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Ismo Ruohomäki | Rosa Palmgren | Riikka Kaipia

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Preface

This document describes the initial supply chain design for reusable packaging to be applied in the take-away food context. The report synthetises knowledge about reusable packaging systems drawn from selected EU reports and company-specific reports, as well as learnings from the implementation of reusable packaging in Europe and Canada.

This report focuses on the operational reuse system for reusable consumer packaging and describes the necessary supply chain activities, as well as identifying the actors that need to run it. It also discusses the prerequisites for the logistics infrastructure that will enable the reuse of packaging.

The report studies the level of centralisation in washing solutions, including the trade-offs between centralised and local washing. It provides insights into economies of scale compared to the benefits of local washing.

We offer examples of solutions for reusable packaging transport units to ensure efficient handling throughout the supply chain, including washing. We also explore incentives to promote the use of existing infrastructure for reuse, including evaluating the actors responsible for managing and participating in the reuse system. The concept of shared assets is discussed.

Additionally, the consumer's role as part of the reuse supply chain and the interfaces with consumers will be outlined from the operational viewpoint.

The geographical scope of reusable package systems is discussed and the possibilities for scalability are evaluated. The report identifies bottlenecks that could affect the scalability of logistics and washing solutions.

The main result of this report is the system design of the reusable packaging supply chain that builds on the reference cases. The solution provided and the optional approaches presented are intended to help companies design the logistics solution in their joint experiment.

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1 Introduction

Currently, the dominant solution for packaging take-away food portions is the use of disposable single-use materials. However, significant attempts are being made to engage and adopt reusable packaging systems to replace the "make-use-dispose" type of consumer packaging. This requires a shift from single-use disposable containers to a system of reusable packaging. These reusable systems are expected to offer substantial sustainability benefits, outperforming traditional disposable single-use options. The Reusify project focuses on accelerating the uptake of reusable packaging systems in Finland.

This report defines the reuse supply chain system, its activities and its actors. We identify the prerequisites for logistics infrastructure to enable reuse and provides knowledge on the integration of the reuse of consumer packaging into supply chains. It also seeks solutions for transport units of reusable packaging to ensure efficient handling throughout the supply chain, including during washing.

The core of the system is a reusable meal container or cup designed specifically to serve as primary packaging, intended to deliver products such as food portions or hot or cold drinks to consumers within a reusable packaging system. Reusable packaging is meant to be used repeatedly, which means that cleaning needs to be included in the system to ensure convenient and safe reuse of the packaging. Moreover, it is designed to endure an appropriate number of use cycles within a reuse system. Each cycle begins with filling and includes use, collection, washing and redistribution for refilling. The cycle is considered complete when the container is ready for its next filling.

Reusable packaging-based food business sectors are very present in the Reusify project, providing consumers with take-away food and beverage products, as well as various food services in different types of environments, including:

Grocery stores such as supermarkets offer a wide range of consumer goods. One notable chain is Prisma, a Finnish hypermarket chain under the S-Group, which operates 74 stores across 51 cities in Finland. Its primary competitor is Kesko's K-Citymarket chain, which had 81 stores in Finland in 2023.[1]

[1] https://www.kesko.fi/492905/globalassets/03-sijoittaja/raporttikeskus/2024/q1/vuosiraportti-2023/kesko_vuosiraportti_2023.pdf

Restaurants and cafes, including those providing take-away food. During the COVID-19 pandemic, take-away sales became a critical factor for the survival of many companies. The Finnish Hospitality Association (MaRa), the leading national trade and labour market association for the hospitality industry in Finland, has 3,100 member organisations operating 7,700 outlets and employing over 70,000 workers. A significant portion of these businesses are small and medium-sized enterprises.

Food service companies, such as the global chains Compass Group and Sodexo in Finland, provide catering services to various institutions, including companies, offices, schools, hospitals and nursing homes.

In the following sections, we discuss various aspects related to the supply chain and logistics of reusable packaging. The first chapter will present the overall system design of the reusable packaging supply chain, including the actors and their activities. We will then delve into the details, covering topics such as the collection and logistics infrastructure enabling reuse, the geographical scope of reuse systems, the level of centralisation in washing solutions and the need for transport units. We will also address incentives to promote the use of existing infrastructure, the consumer's role in the reuse system, and how to solve national bottlenecks with scalable logistics and washing solutions.

2 System design of the reusable packaging supply chain – actors and activities

This chapter outlines the overall system design of the reusable packaging supply chain. This includes the actors directly involved in the chain, as well as the specific activities and roles that they perform within it.

Key roles and responsibilities are described for the reuse supply chain activities to explain how the system operates. The main participants include reuse service operators, their customers (front-line operators), consumers, dishwashing services and logistics providers. The essential activities involve launching and managing reusable packaging for take-away food and drinks, with similar processes across grocery stores, restaurants, cafes and food service companies.

Small-scale dishwashing can be handled in cafes, restaurants and even some grocery stores that have suitable dishwashing equipment. Effective supply chain planning outlines these activities from the reuse service operator's perspective. An overview of key stakeholder roles is provided in the following sections.

Figure 1. Overall supply chain system design for reusable packaging for take-away food, including actors and activities.

Figure 1 above presents the reuse supply chain stakeholders and activities. The different steps and activities are described below. The numbers indicate the order in which the activities are carried out.

1. **Storage of reusable containers** (by the reuse service operator) includes ensuring the safe and hygienic storage and transport of clean, reusable containers, ready to be distributed to food service providers. Efficient handling and storage rely on the use of transport units.
2. **Delivery of reusable containers** (by the reuse service operator) ensures their timely delivery to restaurants, cafes, retail outlets and canteens. This involves logistics planning and partnering with logistics service providers to maintain efficiency and minimise delays. Customers' own (at least grocery store) logistics may be integrated into packaging deliveries.
3. **Storage of reusable containers at the point-of-sale (PoS)** by food service operators using their existing storage spaces. With smaller restaurants in particular, there tend to be challenges as regards storage space. To overcome this issue, collaboration between actors is necessary.
4. **Offering food in reusable containers** (by food service operators) involves arranging it so that food outlets can conveniently handle and use reusable containers (by staff and customers) for take-away or delivery orders, replacing single-use packaging. This includes training staff in the handling of reusable packaging and educating customers about the programme.
5. **Purchasing products in reusable containers** (by consumers) involves consumers first testing and, hopefully, fully adopting reusable containers for purchasing food, beverages or other products, thereby reducing single-use waste. This requires collaboration with retailers to make reusable options available and convenient for consumers.
6. **Return of used containers to the point of sale or to specific return points** (by consumers) involves consumers returning used containers to the point of sale or designated drop-off locations, bins or machines. This is a crucial step for encouraging participation and ensuring the continuous circulation of containers.
7. **Collection and transport of used containers** (by the logistics service provider) requires all operations, solutions and service operators to collect returned containers and transport them to washing facilities. This may involve a dedicated fleet or partnerships with existing logistics providers to ensure the smooth operation of the system.
8. **Washing and delivery of containers** (by the dishwashing and logistics service provider) includes professional cleaning and sanitisation of containers to meet hygiene standards, followed by a hygiene inspection to ensure that the containers are fit for reuse. Once ready, the containers are distributed back into the system for their next use cycle.
9. **Design and implementation of operational and tracking systems – inventory management and replacement** (by the reuse service provider) involves monitoring the safety and usage cycles of packaging (including recycling when it reaches End-of-Life [EoL]) and managing the consumer interface.
10. **Supplementing inventories** includes replacing worn-out or n-times used packaging and transport units with new ones. This requires a functioning packaging reuse cycle, which includes monitoring hygiene, quality and integrity. Once the predefined EoL disposal requirements for reusable packaging are met, it is collected and delivered for recycling.

11. **Recycling of EoL containers** includes managing containers that have reached the end of their lifecycle by recycling or repurposing materials to minimise waste.
12. **Managing the growth of the customer and user base, and developing system efficiencies and partnerships to allow for scalability.** This involves continuous improvements of processes, gathering feedback from actors, developing system-wide tracking, and adapting to changing customer needs. System maintenance includes all regular upkeep of infrastructure, cleaning facilities, collection points, and storage systems to ensure smooth operation. This might also include tasks such as repairing and upgrading collection containers and tracking systems. Development activities are partially executed in collaboration with partner companies.

A key cornerstone of the whole reuse system is the business operator known as the reuse service or system operator. Options for becoming a system operator in this business include the following:

1. Reuse system operator: the reusable packaging system is owned and managed by a single reuse service system operator company.
2. Pool system operator: the reusable packaging system is jointly owned by several pool members, and one of them operates the system.
3. Packaging developer and producer: the reusable packaging system is owned and managed by the packaging developer and producer.

Reuse supply chain activities may vary depending on the background of the reuse system operator and the business model they follow.

3 Collection and logistics infrastructure enabling reuse

An effective reuse business requires a well-planned packaging collection and logistics infrastructure. Essential infrastructures and solutions, such as collection bins or collection machines, are needed to facilitate the first mile of the entire system. Additionally, the geographical coverage, locations and number of collection points are important planning considerations. Collection and logistics solution planning should cover at least the following details:

- **number and coverage of collection points:** dedicated drop-off points, outdoor and indoor collection points, common collection points/shared infra for multiple vendors, guidance and signs related to collection points, etc.
- **type and number of collection bins:** labelled drop-off bins placed in consumer high-traffic areas to facilitate easy return of containers.
- **type and number of automated collection machines:** Reverse Vending Machines (RVMs).
- **type and number of transport units (=boxes):** secondary packaging to facilitate reusable handling.
- **type and number of delivery bags:** if food couriers participate in delivery logistics, e.g., Wolt has announced that they have been operating in six countries with reusable packaging in collaboration with restaurants, and in Sweden, Volt has been active and invited their most important partners to start their operations with reusable packaging.[2]
- **type and number of collection sacks:** event collection and food couriers participating in collection logistics with passenger cars (sacks).
- **type of load carriers:** compatible with transport units to facilitate handling; provided by the logistics service operator.
- **system-wide tracking elements:** tags, QR codes, readers, software, etc.

Currently, according to the European Reuse Barometer, 70% of solutions offer consumers the option of returning their reusable packaging manually at the counter in partnering restaurants within the network. This collection model is the most common for both food containers and cups. The second and third most prevalent systems for collecting reusable containers from consumers are non-automated collection bins and automated RVMs.

[2] https://explore.wolt.com/sv/swe/sustainable-packaging

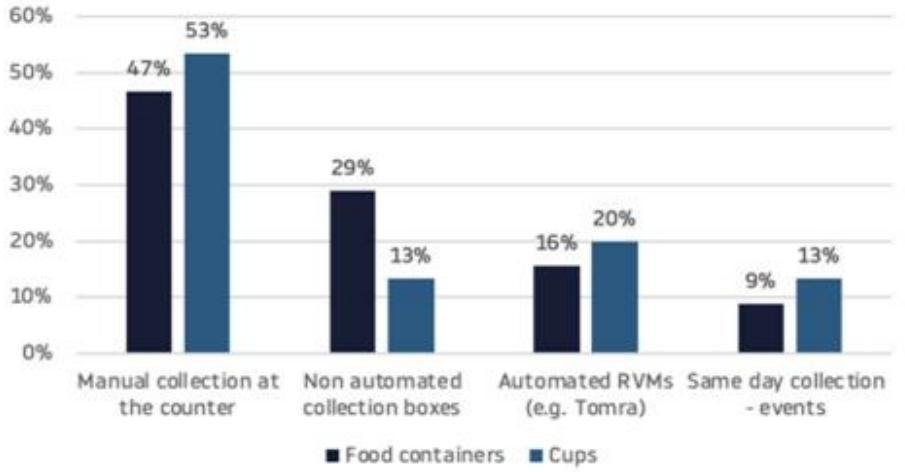

Figure 2. Reusable packaging collection systems in the take-away sector per container type.[3]

According to the European Reuse Barometer,[3] the predominant return model in the take-away packaging solutions provided is the 'return on the go' model, used for both food containers and cups. Solutions operating with a 'return from home' model in the take-away sector are mostly caterers that collect packaging on the same day. This highlights the importance of collection bins that are carefully placed along routes where consumers can easily find them during their daily routines.

[3] https://zerowasteeurope.eu/wp-content/uploads/2024/06/ZWE_June24_Report_InOff-plastic-european-reuse-barometer-.pdf

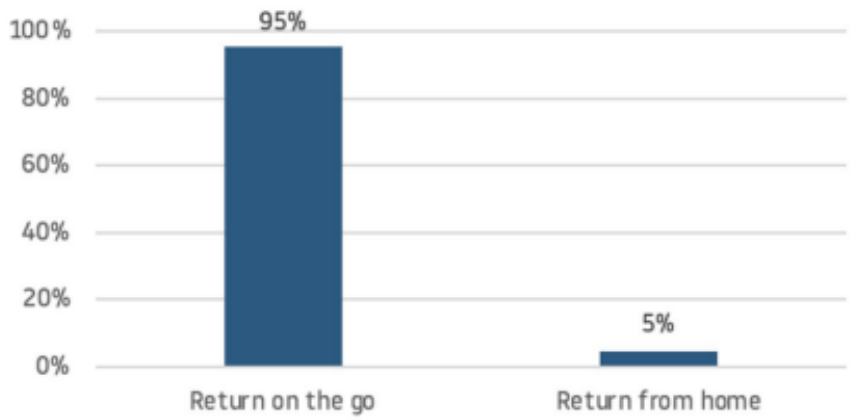

Figure 3. Reusable packaging return models in the take-away sector.[3]

Here are some recommendations for planning reusable packaging collection infrastructure:

- Collection bins should be easy and convenient to use.
- The number and coverage of collection points should be sufficient to ensure accessibility.
- Collection system planning should minimise the number of transports while keeping the packaging circulating efficiently.
- Incentives or rewards should be available to encourage consumers to return packaging.
- Shared collection infrastructure (pooling) can help reduce investment costs for individual companies.

Resolve's project-based standardisation action (PR3)[4] establishes that collection points should be able to accommodate a variety of incentive models, including:

- Where there is a deposit system: the person who returns the container receives the deposit amount via a phone app, in cash, with a printed coupon or with a reuse ID card.
- Where there is discount incentive system: the person who deposits the container receives the discount via a phone app, a printed coupon or, otherwise, they receive the discount on site.
- Where subscription/penalty models are in place: the person who deposits the container receives some form of credit for doing so.

In the piloting phase, wider collection of containers is not necessary, since pilot projects are executed in such a way that container returns take place at the point-of-sale. Pilot projects are useful for collecting data about the collection system's needs and desires. Later, in the scaling planning phase, collection points and methods are evaluated in depth. It can be expected that offering more return

[4] https://www.resolve.ngo/projects/pr3

options will result in a more convenient and easier return experience for customers.

Ownership of collection bins or automated collection machines can vary based on the type of system, the stakeholders involved and the partnerships between them, as well as regional practices. Ownership can also depend on the reuse service operator's business model.

For example, reuse service operator Cupzero owns and manages collection bins and logistics. They place bins at designated collection points (e.g., grocery stores, shopping centres) and coordinate logistics for collection and redistribution.

Figure 4. Cupzero, Vytal and Kooky2Go collection bin examples.

Collection bins are placed at designated points and in designated areas, such as grocery stores, shopping centres, car parks and other recycling activity areas. The collection bin placing plan needs to be coordinated with the collection logistics plan. The operator of the reuse system typically invests in the collection infrastructure, but shared infrastructure is also highly recommended, for example between retailers or restaurants partnering with reuse operators. These investments are considered part of their branding and co-branding, commitment to sustainability and compliance with regulatory requirements. In government and city-led initiatives, municipalities may introduce their own collection bins to encourage citizens to participate in reuse. Detailed planning of collection points, bins and their sizing should take place during the trial phase. In the scaling phase, a re-evaluation of the whole collection system needs to be conducted. Consumer convenience and ease of return are essential, so collection points should be placed close to routes that potential users follow regularly.

In the scaling phase, the potential of automated reverse vending machines (RVMs) provided by companies such as Tomra[5] should also be explored. RVMs make returning containers highly convenient in city centres, public spaces, food stores and parking facilities. Basic collection bins could be placed close to existing RVMs. Recently, Sykell has introduced their reusable packaging compatible with existing RVMs. This innovative packaging solution shows promise for reuse if

[5] https://www.tomra.com/en

successfully adopted in the market. According to Sykell's impact report, returned packaging follows existing logistics routes.[6]

Figure 5. Reverse vending machines for reusable packaging by Tomra, Ozzi and Sykell, compatible with existing RVMs.

Transport logistics primarily rely on vans, trucks and lorries (Figure 6). If food couriers are involved in the collection process, passenger cars may also be used. For transport, reusable packaging is packed into units or crates, and load carriers are used to facilitate handling, loading and unloading. The requirements and solutions for transport units are discussed in more detail in Chapter 4.

Figure 6. Examples of reusable transport vehicles and increasing load capacities from left to right: Swapbox, Re:Dish and Eternity Systems.

[6] https://drive.google.com/file/d/1xyMA7kaOCOBLOVAydSs_TinT6jZ9upZW/view

4 Requirements and solutions for transport units

Transport units are necessary to ensure the smooth operation of a reuse-based system. They perform several critical tasks:

- Collection of used packaging
- Transport of packaging to washing facilities
- Feeding and collection during washing operations
- Post-cleaning transport to packaging storage or warehousing facility
- Distribution of clean packaging to food producers or retailers

Transport units create value for the system by means of the following:

- Protection of food packaging
    - Preventing damage to reusable packaging during transit
    - Ensuring the durability of packaging across multiple reuse cycles
- Efficiency in handling and storage
    - Facilitating the stacking, loading and unloading of packaging
    - Minimising labour costs and handling time, optimising logistics
- Hygiene
    - Maintaining hygiene during transport to prevent contamination
    - Ensuring food safety by keeping packaging clean
- Cost-effectiveness
    - Keeping transport costs low to ensure the overall economic viability of the reuse system
    - Reducing operational expenses, making reuse systems competitive with single-use packaging
- Traceability (optional)
    - Enabling tracking throughout the system
    - Supporting monitoring of the lifecycle and rotation of packaging, ensuring process optimisation
- Environmental impact minimisation
    - Enabling the use of shared infrastructure in logistics and washing
    - Decreasing the carbon footprint and supporting the sustainability goal of the reusable system

Options for transport units should be planned and assessed during the system design phase, together with the packaging candidates. In particular, compatibility

issues, including packaging dimensions and transport units, should be checked. The nestability of reusable packaging is a key design feature, meaning the ability of empty packaging units to fit inside one another when not in use, reducing the space required for storage or transport. With regard to transport units, their critical feature is stackability, which means the ability of packaging units (whether full or empty) to be safely and securely stacked on top of each other during storage or transport, thereby improving the efficiency of handling, storage and transport.

The solutions required for transport units in a reusable food packaging system include:

- Transport unit (secondary packaging required). A number of commercial references are shown in Figure 7.
    - Facilitates the handling, collection, transport and storage of reusable primary packaging
    - Protects reusable packaging during transit and allows for efficient stacking and loading
- Load carriers
    - Facilitate the handling of stacked transport units
    - Ensure the safe and easy movement of large quantities of packaging units, especially in logistics operations
- Pallets
    - Streamline the handling and transport of reusable packaging during logistics operations
    - Enable efficient stacking, stability and compatibility with standard handling equipment (e.g., forklifts)
- Sacks
    - Simplify the collection, handling and delivery of used or EoL packaging
    - Ensure safe and hygienic collection and transport, reducing contamination risk

Reusable transport units are essential for the system. They are typically used to transport used containers to the washing facility and to return cleaned containers to users. Dedicated units are required for both used and clean containers to prevent cross-contamination. A relatively large number of transport units are required to support the system effectively. There is a wide range of leasing-based commercial transport solutions available. The evaluation and selection of transport units goes hand in hand with the choice of container. In the trial phase, transport units should also be tested in practice before final decisions are made.

Reuse service operators manage the reusable packaging system, which includes tasks such as washing, tracking, and maintaining containers. Given the importance of transport units in the reuse cycle, service operators should partner with rental providers or invest in transport units to ensure that the system remains consistent and reliable.

The total number of transport units needed depends on several factors:

- **Packaging return rate:** return rate refers to the percentage of reusable packaging (e.g., containers, cups) that is successfully returned by users to designated collection points for reuse.

- **Packaging cycle time**: this includes the time for collection, transport, washing and redistribution. Longer cycle times increase the number of transport units required.
- **Demand variability:** peak demand periods (e.g., seasonal demand changes) require a buffer stock of transport units to handle higher volumes.
- **Reusable packaging volume:** the ratio of packaging to transport units can vary, but in well-optimised systems, transport units typically represent 5-10% of the total reusable packaging inventory. If the system handles 100,000 reusable containers, it may require around 5,000 to 10,000 transport units, depending on the above factors.

Figure 7. Solution references for transport units: open top container, container with lid, AJ-tuote transport boxes and Zymotec boxes.

Transport units facilitate washing operations in the dishwashing line feeding phase and in the packing phase of clean and dry packaging into the transport units. In this phase, specific covers are used to ensure hygiene standards.

Figure 8. Packing of washed and sanitised wares in transport units using a hygiene cover pouch; Eternity Systems[9] and Re:Dish.[10]

If the existing transport box designs and dimensions are acceptable, these should be integrated into the reusable packaging system. Some transport boxes are available in a 400 X 600 mm format and with two different heights. The overall usability of these should be discussed with retailers and logistics operators. Based

on these discussions and evaluations, an initial recommendation can be made. If there is no way to use existing transport boxes, consideration can be given to how to acquire or develop better options. Transport units may also include smart tags that provide information about packaging flows. Issues related to the monitoring of transport packaging will be discussed in the respective WP.

Lännen Teollisuuspalvelu LTP[7] focuses on plastic crate washing and pallet services for the food industry and retail trade. The company works closely with the food industry together with Transbox Oy, which is responsible for managing the crates. Its clientele includes several meat, processed meat, specialty food and fish companies all over Finland. LTP's washing operations are in Vantaa, Tuusula, Säkylä and Laitila. Transbox Oy[8] was founded in 1994 by trade logistics companies and the food industry to reduce logistics costs and environmental waste load. This resulted in a series of economical, uniform, recyclable and stackable plastic transport boxes: Transbox boxes. Transbox Oy coordinates these box systems.

[7] https://ltplogistics.fi/yritys/lannen-teollisuuspalvelu/

[8] https://www.transbox.fi/

5 Washing solutions and level of washing centralisation

Reuse systems must be safe and hygienic at every step of the process, which means that professional washing systems should be integrated and available for cups, containers and transport boxes.

The level of centralisation in washing solutions refers to how the washing processes for reusable packaging systems are organised, specifically whether they are managed through:

- **Centralised solutions:** a large, specialised washing facility serving multiple regions and service providers. This approach can offer economies of scale, consistent quality and streamlined logistics, bus also usually requires more transport.
- **Decentralised solutions:** many smaller, local washing facilities serve nearby regions and customers. This method can reduce transport costs and improve flexibility in response to local demand.

In the EU, existing reusable washing references and solutions are very diverse. Most reusable packaging dishwashing takes place locally, at the same place where the initial take-away food and drink was bought by the customer. After use, empty containers and cups are returned to the sales point, where they are washed for their second use cycle. This practice is called "reusable local washing" and is widespread among early adopters in restaurants and cafes in the EU, which have enough capacity to also wash reusable packaging. During the Covid-19 pandemic, this option was implemented on a large scale in restaurants, cafes and other types of food businesses. However, it does not allow larger volumes to be washed if the existing dishwashing capacity is limited to the volume of customers consuming in the restaurant. The emergence of large events has driven the growth of reusable cups, drinking glasses and food container concepts and businesses. This trend has also created a demand for centralised dishwashing capacity, infrastructure and related service businesses. For example, in the EU, some leading companies include Eternity systems in France and, globally, Uzaje in Germany and the USA and Re:Dish in the USA. In Finland, there is Green vuokraus- ja pesupalvelut Oy.

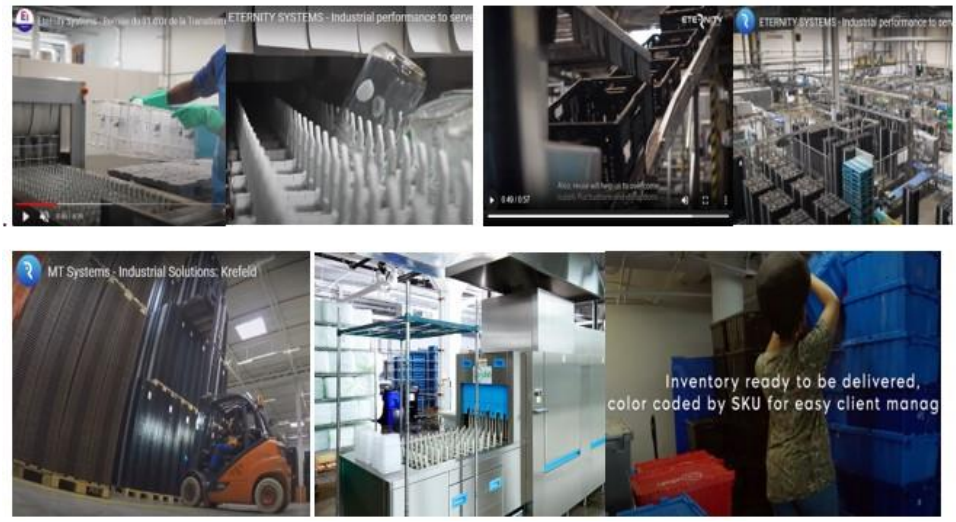

Figure 9. Large-scale centralised dishwashing facility Eternity Systems,[9] Re:Dish.[10]

In urban areas, a significant amount of dishwashing infrastructure is already available. However, the challenge lies in the absence of viable business models, poor accessibility to this capacity, and risks related to dishwashing compatibility and upgrading. These issues need to be assessed and appropriate incentives found for existing operators and key stakeholders to adopt these solutions.

Upgrading existing commercial dishwashing processes to accommodate reusable packaging requires several considerations to ensure efficiency and hygiene. By addressing these factors, it is possible to upgrade commercial dishwashing processes to accommodate reusable packaging, ensuring both operational efficiency and adherence to hygiene standards. The key factors to address are:

- Assessing dishwasher technology compatibility:
    - Material suitability: traditional dishwashers may not be optimised for cleaning reusable plastic items. These machines might not effectively clean the surfaces of such items and drying can be inadequate, leading to hygiene concerns.
    - Adapting existing dishwashing to handle reusable containers and cups – ensuring thorough cleaning and drying – requires upgrades in the dishwashing process and operator training.
- Adjusting washing programmes and detergents:
    - Customised wash cycles: reusable packaging may require different washing parameters compared to traditional dishware. The dishwasher can be programmed with

[9] https://www.eternity-systems.com/en/

[10] https://www.redish.com/

appropriate cycles that address the specific cleaning needs of reusable items.
    - Detergent compatibility: select detergents formulated for the materials of your reusable packaging. This ensures effective cleaning without damaging the items. Consult with detergent and dishwashing technology providers.
- Sanitisation measures:
    - Increased sanitiser use: reusable packaging, especially those with intricate designs, may conceal more bacteria if not cleaned properly. Implement improved sanitisation protocols, possibly involving higher temperatures or additional sanitisers – chemical or infrared – to maintain hygiene standards.
- Operator training:
    - Operational training: educate staff on the differences between cleaning traditional dishware and reusable packaging. This includes understanding new washing programmes and handling procedures, and recognising when items are adequately cleaned.
    - Hygiene protocols: ensure staff are trained in improved hygiene practices to prevent cross-contamination when dealing with reusable items.
- Workflow and capacity:
    - Process integration: assess how the introduction of reusable packaging impacts your current dishwashing workflow. You may need to adjust processes to accommodate the increased volume and different handling requirements.
    - Capacity planning: determine if your existing dishwashing equipment can handle the additional load or if upgrades are necessary.

Leveraging existing dishwashing infrastructure for reuse involves utilising facilities such as large commercial kitchens and food service units in public and private office complexes, universities, schools, and other institutions. These establishments serve many customers who dine on-site, and dishwashing operations are conducted at the same location using high-capacity dishwashing machinery. Expanding the use of existing dishwashing capacity for reusable items is a potential solution, but it requires negotiation and agreements with the parties involved. Key considerations include creating incentives, establishing contracts, ensuring dishwashing safety and hygiene, and conducting risk assessments. Resolving these issues requires collaboration between operators and facility owners, who are responsible for the infrastructure, necessary modifications to the washing infrastructure, investments, storage capacity, and energy management. Additionally, the compatibility of daily legacy dishwashing operations with reusable-based processes must be taken into account. This includes uncertainties regarding necessary changes to dishwashing machines, such as washing programme adjustments, storage of reusable packaging, storage of additional detergents and transport units, daily detergent changes and coping with sanitiser use.

In the pilot phase, dishwashing systems should be somewhat easier to arrange based on readily available dishwashing facilities, at least in the food service

sector. Scaling requires new dishwashing capacity arrangements, contracting and even new capacity investments. In Finland, we have three options for dishwashing reusable packaging, which are:

- Decentralised dishwashing: restaurants, cafes, and stores wash the reused containers they have used themselves.
    - Capacity is readily available for trials.
    - Take-away food and drink sellers who use reusable packaging and collect them for dishwashing and reuse.
- Mid-scale centralised dishwashing: high-volume restaurants with excess dishwashing capacity that start external dishwashing services for reusable service partners.
    - Capacity is available, but its use requires feasibility studies and the willingness of food service business operators to improve this use and start a service business in this area.
    - Shared use of dishwashing capacity requires incentives and contracting between reuse service providers, food service companies and property owners.
- Large-scale centralised dishwashing: newly established centralised dishwashing capacity and related collection and delivery services.

The ZWE study[11] includes references to the costs of reusable dishwashing and transport:

- The cost of dishwashing decentralised, mid-scale reusable food containers is **EUR 0.02 per container.**
- Centralised reusable food containers are washed in a washing facility and the combined cost of transport (including re-distribution) and cleaning is **EUR 0.10 per container**. These are the approximate costs of reuse systems if economies of scale can be achieved.

When dishwashing, the reusable packaging requires specific attention to ensure safety and hygiene standards. This requires changes in the packaging type, material and design. Special attention should also be drawn to detergent and dishwashing programme, including washing time, temperature, disinfection, drying.

In a shared cost model, the business using the facility (e.g., a restaurant or caterer) agrees to partially finance the upgrades or to share ongoing utility costs. This creates a partnership where both parties benefit from the improvements.

[11] https://zerowasteeurope.eu/wp-content/uploads/2023/06/2023-SB-ZWE-The-economics-of-reuse-systems.pdf

6 Incentives to promote the use of existing infrastructure for reuse

In an efficient reuse system that prioritises food safety, each take-away package must be professionally washed to meet high hygiene standards. Scaling this process requires a large-scale conveyor-type dishwashing machine capable of cleaning large quantities of reusable packaging. Both dishwashing capacity and logistics are crucial components for ensuring the feasibility and sustainability of the system.

Instead of investing in new dishwashing capacity, there is an alternative to consider: using existing dishwashing infrastructure for reusable dishwashing needs. It is assumed that there is existing dishwashing capacity in food service companies. Additionally, transport packaging service operators may have excess dishwashing capacity. Food service and campus restaurants are often located in urban areas and city centres, providing clear proximity synergies with reuse systems.

Figure 10. Metos flight-type dishwasher.[12]

For capacity considerations, Figure 11 shows Hobart's large-scale dishwashing efficiency data. In the food service sector, meals and other services are typically provided only during the day, and dishwashing machines operate during normal working hours with existing staff. For example, in one shift (5.5 hours of running time) nearly 10,000 bowls or 18,000 cups can be washed, according to Hobart's throughput figures.

Product	Throughput per hour	Consumables per hour
Cups for Cold Drinks	4,950	
Cups for Warm Drinks	3,300	Electricity: 69kWh
Sushi Boxes	1,179	Water: 250 litres
Bowls	1,800	Detergent: 570g
Pizza Boxes	375	Rinsing Agent: 125g
Burger Boxes	750	

Figure 11. Dishwashing efficiency data based on Hobart's FUX5000 large-scale flight-type dishwasher.[13]

For food service operators, there are two potential scenarios: providing reusable dishwashing services during regular operating hours with current staff or offering these services outside of regular hours with additional staff. Key questions to explore this topic include:

- What is the current dishwashing capacity during normal operating hours, and how much of this is unused or available for additional purposes?

[12] https://www.metos.com/page.asp?pageid=prods&languageid=BE_NL&groupid=392&title=Flight-type%20washers

[13] Assessing Climate Impact: Reusable Systems vs. Single-use Takeaway Packaging, September 2023.

- Which types of food service units (e.g., cafeterias, restaurants, industrial kitchens) have available dishwashing capacity that could be used?
- What is the geographical relationship between food service units with free capacity and the planned reuse system infrastructure?
- What motivates food service providers to offer external dishwashing services for reusable items?
- Are there existing business models or case studies demonstrating successful reusable dishwashing services?
- What incentives, financial or otherwise, would encourage food service providers to participate in reusable dishwashing services?
- What is a fair model for compensating facility owners for the use of electricity, water, and infrastructure when offering dishwashing services?
- Who should finance the required upgrades to dishwashing machines and infrastructure to meet the needs of reusable systems, and under what conditions? For example, drying and sanitisation are issues of concern for reusable packaging that requires upgrades.

Initially, facility owners could be compensated through a service fee per reusable item washed. This creates a direct incentive tied to the increased demand for the dishwashing of reusable packaging. Secondly, public recognition through partnerships with businesses and municipalities promoting reusable packaging can serve as a non-monetary incentive. Being highlighted as a leader in sustainability can attract more clients and business opportunities. Thirdly, in a shared cost model, the business using the facility (e.g., a restaurant or caterer) agrees to partially finance the upgrades or share ongoing utility costs. This creates a partnership where both parties benefit from the improvements. Fourthly, establishing long-term sustainability agreements between facility owners and users of the service (restaurants, caterers, etc.) that include shared goals and commitments, helps both parties to benefit from environmental improvements.

Global centralised dishwashing giant Eternity Systems now operates **four industrial washing sites** in France and 16 outside France, with a total capacity of **205 million units per year** (710 million units per year globally). Centralised dishwashing requires large volumes and densely populated cities with millions of residents.[14] From a sustainability perspective, in Finland we should explore approaches and incentives to utilise the professional dishwashing capacity of existing food service businesses and other operators with washing infrastructure.

The use of existing infrastructure for reusable food packaging involves providing incentives targeted at multiple stakeholders. These incentives aim to promote collaboration, improve efficiency and encourage widespread adoption. Identified opportunities for incentivising the use of existing resources include:

- Use of existing dishwashing infrastructure:
    - Use of existing dishwashing capacity, e.g. in food service businesses (urban area food service restaurants with excess dishwashing capacity, tunnel/conveyor type machinery, location and logistical benefits), incentives for shared

[14] http://eurowasteeurope.eu/wp-content/uploads/2019/10/bffp_rpa_report_reusable_solutions_report_en.pdf

dishwashing use have already been discussed in a previous chapter.
    - In Finland, the major food service and campus restaurant service providers are:
        - Compass Group[15]
        - Sodexo[16]
        - Juvenes Ravintolat[17]
        - Unicafe Oy[18]
        - Antell[19]
- Use of existing logistics infrastructure for reuse:
    - Use of existing grocery logistics
    - Use of existing food service logistics
    - Use of existing transport units, load carriers and equipment (pooled assets), the focal company is Lännen Teollisuuspalvelu Oy[20]
- Use of existing reverse vending machines:
    - As an enabler, containers compatible with existing reverse vending machines are required; one example is the German reuse company Sykell[21]
- Use of existing distribution and logistics centres for storing and redistributing cleaned reusable containers.

[15] https://www.compass-group.fi/

[16] https://www.sodexo.fi/

[17] https://juvenes.fi/

[18] https://unicafe.fi/

[19] https://www.antell.fi/

[20] https://ltplogistics.fi/yritys/lannen-teollisuuspalvelu/

[21] https://www.einfach-mehrweg.com/

7 The consumer's role as a part of the reuse system

Consumers play a crucial role in ensuring that a reusable take-away food packaging system is successful and scalable. Consumers' active contributions can be categorised into **individual and collective actions** that improve the system's adoption and effectiveness.

The most direct way consumers support the system is by returning reusable packaging to designated collection points in a timely manner after use. Timely returns ensure that packaging can be washed, sanitised and reused efficiently. Secondly, consumers should follow the handling and cleaning guidelines for the packaging. They should ensure that reusable packaging is not heavily contaminated before returning it. This is done by basic rinsing with water. It is not necessary to wash it with warm water and detergent, since doubling the consumption of water, energy and chemicals may jeopardise sustainability goals, given that the reuse system includes professional washing. Other potential consumer contributions include encouraging participation among peers, educating friends, family and colleagues about the benefits of reusable packaging, providing feedback to improve the system, sharing user experiences, reporting issues such as insufficient return points, supporting businesses that offer reusable packaging, and using and promoting the system, including digital tools. Reusable packaging systems have apps for ordering, tracking packaging returns, finding return stations, and earning incentives. Consumers can use these tools and promote them to others.

Collectively, consumers can improve the adoption and scaling of the reuse system. They can the expansion of the system by engaging with authorities and businesses to install more collection points and adopt more reusable packaging, leveraging social media and public awareness campaigns to share personal experiences and success stories online, inspiring others to join in. Many reusable packaging systems start with pilot programmes and trials. By participating in these, consumers can provide feedback and refine the system before it is scaled up.

By taking both individual and collective actions, consumers can significantly contribute to the success of reusable take-away packaging systems, making them more accessible, convenient and widespread.

The consumer reuse journey consists of various actions, including those initiated by the consumer themselves and those carried out by the system provider in response. These actions are illustrated below, with consumer interactions denoted by (C) and service provider activities by (S).

- (C) Awareness building
- (C) Signing up and communicating with the system
- (C) Receiving packaging
- (C) Preparing the order
- (C) Making payment, including any deposit if applicable
- (C) Enjoying the product
- (C) Returning the containers
- (S) Collecting and transporting containers
- (S) Washing and sanitising containers
- (S) Delivering containers
- (S) Managing container inventory

Scaling up reusable packaging systems requires broad consumer engagement. This often involves refining and optimising the customer journey to remove obstacles and introducing new sources of enjoyment. Key consumer touchpoints include interactions with physical products (such as packaging, food items, collection bins), digital interfaces, and services provided directly by staff. These touchpoints offer numerous opportunities for operators to create a seamless and enjoyable user experience. See Appendix A for an example from Closed Loop Partners.

This report identified the key activities of reuse service providers (Figure 1 in Chapter 2). When combined with the efforts of necessary partners, these activities are critical for initiating system trials and effectively engaging individual users. However, many trials have faced significant challenges in scaling up and achieving broader system engagement. Key challenges include expanding the customer base, improving system efficiencies, and fostering partnerships. Addressing systemic barriers and enabling factors will be essential to overcoming these obstacles.

The consumer’s role is key, because large-scale system change occurs one individual at a time. We define "consumer" as the citizen-individual who uses the product in various settings: at home, at work, in campus restaurants, in cafés or on the go. Reusable packaging requires far greater user engagement than single-use alternatives, underscoring the need for comprehensive information sharing and communication.

To support this, it is crucial to provide clear and accessible information through various channels, such as packaging, point-of-sale materials, or digital tools like QR codes. This information should include rules and regulations, cleaning instructions, and return options.

In addition to information sharing, consumer reward mechanisms are essential. These incentives should extend beyond a single reward point, such as a deposit, and instead offer rewards throughout the entire system journey.

8 Geographical aspects of the pilot systems

Globally and in the EU, the majority of reusable piloting projects and scaling efforts are located in large urban centres and cities. Notable urban pilot projects have been arranged in Germany (Berlin), France (Paris), the Netherland (Rotterdam) and the UK (Yorkshire). Outside Europe, there have been pilot projects carried out in Canada (Vancouver, Toronto and Montreal) and the USA (west coast region). All these cities stand out for their high total population and potential customer density.

The European policy recommendations for reusable systems are based on the minimum viable population density for reuse schemes. This is understood as the **proximity of a high enough number of users and vendors to provide economies of scale**. As such, **urban populations and specific occasions, such as festivals, are key targets** for a first shift towards fully reusable packaging and have the highest priority because of the prevalence of on-the-go consumption in these areas and the volume of items used. However, simple "bring your own" reuse solutions will still be viable in more dispersed communities with low investment costs.[22]

According to Eunomia,[26] reusable food packaging service trials initiated in Europe are predominantly executed in high-density urban cities, where consumers are environmentally conscious and prefer sustainable products, and thus provide a favourable market. **Cost-Benefit-Analysis (CBA)** approaches to reuse systems are often executed with limitations:[23]

- Urban areas with access to reuse infrastructure, i.e. within a **300 km radius**
- Medium-to-high legislative pressure, with packaging EPR in place
- To compare the costs and benefits associated with implementing and operating the system over its lifecycle

[22] https://zerowasteeurope.eu/wp-content/uploads/2024/09/ZWE_Sep24_Report_Facilitating-the-Adoption-of-Takeaway-Reuse-Systems.pdf

[23] https://zerowasteeurope.eu/wp-content/uploads/2023/06/2023-SB-ZWE-The-economics-of-reuse-systems.pdf

Vytal, a pioneer in reusables, began operating in the sector in 2019 with the idea of exploring a business opportunity to provide a novel, sustainable, circular, and deposit-free packaging system. They initiated trials in large cities such as Berlin, Hamburg and Cologne. In the beginning, the company only operated in selected high-density areas of major cities to minimise the operational costs of container re-distribution. Later, they also needed to distribute containers between partners within different cities or regions. Just recently, Vytal has also expanded into the Nordic countries, Norway and Sweden, with 19 partners in Oslo and 14 in Stockholm.[24]

Vytals' reusable operator service strategy demonstrates that the **key business interests are in the largest cities.** The company currently operates in 16 countries and has replaced more than 9 million disposable containers in those countries. Vytal can also take over the washing of the containers for the partner in selected regions. It is assumed that most containers are currently washed by partner companies. Vytals' current operating model is illustrated in the figures below. When the scaling of operations continues, it may be necessary to reach agreements as regards dishwashing. Currently, dishwashing is carried out solely using the washing capacity of the partners themselves.

Business Description:
VYTAL operates a digital reusable packaging system with premium, 100%-leak proof bowls for take-out and delivery food. We serve canteen operators, restaurants, supermarkets and delivery services that use our bowls in a Packaging-as-a-Service model and on a pay-per-filling basis. For consumers VYTAL is comparable to sharing services: Consumers register in our app or buy an offline member card to receive their food in our bowls and return them to any partner outlet where the bowls are locally cleaned. No cash-out or deposit is needed for the bowl because all transactions run digitally with smart labels and on our technology platform. This enables us to use nudging, incentives, gamification and promotions to motivate quick returns, thereby maximizing bowl utilization and sustainability impact.

Figure 12. Description of Vytal's business and operating model.[25]

[24] https://www.vytal.se/bli-partner/

[25] https://www.vytal.lu/canteens

Eunomia[26] evaluated and compared reuse packaging system cost structures between cities of different sizes in 2024 (Aarhus, with a population of 368,131, and Berlin, with a population of 3.87 million) in a situation where the adoption of reusable packaging has achieved a market penetration rate of 85%. This means that 67,000 meals are served daily in reusable containers in Aarhus, and 650,000 in Berlin. According to Eunomia, while economies of scale do exist for reusable packaging systems, there was no significant difference in costs between Aarhus and Berlin in the cost estimation model created. Extrapolating this conclusion to smaller towns and cities, it seems that although costs would increase as the town/city size decreases, they would not become prohibitively high, even for towns significantly smaller than Aarhus. This means that economic viability can be achieved even in cities with tens of thousands of inhabitants. In the scaling phase, according to Eunomia, centralised washing of reusable packaging would be localised at a city level. Ideally, this could mean one washing unit with tunnel machine capacity.

It was found that the net cost of a reusable packaging system varies significantly depending on the type of packaging format. The figure below shows the net costs (i.e., the cost of adopting a reusable packaging system minus the costs avoided by moving away from single-use packaging) of all packaging formats separately, for packaging reuse systems in both Aarhus and Berlin. Pizza boxes and burger boxes demonstrate a higher net cost than the other formats, as they are the least efficient in terms of washing and transport. On the other hand, cups, bowls and sushi boxes have a relatively low net cost and are almost cost neutral. While the findings for Berlin and Aarhus are similar, it appears that the cost of implementing the modelled reusable packaging system – which does not take into consideration any supporting fiscal policy measures – is lower in Aarhus than in Berlin. The most significant variable impacting the relative cost per serving in Aarhus and Berlin is the unit cost of electricity (€0.36 and €0.56/kWh in Denmark and Germany, respectively). Given that in a reusable packaging system, the packaging needs to be washed at a wash plant, which uses a significant amount of electricity for water heating, and that electric vans are used to redistribute the packaging, the cost of electricity is a key variable in this study.

The reusable packaging systems modelled for Aarhus and Berlin do not demonstrate significant differences, even though the Berlin system is almost ten times larger than the Aarhus system. The economies of scale of the larger city do not significantly impact the results, as the Aarhus system is already a large-scale operation. Reasons for the similarity between the two cities include the fact that both systems are of a sufficient size to fully utilise multiple wash plants (i.e., plants with three industrial washing lines per plant).

[26] https://eunomia.eco/wp-content/uploads/2024/11/ZWE_Sep24_Report_Facilitating-the-Adoption-of-Takeaway-Reuse-Systems-4.pdf

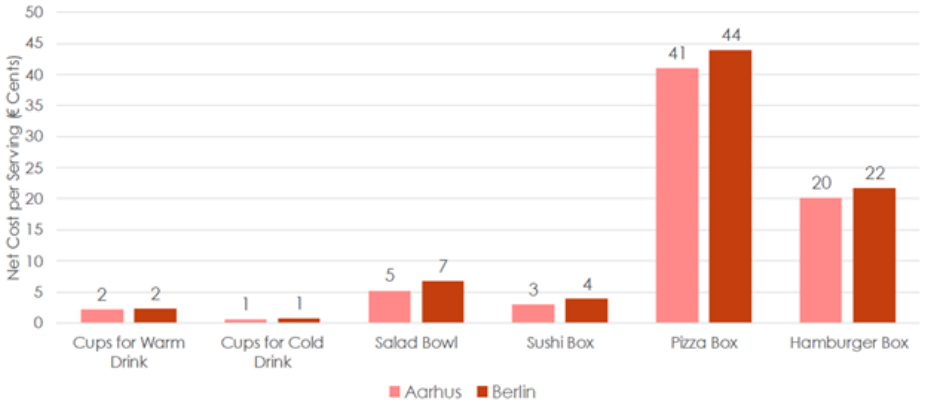

Figure 13. Net costs of reusable packaging by format in Aarhus and Berlin.[26]

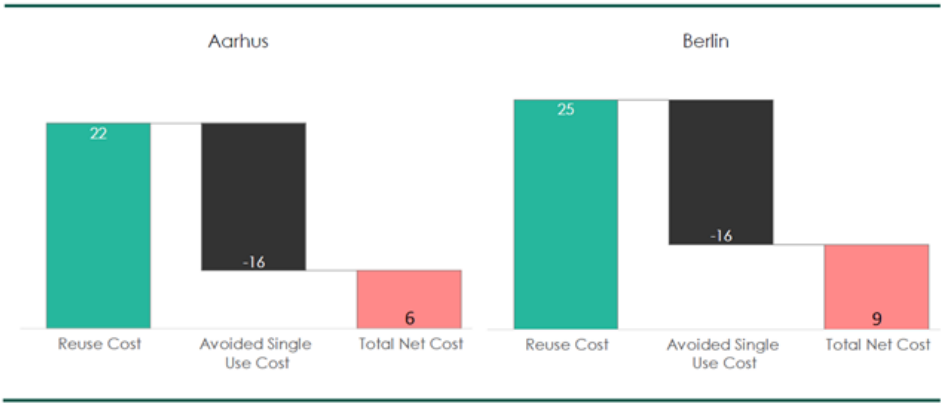

Figure 14. All reuse costs compared to the avoided costs of single use for a mixed-format system: the unit is the cost per serving in euro cents (¢) for all charts.[26]

Outside the EU, there are recent examples available from Canada, where there are more than 50 product and service providers across four provinces (British Columbia, Ontario, Quebec and Alberta) offering reuse and refilling alternatives, mainly located in densely populated urban areas, and often supported by online platforms. More than half (i.e., 27) of the identified service providers are Canadian start-ups, while other successful service providers have their roots abroad.[27]

In Finland, the most promising urban areas for reusable food packaging systems are located in the capital region, which includes large cities such as Helsinki, Espoo and Vantaa, as well as the next largest cities outside the capital region: Tampere, Turku and Oulu. Within these areas, system pilot projects can be

[27] https://plasticspact.ca/wp-content/uploads/2023/04/CPP-Study-on-Reuse-and-Refill-of-Plastic-Packaging.pdf

based on existing washing and logistics operations. This requires incentives, especially for washing facility infrastructure owners and operators. In terms of logistics, it is assumed that there is available capacity, for example, in the outbound and inbound logistics of grocery and food services. The primary reasons for adopting reusable logistics are improved operational efficiency and improved customer service. As Finland is a sparsely populated country, it is clear that consumers living outside cities or in areas with low population density may have limited access to reuse systems.

9 Solving the bottlenecks connected to the scalability of logistics and washing solutions

Reuse system pioneers in the field of reusable dishwashing have also contributed to the scalability of the reusable packaging system. For example, the Buddie-Pack (EU Horizon) project has studied systems for sustainable plastic packaging reuse schemes in mass market applications. The project presented a comprehensive list of barriers and enablers for scaling reuse systems. A full list can be seen in Appendix B.

Some packaging design features may either hinder or enable operational efficiency. The material's strength determines the load resistance of the packaging. This affects the number of units that can be safely stacked on top of one another during storage or transport. Containers should be designed with shapes that allow stacking, enabling efficient use of space when empty containers are stored or transported. The shapes of both containers and their lids must be specifically designed to enable secure transport when filled and stacked. This ensures stability during transport and storage. Also, containers must be compatible with secondary (e.g., transport units) and tertiary (e.g., pallets or carriers) packaging formats. Ultimately, ensuring compatibility improves handling, reduces waste and optimises space usage across the supply chain.

Some other features that facilitate washing efficiency are:

- The material should be non-porous, making it easier to wash.
- The container design should minimise stains, food residues and easy disassembly.
- Avoiding light colours, sharp angles and hard-to-reach areas during washing is crucial.
- Containers should dry easily during the drying programme.
- Easy cleaning and drying designs to prevent microbial growth and biofilm formation, etc.
- Containers must tolerate sanitising steps (for allergen contamination and pathogenic bacteria) after cleaning and before filling.
- Criteria for the acceptable level of scratches, odours, colour changes and deformation.
- The design should allow for packaging to be shared.

Economic bottlenecks. According to the Ellen MacArthur Foundation, in Figure 15, to fully benefit from return systems both economically and

environmentally, collaboration is crucial. Building an effective reuse-return system requires collective action on three key performance drivers: shared infrastructure, standardised packaging design and achieving high return rates. These elements have the potential to significantly improve economic and environmental outcomes.

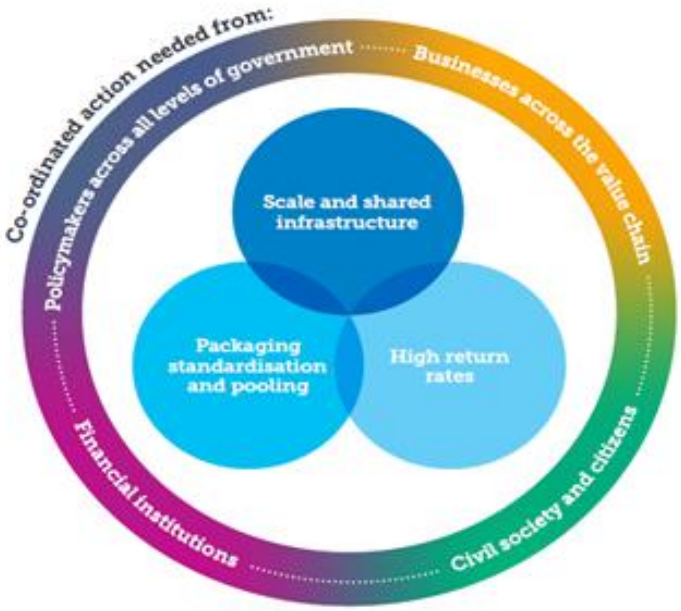

Figure 15. Key factors for the economic and environmental success factors of reusable packaging systems according to the Ellen MacArthur Foundation.[28]

The challenge in Finland lies in getting consumers to commit to using reusable food containers. This change is not simple. Raising consumer awareness is essential to support this transition. Reuse needs to become part of daily routines, requiring consumers to adopt new habits, such as purchasing food in reusable containers, returning them, managing deposits and navigating the related software systems.

In the EU, one way to introduce reusable packaging to new users is during events and large-scale gatherings. Recently, more than 15 million people gathered in the French capital to experience the Olympics.[29] Many of the spectators noticed something new when they stopped by a snack stand to get beverages, as the Paris Olympics were the first to serve drinks in reusable packaging, in partnership with the France-based company Re-uz.[30] The Paris Olympics were the largest

[28] https://emf.thirdlight.com/file/24/sjZ_pROsjk8VSKPsjXVEszMGHY/Unlocking%20a%20reuse%20revolution%20-%20scaling%20returnable%20packaging.pdf

[29] https://www.triplepundit.com/story/2024/paris-olympics-reusable-packaging/807901

[30] https://re-uz.com/en/

sports event ever to replace single-use beverage cups with refillable alternatives. This event sent a clear message to all event organisers and beverage brands that reuse is possible on a large scale. Could these events be fully used to boost the adoption of reusable packaging outside the event sector too? Re-uz has been active in reuse setups at major events such as the Wimbledon tennis tournament and music festivals across Europe. The company has a network of washing centres across the continent to minimise excessive shipping, operating at more than 32 sites within France alone for the distribution, logistics, washing and delivery of reusable packaging. In Finland, event attendees are also familiar with the use of reusable packaging. This may pave the way for the adoption of other types of reuse.

Figure 16. Snapshot and achievements of the Re-uz reuse service, and reusable packaging for the GreenCup event by Green Vuokraus- ja Pesupalvelut.[31]

Vytal[32] has pioneered software platform functionalities with a focus on user commitment and growth opportunities. The company refers to this approach as user-based learning, emphasising the importance of listening carefully to customer feedback through the platform about their demands and desires. The software

[31] https://greencupnordic.com/fi/how-it-works/introducing-reusable-event-solutions/

[32] https://www.vytal.org/vytal-global-home

platform is used systematically to gain insights into users' new product desires and functionalities, ensuring that the product remains fit for the market and that consumer engagement is sustained. Vytal also uses algorithms to detect changes in user behaviour (e.g. patterns in the acquisition and return of food containers) and to analyse comments and ratings provided by consumers and partners. This is crucial in the food business, where consumer demand and behaviour patterns are highly volatile.

The key task of reusable service operators is to organise container distribution, collection, washing, redelivery and recycling when the packaging is at the end-of-life for reuse. Before initiating trials, the service operator first acquires a suitable portfolio of containers from the packaging developer and manufacturer. The service operator also plans and arranges logistics and container flow optimisation systems, typically by partnering with existing logistics service operators. Early adopters have faced challenges with container deliveries; for example, Vytal has its own small delivery fleets to redistribute containers between partners when there is a shortage of containers in specific locations, and the system has been unable to predict major changes in demand. Normally, however, inter-city transfers are managed through third-party logistics providers.

The company Re:Dish[33] has identified three main challenges when developing a large-scale reusable programme.

Challenge #1: Seamless transition to reuse: transitioning from single-use to reusable packaging needs to be as smooth as possible to minimise disruption. Reusable programmes should be comprehensive and require minimal staff training, while providing full implementation support. To make the transition easier, the cost of a reusable programme should be comparable to single-use options, achievable by designing for scale. The washing facility must have the capacity to easily wash tens of thousands of units daily, leverage the latest technology for efficiency, and ensure all containers are tracked, cleaned and delivered on time.

Challenge #2: Return rates: one of the primary challenges is ensuring high return rates. High return rates are enabled by closed-network food system units, such as corporate restaurants and cafes, where individuals typically consume their food in the same environment in which it is served. Since people tend to use reusable containers in a central location, it is much easier to retrofit existing trash and recycling bins for reuse. Moreover, repeating the process of reuse daily creates muscle memory and reinforces the habit of returning reusable packaging to the appropriate locations.

Challenge #3: Consumer and stakeholder acceptance: reusable programmes must be easy to understand and implement for both consumers and other stakeholders. Kooky's[34] experiences in Switzerland highlight the first

[33] https://www.redish.com/empoweringorganizations

[34] https://www.bluewin.ch/en/news/reusable-cup-start-up-kooky-tries-its-luck-in-the-corporate-business-2307136.html

challenge: if given the choice, 99% of the customers will choose disposable packaging. This is primarily because the existing infrastructure is designed for disposable packaging, with widely distributed waste collection bins and a well-established collection system. Making the new system as convenient as the old one is crucial. However, one challenge remains: disposable cups are cheaper. Changing customer behaviour requires guidance and ensuring that all benefits are apparent if the necessary reuse cycles are achieved.

The adoption of take-away reuse food systems tends to be easier in urban areas due to the larger number of younger residents, higher population density and the presence of established brands and operators. These factors simplify the creation of system boundaries. For smaller cities, the reusable packaging system can be adjusted by modifying elements such as truck size, dishwashing machinery capacity and staff roles, which can be part-time or multifunctional. Overall, the issues to be addressed in Finland are illustrated in Figure 17.

Figure 17. Key issues to be addressed as regards the adoption of reusable packaging systems in Finland.

10 Economic viability aspects of the system

This report presents a reuse system where, e.g., food can be purchased together with its packaging, which can be used and, once used, returned, cleaned, and refilled for the intended number of use cycles. In EU countries, numerous reusable packaging trials have been carried out, many of them in Germany, the Netherlands, France, Spain and the UK.

The economic viability of implementing a reusable food packaging system is influenced by several factors, including city size, population density and demographics. The entire reuse chain and its interdependences must be taken into account. To start with, we recommend considering the following first:

Population density and city size: densely populated urban areas are more conducive to cost-effective reusable packaging systems. High population density facilitates efficient collection, cleaning and redistribution processes, reducing transport costs and associated emissions. Conversely, in sparsely populated areas, longer distances between users can increase operational costs.

Demographics: the success of reusable packaging systems also depends on the demographic profile of the city. Cities with a higher concentration of environmentally conscious residents may experience higher participation rates, enhancing the system's effectiveness. Additionally, areas with a younger population might be more adaptable to new practices, such as using digital platforms for managing reusable packaging.

Economic viability threshold: while there is no universally defined minimum city size for economic viability, the system's success hinges on achieving a critical mass of users to justify the infrastructure investment. For instance, a study by Zero Waste Europe indicates that reusable plastic food containers become more economically advantageous than single-use containers when a high return rate is achieved, allowing each container to be reused multiple times (at least 20). This scenario is more attainable in larger cities with the necessary user bases.

11 Conclusions

This report provides a comprehensive overview of the initial design and implementation strategies for a reusable packaging supply chain system in the context of take-away food. It summarises the findings of various EU and company-specific reports, as well as learnings from implementations in Europe and Canada. The main results of the report include the system design of the reusable packaging supply chain, which highlights the operational reuse system, the necessary supply chain activities and the actors involved. It builds on reference cases and offers solutions to support companies in designing the logistics solutions for their joint experiments. The most important outcome of the system design of the reusable packaging supply chain is the figure illustrating the actors in the reusable packaging supply chain and their activities. The most important actor is the reuse service or system operator, who is responsible for most of the activities. The other actors are frontline operators (e.g. retailers and restaurants), customers, and washing and logistics service operators. All the actors play an important role in the system.

The report also discusses the collection and logistics infrastructure that enables reuse, emphasising the importance of the first mile. The key aspects to consider when planning the system are the type and number of collection points, bins, collection machines, transport units, delivery bags, collection sacks, load carriers and tracking elements. Additionally, the geographical coverage and location of these components should also be taken into account. Return models were also presented, of which ‘return from home’ seems to be the most common, and examples from reference cases were given.

Furthermore, the report provides examples of solutions for transport units that ensure efficient handling at all stages of the supply chain: collection, transport to washing, feeding and collection during washing, transport to storage and redistribution to food producers and retailers. The transport units create value through protection and hygiene, efficiency and cost-effectiveness, traceability and minimisation of environmental impact. There are also different levels of transport units, and the number needed depends on return rate, cycle time, demand variability and the total volume of reusable packaging.

The main findings regarding centralised and decentralised washing solutions concern their various advantages and disadvantages, with centralised washing

requiring more transport but enabling more streamlined and efficient handling. Key questions to address regarding the use of existing washing infrastructure are provided. Between centralised and decentralised dishwashing, there is also mid-scale centralised dishwashing, which makes more efficient use of existing infrastructure without requiring heavy investment in a completely new centralised facility. The ZWE report shows calculations comparing decentralised and mid-scale centralised dishwashing with centralised dishwashing, including the transports required, and found that decentralised and mid-scale centralised dishwashing was the more cost-effective option.

In the chapter on incentives to promote the use of existing infrastructure for reuse, the main conclusions are the suggestions and considerations provided on the use of existing dishwashing and logistics infrastructure, reverse vending machines, and existing distribution and logistics centres.

Next, the main results regarding the role of consumers from an operational viewpoint and as part of the reuse system are that they play a central role in the system as actors that return packaging to circulation. It is central for the system and for reusable packaging to circulate that consumers return packaging in a timely manner. Consumers can also act collectively to improve the adoption and scaling of the reuse system.

The key findings of the chapter discussing the geographical aspects of pilot systems are that large cities usually have the most potential for reusable packaging. European policy recommendations rely on the minimum viable population density for reuse schemes. Reusable packaging trials are also usually carried out in high-density urban cities. The chapter also presents a cost comparison by Eunomia, where the net costs of reusable packaging systems in Aarhus and Berlin did not differ significantly, even though Aarhus is approximately 10% of the size of Berlin in terms of daily servings. This shows that economic viability is possible even in smaller cities. The conclusion is still that the largest cities in Finland have the most potential.

The main bottlenecks that could affect the scalability of logistics and washing solutions are discussed in Chapter 9. A full list of barriers and enablers for scaling reuse systems developed by the Buddie-Pack project (EU Horizon) can be found in Appendix B. Packaging design features that affect handling and logistics, such as stackability and durability during handling, are listed. To overcome economic bottlenecks, collaboration is crucial and collective actions are needed on three key performance drivers: shared infrastructure, standardised packaging design and achieving high return rates. Consumer commitment is also one of the main challenges that relates to the last key performance driver in achieving high return rates. Large events are cited as an example, such as the Paris Olympics, which was the largest sports event ever to replace single-use beverage cups with refillable ones. These were provided by the company Re-uz, which has a network of washing centres across Europe. Another important finding regarding the main bottlenecks is the list of three main challenges listed by the company Re:Dish, of which the first is the seamless transition to reuse, the second is return rates, and the third is consumer and stakeholder acceptance. To conclude this chapter, four

key questions to be addressed in terms of the adoption of reusable packaging systems in Finland are presented in Figure 18. These are: 1. Is system-wide tracking, including transport units, possible? 2. Is asset-sharing between frontline operators possible and desirable (including shared packaging, collection infrastructure, dishwashing and logistics)? 3. Can excess dishwashing capacity in food service businesses be used? 4. Can free load capacity in transport logistics be used between frontline operators and washing service operators (inbound and outbound)?

Lastly, as regards the economic viability aspects of the system, it is necessary to consider the entire reuse chain and its interdependencies, and we recommend considering population density and city size, demographics and the economic viability threshold.

The overall aim of this report and the initial reuse supply chain system design provided is to support companies in designing and implementing effective reusable packaging systems.

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Appendix A: Example – The customer journey in reusable cups, Closed Loop Partners

In the figure below, an example of a system customer journey is illustrated by Closed Loop Partners.

Figure A1. Steps in the customer journey of reusable cups.[35]

[35] https://www.closedlooppartners.com/wp-content/uploads/2021/01/CLP_Bringing-Reusable-Packaging-Systems-to-Life.pdf

Appendix B: BUDDIE-PACK – Barriers and enablers for scaling the system

Pioneers in the field of reusable dishwashing have also contributed to EU Horizon-funded projects. One notable example is BUDDIE-PACK—Business-driven systemic solutions for sustainable plastic packaging reuse schemes in mass market applications—which started on September 1, 2022, and will last for 42 months. Deliverable D2.1 - Consumer Interaction with Reuse Systems - outlines a comprehensive list of identified barriers and enablers for scaling reuse systems.

Table B1. List of barriers and enablers for scaling reuse systems based on the BUDDIE-PACK project.

Factor	**Barriers**	**Enablers**
Availability	Not available where people live or shop Not designed for users with physical, sensory or age-related disabilities Harder to transport if using public transport or cycling	Availability of reuse systems and packaging Choice of brands and locations Shared distribution and return points Density, mix of location and return points Allows physical, sensory and age-related access
Awareness	Lack of knowledge about how reuse works No awareness of environmental impact Specific skills needed for different types of reuse systems	Understanding of environmental and cost benefits Awareness that packaging is reusable and where to return
Communication	This is ‘greenwashing’ Lack of trust in sustainability claims and influencers	Clear, reliable, positive and consistent communication Points of sale, display devices and signage, timely prompts to act Marketing campaigns and social media
Competencies	Lack of confidence and knowledge about how reuse works	Learning how to use systems through being shown what to do and experience Feeling skilled and capable of engaging

	Inconsistency, different skills needed for different types of reuse systems	
Convenience	Time-consuming, extra effort needed Limited home storage space Inconvenience of returning Messy (e.g. refills, leakage) Difficult to transport, store and/or clean	Timesaving or time neutral Easy to opt-in, use and return Removes friction points and saves time Easy to transport, store and/or clean
Costs	Higher initial cost More expensive than single-use Hard to compare reusable and single-use prices Too high or low deposit or penalty for non-return	Same or cheaper than single-use Single-use packaging charge Easy to compare reusable and single-use prices Opt-in incentives, promotions, discounts, free packaging Return incentives, e.g. deposit return scheme, loyalty points, subscription models Charge for loss or late return
Demographics		Female/Male Older; with higher education Young urbanites Higher income Younger online shoppers Hybrid workers
Environmental attitudes	Scepticism regarding environmental benefits Belief that recycling is better than reuse Perception of plastic as problematic Feeling - "it's not for me" Low perceived impact of own behaviour Do not feel responsible for reducing waste	Concern for the environment and single-use plastic waste Green self-identity High perceived efficacy of own behaviour Belief that it is less wasteful and more sustainable Positive emotions associated with reuse Negative emotions associated with waste Responsible for reducing waste

Habits	Forget to return Does not fit in with routines Irregular and spontaneous consumption Reluctance to try something new Used to functionality of single-use	Regular consumption Fits in with routine Goal-setting and habit-forming interventions Feedback on impact of actions
Hygiene	Concerns: contamination, product freshness and safety Sensitivity to food-related disgust Absence of packaging labels and expiry dates Seeing others touch product or packaging Perception of food safety regulations e.g., not allowed to bring own container	Reassurance of cleanliness Perceived freshness of unpackaged goods
Packaging design	Attractiveness and branding Breakage or damage Bulky or heavy packaging Chosen material Not recyclable at EoL Poor functionality, difficult to open/close, not resealable, gets too hot, contents go cold quickly, wear and tear, discolouration, scratching, staining Wrong size for preferred quantity	Attractive to use but not keep Designed to use, stack, store and transport Durable and lightweight Looks: clean, like new, quality, reusable, transparent if food contents inside Recyclable at EoL Similar or improved functionality compared to single-use, e.g. easy to open and close, thermal, heat-resistant, leakproof, resealable Right size for preferred quantity
Product	Limits product range and type Quality concerns, freshness Changes ready-to-eat experience, humidity, smell, looks different Slicing?	Product variety Custom portion size Quality control, e.g. can see and choose Product attributes, e.g. organic, local Improves ready-to-eat experience, e.g. food better presented or protected

Social norms	Unfamiliar reuse system, unsure what to do Embarrassed if things go wrong Fear of judgement from social environment Lack of examples from others Eating outdoors, on-the-go, in large groups	Familiar reuse system Reusable packaging as the default Single-use packaging removed Prominent placement of reuse system Reuse system looks busy Trendiness and peer influence
Systemic factors	Open-loop systems, e.g., city-wide	Closed-loop systems/workplace, festival Collaboration across brands Upscaling Remove the option of single-use packaging Policies, regulations and bans
Staff engagement	Busy with other tasks Not available to assist customers Shared reusable packaging: staff less willing to serve customers	Ambassadors for reuse Available to assist customers Incentives to recruit new users Training Personal reusable packaging: willing to serve
Technologies	Complicated app/QR code process Digital access Digital and mechanical malfunctions	Simple sign-up and return process Timely maintenance and repair Return reminders via email and app alerts

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Author(s)	Ismo Ruohomäki, Rosa Palmgren & Riikka Kaipia
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