with employees corroborated the findings as the employees were not actively promoting the reusable bowl due to language barriers, other work priorities, additional workload needed to explain reusable packaging during peak hours, not feeling informed enough or established work routines defaulting to single use. During informal conversations, passengers expressed limited interest in using a new system because they felt stressed about navigating the unfamiliar airport environment, had little time before boarding, and viewed the system as potentially risky due to uncertainty about locating a smart return machine in time. Consequently, employees also felt demotivated.

Observations revealed that disposable packaging as the default was due to prepacked meals being served in disposable packaging as standard. This was partly a result of logistical processes in airport food production and partly due to employees not asking passengers about their intended consumption location and defaulting to disposables. However, the passenger survey indicated that a majority of 66% planned to eat at the restaurant, 15% at their gate or another terminal location, 14% intended to take their food onto the plane, and 5% planned to eat in other locations. Ultimately, the lack of passenger awareness and employee routines defaulting to disposable packaging were identified as key bottlenecks in the pilot's low turnout.

Constraints of the airport environment	
Limited space in airport restaurants	Limited space makes it a challenge to install additional smart return machines and payment devices, as well as to store reusable bowls at the restaurants in addition to the disposable ones
Time constraints	Reusable packaging preferably needs to be returned before a flight departs
Airport restaurants have different ways of working	A standardised approach was difficult to apply across all serving units
International payment requirements	Multiple card payment options for borrowing reusable packaging and processing 'authorisation holds' were required and posed some technical challenges
Businesses' pricing policies	Some restaurants had pricing policies that made takeaway meals cheaper than dine-in options, indirectly incentivising disposable packaging
Pre-packaged food practices	Some food items arrived at restaurants already prepacked at a centralised kitchen in disposable packaging, limiting the scope of reuse
Security regulations and infrastructure challenges	• Restricted internet accessibility is affecting real-time data tracking and payment processing. • Limited access for external personnel is making installation and troubleshooting more difficult for external stakeholders. • Pre-approval requirements for any infrastructure changes, such as installing smart return machines or modifying payment systems, significantly slowed down the implementation process
Unpredictable passenger and employee behaviour	• Passengers unplugging smart machines to charge their phones, disrupting operations. • Passengers misidentifying the machine as luggage trolleys' return stations due to airport branding, blocking the machine's usage. • The disappearance of cables and phone stands, potentially due to theft, requiring unexpected replacements

Figure 10.5 Airport environment constraints.

Causal-Loop-Diagram

To synthesise the findings and visualise the complex relations of the 8 themes of the analytical framework, a CLD (Figure 10.6) was developed. The diagram visually maps key feedback loops and interdependencies between the themes that emerged from the thematic analysis, providing an integrated systems-level understanding on how reusable takeaway packaging interventions operate in the complex setting of an airport. The CLD addresses both research questions by organising insights into two overarching clusters: **Case-Specific Engagement and Feasibility** (RQ1) and **Transition Enablers** (RQ2). The embedded themes in the CLD are briefly elaborated below, and detailed summaries of the themes can be found online in appendix B.

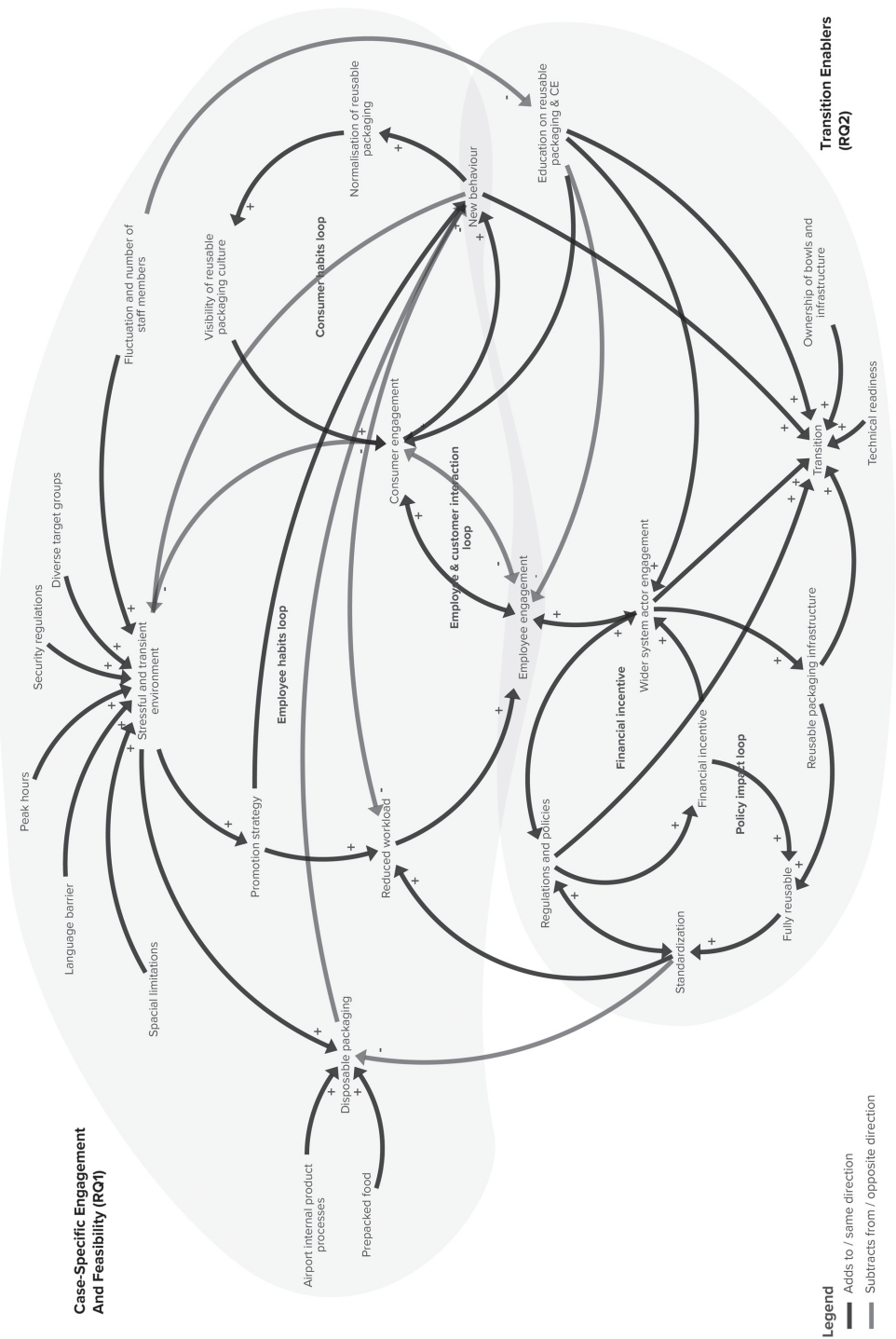


Figure 10.6 Causal-loop-diagram (high resolution available online in appendix C).

Case-Specific Engagement and Feasibility (RQ1)

Airport contextual issues: The CLD shows the complexity of the airport environment, highlighting unique barriers such as spatial limitations, language barriers, diversity in target groups and time pressure. These barriers contribute to the transient and stressful nature of the airport's open-loop system, putting it in a less suited position to lead the transition to reusable packaging.

Communication and information flow: Clear and consistent communication was vital for employee and passenger engagement during the pilot. However, the airport environment presented challenges, such as fluctuating staff numbers over time and an overall high number of staff (20–60 per restaurant). This made it difficult to ensure that all employees were well-informed. Increased customer awareness regarding reusable bowls, additional staff training, and accessible information were suggested for broader engagement with the system.

Entanglement of “Consumer engagement” and “Employee engagement”: The CLD reflects the interdependence between employee engagement and consumer uptake. As seen in the pilot, without active promotion from employees, the system remained largely invisible to passengers. The variables “Visibility of reusable packaging culture” and “Normalisation of reusable packaging” in the consumer habits loop illustrates the reinforcing relationship needed to establish a new consumer behaviour and its relation to employee engagement. When reusable packaging becomes more visible, passengers are more likely to adopt it. As adoption grows, the behaviour becomes self-reinforcing, reducing the need for active employee promotion and lowering their workload. This, in turn, enhances the overall passenger experience and boosts engagement among both employees and passengers. Additionally, these loops highlight the significance of clear communication and education in facilitating engagement. Enhancing promotion, simplifying touchpoints, and integrating system information into staff training and ads can help reduce friction and encourage participation.

Transition Enablers (RQ2)

Broader system actors: Engaging both internal and external stakeholders proved essential for aligning incentives, standardising infrastructure, and establishing shared ownership of the reusable packaging system. This becomes even more relevant when scaling beyond the airport, as no single actor can drive this transition alone. Instead, collective action from a consortium of brands, retailers, and public bodies is necessary. Additionally, the CLD indicated a positive impact on the engagement of diverse system actors through education on CE and the benefits of reusable packaging.

Feasibility & implementation: The pilot revealed that implementing reusable packaging in an airport context is constrained by lack of engagement and internal logistics. Additional challenges stemmed from established operational routines, such as the use of pre-packed food in disposable packaging, as well as technical issues with the emerging technologies utilised during the pilot. These findings highlight the importance of robust infrastructure, regulatory alignment, and a context-specific design. These dynamics are captured across various loops and variables within the CLD, as the operational feasibility insights are spread throughout.

Scalability: Scalability of reusable packaging depends on standardisation, regulation, and ownership. Standardization across product types, infrastructure, and return processes reduces

friction and enables broader adoption, while granting individual vendors flexibility. National and EU regulatory frameworks can position reuse as the default option, enhancing its financial viability and creating a self-reinforcing loop of standardisation and scalability. Ownership needs to align with system scale, while airports may manage infrastructure locally, broader expansion requires government or consortium-led models.

Policy & regulations: In the CLD, two primary loops emerged concerning this theme. The “Policy impact loop” focuses on how policies encourage infrastructure development and standardisation, making reusable packaging feasible for businesses to adopt. The second loop, “Financial incentive”, illustrates how regulations associated with financial penalties or rewards can motivate wider system stakeholders to prioritise and enforce reuse.

Discussion

This research explores how participatory engagement and SD approaches can drive green transitions in complex organisational settings, illustrated by a case study on reusable takeaway bowls. The discussion reflects on the eight themes identified in the CLD, their broader implications, theoretical contributions, and study limitations.

Contextual Factors Shaping Sustainable Behaviour

This case study supports existing literature on how contextual factors, such as time pressure and environmental unfamiliarity, influence sustainable behaviour in airports, affecting both passenger and employee engagement (Ertz et al., 2017). For instance, environmentally conscious employees faced challenges promoting reusable bowls due to peak-hour pressures, limited system knowledge, and stressed passengers. This stress aligns with literature on perceived time scarcity among consumers (Ertz et al., 2017), potentially heightened in airport settings. The concept of prosumption (Ritzer & Jurgenson, 2010) is relevant here, as consumers increasingly take on tasks once performed by employees, such as check-ins and digital ordering, shifting responsibility and cognitive load onto themselves. This shift increases the desire for speed and convenience, making disposable packaging more appealing, while reusable alternatives may seem like additional tasks. Thus, reusable systems must require minimal cognitive effort and integrate seamlessly into existing service flows, especially in high-stress environments like airports. These findings underscore that intrapersonal variables, such as intentions or environmental values, are insufficient for sustainable behaviour (Ertz et al., 2017; Steg & Vlek, 2009). Contextual “nudges” are more effective than those based solely on value orientation or information provision (Campbell-Arvai et al., 2014). This was evident in the pilot, where promotional campaigns and employee ambassadors alone were insufficient. Insights suggest potential for context-based interventions, like green procurement policies that charge extra for takeaway to discourage disposable containers. However, some barriers, such as work culture, limited space, diverse payment systems, and cultural differences due to international backgrounds, are inherent to airports and not easily solvable.

Theory of Planned Behaviour and Engagement at the Airport

The insights align with the Theory of Planned Behaviour (TPB), which frames behavioural intent as being influenced by perceived control, subjective norms, and attitudes (Ajzen, 1991). The pilot demonstrated that behavioural intent may not predict behaviour when ‘actual

behavioural control', including environmental constraints and facilitating conditions, is lacking. For instance, employees with positive sustainable attitudes struggled to promote the bowls due to high workloads or pre-packaged meals. Similarly, passengers' use of reusable bowls was hindered by weak subjective norms, time constraints, the unknown airport environment, and insufficient promotions. The CLD further aligns with TPB by identifying factors that hinder behavioural change. Passengers not seeing others return the bowls weakened subjective norms, and those with pro-environmental attitudes were discouraged by stress or uncertainty about the return process. Employees faced technical issues or were unable to promote reusable bowls during peak hours, limiting their perceived control. Collectively, these barriers undermined engagement.

Strategies and Enablers

The pilot revealed both challenges and feasible strategies within the airport environment. Reusable packaging systems must be designed to be visible, convenient, and frictionless while considering context constraints to enable normalisation. Simultaneously, disposable alternatives should be made less accessible or attractive. As Ertz et al. (2017) argue, environments that facilitate reuse and discourage disposables shift perceived utility toward sustainable choices. When passengers perceive reusables as the default or less of a hassle, they are more motivated to choose them. Future research could implement a phased approach to promote reusable bowls, starting with employees to establish internal norms, then extending to domestic flights familiar with reuse practices. Once integrated, additional reusable packaging can be introduced, leading to full airport-wide implementation. In addition, stricter national regulations and supportive airport policies can accelerate the transition to reusable packaging. However, questions of ownership arise as infrastructure grows, requiring effective governance structures with clear accountability and lifecycle oversight.

Interventions Required Beyond the Techno-fix to Drive Green Transitions

The pilot offers broader insights into interventions advancing green transitions. While emerging technologies like smart return machines and QR-linked POS devices are essential for operationalising reusable packaging, they alone are insufficient for systemic change. Drawing on Sætra and Selinger (2024), the reusable packaging system exemplifies a techno-fix – “*a technological remedy for a social problem involving minimal political or economic incentives, without requiring changes in social norms.*” Framing reusable packaging as a standalone solution risks ignoring necessary socio-political and institutional changes. The pilot found that airport practices, such as prepacking food in disposable packages or restaurant staff not inquiring about passengers' consumption preferences, are as influential as technical setups in waste reduction. These findings emphasise that beyond reusable infrastructure, behavioural adjustments and policies are crucial. Therefore, both top-down interventions, which reshape market conditions through legislation and incentives, and bottom-up initiatives, which drive innovation through new technologies and business models, are essential (Guzzo et al., 2022). The CLD confirms that supportive regulation plays an enabling role in changing consumer behaviour towards reusable packaging and further indicates that an airport alone cannot lead such a transition. Broader regulations, such as the PPWR, create top-down pressures and opportunities for standardisation, aligning efforts across the value chain and normalising circular practices. This requires collaboration at all levels from diverse system actors, as found in the “Transition Enablers” cluster of the CLD, aligning with Fichter et al. (2023).

SD Addressing Complex Sustainability Challenges

The pilot demonstrated the value of SD in navigating the complexity of highly regulated, multi-stakeholder environments like the airports. As Jones (2014) argues, SD is well-suited for addressing “wicked problems” in sustainability, where actors, goals, and systems co-evolve. In this study, SD enabled iterative, co-creative processes involving various airport departments, hierarchical levels, and external stakeholders to collaboratively design systemic interventions. The SD approach further aligns with critiques by Sætra and Selinger (2024), who highlight that framing societal issues as purely technical can obscure their political, cultural, and human dimensions. Following an SD approach reframes technology as a tool for deeper socio-behavioural change rather than the solution itself. Thus, following the holistic and co-creative SD approach, the risk of reusable packaging becoming a techno-solutionist endeavour that overlooks the constraints of the complex contextual challenges, internal processes, and regulations can be reduced.

Limitations

This study provides context-specific insights into reusable packaging adoption within an airport environment with several limitations. First, the findings are based on a single pilot, which limits the insights generalisability. More case studies across different contexts are needed to validate and generalise the findings. Second, the environmental impact of the reusable bowl was not assessed through a life cycle assessment, which could offer insights into sustainability regarding emissions, water usage, and material consumption. Lastly, the pilot was brief and limited in scope, focusing on one intervention model. Broader engagement, longer timeframes, and varied contexts are needed to test the long-term feasibility and adaptability of reusable take-away packaging.

Conclusion

This case study explores the implementation of a reusable bowl system in the complex environment of an international airport using an SD approach. The pilot revealed that technological interventions alone are insufficient for driving sustainable transitions. Behavioural, contextual, and institutional factors also play critical roles. At the case-specific level, the findings highlight the interdependence of passenger and employee engagement, both heavily influenced by the airport environment. Airport-specific constraints such as stress, time scarcity, spatial limitations, and cultural diversity posed challenges to implementing reusable bowls, suggesting that scaling such solutions would be easier in less demanding environments. Nonetheless, the pilot identified feasible interventions like green procurement, phased implementation, and increased promotion. Beyond the pilot, insights emphasise the need for alignment between top-down and bottom-up efforts, such as government incentives for reusable packaging and startups developing new technologies. The CLD from this study visualises the complexity of transitioning to reusable packaging, demonstrating that techno-fixes alone are insufficient. Social and institutional transformations are essential for advancing green transitions.

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Appendices A-C online material

4TU.ResearchData. Case study data: Reusable takeaway packaging system piloted at Norwegian airport. <https://doi.org/10.4121/5921750a-aa77-461b-a4b1-090647626b1a>