DEVELOPING A FRAMEWORK TO SUPPORT THE INTRODUCTION OF REUSABLE GLASS PACKAGING INTO A VALUE CHAIN

ESTABLISHING AN ECOSYSTEM CONFIGURATION AND CORRESPONDING IMPLEMENTATION ROADMAP FOR THE CONTENT PRODUCER BRINKERS FOOD

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Developing a framework to support the introduction of reusable glass packaging into a value chain
Establishing an ecosystem configuration and corresponding implementation roadmap for the content producer Brinkers Food

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PREFACE

The past nine months have been dedicated to this graduation thesis for the study of Industrial Design Engineering at the University of Twente. The establishment of this thesis would not have been possible without the aid and support of Brinkers Food. In most particular my mentor, Bernd Brinkers, who has been generous with his time and effort to provide, not only insights on the details regarding Brinkers Food, but also valuable feedback based on his academic knowledge and many years of experience in the industry. The warehouse tours and the interactive discussions we have had have helped me greatly to achieve the results that I can now proudly present in this report. I am very grateful that you have gone the extra mile to include me in additional projects and aided the possibility of publishing articles in different food-related magazines. Bernd, thank you for your trust in my abilities and providing me this opportunity to get to know Brinkers Food, meet a variety of amazing collegues and make use of your resources and connections to get to generate the best possible version of this thesis.

Another thank you note is dedicated to the University of Twente, in most particular my supervisor Bjorn de Koeijer. Despite the fact that we have had a limited number of meetings, you were always open to discuss my problems and progress. During these meetings, the discussions we have had have been a valueable contribution to my research and have challenged me to dig a bit deeper and not take the first answer for granted. Your honest and constructive feedback have always pushed me to achieve the best possible result. Your door was always open and your guidance and experience have helped me greatly during this thesis, for which I am very grateful. Bjorn, thank you for your time, knowledge and advice throughout the past nine months.

SUMMARY

This thesis aims to develop a framework that supports the establishment of an ecosystem configuration *(network of entities and responsibilities enabling the presence of reusable glass packaging in the value chain)* which aids the development of a corresponding implementation plan for the introduction of reusable glass packaging into a value chain.

This thesis is split in the following four parts. Part I contains the background, aim, research questions and research approach of this study. Part II the framework development. Part III applies the framework through a case study and Part IV evaluates the framework and provides recommendations.

PART II

Through desk research and by consulting experts on the topic of reuse and ecosystems for reuse the framework is established. To provide clarity in the research, a multilevel Macro, Meso, Micro approach is used (Jackson et al., 2014). The Macro and Meso levels cover the indirect and direct entities that will interact with the ecosystem for reusable glass packaging. The indirect entities that have been identified are the food safety standards, legislative powers, environmental and reuse organisations and suppliers of the value chain. The direct entities are the companies present in the value chain: glass manufacturer, content producer, retailer, store, consumer, collection hub and a cleaning facility. For a linear value chain, the end of life solutions can be considered as direct entities as well. The Micro level is the identified responsibilities necessary to create a viable ecosystem. A total of 17 responsibilities are highlighted, of which 8 are related to the linear logistics, and the other 9 are related to the reverse logistics.

These findings have been combined in an accessible tool, further referred to as "framework", that can be used to support the establishment of an ecosystem configuration for reusable glass packaging suitable for a specific value chain in the food industry.

PART III

To evaluate the applicability and usability of the framework, it has been put into practice through a case study. The case study is executed for the chocolate spread content producer Brinkers Food, with the goal to generate an ecosystem configuration for a reusable packaging for their own brands (La Vida Vegan and So Vegan So Fine), combined with a corresponding implementation roadmap.

Firstly, the current situation is depicted, using the framework to provide an overview of the entities present and the responsibility division in the ecosystem from an external (Macro and Meso level) and internal perspective (Micro level). This is executed through desk research and expert interviews. Thereafter, the future situation of the implemented reusable glass packaging is depicted. Through interactive sessions with entities present in the ecosystem and by interviewing experts, again an external and internal ecosystem configuration is created by combining the findings in the framework. To establish the implementation roadmap, the current and future situation have been compared which has led to the identification of the steps needed to facilitate the transition between the two situations. These steps have been combined in a 5-phase roadmap that guides the subject of the case study, Brinkers Food, through the implementation process of introducing reusable glass packaging into their value chain.

PART IV

To conclude this thesis, the applicability and usability of the framework have been evaluated. This has led to the identification of several limitations of both the case study and the framework itself. Based on these limitations, the framework is improved and recommendations for future research have been established. The final result of this thesis a more interactive version of the framework that can support the establishment of an ecosystem configuration for the introduction of reusable packaging into the value chain.

INTRODUCTION & RELEVANCE

The coming introduction of the adapted European Packaging and Packaging Waste Regulation (PPWR)(Directive 94/62/EC) and the Single Use Plastics (SUP) regulation (Directive EU 2019/904) has put pressure on industries to switch to more sustainable alternatives for their packaging, predominantly focusing on reusable packaging. As a result, in the Netherlands and Germany specifically, 70% of beverage containers must be reusable by 2022 and the French market has aimed for 5% reusable packaging in the market by 2023 (Fabre & Joannard, 2022). However, glass has not yet been specifically included in these regulations as of yet, which is striking, as the environmental impact of glass is higher than any of the other single-use packaging materials (Ingarao et al., 2017).

Over the past decades, successful efforts have been made to improve the circularity of glass packaging, using for example deposit money as a motivator for consumers. However, most of these solutions are specifically targeted to beverage containers, for example beer, refreshments or wine(Lee et al., 2018; Tsiliyannis, 2005). Only little research is executed on glass jars and mostly results in a reuse principle where the consumer can turn their jar into a vase, spice jar or gift packaging (Ardagh, 2021). Notably, the largest amount of disposed glass (over 50 %) is in the form of such jars for solid or viscose food products, as concluded in a pilot study questioning the willingness of Dutch citizens to make use of a deposit-return system arranged by a pick-up service (Wester & Verweij, 2022). Additionally, the study concluded that 93% of the questioned inhabitants were enthusiastic to join the waste collection system, but most were not willing to pay for the service. This suggests that there is a motivated user group ready to participate in an ecosystem for reusable glass packaging, such as the PAKT initiative in the Netherlands already does on a local scale (Brouwers, 2023). This illustrates that the only thing lacking is the presence of an ecosystem for reusable packaging on a large scale.

This is where this research aims to make a difference. Through exploring how an ecosystem configuration can be established for a value chain that has not yet implemented reusable glass packaging, future introductions of ecosystems for reusable glass packaging for solid and (highly) viscose food can be supported. This does not only provide the starting point to increase the presence of such ecosystems in modern day society, but it also bridges the knowledge gap on how to integrate reusable packaging in industries that have no experience in this area as of yet. This research provides a framework that aids the establishment of a suitable ecosystem configuration for a given value chain though a case study, which is then compared to the current situation. As a result, an implementation roadmap is established that is tailored to the needs of the affected entities. This process of developing suitable ecosystem configuration for reusable glass packaging for a specific value chain can serve as an example for research and industries.

To create the overview that helps determine the ecosystem configurations, this research will use a Macro, Meso, Micro analysis (Jackson et al., 2014), hereby including all possible interactors with the ecosystem. This leads to a holistic understanding of all entities involved in the ecosystem for reusable glass packaging, resulting in a widely applicable overview for establishing ecosystem configurations. Through reviewing academic literature and engaging with experts by experience and the involvement of company employees, the ecosystem configuration and following implementation roadmap is tailored to the situation of the case study.

Through using methods adapted from literature and combining this with knowledge gained through interactions with experts on this topic, the framework for determining ecosystem configurations is established. This framework is then put into practice through a case study, which serves as a real life example for the development of an ecosystem configuration for a chocolate spread value chain. By combining desk and field research, this study bridges the current gap between academic research and industrial practices on the topic of reusable glass packaging specifically. Hence, the value gained from this research finds itself not only in the results from the case study, but also in the verification of the presented overview for determining ecosystem configurations for reusable glass packaging, which can be used in the future as a basis for industries to gain confidence to start implementing reusable glass packaging.

PART I

RESEARCH TOPIC EXPLORED

Part I consists of the initial exploration of the topic of this research. This covers necessary background information to understand the topic, the scope determination of the research and the research questions and research approach to guide this research.

1. RESEARCH QUESTIONS

1.1 Aim

The main goal of this thesis is to develop a framework that supports the introduction of reusable glass packaging in a specific value chain that currently only makes use of single-use packaging. This framework will be established through comparing current ecosystems that enable the use of reusable glass packaging. To evaluate the application and relevance of the developed framework, a case study will be executed for a value chain that has not yet implemented reusable glass packaging. This value chain is that of the chocolate spread production company Brinkers Food. In addition to evaluating the framework, its usefulness will be tested through the establishment of an implementation roadmap. This implementation roadmap will not only aid Brinkers Food in the possible future introduction of the envisioned ecosystem configuration, but also helps increase understanding of the proposed framework and its application.
In order to establish, implement and evaluate a suitable framework, this research will be guided by the research questions presented in this chapter.

1.2 Main research question

This achieve the goal of this thesis, the following main research question is formulated.

"To what extent can a framework based on existing solutions for reusable glass packaging support the introduction of a reusable glass packaging in a currently linear, single-use packaging-oriented value chain in the food industry with multiple actively involved (industrial) entities?"

1.2.1 Sub-questions

To support this main research question, the following sub-questions are generated.

1. What is the current state of ecosystems for reusable glass packaging?

a. How do research methods currently support the introduction of and research on reusable packaging?

b. What are the alternatives for reusable glass packaging and can these outperform reusable glass packaging regarding sustainability?

c. What direct and indirect entities and responsibilities are crucial for the success of an ecosystem for reusable glass packaging?

d. What are the best practices and/or failures of these ecosystems for reusable glass packaging and what can be learned from them?

2. How can a framework be forged based on the identified entities and responsibilities that enable an ecosystem for reusable glass packaging?

a. What are the specifications for each of the entities and responsibilities on the different ecosystem levels?

b. How can the knowledge of existing ecosystems for reusable glass packaging be combined?

c. To what extend does the framework reflect the ecosystem configurations of existing ecosystems for reusable glass packaging?

3. To what extend can a the framework provide support for the establishment of an ecosystem configuration for reusable glass packaging for a specific case study?

a. To what extend is the subject of the case study suitable for exposure to the framework?

b. What is the current ecosystem configuration of the subject of the case study and the corresponding value chain?

c. What is a suitable ecosystem configuration for reusable glass packaging regarding for the subject of the case study and the corresponding value chain?

d. What are the differences between the current and future ecosystem configuration and how can a transition between the two be supported?

e. To what extend are the results a reliable basis for the subject of the case study to introduce reusable glass packaging into their value chain?

4. To what extend can the framework provide insights and support when establishing an ecosystem configuration for value chains that do not yet make use of reusable glass packaging?

a. What are the limitations of the framework and how can these affect the useability and applicability of the framework?

b. What is necessary for the framework to be a useful tool for the development of an ecosystem for reusable glass packaging for a currently single-use oriented value chain?

2. BACKGROUND

Before jumping into the research itself, it is important to have an understanding of the background of this thesis. Therefore, the following section will focus on the setting the foundation through elaborating on the following topics:

***Circular Economy and Reuse** – This section explains circular economy, and how this relates to reuse specifically. Additionally, system perspectives are addressed as a means to analyse all levels of interaction with and within an ecosystem, which can aid the overall development of an ecosystem for reusable glass packaging.*

***Material analysis** – This section covers the environmental impact of competitive materials, such as recyclable glass packaging or PET packaging. This allows for comparison between packaging materials and gives an understanding of the differences in environmental impact between packaging materials.*

2.1 Circular Economy and Reuse

Recycling is one of the first things that comes to mind when developing for circular economy. However, not only recycling, but also reuse and circular economy are two concept often used in similar contexts. The following section will explore the relation between these concepts and addresses how the development of an ecosystem for reuse might be aided.

2.1.1 Circular Economy

Sustainable development is becoming an increasingly important global concern (Wandosell et al., 2021). To accommodate for improvement of sustainability within a company, different measures can be taken. As an example, transitioning towards circular economy, specifically regarding packaging of products, is seen as a crucial step for enhancing a company's sustainability (Testa et al., 2020), as this is claimed to be an efficient and sustainable alternative to linear economy (Bhat et al., 2023). This has resulted in an increase in scientific research on this topic, leading to many interpretations of the concept of circular economy. A common description for circular economy is that of the Ellen MacArthur Foundation (2013), who states *"A circular economy is an industrial system that is restorative or regenerative by intention and design. It replaces the 'end-of-life' concept with restoration, shifts towards the use of renewable energy, eliminates the use of toxic chemicals, which impair reuse, and aims for the elimination of waste through the superior design of materials, products, systems, and, within this, business models."*.
However, this is certainly not the only promising definition. Vlajic et al. (2021) particularly recommends the depiction of Van Buren et al. (2016), who explains *"A circular economy aims for the creation of economic value (the economic value of materials or products increases), the creation of social value (minimization of social value destruction throughout the entire system, such as the prevention of unhealthy working conditions in the extraction of raw materials and reuse) as well as value creation in terms of the environment (resilience of natural resources)."*. This 2016 explanation is not the first time such categories have been addressed.

Over a quarter of a century ago the concept of the Triple Bottom Line by Elkington (1994) is established, hereby making mention of three sustainability pillars: social, economic and environmental. In the years following, different researches connect sustainability to the similar concepts, such as people, planet, profit (Fisk, 2010; Palmer & Flanagan, 2016). Though Elkinton seems to rethink the actual execution of the Triple Bottom Line (Elkington, 2018), it becomes apparent that research still makes use of his proposed pillars for sustainability. Where Van Buren quite literally uses Elkington's pillars by defining circular economy through value creation, the Ellen MacArthur Foundation focuses on the immediate solutions and approaches to increase circular economy. Both descriptions offer an overarching definition of circular economy. However, this does not mean that all circular ecosystems are the same. The embodiment of circular economy can range from a remanufacturing loop to a fully established reuse system. Though both are regenerative in their nature, there is a difference in the amount of cost, time and energy needed. Figure 1 illustrates different circular loops, where in most cases the shorter loops are preferred over the longer loops, mainly because less natural resources and energy are required (e.g., maintaining over remanufacturing) (Mihelcic et al., 2003). The recycling loop is a bit of a different story. Recycling does seem to be circular, but since this process often leads to a material downgrade, an undesirable environmental impact occurs which leads to the need for raw materials over time (Jiang, 2021). Even though recycling leads to a reverse logistic system in a circular manner, it is not regarded as circular economy, because of its degenerative result. Hence, the absence of this loop as a means for circular economy.

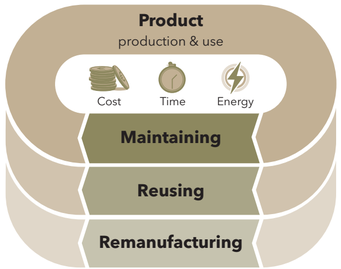


Figure 1 Levels of circular economy, adapted from the Ellen MacArthur Foundation (2021) and Mihelcic et al. (2003)

2.1.2 R frameworks

One of the approaches for circular economy described by Van Buren et al. (2016) and Klemeš et al. (2021), which is the use of R frameworks as a key guideline for achieving circular economy. One of the more well-known R frameworks is "Reduce, Reuse, Recycle" (3R waste strategy)(Rohr & Martin, 2012; Rosam, 2017), which elaborates on the most important actions industry can take to transition towards circular economy (Vlajic et al., 2021). Aside from the traditional 3R's, multiple alternative R configurations have been made. Taylor (2021) suggests a fourth R, Recovery, which is the process of mixed material separation through environmentally friendly ways. Morseletto (2020) even suggests a total of 10R's, hereby adding Repurpose (giving waste materials a new purpose if their original purpose cannot be achieved), Remanufacture (combining used and new materials for a product), Refurbish (repaired products that are resold), Repair (repaired products that do not change owner), Rethink (changing material usage, hereby considering different materials or even leaving out materials), Refuse (active refusal of (certain) material usage). National governments also adopt such concepts, such as the Dutch National Waste Management Plan (Landelijk Afvalbeheerplan). This plan, inspired by a motion by Ad Lansink in 1979, includes "Lansink's Ladder", which presents a hierarchy of desired waste management (Bergsma et al., 2014). In chronological order, "Lansink's Ladder" covers the concepts Prevent, Reuse, Recycle, Incineration with energy generation, Incineration, Landfill, which are slightly different to the other presented R-concepts, but generally cover the same principle.

To provide clarity in the many possibilities of R-frameworks, Zero Waste Europe has created the Zero Waste Hierarchy (Oliveira, 2019). This hierarchy (Figure 2), similarly to circular loops of Mihelcic et al. (2003) (Figure 1), provides an overview of the best to worst options for resource management and illustrates the impact differences each of the different R's can have in terms of increased sustainability. However, it is much discussed whether the actual impact of each of the R's is in fact similar to the depicted hierarchy. Holt (2018) has studied that Reduce and Recycle are actively adopted, whereas Reuse is a "costly and time-consuming option for industry", therefore often not considered. On the other hand, in research conducted by Kirchherr et al. (2017), it becomes apparent that Reuse might be gaining popularity. Of all 114 analysed articles, the terms Reduce and Recycle have been used less frequently as a means to describe circular economy, whereas the term Reuse is use more often in this context. Nevertheless, Reuse is the most sustainable option in cases where packaging is indefinitely required (Refuse/Rethink/Redesign is often focused on completely leaving out the packaging). Therefore, this topic will be further addressed in the following section.

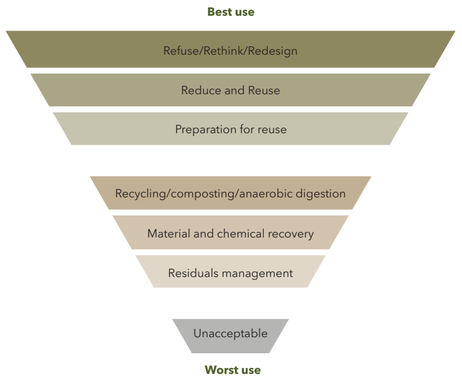


Figure 2 Zero Waste Hierarchy, adapted from Oliveira (2019)

2.1.3 Reuse

Reuse is not a new topic within the packaging world. The example of the milkman in the 1950s and the introduction of reusable bottles in the 1960s (Emmins, 1991) has been translated into a modern day version with initiatives such as Loop (Fleming, 2020) or Pieter Pot (Derkse, 2021) and the deposit-refund systems for bottles and cups on festivals. For the latter, the deposit-refund system functions as an extrinsic motivator for consumers, not only to return the cup, but also to take better care of it (Šuškevičė & Kruopienė, 2021). However, not all the implemented reuse initiatives are a guaranteed success. According to Coelho et al. (2020), the difficulty to implement reusable packaging "is the increased logistic complexity, requiring reorganizing supply chains to ensure that packaging is available and returned through better management of distribution, returns, brand recognition and loyalty, as well as stocks", based on the analysis of current developments in reusable packaging. Standardisation is suggested as a means to remove part of the hurdle, as it improves the ease of cleaning and transportation (PackBack, 2020) as well as increases efficiency, interchangeability or interoperability. Additionally, it is stated that standardisation must be paired with a high product range to choose from, as this allows for continuous exposure of the packaging towards the consumer, hereby subconsciously becoming more and more integrated into their daily life (Fabre & Joannard, 2022). However, such standardisation may also come with disadvantages, as it leads to a necessity for collaboration between production companies, and it could lead to unwanted lock-ins and a reduction of flexibility, ultimately leading to potential obstruction of innovation (Vink & Blanksma, 2023). Factors that are of influence are not only the environmental consciousness of consumers, but also the environmental (e.g. material, use), social (e.g. convenience, perception), economic (e.g. policies, costs) and technical (e.g. logistics, infrastructure) context plays an important role (Beswick-Parsons et al., 2023; Bradley & Corsini, 2023). All of these factors are interconnected, which makes it difficult to predict whether a reuse system that works in one context will also be successful when adopted in a different environment.

2.1.4 System perspectives

The different R frameworks offer an overview of different options for promoting circular economy in a company. However, the process of setting up an ecosystem based on one of the options is not described. Kirchherr et al. (2017) explains that a systems perspective approach addresses the means to achieve circular economy, regardless of the topic of interest (e.g., reuse or recycling). Through ensuring all levels of interaction with an ecosystem are analysed, the effect of adaptations is not limited to the primary entities in the system, but is additionally stretched to all entities that might be somehow involved. This is desirable, as one seemingly simple adaptation can lead to major changes on different levels. By distinguishing Macro ((inter)national level), Meso (regional level) and Micro (local level) perspectives, suitable approaches for each perspective can be taken regarding circular economy. As an illustration, Macro level changes could be whole recycling systems, whereas Micro could be the identification of byproducts during manufacturing (Jackson et al., 2014). Ultimately, this approach helps to identify how industries can implement or adapt their ecosystem to improve circular economy, based on the influence they have in each of the system perspectives. However, when implementing a change that potentially might affect the whole system perspective, it is important to ensure proper transition management to decrease disruptions within the level. As stated by Fang et al. (2007) "successful sustainable transitions require knowing and doing that is both reflexive and shared", hereby highlighting the importance of co-evolvement, co-designing and social learning.

2.2 Material analysis

Seemingly, reuse of material can be beneficial from an environmental perspective. However, does this also hold for reuse of a heavy material such as glass? This section covers the analysis reusable glass packaging alternatives regarding material choice. This includes comparison of the environmental impact of glass packaging over the whole life cycle, glass packaging and alternatives and current reuse initiatives for glass packaging.

2.2.1 Environmental impact of glass packaging

Annually, 130 million tonnes of glass are produced, of which nearly half is allocated towards container glasses for food and beverages (Harder, 2018). The general impression is that most glass packaging can repeatedly be recycled/reused through the presence of a system for waste collection (Geueke et al., 2018). However, in practice, this system is not nearly as sophisticated as often expected. Averagely, in Europe, 70% of used glass packaging ends up in a recycling loop (Lebullenger & Mear, 2019). In Germany, however, a striking 98.4% of glass is recycled (CM Consulting, 2018). Even though this recycling rate in Germany is of significant value, often times the collected glass cannot be reused due to the particles being too small for sorting or the amount of incorrect materials (ceramics or treated glass) that are being wrongfully collected by consumers due to negligence or ignorance (Agerbeek, 2003; RIVM, 1994).
Additionally, such recycling might not be as environmentally friendly as often assumed. In research from Ingarao et al. (2017), the environmental impact of single use jars has been studied (Table 1). They have concluded that obtaining the raw material and manufacturing it into a single use glass packaging (jar) contributes to over 87% of the overall CO2 emissions. On the other hand, transport is only responsible for 11.7% of the total CO2 emissions. If recycled glass is used to manufacture the glass packaging, a lower percentage of raw materials is needed, leading to a lower overall contribution

	Material	Production	Transport	Use	Total
CO_2 emissions	0.136	0.103	0.032	0.003	0.274
Percentage	*49.6%*	*37.6%*	*11.7%*	*1.1%*	*100%*

Table 1 Environmental impact of glass packaging during its life cycle, based1on Ingarao et al. (2017)

to environmental depletion. However, the recycled glass still needs to be remolten, therefore emissions for manufacturing will remain. Even though remelting cullet has a lower impact than manufacturing virgin glass, the energy reduction reaches a maximum of 13-15% in comparison to the production of the virgin material (Gaines & Mintz, 1994; Kovacec et al., 2011). Camps-Posino et al. (2021) show that an energy reduction of 50% during the cleaning phase of reusable glass packaging can result in 24% less impact. Nevertheless, good cleaning is needed to guarantee food safety, as most glass jars (77%) are likely to be contaminated with the product it previously contained (Wester & Verweij, 2022). On the other hand, when using reused glass packaging, less industrial processes are needed for the establishment of the glass packaging (e.g. material extraction, manufacturing) and there is no pollution through landfill or incineration (Gertsakis & Lewis, 2003). Moreover, making one glass bottle takes 2L of water, whereas the cleaning process only take 600mL of water (Isbouts et al., 2023). When comparing the losses and gains, reused glass packaging is still 70% more energy efficient than manufacturing glass packaging from recycled materials (Noto, 2023). As a conclusion, reusable glass, for which the raw material extraction and manufacturing are distributed over the total amount of reuse cycles, will still end up with a relatively lower impact, compared to recycled glass.

2.2.2 Reusable glass packaging and alternatives

In addition to studying single use glass jars, Ingarao et al. (2017) have calculated the impact of reusable jars (Figure 3). The CO_2 emissions of the reusable jars show a decreasing trend the more the packaging is reused. It should be noted that this reuse cycle does not take cleaning into consideration, as it was considered negligible in this particular research. This could be explained through the content of the jar, which was caponata (Italian vegetable sauce), which might be less persistent compared a more sticky food product such as chocolate spread, for which the cleaning emissions should be considered.
Based on this study, the total amount of reuse cycles needed to make a significant difference compared to single use tin steel (TS) and polypropylene (PP) alternatives, a minimum of two reuse cycles are needed for the glass packaging (jar) to result in a lower CO_2 emission (Figure 3). However, when including the impact of cleaning (for reusable glass beverage bottles), again only two reuse cycles are needed to have a lower impact compared to HDPE bottles, beverage cartons and single use glass bottles, (Carter, 2022; Tua et al., 2020). This means that, even when cleaning is considered, the reusable glass packaging has a lower carbon footprint compared to single use packaging alternatives. In addition to this, the prospective amount of reuse cycles can be between 23-50 times for reusable glass bottles (Coelho et al., 2020; Fabre & Joannard, 2022), hereby exceeding the needed amount of cycles for decreased environmental impact significantly. However, the transport distances should be taken into consideration, as, according to Tua et al. (2020) a distance of 800 km will never be more sustainable than single use glass packaging and a distance of 600 km will only be more sustainable after 10 reuse cycles. Accorsi et al. (2015) have concluded that having virgin, single use PET as material for bottles has a considerably higher environmental impact compared to glass as a material, due to its popular end of life solution, which is landfill (USA) and incineration for energy (EU) (Bersi

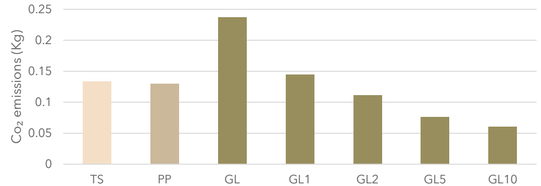


Figure 3 CO_2 emissions comparing TS, PP and Glass with multiple reuse cycles, adapted from Ingarao et al. (2017)

et al., 2023). When changing this end of life solution to reusage of material through recycling, a different outcome is observed. When comparing the glass bottle to an rPET (recycled PET) bottle, the overall impact of the rPET bottle is much lower compared to the glass bottle, as the recycling rate for rPET is much higher. This can be explained through the significant response to recycling the bottles, which is a favourable end of life option, hereby revealing the response rate to recycle packaging is an important contributor to lowered environmental impact. However, it is questionable whether rPET is a safe solution for food contact, as more chemical migration is present in these bottles, compared to virgin PET (Gerassimidou et al., 2022). Using rPET in a European environment results in additional checks to ensure compliance with regulations set by the European Food Safety Authority (EFSA) (Van den Hoeven, 2022). Additionally, using a flexible material as packaging for a viscose content, for example chocolate spread, can decrease the quality of the content. When compressed, the chocolate paste can separate due to the added pressure, which leads to product deterioration (Brinkers Food, 2023b).

2.3 Conclusion

The provided theoretical background shows benefits of reuse in the form of glass packaging, hereby not only informing the reader on the topic, but also demonstrating the importance of the introduction of reusable glass packaging into a value chain. Current research (R-frameworks and system perspectives) evaluates the possibilities, as well as the hurdles of including reuse in a value chain. This highlights that although reuse is a well discussed topic, the actual transition of industries to this type of packaging is difficult due to the risks and uncertainties associated with this transition. Additionally, the material research highlights findings of decreased environmental impact that can be gained by switching to reusable glass packaging. Although there are alternatives to glass packaging, it is implied that reusing glass can make a significant difference. The strength and durability of the material enable reuse at low costs (only cleaning and transport) and poses a low risk for food-contact usage, in comparison to plastic alternatives.

However, it should be noted that for all these LCA studies different inputs for packaging weight and the reverse logistics network are taken as a basis for calculations. The packaging weight of a future reusable glass packaging is difficult to determine, as for each packaged product, a different packaging strength can be required. Also, the reverse logistics network can be different for each reusable packaging. Therefore, the information obtained from the mentioned studies is valuable, but not at all a definitive result for the carbon footprint for the envisioned ecosystem for reusable glass packaging for solid and viscose food (Furberg et al., 2021). Nevertheless, this section provides important background information that highlights the value of transitioning to reusable (glass) packaging.

3. RESEARCH APPROACH

Not many ecosystems for reusable glass packaging for solid and highly viscose food have been stated in use. Some current examples are only introduced locally (e.g. Circujar (Alnatura, 2023), PAKT (Wester, 2023)) or focus predominantly on medium viscose food types, such as yoghurt (e.g. MMP (Bielenstein, 2023)). To evaluate what type of circular ecosystem is most compatible with a given value chain and their current ecosystem structure, a suitable research method should be followed.

A frequently used design methods are a Stage Gate or Design Thinking approach. Both methods focus on breaking down the product development process into managable phases. Where the Stage Gate offers a step by step approach (Edgett, 2018), the Design Thinking process is more iterative (Razzouk & Shute, 2012). The generic nature of the methods allows for broad implementation, but hereby lacks in providing specific guidance. To create a framework for the introduction of reusable glass packging into a value chain, a more detailed approach is necessary. Therefore, a more comprehensive method is chosen. For this, different methods for innovation are consulted, such as the multilevel design model (Joore & Brezet, 2015) and constructive technology assessment (Rip & Robinson, 2013). Both of these methods describe different interaction levels, hereby including not only the innovation development itself, but also the necessary circumstances that enable this. These methods are comparable to the system perspectives of Jackson et al. (2014), as elaborated upon in section 2.1.4. Using this strategy as a basis, a structured evaluation of existing ecosystems can be executed. The levels described by the different methods are used as a reference to create a total of three ecosystem evaluation levels. This allows for evaluation of entities and responsibilities present in the ecosystem. As a result, possible connections between entities can be identified, hereby definging both the entities present in, as well as the interactors with the ecosystem.

The **Macro level** will entail all entities that have no direct interaction with the ecosystem, but can have an indirect influence due to for example legislative decision making (e.g. governmental institutions) or organisational support (e.g. packaging or reuse associations).

The **Meso level** will entail all entities that are in direct contact with the ecosystem. This is not only the content producer, but also the logistic partners, the consumer and the glass manufacturing company.

The **Micro level** will entail all the responsibilities each of the entities on Meso level may have. Examples can be the cleaning, return or storage of the packaging.

Through analysing varying ecosystems using reusable glass packaging on each of the different levels, a comparison can be executed. Hereby, essential entities and responsibilities can be identified, which can be combined in a holistic framework that presents these findings. This framework will not only provide an overview of entities or responsibilities for each level, but also the interconnections between the levels. This way the framework can visualise ecosystem configurations for reusable glass packaging, hereby servingas a basis of future development and implementation of reusable glass packaging into value chains.

The establishment of this framework will be elaborated upon in Part II, using the three level approach as guidance. The established framework will then be subjected to a case study to experience its usability. Thereafter, an implementation roadmap will be established, based on the results of the framework. Finally, a conclusion will be drawn on the applicability of the framework for the particular case study and a more broad reflection will be executed elaborating on the limitations and recommendations for the framework.

PART II

ECOSYSTEM ANALYSIS
MACRO, MESO, MICRO LEVEL

Part II will make use of the approach as described in section 3, hereby researching existing ecosystems on Macro, Meso, Micro level. This will lead to an overview of entities, responsibilities, drivers and barriers that enable the ecosystem, based on past and current initiatives. The results are obtained using desk research and through consulting experts by experience.

4. MACRO LEVEL

This chapter covers the macro entities that could possibly be connected to the ecosystem for reusable glass packaging. These entities can be divided into three categories: legislative institutions, organisations and product suppliers. For each category, all entities are identified and an additional analysis is executed to reveal possible barriers and/or drivers for the ecosystem. An overview of the entities on macro level is established in Figure 14.

Figure 14 Overview of Macro level entities

4.1 Legislative institutions and food standards

The Macro level entities can vary depending on the country in which the value chain is mostly active. Take for example the company that will be subjected to the case study, Brinkers Food. The largest market for this company is Germany (Brinkers Food, 2024), hence, not only European, but also German legislation regarding reusable glass packaging and food safety standards should be considered. However for other initiatives, different Micro level entities are at stake. Such as the Dutch initiative Pieter Pot (Derkse, 2021), which relies on Dutch legislation and food standards.
As a matter of illustration, this section will focus on both the European and German legislative influences and food standards that should be considered while developing a framework supporting the introduction of reusable glass packaging in the value chain. However, there can be country specific differences if the to be established framework is exposed to a different value chain. Therefore, the entities on Macro level should be re-evaluated to ensure reliable results.

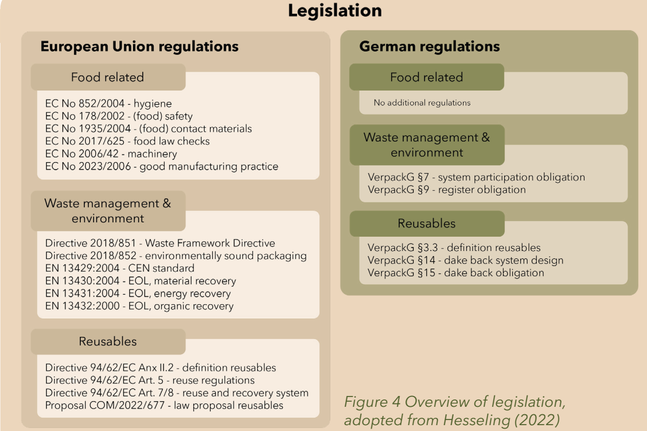


Figure 4 Overview of legislation, adopted from Hesseling (2022)

4.1.1 Legislative institutions

The European Union and the German legislative institutions are creating and enforcing laws and regulations regarding (food) safety, packaging waste management and environment, and reusables. Although not all legislation is directly targeted towards reusable glass packaging specifically, it does target all food packaging types, including reusables. Moreover, having an understanding of the current laws and regulations concerning packaging, ensures that the ecosystem solution for Brinkers Food is in accordance with current laws and potential new laws that likely will be established for reusables, based on the legislation that is already present.
Figure 4 provides an overview of the legislation currently in force in the European Union and Germany specifically. For each law there is a short description of what it entails.
The European Union laws are forged by the European Commission, which consists of a representative of each of the 27 member states (European Commission, 2023). Over the years, a number of laws have been implemented regarding food, environment and waste management, but more recently, reuse has been adopted in these laws as well. However, this topic is only limitedly addressed, and as of the 30th of November 2022, a proposal (Packaging and Packaging Waste Regulation (PPWR)(94/62/EC)) has been submitted to include reusable packaging into the European legislation. Thus far, this proposal has not yet been adopted, but will likely be in force as of 2025.
For the national laws in Germany, the European legislation is enforced directly. The Lebensmittelverband Deutschland (Food Federation Germany) cooperates with the Bundesregierung (German Government) to facilitate the development of food laws in Germany and Europe and supports relevant research fields for this purpose (Lebensmittelverband Deutschland, 2023). Similarly, the Umweltbundesamt (German Environment Agency) conducts scientific research to support legislation from an environmental perspective (Meunier, 2013).

Reusable packaging definition

Both the European Union and Germany have established their own definition of reusable packaging. These are stated as follows (Figure 5). Notably, the European Union definition is largely focused on the processes and end of life of the packaging. In contrast, the German definition includes the reverse logistics system, hereby covering both the logistics as well as consumer incentive. The upcoming PPWR is accompanied with an updated definition (COM/2022/677), largely covering topics already adressed by German law. The complete overview of the definition and accompanying requirements can be found in Appendix A. Though the updated PPWR regulation is not yet at force, these regulations can become the baseline of reusable packaging and accompanying systems in the European Union and should therefore be considered during this research.

Figure 5 Definitions of reusable packaging, adopted from the European Directive 94/62/EC Anx II.2 and VerpackG

Waste management systems

Another law that is of interest for this research is the VerpackG (German packaging law), which describes obligatory system participation for waste management and the regulations for reusables.

In Germany, there are three main waste management systems, out of which two have a deposit-return scheme. The latter can be split up into beverage packaging for single-use and reuse, where the former has a mandatory deposit of €0.25, and the latter ranges between €0.08-€0.50. The waste management systems that include a deposit-return scheme only cover beverage packaging. This means that currently, according to German legislation, there is no explicit system to which reusable packaging – other than beverage – should adhere. The other waste management system forces industries to take responsibility for all that they produce, including packaging, resulting in obligatory participation in one of the German dual systems for waste management.

Overview

As there are multiple legislative approaches to reusable packaging, it can be difficult to maintain a clear overview. To make sense of it all, the most important points of attention for a feasible ecosystem for reusable glass packaging, from a legislative point of view, are summarized as follows.

The packaging is reusable through its design, which facilitates:

- *safe emptying without damage*
- *safe cleaning without damage*
- *attachment of labelling which informs about the content as well as reuse*
- *a sustainable end of life solution (e.g., recycling)*

The reusable packaging has an accompanying ecosystem that has:

- *a defined (governance) structure which is fair and transparent*
- *a set description for industry participation and packaging choice and usage*
- *a properly functioning linear and reverse logistics, including collection, storage, filling and consumer incentive.*
- *a verification of performance*

4.1.2 Standards

Food safety

The reusable glass packaging should also adhere to the food safety regulations. The BRCGS (British Retail Consortium Global Standards) and IFS (International Featured Standards) are organisations that offer standard measures, for example, food safety standards for the food production industry. Not only the content, but also the packaging is covered in the guidelines of the BRCGS and IFS (BRCGS, 2022; IFS Food, 2023). When following these guidelines, production companies can obtain a certification that grants their food safety compliance. With regards to the guidelines of the BRCGS and IFS, an analysis is executed to determine their influence on the reusable glass packaging.

Manufactured glass packaging

The food safety guideline process can be seen as a linear process between entities. For a single use ecosystem, the content producer and the glass manufacturer are the entities at stake (Figure 6, *'New'*). The following figure illustrates the interactions between the entities that are related to the guidelines of the BRCGS and IFS. Firstly, the content producer puts in a request for packaging with certain specifications suitable for their produced content. Often, such packaging specifications are obtained from an existing design in the portfolio of the glass manufacturer, an existing design from a different glass manufacturer or a completely new design (Brinkers Food, 2023). The glass manufacturer delivers the packaging to the content producer, hereby ensuring it is created following Good Manufacturing Practice and in accordance with the specifications earlier provided by the content producer. Through a Declaration of Compliance and a Quality contract both parties know what their promises to one another are (IFS Food, 2021). When received, the content producer will check if the packaging is meets the promised compliance of specifications. Sometimes, this check is executed by an independent party assigned by the content producer and/or the glass manufacturer (Brinkers Food, 2023). When the packaging is approved, the content producer knows the packaging suits their content and will order a full batch and start the filling process. These orders are usually done on a yearly basis with a scheduled frequency of delivery. Throughout this process, the packaging and content should be traceable. Often, the glass packaging delivered with a batch and pallet number, which the glass manufacturer can trace back to the specific material batch, machine and mould (Brinkers Food, 2023). The content producer registers which batch of glass packaging is used for filling a certain content. They additionally register the start and end time of the of the fully filled pallet of packaging to ensure they can trace the correct products in case of a recall.

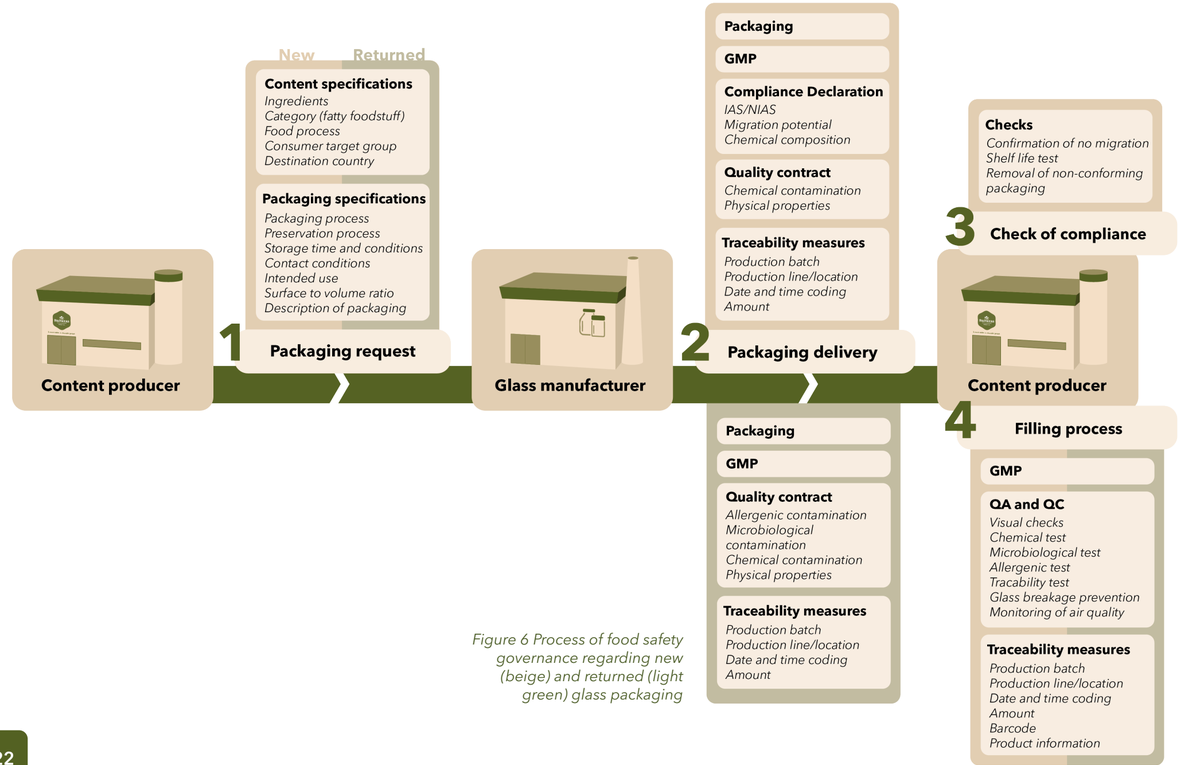


Figure 6 Process of food safety governance regarding new (beige) and returned (light green) glass packaging

Cleaned reusable glass packaging

For an ecosystem for reusable glass packaging, the glass is reused. As a result, the entity responsible for the glass packaging changes from the glass manufacturer to the entity that performs the cleaning. This can be done in-house or externally. When executed in-house, there is no need for contractual agreements. The content producer takes the responsibility of using glass packaging that meets their specifications in their own hands, through executing their own packaging tests and checks. However, in the case of external cleaning, the cleaning facility is responsible for delivering glass packaging that meets the specifications posed by the content producer. Essentially, the same steps and prerequisites are at stake when compared to the single use ecosystem (Figure 6, *'Returned'*). The content producer creates a packaging request, the cleaning facility provides the packaging with a corresponding quality contract, after which the content producer can start filling. However, there are some elements that have notable changes.

Traceability measures – The BRCGS and IFS state that the origin of produce should always be traceable (BRCGS, 2022; IFS Food, 2021; IFS Food, 2023), also when distributed by an entity that is not the original producer. As a result, not only the content, but also the packaging should be traceable to the original manufacturing source. The latter can be achieved by unique engravings or UV print on the glass. However, when combining packaging and content batches, the traceability becomes more complex. Especially, in the case of the reusable glass packaging, where the packaging population is of mixed manufacturing batches or origin. Therefore, as there are multiple cycles in case of reusable packaging, it is necessary to ensure quality control and quality assurance (automatically) checks for each packaging to detect any defects that can lead to a quality or safety compromise (Grolsch, 2024). Hereby safety can still be guaranteed without the need for this traceability. However, being engraved in food safety standards, traceability in a value chain is a mandatory process, and therefore it is difficult to just 'leave it out'.

Quality contract – The cleaning facility needs to ensure that the packaging is of expected quality (IFS Food, 2021). Though they have not created the packaging, they need to ensure that packaging usage, transport and cleaning has not influenced any of the properties of the packaging. Additionally, the packaging has been used for a (different) content before. As a result, the cleaning facility needs to be extra careful with allergenic and microbiological contamination. Moreover, the glass packaging is possibly cleaned with chemicals, hereby potentially leading to chemical contamination. The cleaning facility needs to ensure that all these possible contaminations are eliminated.

Check of compliance – The check of compliance by the content producer is left out in this model. The check of compliance is for new glass packaging requests that are produced by the glass manufacturer, to ensure that the glass packaging is suitable for the content (IFS Food, 2023). As the reusable glass design has already been through such a check of compliance, it is not necessary to perform it again, as the migration properties and shelf-life of the packaging have not changed.

Quality Control and Quality Assurance – By using glass packaging that has already been used before, the content producer might want to perform additional test to the packaging they receive, such as allergenic and microbiological contamination checks. However, it is likely to be the case that within a quality contract certain agreements are made between the cleaning facility and the content producer how this responsibility is divided.

4.2 Organisations

The second category are the organisations that are active in the specific country where the introduction of reusable glass packaging will take place. Similar to the legislation and food safety standards, the organisations present can vary. As a matter of illustration, the organisations in Europe and Germany are again chosen to be elaborated upon. However, there should be noted that for other value chains, different Micro level entities regarding organisations might be present.

The organisations present in Europe and Germany can be split into three sub-categories, which are reuse organisations in the European Union, reuse organisations in Germany and German environmental organisations. These organisations can influence the development and/or implementation of an ecosystem for reusable packaging. For example, Mehrweg.Einfach.Machen. and Mehrweg Mach Mit aid industries and companies to start using reusable packaging for their products. They provide training to ensure such implementation happens smoothly. On the other hand, the non-profit organisations largely cover the role of informing the industries about the possibilities of reusable packaging. This can motivate companies to look into such packaging and consider implementing it for their products. This way, both the profit and non-profit organisations provide knowledge to the industries to make them more confident in joining an ecosystem for reusable packaging. As most companies are reluctant to join because of high investment costs, increased complexity and a lack of proof of concept (Bocken et al., 2022; Coelho et al., 2020), these organisations can be an important stimuli to eliminate the hesitation the industries currently have. However, in order to make a change, these organisations need to continue their research on the topic of reuse and, more importantly, need to actively present the outcomes to the relevant industries.

4.3 Product suppliers

The last category is the product suppliers. These are involved with the directly participating entities of the ecosystem (Meso level), but do not take an active role in the linear and/or reverse logistics system for the reusable glass packaging. The following distinction can be made, where the amount of influence the implementation of the ecosystem has on the entities is depicted.

4.3.1 Moderate influence

The entities that are moderately influenced by the adaptation of an ecosystem for reusable glass packaging are the glass packaging manufacturer and the end of life solutions. The glass manufacturer needs to produce a different design that can withstand the forces paired with reuse, which can be achieved through larger wall thickness on certain areas of the packaging or a different blend of virgin glass and cullet. This way, the glass packaging should be able to last a set number of reuse cycles without breakage, though the manufacture cannot guarantee this, as external forces through (non-intended) usage cannot be controlled. Additionally, the demand for production of new packaging will decrease over time. The end of life solution that is influenced mostly is the recycling facility. The cullet that is used to make new reusable packaging should be of excellent quality, as the reusable packaging needs to be made of strong material to ensure it can survive multiple reuse cycles. Ideally, there will also be less supply of disposed glass packaging, since the used packaging will be returned instead of recycled.

4.3.2 Minor influence

The lid and label manufacturer only experience a minor influence of the adaptation of an ecosystem for reusable glass. The former needs to adjust the lid size and closure type to fit the new reusable packaging design (Circujar, 2023a). The latter might need to adjust the label size, but more importantly, must use a label adhesive that is easily removed using industrial cleaning and must ensure that the label does not fall apart when in contact with water, as this can cause a paper sludge that might clog the cleaning system (Circujar, 2023b). Only then the glass packaging can be reused, as a clean outside is just as important as a clean inside.

4.3.3 Negligable influence

Lastly, the entity that experiences a negligible influence is the ingredient supplier. Whether the product is packaged in single-use or reusable glass packaging does not change anything about the ingredients that are needed for producing the content. The only change the ingredient supplier might experience is a different demand due to packaging size or volume sold.

5. MESO LEVEL

The meso level research entails all entities that are directly involved in the ecosystem of the reusable glass packaging. For the sake of comparison, the linear and reverse logistics have both been analysed. Through establishing the entities involved in the linear ecosystem, the differences can be visualized with regards to the reverse logistics ecosystem, hereby highlighting additional entities needed to facilitate for a reverse logistics system, as well as showing changes in responsibilities. Below (Figure 7), the overview of the different entities in presented, hereby distinguishing between the linear and reverse logistics section of the reusable glass packaging ecosystem.

Figure 7 Overview of Meso level entities

MESO

Linear logistic entities

Content producer	Hub/Retailer
Store	Logistic partner

Reverse logistic entities

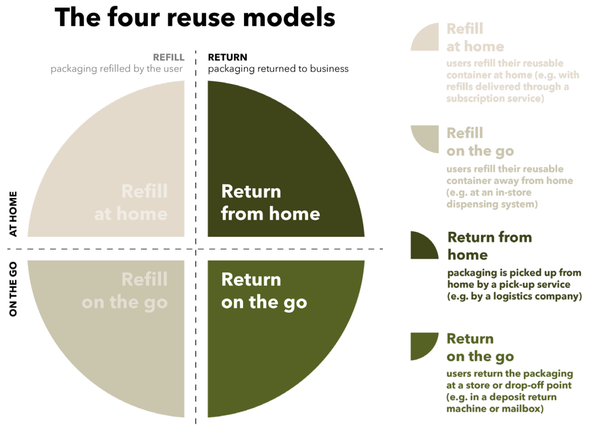
Content producer	Hub/Retailer
Store	Logistic partner
Collection hub	Cleaning facility

5.1 Reuse models

When looking at different reuse ecosystems, four reuse models have been distinguished by the Ellen MacArthur Foundation (2019) (Figure 8). These models cover the different ways how reusable packaging can be realised from a consumer point of view. One important distinction that is made, is the difference in responsibility division between refill and return. Refill means that the consumer can refill the packaging themselves, hereby using either a refill package or an in-store dispenser. For the return models, this responsibility lies with the content producer. This means the package should be returned via a reverse logistics system (from home or on the go) and will, from the moment of return, no longer be in possession of the consumer. This makes the reuse loop bigger in comparison with the refill loop, as the latter only involves two entities: refill location and the consumer.

It should be noted that not all reuse models are suitable for all reusable packaging ecosystems. In the case of this research, the focus is placed on solid/highly viscose contents, as this type of content is currently only limitedly implemented in reuse ecosystems. This could be caused by the challenges regarding cleaning, as such content leads to heavily sticky residue on the sides of the contained (Wester & Verweij, 2022). To maintain food safety and quality, the glass packaging should be thoroughly cleaned before a content refill takes place, especially if the content of the glass packaging changes (e.g., from chocolate spread to sandwich spread). If the glass packaging were to be used for refill at home or on the go, it is difficult to ensure product contamination does not happen. Currently, this refill model is mostly used for cleaning supplies, dried goods or fruit and vegetables. Using this model for solid/highly viscose contents is less viable due to the sticky residue of previous content that might result in safety and quality issues, hereby potentially damaging the brands name and status.

Figure 8 Reuse models with a primary focus on refill, adapted from Ellen MacArthur Foundation (2019)



Another quality issue can arise when filling the spreads at an incorrect temperature. Having the right filling temperature when working with chocolate spreads is crucial, and should therefore be executed by specialized content producers, rather than by the consumer in a store. Because safety and quality is of high regard for any food production company refill by the consumer is not a viable option. Instead, the return option will be analysed, as this ensures that the safety and quality of the food is in the hands of the content producer. Therefore, the next sections will evaluate existing ecosystems for reusable glass packaging that make use of a return model, rather than a refill model.

5.2 Ecosystem linear logistics

The linear ecosystem of single-use glass packaging for a solid/highly viscose food product is depicted in Figure 9. This model only regards the direct entities involved in the ecosystem as this is the Meso level research. This means the Macro level entities of the ecosystem have been excluded. This allows for better comparison between the single-use and reuse ecosystems on Meso level. The entities involved in this system are indicated in brown rectangles, including their responsibilities (marked in beige). The ecosystem also includes the moments of possible interaction with a recycling stream, marked with a recycling symbol. As can be seen, the main entities in this system are the content producer, the hub, the store and the consumer. The waste management at the end of the system shows recycling and landfill as an option. Recycling is the desired means of disposal of the packaging, but it cannot be guaranteed that disposal through municipal solid waste does not happen at all. Hence the addition of this separate responsibility.

Figure 9 Linear ecosystem for single-use glass packaging for solid/viscose food products, adapted from Brinkers Food (2023) and Uthayakumar (2020)

5.3 Ecosystem including reverse logistics

Different reuse initiatives have been researched regarding their current ecosystem design. Due to the limited presence of ecosystems for highly viscose/solid food specifically, other ecosystems that make use of reusable glass packaging are analysed as well. For all initiatives, a general ecosystem overview is created. For these ecosystems, the linear flow, reverse flow and deposit flow (if applicable) are also indicated. Additionally, the start of the reverse logistics is highlighted in green. For all systems, the flow of new packaging coming in is indicated as well, to account for the packaging that cannot be reused due to quality issues. For the sake of simplification, it is assumed that the packaging is disposed of through similar disposal systems as present in the linear system for single use packaging, hence the exclusion of the waste management stream, but the addition of the recycling symbol at different actions.

5.3.1 Ecosystem configurations

The following six ecosystems including exemplary real life cases are visualised (Figure 10-15):

Ecosystem 1a | Return on the go – Direct return (local stores)
Ecosystem 1b | Return on the go – Return via hub (beer industry)
Ecosystem 2a | Return on the go – Outsourced cleaning (Circujar)
Ecosystem 2b | Return on the go – External collection hub (Loop)
Ecosystem 3a | Return from home – In-store buying (PAKT)
Ecosystem 3b | Return from home – Logistic partner (Pieter Pot)

The elaborations of the ecosystem configuration visualisations can be found in Appendix B.

Figure 10 Ecosystem 1a with a direct return on the go principle

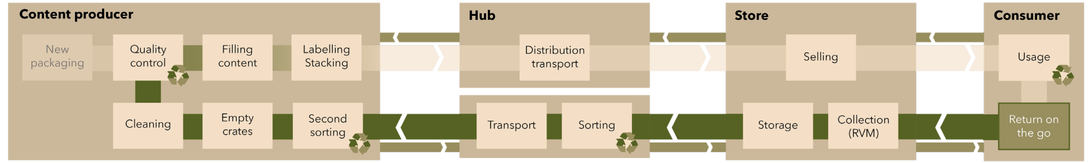


Figure 11 Ecosystem 1b with a return on the go principle via a hub

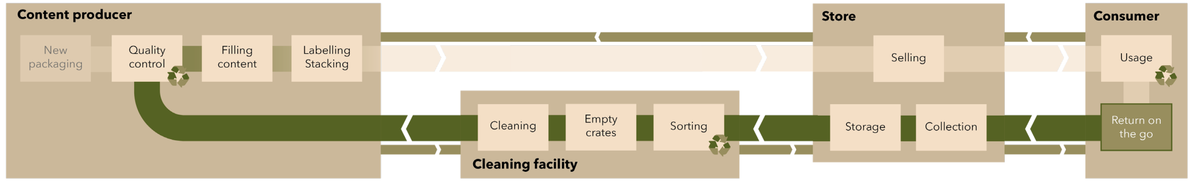


Figure 12 Ecosystem 2a with a return on the go principle with outsourced cleaning

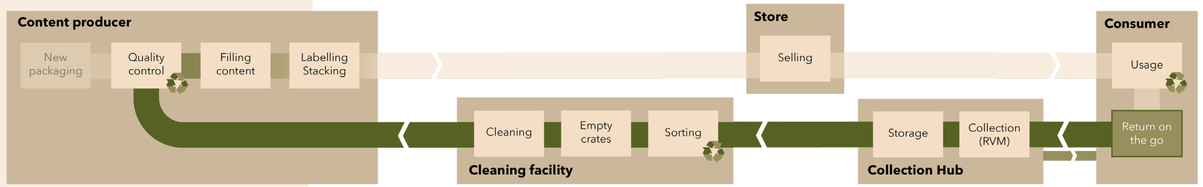


Figure 13 Ecosystem 2b with a return on the go principle, outsourced cleaning and an external collection hub

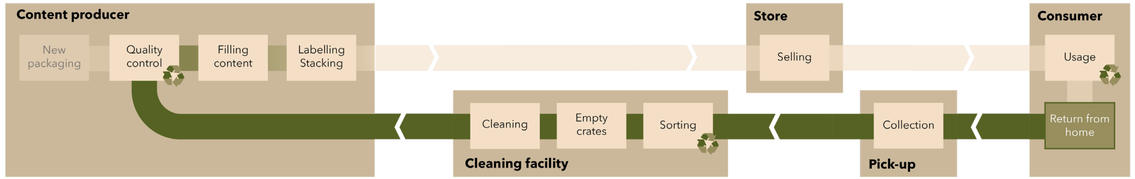


Figure 14 Ecosystem 3a with a return from home principle, outsourced cleanging and in-store buying

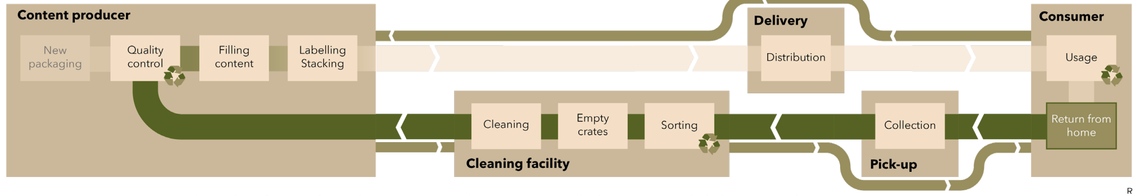


Figure 15 Ecosystem 3b with a return from home principle, outsourced cleaning and delivery/pick-up service

5.3.2 Evaluation of ecosystem configurations

All ecosystems show a difference in viability. For that reason, this section aims to highlight the causes of best practices and hurdles that can be experienced while establishing a new ecosystem for reusable glass packaging.

Financial viability

In order to establish a successful ecosystem for reusable glass packaging, financial viability is of utmost importance. For example, the Dutch Bruine Nederlandse Retourfles (BNR), that has been used since 1986 as a standardized solution for beer packaging. The BNR is developed by Heineken in the 1980s, at that moment the number one exporter of pilsner. Being a major player, they had the financial ability to not only develop this bottle, but also the whole reverse logistics system, costing a total of “several tens of millions guilders” (Hoogerwerf, 1985). Since then, a total of 14 Dutch breweries have joined the group of Nederlandse Brouwers, covering 95% of the beer market in the Netherlands (Nederlandse Brouwers, 2024). Moreover, three major Dutch brands have, after joining this ecosystem, decided to create their own bottle and reverse logistics system. This indicates that the having the financial means to establish such an ecosystem is a necessity. Therefore, a large entity, such as Heineken, is able to kick start this on their own, whereas for the Nederlandse Brouwers, the ecosystem is supported by multiple entities.

Proving this point is the initiative of Pieter Pot, which has faced bankruptcy in late 2023 (Thole, 2024). This bankruptcy is attributed to the high financial costs associated with creating a complete cleaning facility, the 200 employees initially necessary for filling the packaging and the lack of returned packaging. Through crowdfunding have been able to make a comeback, but the investors that have faced thousands of euros in losses will likely not support them in the future (van Rijswijk & van den Berg, 2024).

This indicates that entities willing to develop and implement an ecosystem for reusable packaging need to have the financial means at hand. Even though relying on investors can help kick start the ecosystem, the possible consequences should be considered. If the ecosystem, in the end, is not viable, entities could face high financial losses, similar to Pieter Pot.

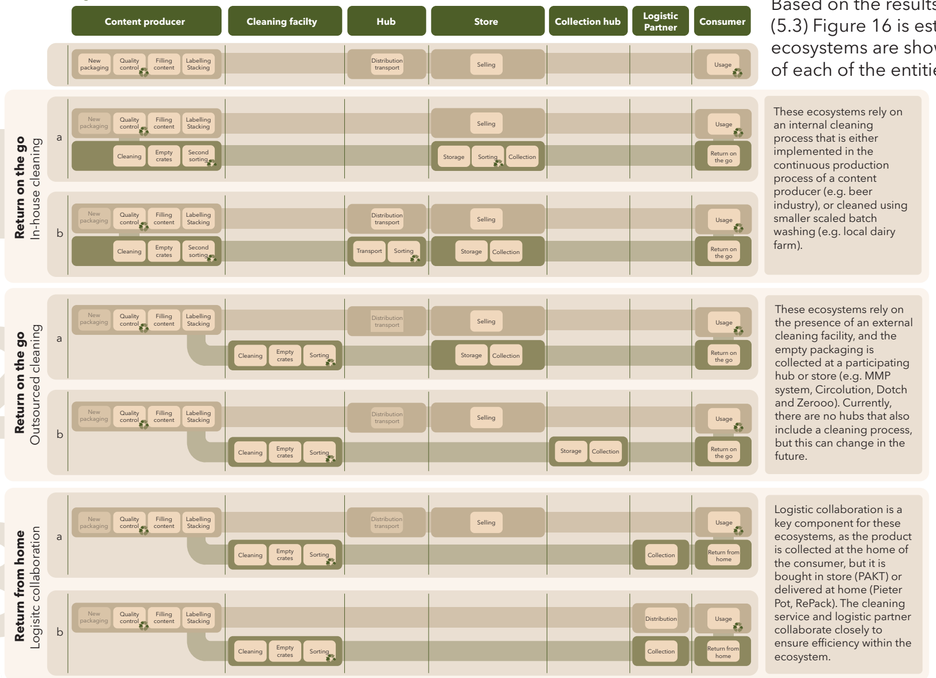
Ecosystem complexity

The size of implementation matters. Ecosystems for local produce are locally oriented and therefore have limited amount of reverse logistics. For example, in the case of farm stores, the activities of selling, collection, cleaning and filling happens on site. The limited complexity of such ecosystem allows for smaller sized entities implement reusable packaging as well.

When scaling up the system, the logistics become more complex (Coelho et al., 2020). The necessity of a dense collection network comes into play (Bocken et al., 2022) due to the presence of multiple entities, instead of just two (farmer and consumer). All exemplary ecosystems have been able to cope with this due to their well evaluated area of implementation. Where the brewers can immediately target a full country, new initiatives have focused on smaller regions. For example, PAKT has initially tested their idea on a small scale (90 households)(Wester & Verweij, 2022), but has thereafter scaled up their pilot to over 800 households (Swart, 2023), and are currently working together with different brands to facilitate the return and cleaning of reusable glass packaging (PAKT, 2024).

This illustrates that the scale on which an ecosystem starts is crucial for its success. Through slowly scaling up the system, rather than starting to large, the risks associated with implementation (e.g. financial, brand image) are minimized.

Figure 16 Overview of ecosystem configurations on Meso level



These ecosystems rely on an internal cleaning process that is either implemented in the continuous production process of a content producer (e.g. beer industry), or cleaned using smaller scaled batch washing (e.g. local dairy farm).

These ecosystems rely on the presence of an external cleaning facility, and the empty packaging is collected at a participating hub or store (e.g. MMP system, Circolution, Dotch and Zerooo). Currently, there are no hubs that also include a cleaning process, but this can change in the future.

Logistic collaboration is a key component for these ecosystems, as the product is collected at the home of the consumer, but it is bought in store (PAKT) or delivered at home (Pieter Pot, RePack). The cleaning service and logistic partner collaborate closely to ensure efficiency within the ecosystem.

5.4 Overview of ecosystems and entities

Based on the results of the previous sections (5.3) Figure 16 is established, in which all six ecosystems are shown with the responsibilities of each of the entities involved.

This overview is, however, not complete. There can be many different ecosystem designs for reusable packaging. However, the six analysed ecosystems have been in use for at least one (type of) product, and hereby, proven to be feasible. Therefore, these ecosystems are a good basis for understanding the differences and similarities between initiatives for reusable packaging and what an ecosystem overview combining all levels of research might look like. Figure 16 shows the three different identified general types of ecosystem configurations and a description thereof

5.5 Elaboration of entities

Based on Figure 16, it becomes apparent that there are a total of 7 entities that are present in the meso level of the ecosystem for reusable glass packaging. The entities each have different presence during the linear and reverse logistics loop, which is partially dependent on the reuse model type from the Ellen MacArthur Foundation (2019). The other dependency is the type of retrieval of the product from a consumer perspective, meaning, if they can buy the product on the go (physical store) or from home (online store). An overview of the entities, the return type and a short description is presented in Figure 17.

The entities are split up into three categories, which are entities that are always present in an ecosystem, entities that can be present in both the linear as well as the reverse logistics part of the ecosystem and entities that can be present only in the reverse logistics part of the ecosystem. The last two categories emphasise that the entities present can differ for each ecosystem design, and that not only the linear, but also the reverse logistics can influence which entities are present at which moments in the ecosystem. Nevertheless, the seven entities that are identified will form the basis of the framework that will serve as a guidance to establish a suitable ecosystem configuration.

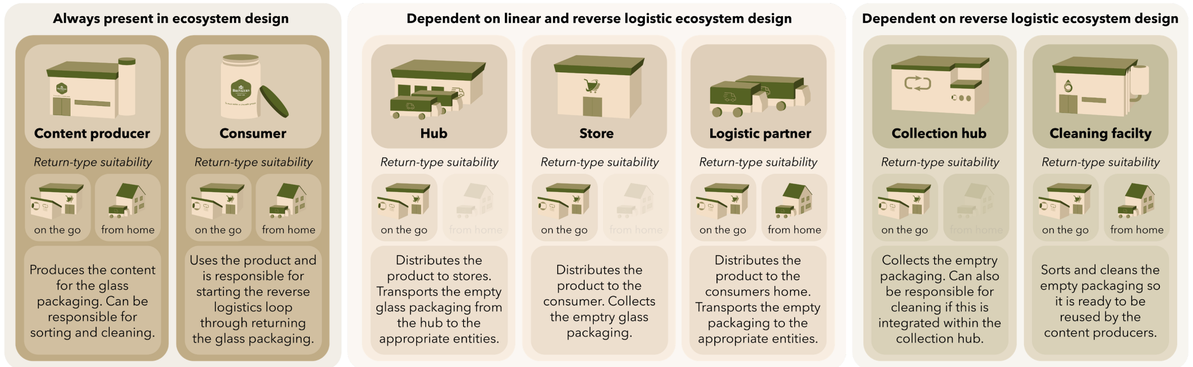


Figure 17 Detailed overview of entities on meso level

5.6 Elaboration of flows

For the ecosystem to function, there are two flows present (Hou et al., 2009). Firstly, the flow in the direction of the product and packaging, which is the material flow. Secondly, the flow that goes against the direction of the product and packaging, which is the financial flow. Both flows ensure the ecosystem is viable, and therefore, these will be elaborated upon in light of an ecosystem for reusable glass packaging.

5.6.1 Material flow

The material flow in an ecosystem for reusable glass packaging is driven by transportation. The expression of this transportation is quite similar to that present in an ecosystem for single use glass packaging. The only difference is the increase of demand, since additional transport is needed to facilitate the reverse logistic stream. However, this transport can be planned efficiently, by ensuring collaboration between the linear and reverse logistics. For example, if a lorry delivers empty packaging to the content producer, it should also be filled with products to deliver to a store or hub. Moreover, increased efficiency finds itself in saturated transport (Hesseling, 2022) and a dense logistic network, where short distances are preferred over long distances (Bocken et al., 2022; Isbouts et al., 2023).

5.6.2 Financial flow

The financial flow is more complex, as it covers not only the regular financial flow paired with product sales, but also necessity of added value, revenue structure and ownership of the reusable glass packaging. This section will elaborate on the financial flows and how these relate to the ecosystem for reusable glass packaging. It is important to note that the calculations in this section make use of estimated values for the different variables. Therefore, the results are illustrative examples of the ecosystem for reusable glass packaging. Though the value of each variable has been researched, the results are still an approximation of reality.

Financial flow of product sales

The financial flow of product sales is mainly on mutual exchange basis. The product is sold to a store or hub, who then becomes the new owner of the product in exchange for a financial compensation. Similarly, the consumer pays for the product (online or in-store) to then become the final owner of the product. In the case of Brinkers Food, the chocolate paste switches owner multiple times. For example, Brinkers Food owns the chocolate paste at first, then the hub, thereafter the store and finally a consumer. In each of the exchange steps, the product can get a higher price, depending on the costs of the added value in each of the steps and the revenue each of the previous owners wants to make (Bloemers, 2022).

Added value

The viability of the ecosystem for reuse is largely dependent on the participation of entities. To ensure such participation, the use of reusable packaging should be equal or lower in cost and effort compared to single use packaging. If this cannot be realised, the ecosystem should provide added value to the entities to balance out the effort needed for implementation of the reusable glass packaging. Such value can be, for example, increased revenue or consumer brand loyalty (Brinkers Food, 2023; Coelho et al., 2020), but also governmental subsidies for reusable packaging or additional waste costs for single-use packaging can motivate entities to participate in the system and implement reusable glass packaging (Brinkers Food, 2024).

Revenue structure

To illustrate this concept, an exemplary calculation has been made. For this, the following cost values have been estimated (Figure 18). In this case, the content producer can choose to buy new packaging, fully made from virgin material (0% cullet), recycled packaging with the maximum percentage of cullet possible (80% cullet), and the reusable packaging. As can be seen, the recycled packaging is 13% cheaper, as there is 13% less energy needed for the production of glass packaging from cullet material (Kovacec et al., 2011). The reusable packaging is estimated to be 5 cents more expensive, to compensate for the additional material to increase the strength of the packaging and the changes this brings during production. Additionally, the costs associated with the reverse logistics, such as transport and cleaning, have been established. Transport covers 11.7% of the energy costs for single use packaging, which is taken as a base point for the reverse logistics as well (Ingarao et al., 2017). Cleaning is estimated to cost about 2% of the energy compared to single use glass packaging, based on the specific heat capacity to get water to 80 °C for cleaning and sterilisation (Energy Education, 2023; Isbouts et al., 2023; Last et al., 2023). An estimated graph for the cost for the different glass packaging options is obtained (Figure 19). Looking at the reusable glass packaging, when the glass packaging is first reused, the cost price is visibly higher. However, the higher the number of reuse cycles of the reusable packaging, the lower the price gets. The average cost of the material, cleaning and transport spread over 30 cycles ends up being the following (Figure 2-). The cost of the reusable glass packaging is stabilizing far below the cost prices of the single use glass packaging options, which results in different possibilities for revenue structures, depending on the benefiting entity.

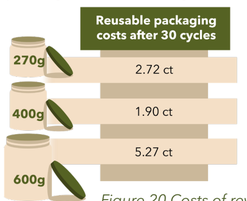


Figure 20 Costs of reverse logistics per glass packaging volume for 30 use cycles

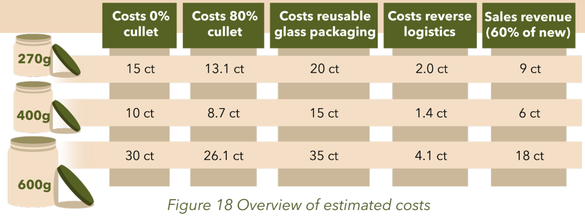


Figure 18 Overview of estimated costs

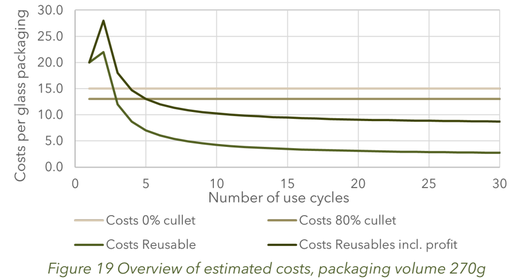


Figure 19 Overview of estimated costs, packaging volume 270g

Content producer - When the glass packaging is cleaned in-house at the content producer, the added value for the content producer is the difference between the costs of single use and reusable glass packaging. As can be seen in Figure 19, after three reuse cycles, the cost of reusable glass packaging is lower than single use glass packaging. After 20 cycles, this difference is even as big as 10 cents. Such a difference in cost price over a number of cycles of single use glass packaging compared to reusable glass packaging could cover the expenses and effort for in-house cleaning. As a result, the content producer might be cheaper off in the end as opposed to using single use glass packaging. On the other hand, the content producer is in charge of the cleaning logistics, which not only brings additional costs, but also additional efforts.

Sorting and cleaning facility - If the sorting and cleaning is performed by an external party, this party can gain value by selling the fully cleaned glass packaging to the content producer with profit. However, the sales price may not exceed the costs of the single use packaging alternatives. Therefore, the sales price as a percentage of single use glass packaging with 0% cullet is plotted against the number of reuse cycles needed to break even. This break-even point is always compared to the cheapest alternative, which is single use glass packaging made from 80% cullet. Following this line of thought and the previously mentioned variables, the graph in Figure 21 is obtained. As can be seen, 0%-20% of the sales price of new packaging is excluded from this graph, as this leads to unattainable scenarios. For example, 20% of the sales price of new packaging results in a sales prices of 3ct, which leads to a break-even point after 110 reuse cycles, highly exceeding feasible estimated reuse cycles (Coelho et al., 2020; Fabre & Joannard, 2022). However, the lower the sales price, the higher the chances that content producers will adopt the reusable glass packaging, hereby creating a more saturated and normalised system. Therefore, the choice of sales percentage lies with the sorting and cleaning facilities, where right balance of profit versus feasibility and adoption should be found. It could be the situation that the sorting and cleaning facility are separate entities. In that case, a similar revenue structure should be created in between entities. Hereby, both costs associated with sorting and cleaning as well as profitability for both entities should be considered.

Figure 21 Amount of reuse cycles needed to break even, packaging volume 270g

It is important to note that the portrayed prognosis of reuse cycles needed to reach a break-even point is solely based on a fixed environment. In reality, there are external variables, such as material and production costs, that fluctuate and result in differentiating prices. Moreover, the ever changing supply and demand can cause variations in prices. The graph in Figure 20 is merely an indication to what extend the ecosystem can be economically viable. Therefore, when the ecosystem for reusable glass packaging is implemented, such calculations should be updated, taking into consideration price fluctuations over time and potential presence of subsidies for reusable packaging.

Reusable packaging ownership

The owner of the reusable glass packaging can differ for each ecosystem. In a linear, single use packaging ecosystem, the packaging changes ownership, until, in the end, the consumer is the final owner (Makower, 2019; Southey, 2023). However, with an ecosystem for reusable packaging, the ownership often does not change. Most likely, the content producer or the store for whom a certain product is produced remain the owners of the packaging. In order to ensure the packaging is indeed returned to the owner, the label provides information regarding the ownership (e.g. "Bottle remains property of the brewery" on beer bottles) and often the bottle is part of a deposit-return scheme. Having financial incentive can motivate consumer to return the glass packaging. For the different ownership situations in an ecosystem for reusable glass packaging, the implications have been analysed.

Content producer as owner | For most own brand produce, the owner of the packaging is the content producer. Examples are the beer industry. Often, when paired with a deposit-return scheme, the consumer pays a deposit fee. When returning the packaging, the consumer delivers their proof of return (through means of a receipt) at the cashier (Morkoc, 2020). If this is the case, the glass packaging returns to the content producer in exchange for the deposit money. Then the packaging is returned to the initial owner, in this case the content producer. This can work in two ways. Either there is a direct exchange of goods and money between the store and the content producer, or an association, such as the Stichting Retourverpakkingen Nederland (Association for Returnable packaging Netherlands) in the Netherlands, collects the packaging and redistributes the deposit money and returned packaging to the correct entities.
The benefit as a content producer to remain the owner of the packaging is the choice of packaging standardization. Once dedicated to a certain reusable packaging option, the content producer can use this for their other own brands as well, leading to efficiency in production and lower costs.

Store/retailer as owner – If the deposit-return scheme does not involve any proof of return, the deposit money goes directly to the consumer, for example through cash change. This is often the case when the store is the owner, creating a closed loop deposit return scheme where only the consumer and store are involved. The additional deposit fee that is paid by the consumer is compensatied when the packaging is returned to the owning store. This can be paired with store specific return, but it does not necessarily have to be the case. Examples of such an ownership structure can be a store's private label products, or retail initiatives such as Pieter Pot.
The benefit as a store/retailer to remain the owner of the packaging is uniformity across all private label produce. This leads to standardization in store, which results in more of the same glass packaging for different product categories. Choosing only one type of reusable packaging makes the return and sorting of the packaging easier and less time consuming. Moreover, there is a higher number of packaging that will be returned by regular consumers, as they only have one type of packaging to collect and return. As a result, the whole ecosystem becomes more saturated and efficient.

Change of ownership – In a situation where the owner changes, similarly to the linear single use ecosystem, a different situation occurs. The change of packaging ownership happens when an entity buys the product, therefore, there is no need for a deposit return scheme. If the glass packaging is returned, it is completely out of free will of the consumer. There lies the problem with this type of ownership. The consumer often chooses the most easy way to dispose of packaging. If there is no (financial) incentive to return the packaging, the chances are high the packaging will not be returned. The benefit to have a change of ownership is minimized financial monitoring, as there is no exchange that involves deposit money. Additionally, this could create a new financial environment in which a wholesaler buys off the used packaging of the consumer for an extremely low price. Then, they clean the packaging and sell it with profit. Though this seems to be a feasible solution, it is important to note that such a situation requires a matured ecosystem to decrease risk and increase consumer participation. Additionally, having no incentive for return can drastically lower the return rate, which might ultimately make the whole ecosystem for reusable packaging fail due to a lack of glass packaging that makes its way back through the reverse logistics.

Overall, there are different structures regarding the ownership of the packaging that could be suitable for the ecosystem. Depending on the needs of the entities involved and the design of the ecosystem itself, a decision can be made which structure is most appropriate.

6. MICRO LEVEL

The Meso research has already included the responsibilities different entities might have. These responsibilities are not necessarily fixed to one particular entity. For example, the responsibilities regarding cleaning could belong to the content producer or a separate cleaning facility. Therefore, the responsibilities have been re-explored and placed into a Micro overview, which shows the responsibilities as identified in section 5.2-5.3 and the corresponding prerequisites. The overview below (Figure 22) presents the responsibilities that have been identified

Figure 22 Overview of Micro level entities

MICRO

Linear logistic requirements

- New packaging
- Quality control
- Filling content
- Labeling & boxing
- Distribution
- Selling
- Home delivery
- Usage

Reverse logistic requirements

- Return on the go
- Collection
- Return from home
- Home collection
- Storage
- Sorting
- Preparation
- Cleaning
- Reverse transport

6.1 Elaboration on responsibilities

The previous section has identified 17 different responsibilities. This section aims to elaborate on each of these responsibilities, hereby additionally highlighting the related Meso level entities. Through evaluating the different ecosystems and by speaking with experts, additional guidelines for these responsibilities have been established, which can be accessed in Appendix C. These can be aided to evaluate the suitability of an entity for a specific responsibility and which changes might be necessary to consider.

Figure 23 portrays the responsibilities and descriptions related to the linear logistics, whereas Figure 24 presents the responsibilities and descriptions of the reverse logistics. However, this division is not set in stone, as responsibilities (e.g. Quality Control) can also be present during both logistic flows.

Figure 23 Elaboration of responsibilities (linear logistics)

Linear logistics

New packaging	New glass packaging is received by the **content producer**. In a linear ecosystem, all the glass packaging that is needed comes directly from the glass manufacturer. In case of presence of reverse logistics to ensure reusability of the glass packaging, less new packaging is needed, as the used packaging is returned to the content producer.
Quality control	Quality control is always present at the facility of the **content producer**. This ensures the packaging is usable. All glass packaging that is not up to standards (blemishes, incorrect materials etc.) will be eliminated and recycled for creating new (recycled) glass packaging. This check happens at the facility of the content producer, but might also happen already during initial sorting.
Filling content	The content is filled at the facility of the **content producer**. Regardless of having a linear or reverse logistics system present, this filling process should be continuous. Therefore, enough glass packaging stock should be present at the facility, meaning that the overall ecosystem for reuse needs to be saturated, rather than having glass packaging on demand only.
Labeling & boxing	At the end of the filling process of the **content producer**, the filled glass packaging is labeled and boxed. Labeling is important, as this allows the consumer to see any tampering with the product and this indicates whether the glass packaging is reusable, in case of the presence of a reverse logistics system for reuse.
Distribution	The packaged products will be transported to a **hub** and from thereon, the product will arrive at the proper locations. It can be a possibility that the transport is arranged from the content producer directly to the store. In this case, the distribution will take place via a **logistic partner**.
Retreive on the go — Selling	In case the product is *retrieved on the go*, the consumer will go to a **store** where they can buy the product. The store can be either a supermarket or a specialist trade store when looking at LVV and SVSF solely, but could be different for other types and brands of content. This type of retrieval is likely paired with a return on the go system, but this does not necessarily have to be the case.
Receive at home — Home delivery	In case the product is *received at home*, the consumer will stay at home and order the product online. This product is then delivered at home by a **logistic partner**. This type of recieval is likely paired with a return from home system, but this does not necessarily have to be the case.
Usage	In the use phase, the **consumer** makes use of the product as intended. In this case, using the content to their desire. Once the packaging is empty, it can be returned for reuse through the appropriate reverse logistics channel, if one is present. In case of a linear ecosystem, the glass packaging will be recycled, or, in the undesired cases, be disposed of through incineration or landfill.

Figure 24 Elaboration of responsibilities (reverse logistics)

Reverse logistics

Return on the go — Return on the go	In some cases, the **consumer** can *return the product on the go*, which means they will have to visit a participating store or collection hub that makes use of reverse vending machines for the collection of the used glass packaging.
Return on the go — Collection	The collection of the glass packaging takes place through vending machines at a **participating store** or **collection hub**. The store can make use of the current reverse vending machines but should ensure that the new packaging is recognized by the system. The collection hub can be a self-sufficient location which collects and stores the glass packaging.
Return from home — Return from home	In some cases, the **consumer** can *return the product from home*, which means they can stay at home and book a time slot in which the packaging will be retrieved from their doorstep by a logistic partner.
Return from home — Home collection	The home collection of the glass packaging is facilitated by a **logistic partner**. This logistic partner collects the packaging and ensures that it is transported to the next entity in the ecosystem. This can be a cleaning facility, a hub or perhaps even the content producer itself, depending on the design of the reverse logistics of the reuse ecosystem.
Storage	When the empty packaging is collected, it takes up storage space. The collection locations, which are **store** or a **collection hub**, should ensure they have space allocated for the empty glass packaging that is collected.
Sorting	The sorting process can take place at the **store**, **cleaning facility** or at a **hub** that redistributes different types of reusable packaging to different content producers. This sorting process can range from sorting boxes of the same packaging to loose empty packaging.
Preparation	The glass packaging that is collected is emptied from the boxes in preparation for cleaning. This happens at the **cleaning facility** or **content producer**. This solely depends on the design of the reverse logistics of the reuse ecosystem. It is important to have the glass packaging removed from the protecting transportation box, to ensure the labels and residue can be removed properly.
Cleaning	The empty glass packagings are cleaned using pressurised heated water (65°C for cleaning, >80°C for desinfection). This can be done through a continuous system or via batches in industrial dishwashers. This process happens at a **cleaning facility** or at the **content producer**, depending on the design of the reverse logistics of the reuse ecosystem.
Reverse transport	The reverse transport is present throughout the full reverse logistics of the ecosystem for reusable glass packaging. The transport can be done by **logistic partners** or be overseen by the **hub** that connects the content producer to the store and cleaning facility.

7. FRAMEWORK

The results of the Macro, Meso and Micro research have led to a broad overview of the different relevant parts of the ecosystem. This chapter aims to connect the findings of the different levels to provide an overarching framework, in which not only the levels, but also the interconnections between these levels are elaborated upon. This framework is envisioned to serve as a guidance for industries exploring the possibilities of implementation of reusable glass packaging into their value chain.

7.1 Establishment of the framework

The results of the Macro, Meso and Micro level research are combined into one overarching framework. For this, an evaluation is executed regarding which Meso level entities might be connected to the Macro level entities and Micro level responsibilities. The Meso level entities are taken as a basis, as they have been identified as enabling actors of the ecosystem (section 5.5). An illustrative example is taken of the analysis of the Meso level entity 'content producer'. Similar evaluations have been conducted for the other entities, creating an overview of multilevel connections that is translated into a framework.

Macro level evaluation - Content producer | The Macro level entities influence the behaviour of the Meso level entities and vice versa. The content producer is influenced by legislative institutions and organisations to start using reusable alternatives. For the former, no such legislation is yet at stake for glass packaging specifically, therefore the influence of legislative institutions will currently be minor. However, entities still need to follow the laws and regulations set up by the legislative institutions, and therefore, these institutions will always be connected to the content producer. On the other hand, reuse organisations are very active in the field of introducing reusables in the industries, including content producers. The push for reusables through the European PPWR and the SUP-regulation has activated these organisations to help and stimulate, for example, content producers to implement reusable packaging.
As mentioned, the Meso level entities can also influence the Macro level entities. For instance, the content producer, in combination with the cleaning facility, has an influence on the glass manufacturer. A change of packaging results in adapted manufacturing processes. Moreover, the returned packaging leads to packaging volume fluctuations, resulting in a variable need for new packaging. Even though the glass manufacturer is not directly involved in the framework, their sales can be influenced due to the implementation of reusable glass packaging into the value chain.

Micro level evaluation - Content producer | The Micro level responsibilities that can possibly be covered by a content producer have been taken from real life examples. Section 5.3 has highlighted that the same responsibilities regarding the linear logistics happen at the premises of the content producer: arrival of new packaging, filling, quality control, and labeling and boxing. However, the reverse logistics can deviate, as for some ecosystem the content producer is responsible for cleaning-related processes, whereas for other ecosystems, they are not. To include the possibilitiy of coverage of the responsibilities of cleaning-related processes by the content producer, these responsibilities have been added to the content producer responsibility set.

Through this evaluation, the related Macro level entities and Micro level responsibilities have been identified for the content producer specifically. For each of other the Meso level entities, a similar analysis is conducted and the results are combined into one overview: the framework.

Figure 25 Legend of Macro level entities icons

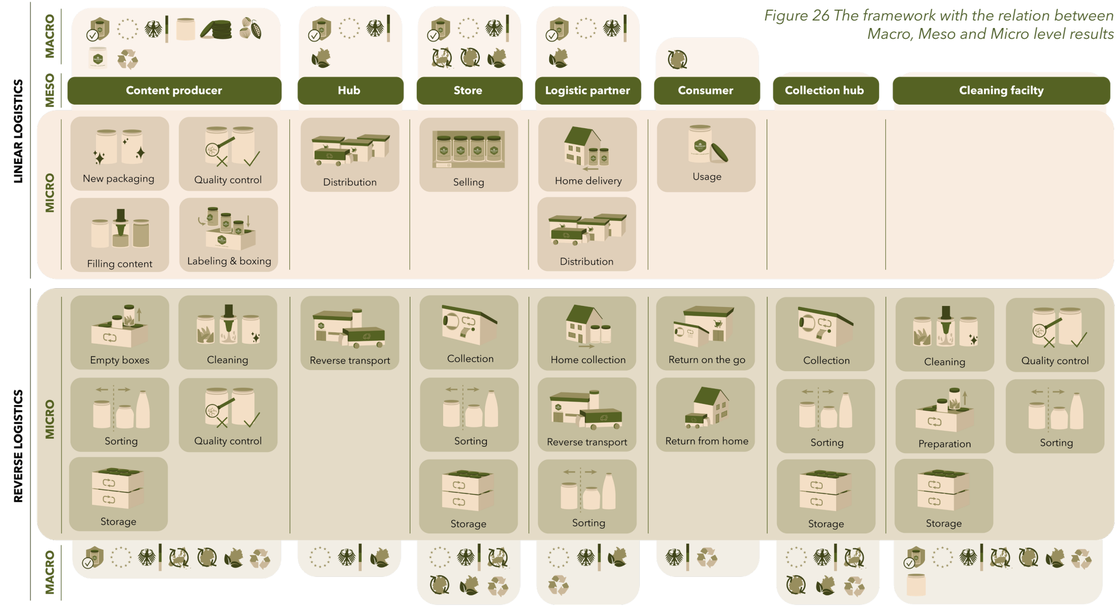


Figure 26 The framework with the relation between Macro, Meso and Micro level results

Figure 25 provides an overview of the icons used to indicate the different Macro level entities. Figure 26 shows the framework as an overview of the Macro and Meso level entities and Micro level responsibilities in relation to each other. Through providing this framwork of ecosystem elements (entities and responsibilities) the ecosystem as a whole can be better understood.

7.2 Overview of ecosystem configurations

The ability of the framework to visualise existing ecosystem configurations is evaluated through exposure to exising value chains that make use of reusable glass packaging. The corresponding entities and responsibilities on Macro, Meso and Mirco level for these different value chains highlight how the involvement of entities can differ. It should be noted that not all responsibilities are necessary fulfilled by the indicated entities. Based on the ecosystems defined in Chapter 6, two exemplary ecosystem configurations (Figure 27 and 28) have been established. For some value chains, entities on Meso level have become obsolete. For other value chains, all Meso level entities are necessary to make the ecosystem feasible.

Configuration 3b– Return from home – Logistic partner

In this configuration (Figure 27) the presence of the logistic partner is of utmost importance. Not only does this entity cover the transport of the product and packaging, it also executes part of the sorting process, where an initial division is made between reusable packaging suitable for the ecosystem and (non-)reusable packaging that is determined to be unfit for the ecosystem. Through the overview, it is revealed that the responsibility of sorting the packaging is linked to the end of life solution entity of the Macro research. Any reusable packaging suitable for the ecosystem that does not comply with the expected quality (e.g. breakage, damage, scuffing rate) is removed from the system by disposal through recycling. Pieter Pot makes use of this ecosystem (Derkse, 2021).

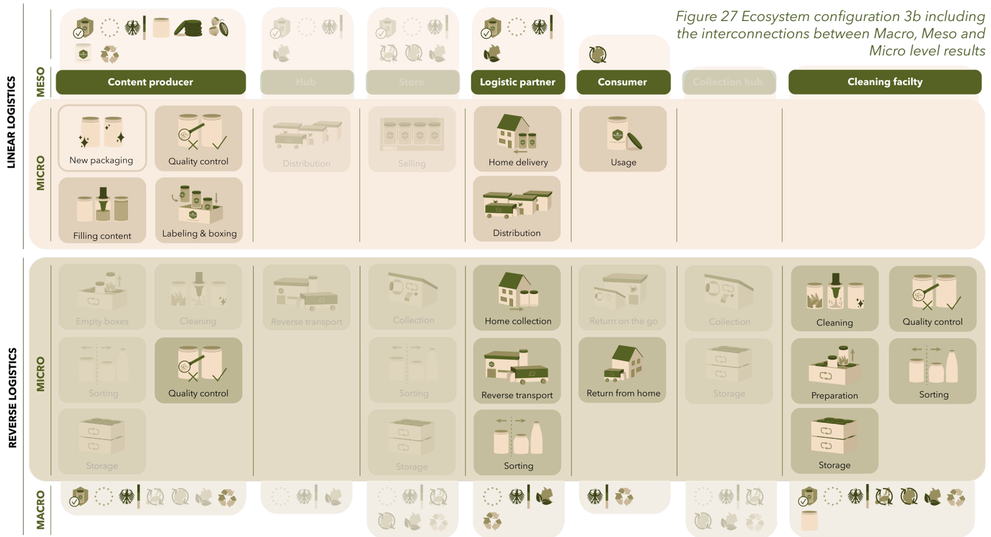


Figure 27 Ecosystem configuration 3b including the interconnections between Macro, Meso and Micro level results

Configuration 1b – Return on the go – Direct return

This ecosystem configuration (Figure 28) illustrates the return on the go principle with in-house cleaning and a hub in between the content producer and store. As can be seen, the collection hub and cleaning facility are not present in this ecosystem and the independent logistic partner is only present during the reverse logistic of the system. Since the hub distributes the product to the stores, there is no need for an additional logistic partner service. This means that all Macro level influences associated with the logistic partner during the linear part of the ecosystem are not present. For the reverse logistics, the logistic partner arranges the transport directly from the collecting store to the content producer. For this particular configuration, the logistic partner is not responsible for sorting the packaging, as this happens at the store and the content producer. Hereby, the logistic partner is not influenced by the end of life solution entities. However, they still need to adhere with European and German legislation regarding transport of goods. Environmental organisations can slightly influence the logistic partner through pushing for sustainable means of transport (e.g. electric vehicles).

Figure 28 Ecosystem configuration 1b including the interconnections between Macro, Meso and Micro level results

7.3 Conclusion

7.3.1 Visual communication

The decision is made to create a framework that makes use of visuals and interactions, rather than text or a step by step plan. Icons, in combination with written clues, are used as visual communication, leading to quicker understanding and recognition of elements (Parkinson, 2012). This is important, as there is a high number of variables to be understood. Moreover, graphics can stimulate creative thinking (Parkinson 2012). This can be beneficial during discussions, as it results in a more open mind to ideas of others, leading to more wide ranging discussions (Rutter & Stephenson, 1977). It is suggested that dialogues supported by visuals create an environment which enables interruption without conversation breakdown (Stephenson, 1976), hereby fostering better discussions. Additionally, by offering a starting point and cues for discussion topics (e.g. the division of responsibilities), the discussion is guided (Rutter et al., 1981). Not only does this keep the conversation relevant, it also leads to the possibility of comparing and/or combinging seperatly generated ecosystem congifurations due to standardisation of results. Through using visuals, the framework aims to foster and support discussions regarding the division of responsibilities in the value chain when reusable glass packaging is introduced. As opposed written communication only, the added visual communication of the framework aims to support and improve the verbal communication that is necessary to obtain a unified ecosystem configuration result.

7.3.2 Relation of Macro, Meso and Micro level

The different levels depicted in this research (Macro, Meso, Micro) are interrelated and can therefore not be seen as individual levels only. It becomes apparent that even though the different configurations change, all Macro level entities and Micro level responsibilities remain the same. Therefore, it can be concluded that, regardless of the ecosystem configuration, the identified Macro level entities will always be involved to some extent. The same holds for the Micro level responsibilities, which are crucial for the feasibility of the ecosystem. Constrastingly, the presence of the identified Meso level entities cannot be guaranteed. This highly depends on the division of the Micro level responsibilities. The configurations currently show a division of responsibilities that is the consequence of the chosen ecosystem configuration and the corresponding presence of entities. However, the opposite holds as well. When dividing the responsibilities amongst the entities in a linear ecosystem (content producer, hub, store, consumer), some responsibilities might not be covered by any entity at all. Consequently, a new entity could be needed, or a different division of responsibilities. For either one of the solutions, external Macro level forces might be at stake, such as legislation that steers entities into expanding their skill and knowledge set to accommodate for new responsibilities. Or, the support of organisations in forging new entities that can be directly adopted by the ecosystem to facilitate for more easy transition from a linear system to a circular one that includes reusable packaging.

The presented framework (Figure 26) can form the basis of introducing reusable (glass) packaging into the value chain. By using the framework, an ideal, mature ecosystem for reusable glass packaging can be defined, that is suitable for a specific value chain (as presented by the exemplary existing ecosystems in section 7.2). All entities on a Meso level are depicted, including the connected entities on a Macro level and the corresponding responsibilities on a Micro level. Using this as a basis, the different entities using the framework can work towards a unified result. Collaboration between entities, on both Macro and Meso level is essential. Where the Macro level entities need to offer unified support, guidance and standardisation, the Meso level entities are directly connected, thus a smooth transition between responsibilities should take place. Similarly, achieving the defined ecosystem on a Micro level is crucial. If one entity is not able to fulfil their responsibilities sufficiently, the whole ecosystem is affected. Each entity knows of which responsibilities they are in charge.

Through defining the differences between the current linear ecosystem situation (A) and the future situation in which the ecosystem for reusable packaging is implemented (B), each entity can create a suitable roadmap from situation A to situation B over a realistic timespan. This process should not only be executed on Micro level, but on Meso and Macro level as well, in order to ensure that the ecosystem as a whole can be realised as defined by the overview.

PART III

CASE STUDY
ECOSYSTEM CONFIGURATION

Part III explores the usability of the framework presented in Chapter 7.1 as a tool for establishing an ecosystem configuration suitable for a value chain that has not yet implemented reusable glass packaging. The subject of the case study is Brinkers Food, a content producer within a value chain for chocolate spreads. Firstly, the scope of the case study will be explored. Thereafter, the current external and internal linear ecosystem configuration will be depicted. Then, the external and internal ecosystem configuration for the implementation of reusable glass packaging will be established. Finally, the current and proposed situation will be compared and an implementation roadmap will be established.

8. SCOPE

The framework presented in Chapter 7.1 aids in the understanding of ecosystem configurations for reusable glass packaging for specific value chains. The ecosystems of the value chains thus far exposed to the overview have been in existance for a number of years. In order to test if this overview is relevant to be used for a value chain that has not yet implemented reusable glass packaging, a case study is executed. This case study explores the usability of the overview as a tool for defining an ecosystem configuration for reusable glass packaging for a currently still linear ecosystem of Brinkers Food, a producer of chocolate spreads, based in the Netherlands. This chapter will explore the current linear ecosystem in which Brinkers Food parttakes with a select number of personal brand spreads. Firstly, the scope of the case study will be provided. Thereafter, the overview of the current situation covers the ecosystem as a whole will be researched, as wel as a Micro level analysis of the process chain at the facility of Brinkers Food.

8.1 Subject of study: Brinkers Food

Brinkers Food originates from 1889, when it was first founded by Bernardus Brinkers as a margarine trading company, to facilitate for the need of affordable butter (Brinkers Food, 2022a; Brinkers Food 2022c; Mihelcic et al.,2003). The company grew over the years, with, as main milestones their first margarine factory in 1927, the production of Choba (chocolate butter) in 1946, the new main and current factory in Enschede in 1993, and the addition of a large warehouse in 2019. Up until now, Brinkers Food has been a family owned business, currently supported by 80 employees in different departments, such as production, R&D and marketing.

The ambition of Brinkers Food is as follows: "to further grow the successful family business by being flexible whilst focusing on achieving the highest quality and sustainability standards supported by a no-nonsense management style." (Brinkers Food, 2022a).

Key components of this ambition in relation to this research are delivering high quality products which are conform sustainability standards. This is reflected in their own private labels (e.g., Nuscobio, La Vida Vegan and So Vegan So Fine), which are vegan, organic and premium chocolate spreads, created by fair and sustainably sourced ingredients and which cover a major part of the output of Brinkers Food. Additionally, the facility of Brinkers Food has implemented energy efficiencies and makes use of 100% green energy (Brinkers Food, 2021). Lastly, they are improving their packaging waste separation through easily removable labels and usage of recyclable packaging, predominantly glass. Not only consumer waste, but also the improvement of separation of internal waste is a key component in the sustainable vision of Brinkers Food.

8.1.1 Brands

Brinkers Food produces spreads for external private labels, and their own conventional and organic private labels. The external private label brands vary from spread production for large to small retail and organic to conventional. Aside from production for external private labels, Brinkers Food produces spreads for their own private labels. On one hand, there are the private conventional labels, and on the other hand the private organic labels.

Figure 30 Comparison of La Vida Vegan and So Vegan So Fine flavours, adapted from Brinkers Food (2022b, 2022c)

Organic private labels

There are a total of four different own private labels produced by Brinkers Food, of which La Vida Vegan (LVV) and So Vegan So Fine (SVSF) are leading. The other organic personal brands are Nuscobio and Chocolate Rhapsody. The major difference is the amount of different flavours and the volumes in which the products are sold. These are visualised in Figure 29.
The leading organic spreads (LVV and SVSF) are available in 10 different flavours, sold in glass packaging in volumes of 600g, 270g and 200g.
The flavours for both brands are exactly the same, just the packaging is different (Figure 30). This due to the sales in Germany, the biggest market of Brinkers Food, where a clear distinction is made between brands sold in supermarkets versus specialist trade stores. Both sectors do not want to sell products from brands that are also sold in the other sector. Hence, the need for two different brands. This distinction is also taken over by other countries of sale, but not as strictly as in Germany.
These differences are not only present visually, but also throughout the whole brand identity. LVV is targeted towards organic and vegan oriented families to facilitate for a conscious lifestyle for parents and children (La Vida Vegan, 2023). On the other hand, SVSF is targeted towards a more youthful, environmentally conscious audience (So Vegan So Fine, 2023). The latter is also present on different media platforms, such as TikTok and Instagram.

Figure 29 Comparison of the private labels of Brinkers Food

Suitable brands

In order to create a feasible ecosystem configuration, brands needs to be willing to participate. To ensure the least amount of hurdles, a brand should be chosen that can most easily adapt to the changes of going from single use to reusable packaging. All the external private labels for which Brinkers Food currently facilitates the production and packaging, are often connected to a larger entity of that brand (e.g. retail chains), or do not necessarily suit the sustainable identity of using reusable packaging. This means that changes are often difficult to bring to the market, because of intermediaries, a lack of brand suitability and the uncertainty of the reuse ecosystem itself. As Brinkers Food has their own conventional and organic brands (Brinkers Food, 2023), it is a logical step to choose either of these brands as a starting point, as only internal communication and consensus is needed for the implementation of the ecosystem. Not only does the use of own private labels result in clear communication during changes to, for example the filling line, it also allows for Brinkers Food to adapt whatever necessary in a short period of time. Additionally, it enables Brinkers Food to add the unique marketing feature of being one of the first companies to be using reusable glass packaging for their private labels.

Of these two choices (organic and conventional), the organic brands are most suitable for the mentioned sustainable identity of reusable packaging. The four personal organic brands can be separated in leading and following brands (Figure 31). The leading brands are La Vida Vegan (LVV) and So Vegan So Fine (SVSF), which have the highest number of sales and the largest variety of flavours and sizes. The other brands are Nuscabio (organic brand extension of Nusca) and Chocolate Rhapsody (organic luxurious spreads). Compared to LVV and SVSF, these brands are less popular and have limited options regarding flavour and size, hereby being less ideal for the implementation of the ecosystem for reusable glass packaging. Moreover, the LVV and SVSF brands are actively promoted through different (online) mediums, which reaches a conscious and sustainably oriented target group. Due to the success and variety of the products, the decision is made to focus on LVV and SVSF as target brands for this case study.

Figure 31 Overview of personal organic brands of Brinkers Food (left: leading, right: following)

So Vegan So Fine (SVSF)

La Vida Vegan (LVV)

8.1.2 Relevance for Brinkers Food

It is important that the subject of the case study is indeed suitable for exposure to the overview presented in Chapter 7.1. Therefore, the relevance of the possible transition of Brinkers Food from single use glass packaging to a different, more sustainabel packaging is analysed, specifically the suitability of reusable glass packaging. Hereby, external and internal drivers have been identified.

External drivers

The current target group of the brands of Brinkers Food, So Vegan So Fine (SVSF) and La Vida Vegan (LVV) are people who have a preference for sustainable and responsible products that are fair for people and planet. The natural tendency for the target group to choose sustainable products can also transfer to choosing sustainable packaging, which can aid the implementation of a reusable glass packaging ecosystem.
From an external viewpoint, Brinkers Food is likely to experience some kind of governmental pressure in the future to switch to a more sustainable alternative to their current packaging, as is already at stake for plastic packaging through the introduced SUP regulation (Directive EU 2019/904). Additionally, the implementation of a reusable glass ecosystem does not clash with the wishes of current consumer of the brands of Brinkers Food, but rather supports them.

Chocolate Rhapsody

Internal drivers

Given that the current packaging material of Brinkers Food is predominantly glass (lids are plastic and metal), the transition to a different, more sustainable packaging material goes paired with a considerable amount of alterations to the current filling line and facility infrastructure. Alternative materials, such as rPET, could be a suitable option from a sustainability perspective. However the consequences resulting from such a material change are undesirable, as it leads to a significant amount of downtime due to process and machine adaptations.
Moreover, rPET is not necessarily food grade (Van den Hoeven, 2022) and the flexible nature of the material is incompatible with the chocolate spread (Brinkers Food, 2023b). Looking at these internal factors, reusable glass packaging poses the least amount of obstacles for Brinkers Food and the products they produce, when regarding more sustainable alternatives to single use glass packaging. Hence, the overview in Chapter 7.1, specifically suitable for ecosystems for reusable glass packaging, is a relevant means for Brinkers Food to explore a suitable ecosystem configuration.

Nuscobio

8.2 Scope definition

As illustrated by the brand choice in Section 8.1.1, there are many possibilities to use as a baseline for the determination of a suitable ecosystem. Therefore, this case study is scoped down to the following.

This case study will make use of the overview presented in Chapter 7.1 to obtain a suitable ecosystem configuration for the introduction of reusable glass packaging for solid and highly viscose food products that will be marketed in Germany for the company Brinkers Food, and will focus on the primary packaging of the brands La Vida Vegan and So Vegan So Fine.

The reasoning behind this scope will be explained in the coming sections (8.2.1-8.2.3).

Table 2 Example of the market analysis of existing initiatives, Netherlands

	Company	Sector	Reuse glass	Reuse plastic	Reuse cleaning	Reuse system	Associa-tion	(Digital) label	Deposit system	
DE/NL	Recircle	Food		⬢		⬢			⬢	return on the go
NL	Pieter Pot	Food	⬢			⬢			⬢	return from home
NL	PAKT	Food	⬢			⬢				return from home
NL	Wellmark	Cosmetics/home	⬢			⬢				refill from home
NL	Packcontrol	Industries				⬢				system based
NL	KIDV	Industries					⬢			system based
			3	1		5	1		2	

8.2.1 Packaging purpose

The case study will focus on reusable glass packaging for **solid and highly viscose food products** specifically. The company Brinkers Food produces chocolate and nut spreads, which are highly viscose food products. In the likely event that the ecosystem resulting from the overview is only viable when collaborating with other food production companies (Roussell & Shaw, 2023), the scope is enlarged to solid foods as well (e.g. pickles, beans, peas), provided that the current single use packaging of these food products is a glass packaging. Following from this decision, this case study will not take the possibility for glass bottles into consideration, as these are incompatible with the chosen food products. Additionally, choosing a jar shaped glass packaging complies best with the current setup of the production environment at the Brinkers Food producion site.

8.2.2 Focus area

The retail numbers of Brinkers Food present the highest market in Germany, the Netherlands and France, respectively. For each of these countries a suitability study is executed in order to make a well-considered comparison between the countries, ultimately leading to the **best suitable target country** for Brinkers Food. The components of the suitability study are the following.

- Analysis of current initiatives for reusable packaging
- Analysis of the market penetration of the own brands of Brinkers Food
- Analysis of the environmental attitude of the inhabitants

The suitability study can be found in Appendix D. The results are summarised on the following pages.

Market analysis of initiatives for reuse

The market analysis includes the establishment of a general overview of initiatives in each of the subject-countries. These initiatives can range from fully established glass reuse systems (e.g. Pieter Pot) to B2B systems to support reusable packaging amongst the industry (e.g. Packconnect). The analysis is placed in an overview similar to Table 2 which offers an example of the market analysis of the Netherlands. A similar analysis has been executed for all the subject-countries (Appendix D1). Looking at the results of the, the following conclusions can be drawn.

Germany has a well-founded deposit-return system (Pfand) that can be used for the collection of the used packaging and has one promising solution for reusable glass packaging in the food sector. However, as this solution has been on the market since spring 2023 and is not specifically tailored to the current single-use ecosystem of Brinkers Food, deciding for this option might be too unreliable as of now for Brinkers Food.

The Netherlands has a wide variety of initiatives that can function as inspiration for an ecosystem that suits Brinkers Food. However, as the amount and active years of these initiatives is limited, the reliability and feasibility of these systems are difficult to determine. Though they are promising, the evidence of success might be too little for Brinkers Food to participate in these systems.

France has multiple examples for reusable glass food packaging. Nevertheless, the backbone of the collection, cleaning and logistics is only focused on a regional level and therefore could lack nationwide viability.

This means that none of the countries has an existing reuse ecosystem that can be used immediately and successfully for reusable glass packaging for solid and highly viscose food. Therefore, the market penetration of Brinkers Food is analysed as well to ensure a well-considered choice for the target country.

Market penetration of Brinkers Food

The analysis of the market penetration consists of the analysis of the sales and sales points of the brands So Vegan So Fine (SVSF) and La Vida Vegan (LVV) (Brinkers Food, 2024). Due to confidentiality, these results cannot be disclosed. However, the following conclusions can be drawn regarding the market penetration of the SVSF and LVV brand of Brinkers Food.

For Brinkers Food, the *German* market the largest target market. As the products produced by Brinkers Food are relatively popular in Germany, perhaps possible ecosystem expansion is possible from their own private label external private labels.

The Netherlands, is runner up regarding market size of SVSF and LVV. Contributing to this are the number of sales points of these different brands. Also, there is a less strict distinction between sales locations, as opposed to Germany, where only LVV is only sold in supermarkets, and SVSF is only sold in specialist trade stores.

SVSF and LVV are not yet sold in *France*. To implement the ecosystem in France, Brinkers Food needs to establish relations with supermarkets and retailers first. As connections with French retailers are limited, the implementation of a whole ecosystem for reusable packaging might be too big of a step.

	D1	D2	D3	D4	D5	D6	D7		
	Reusable glass packaging solutions		Reusable plastic packaging solutions		Established reuse ecosystem	Established deposit-return ecosystem	Market viability	Total score	Suitabilty percentage
	Food	Other	Food	Other					
Germany	2	3	4	3	3	5	4	**3.4**	**68%**
The Netherlands	2	2	1	0	3	4	5	**12.7**	**54%**
France	3	2	0	0	4	2	1	**1.97**	**39%**

Table 3 Overview of weighted scores for the subject-countries

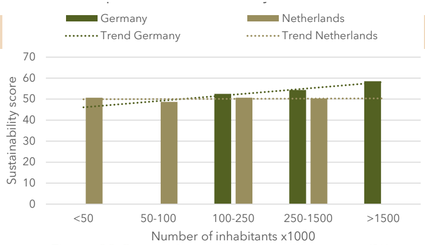


Figure 32 Comparison of sustainability scores (%)

Societal attitude

Based on the analysis of initiatives and market penetration, an initial comparison is made between the three subject-countries, using weighting factors. These weighting factors are generated through assigning percentages to different demands which reflect to what extent these demands contribute to the suistability of a country for ecosystems for reuse. In total, the weighting factors should add up to 100%. For example, the presence of current ecosytems for reusable glass packaging for food contents in a country show a certain societal readiness for adoption of such ecosystems. The decision is made to assign a value of 20% as a weighting factor, due to the importance of the demand. For a total of 7 demands (reusable glass packaging solutions for glass and for other materials, reusable plastic packaging solutions for glass and for other materials, established reuse ecosystems, established deposit return ecosystem, and market viability) a similar analysis has been executed. This is elaborated upon in Appendix D2. As a result, the following overall suitability scores are compiled (Table 3).

Germany: 68% | The Netherlands: 54% | France: 39%

Based on these scores, the environmental attitude analysis will only cover Germany and the Netherlands, as the evaluation has led to a low suitability for France.

To ensure a well-considered choice between Germany and the Netherlands, the last analysis consists of an analysis of the societal attitude of the inhabitants of the country (Appendix D2). It is important that the consumer is intrinsically motivated to return the packaging for reuse (Searious Business & Zero Waste Europe, 2023). This motivation can be largely triggered by the environmental attitude in a consumers' surroundings (Escario et al., 2020). Through using the Telos Sustainability Monitor Method (TSMM), a conclusion can be drawn about the sustainability score in each of the countries, which reflects the environmental attitude of the inhabitants (Figure 32) (Zoeteman, van der Zande, Smeets, et al., 2015). The comparison of the sustainability scores reveals that in Germany, the higher the number of inhabitants, the higher the sustainability score. For the Netherlands, the sustainability score does not change as a result of increase or decrease in population. As the most points of sale are often found in the more densely populated areas, it is desirable that the sustainability score in these areas is high. This means that, according to the analysis, Germany seems to be the most suitable country for the implementation of an ecosystem for reusable glass packaging. This means that the previous Macro analysis executed in Chapter 4, regarding legislation, food safety standards and organisations, can be used directly. For a more extensive elaboration on the focus area determination, the conclusion in Appendix D can be consulted.

8.2.3 Style and type

Finally, this case study will focus only on the **primary packaging** for the chosen brands of Brinkers Food: La Vida Vegan and So Vegan So Fine. The secondary packaging is not (yet) covered in the framework To ensure usage of the framework leads to a desired solution, the secondary and tertiary packaging need to be evaluated and possibly excluded from the scope.

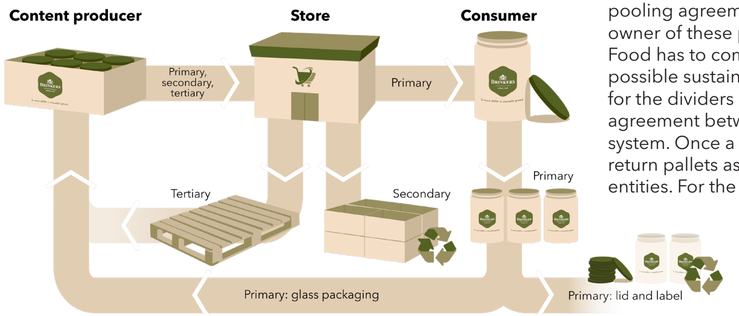


Figure 33 Packaging flow of primary, secondary and tertiary packaging for Brinkers Food

Brinkers Food currently makes use of half tray cardboard boxes and shrink film as secondary packaging, and stacks these onto a pallet, enforced by stretch wrap. The secondary and tertiary packaging that Brinkers Food receives is similar. The only difference is the presence of dividers between each level of glass packaging. This is needed for the filling process and to protect each layer of glass packaging from contamination.

As portrayed in Figure 33, the secondary packaging never makes it back to the production company, as the end of life of this packaging is the responsibility of the store where the product is sold. As the secondary packaging is usually easily separated (cardboard and shrink wrap), it can be conveniently added to the waste stream present at the store, which already separates cardboard and plastics. As for the tertiary packaging (pallets), Euro pallets are often coordinated by a pooling organisation (CHEP, 2023) or through pooling agreement between companies. For the first, the primary owner of these pallets is the pooling organisation, thus, Brinkers Food has to comply with the system of the organisation, including possible sustainability decisions. A similar pooling system is in place for the dividers between the layers of glass packaging. The pooling agreement between companies is on the basis of a mutual exchange system. Once a company receives pallets from Brinkers Food, they return pallets as well, to keep an equal division of the pallets amongst entities. For the primary packaging, there is a waste stream for the lids and labels. Currently, the lids are sorted and recycled (where possible) and the labels are broken down or incinerated during the process of recycling the glass. However, in an ecosystem for reusable packaging, a different label separation takes place, as the glass is no longer molten, but cleaned instead.

Due to the well-arranged recycling or reuse of the secondary and tertiary packaging, the decision is made to exclude this packaging type from the scope of the case study. However, it should be noted that in order to achieve a viable introduction of the reusable glass packaging, it is possible that alterations to the secondary and tertiary packaging might be necessary. Nevertheless, these changes should be minor, to ensure a minimized amount of adaptatios and corresponding time and financial resources are needed to implement the ecosystem.

9. SINGLE-USE CONFIGURATION

In order to determine what internal and external adaptations need to be made, as a result of the introduction of reusable glass packaging, it is important to identify the current situation at Brinkers Food. This entails the current filling process, as well as the process of delivery and pick up of goods (logistics). Through consulting employees at Brinkers Food and by observing the production process, the current situation can be determined. This chapter will describe these findings and hereby create an overview of the current situation at Brinkers Food, which will aid the establishment of the implementation roadmap for the ecosystem for reusable glass packaging.

9.1 Current ecosystem - External

9.1.1 Exploration

Brinkers Food cooperates with other entities to ensure their products reach the consumers. This creates an external linear ecosystem with partial reverse logistics through recycling of the packaging, as depicted in Figure 34 (Brinkers Food, 2024).

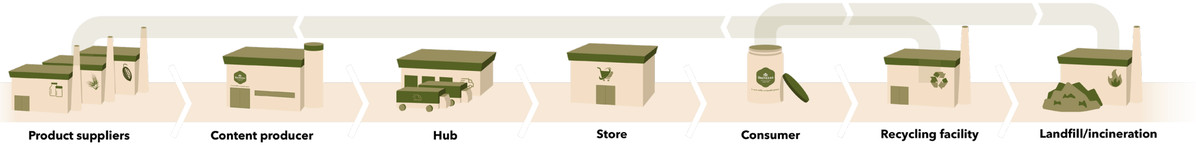


Figure 34 Simplification of the current linear ecosystem of Brinkers Food

Hub – This is the overarching distributer of the product created by the content producer. This can be a regional wholesaler or supermarket distribution centre.

Store – This is the location of direct product-consumer interaction. The stores can range from supermarkets, for the brand La Vida Vegan, to specialist trade stores, for the brand So Vegan So Fine.

Product suppliers – These are the companies that provide the ingredients and packaging elements for the product. This includes, for example, the glass and lid manufacturer.

Content producer – his is the company that produces the product. In this research, the content producer is Brinkers Food, which produces different types of chocolate spreads for varying brands.

Consumer – This entity is the direct user of the product. This also includes opening and disposal of the packaging. Depending on the consumer, the used empty packaging will be disposed of through recycling or municipal waste, which ends up in landfill or incineration.

Recycling facility – In the ideal scenario, the packaging is disposed of through recycling. The recycling facility separates the materials and grinds them to create, for example, cullet. This is then transformed into recycled packaging, such as the glass jar it was previously.

Landfill/incineration – The last stage are the unfavourable end of life solutions. The amount of packaging that ends up in landfills or incineration depends on the return rate and quality of the material.

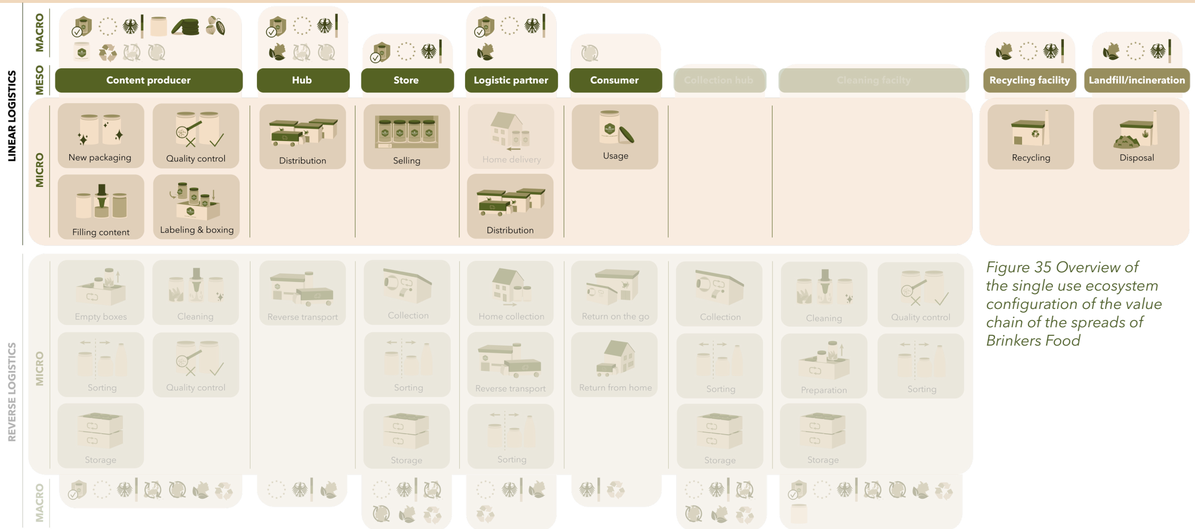


Figure 35 Overview of the single use ecosystem configuration of the value chain of the spreads of Brinkers Food

As can be seen, there is a visual circular loop present in the ecosystem through the recucycling process. However, recycling often leads to material downgrade and a need for replacement of material loss by implementation of raw materials (Ellen MacArthur Foundation, 2021; Jiang, 2021), and therefore it is not regarder as circular economy , which isregenerative in its nature (Ellen MacArthur Foundation, 2013). The entites present in this linear ecosystem depiction are similar to the ones identified in the linear part of the ecosystem configuration in the framework in Chapter 7.1. Hence, it is expected that this same framework will be a suitable means for establishing an ecosystem configuration for reuse as well.

9.1.2 Single-use ecosystem configuration

To allow for comparison between ecosystem configurations (current and reuse), the ecosystem configuration has been depicted through using the framework (Figure 35). There are two notable differences. Firstly, the whole reverse logistics element is absent, which is a direct consequence of the linearity of the ecosystem. As a result, the collection hub and cleaning facility are not included either. Secondly, the recycling facility and landfill/incineration have been added. Though these are not present in the original framework, they have been placed here to ensure direct translation of Figure 34 into the framework.

9.2 Current ecosystem - Internal

In order to determine the current internal situation at Brinkers Food, two methods have been consulted: observations and expert interviews. Firstly, an initial observation of the warehouse and processes is done. This helps understanding the processes in general, which aids as a context for the expert interviews. Secondly, expert interviews have been executed with employees at Brinkers Food who are closely involved in the internal and external processes at Brinkers Food. This allows for in depth conversation and evaluation of the current situation, and will highlight the processes from the perspective of experienced, heavily involved employees. However, the results of the expert conversations can be slightly different in comparison to the actual situation in the warehouse. Therefore, to support these findings, the warehouse processes are observed again by the researcher. This time, the researcher is able to look at the processes keeping the expert knowledge in mind. This allows for the identification of elements that might have been missed or different than initially depicted in the expert interviews. Through combining expert knowledge and the actual warehouse situation, an accurate representation of the current situation at Brinkers Food can be created.

Figure 36 The 11 stages of the process chain at Brinkers Food

9.2.1 Initial observations and expert interviews

Initial observations

A tour by the Sustainability and Innovation Manager (SIM) around the warehouse served as the initial observation of the processes in the warehouse. The SIM has an overall understanding of the activities in the warehouse. Though not an expert on this, the SIM can provide more insights on the overall picture, which gives a solid foundation for the current situation, that can be further detailed with the results of the expert interviews. Based on the observed processes and the additional knowledge provided by the SIM, an initial process chain has been depicted (Appendix E1). A total of 11 stages (Figure 36) have been determined to be present during the filling and logistic processes, each requiring different actions. It is important to note that for the depiction of the current situation, only the process chain which involves the glass packaging of the brands La Vida Vegan (LVV) and So Vegan So Fine (SVSF) is portrayed, as these are the chosen brands for the case study. As a result, other processes and process elements are left out (e.g. other sealing/capping processes).

Expert interviews

The expert interviews are non-structured, as this allows for open conversation on the topic with possible in depth insights and follow up questions that otherwise would not have been addressed. The experts are consulted on specific details of the processes in the warehouse regarding their expert position. As a basis for the retrieval of information from the interviewees, the established process chain has been used as reference. Through posing open questions regarding the completeness and correctness of the stages in the process chain, further detailing can be achieved. The following questions have been asked to three different experts.

To what extent is the depicted process chain an accurate representation for the production process at Brinkers Food?

What elaborations are needed to create a more complete process chain?

What are processes and/or tasks that could be (majorly) influenced by the introduction of reusable glass packaging?

The following results have been obtained during the expert discussions with the employees at Brinkers Food [1]. Additionally, a short description is added of the general related job activities. The altered process chain depiction following from this input is available in Appendix E2.

[1] Due to confidentiality, the participants of these interviews have been kept anonymous. Instead, the global reference of Brinkers Food (2024) can be consulted.

Head of Production

The Head of Production has the broadest set of knowledge of the warehouse. This includes warehouse space, layout and conditions, as well as the overarching overview of the production and filling space.

The Head of Production has provided information regarding the warehouse conditions. These are not limited to the borders of the warehouse, but also stretch to the transport vehicles. The following has been highlighted by the Head of Production.

Vehicle check – The delivery and export trucks are checked upon several parameters to ensure the packaging is clean and correct, and that there is no migration of smell.

Storage – The storage is variable, due to the preferences of each of the clients of Brinkers Food. The empty glass packaging has the shortest possible stay, as this takes up most space. When filled, the packaging is kept at room temperature and picked up within a few weeks. The duration of storage depends on the agreements made with the retailer, but Brinkers Food strives for the shortest storage time.

Transport – The transport is arranged in agreement with the retailer. There are a total of three options for transport. The first being that Brinkers Food arranges the transport, for which they use one of their logistic partners. The second option is that the retailer arranges the transport themselves. Lastly, there is the possibility that there is an external storage facility. For this, Brinkers Food arranges the transport to the external storage facility, where the product is stored and picked up by the retailer when they need new supply.

The introduction of reusable glass packaging can create problems in the warehouse, in case the streams are separated. In the unlikely event that Brinkers Food chooses to clean their own packaging, the whole warehouse setup will need to be changed. Another scenario is the complete separation of new and reused packaging, where additional chemical, microbiological and hygienic checks are executed before filling. However, the most successful introduction of reusable glass packaging, according to the Head of Production, is the one that leads to the least amount of changes needed. Therefore, the reused glass packaging should be up to the quality and safety standards of new packaging, so the streams can be combined.

Head of Purchase and Planning

The Head of Purchase and Planning creates the planning for the different contents that need to be produced and filled. This includes the consideration of content type, glass packaging type and volume, lid type, label and secondary packaging. Moreover, the Head of Purchase and Planning ensures all needed goods are in stock, based on the planning prognosis they have created.

The Head of Purchase and Planning has highlighted certain background details of the planning process. They have revealed that the filling processes shape the planning, where the key is to create the least amount of downtime, thus the least amount of adaptations. These matters apply to all three of the filling lines, out of which two are in continuous operation (the third is for small volumes).

Content type – Often, one type of content (e.g. palm oil free spread) can be filled in multiple packaging types. As a content type change leads to significant downtime due to cleaning, the planning is structured around having the least amount of content changes.

Glass packaging volume and type – When changing to a different jar type, this often goes paired with filling-line wide alterations, which is undesirable due to the associated downtime. However, some jars can run consecutively with only minimal changes to the filling line, such as specific 200g and 270g jars, for which only the filling height needs adaptation.

Lid type – A lid type change leads to local alterations at the closing and sealing machines (e.g. glue or induction sealing). Though this does lead to downtime, this is significantly less impactful compared to a content or packaging change.

Label type – Similar to the lid change, a change in label leads to a manageable downtime as only minor adaptations need to be made.
Secondary packaging - Similar to the lid and label change, a change in secondary packaging leads to a manageable downtime, as only minor adaptations need to be made.

Purchases – Based on the planning, an estimation can be made about the inventory of goods. This leads to a general yearly estimation of the amount of, for example, packaging that needs to be purchased. The 8-week planning provides a more detailed overview of what needs to be ordered. In the end, the planning is leading for the purchases of goods to ensure sufficient supply during the filling process.

Based on this, the implementation of reusable glass packaging finds the highest impact in the packaging type. As of now, there are 9-10 types of jars that lead to filling line alterations. If the reusable glass packaging is not conform any of these types, the implementation of these jars leads to another type that needs to be implemented in the planning, possibly leading to relatively more downtime. On the other hand, if introduced on a large scale, the reusable packaging can lead to standardization, hereby decreasing the number of types at Brinkers Food. However, this requires strong cross-chain collaboration, which might not be achievable as of yet.

Team of QA and QC

QA covers processes and procedures that ensure product quality. This includes obtaining certificates, quality protocols and procedures and documentation. QC covers the product specific quality, such as content and packaging quality, filling conditions and the associated tests. Though closely related, multiple experts in this team have been consulted to create a complete overview from the QA/QC perspective.

The team of QA and QC has highlighted specific measures that are taken during the filling process to guarantee the quality and safety of the packaging and content, in addition to the measures already mentioned.

Contamination prevention – The packaging enters the warehouse wrapped in shrink wrap which remains around the packaging until placed onto the conveyer belt. This is not only to keep the packaging in place, but also to prevent contamination. Moreover, the glass packaging gets rotated and with pressured air any residue is removed, after which the packaging is covered with a roof to prevent contamination during the filling process. The pressured air is checked every 30 minutes as well.

Traceability – The pallet number of the glass packaging is linked to the content batch through noting down the start and end time of the filling procedure. This way, both the content and packaging can be traced back.

Vehicle check – The vehicle check mentioned by the Head of Production has also been mentioned by the team of QA and QC. Having contaminated glasses highly compromises the quality and safety of the product.

Routine QA and QC – The routine checks cover the procedures of checking the content on different parameters. Such checks ensure that the filling procedure can be stopped in a timely manner if inconsistencies have been discovered.

The team of QA and QC foresees problems in the introduction of reusable glass packaging due to the mandatory traceability and the risks associated with reusables. The glass packaging cannot be traced back to the manufactured batch. Therefore, each packaging should be individually checked to ensure it meets the requirements (Grolsch, 2024) and to limit the possible risks as a result of production errors. Other risks associated with reusables are chemical and microbiological residue from (insufficient) cleaning. Moreover, insufficient cleaning can lead to safety compromises, such as the presence of allergenic substances. Especially in the food industry, these measures are very strict, and therefore any additional major risks should be avoided at all times.

9.2.2 Final observations and current process chain

Final observations are made by following all steps a glass packaging encounters at the Brinkers Food premises. The following observations have been made and a final process chain is established (Figure 37).

Adaptations to filling line – Before filling, multiple key locations are altered based on the packaging type and volume. These key locations have been identified as the following, including the possible adaptations: filling station (content volume, filling line), closure station (filling line, lids), labelling station (filling line, labels), secondary packaging station (secondary packaging) and tertiary packaging station (stacking layout, stacking process).

Contamination prevention – A roof covers the packaging to prevent contamination, which is present throughout the whole filling process. The moment the pallet is unwrapped, the top cover remains on the glasses, until these are placed at the roofed entry location. When the first layer gets inserted, only then, the pallet cover is removed.

Packaging consistency – The influence of mistakes in the packaging can result in severe consequences. Therefore, multiple checks are added to ensure the packaging is correct. However, what is not yet accounted for, is possible deviation of packaging due to different production locations. Currently, all packaging from a similar type originates from the same producer, often also produced within the same period of time. If a defect is detected in the packaging, the whole pallet is prone to have that same defect. This limits the amount of checks needed to determine if a pallet is suitable for the process chain and decreases the amount of adaptations to the process chain to make it fit the packaging that is deviating from the standard. In the event that a pallet of mixed packaging arrives (e.g. cleaned reusable glass packaging), the consistency of the packaging can differ throughout the pallet. This results in impossible adaptations to the process chain, hence making the whole pallet unfit. A solution must be found for this issue in order to ensure reusable glass packaging can be a viable option for a content producer, such as Brinkers Food.

Vehicle check – During the final observation round, the following specifics of the vehicle check were discovered: smell, moisture, dirt/residue, fraud, damage and type.

Vehicle sealing – In addition to checking the inside of the vehicle, there should be a guarantee that the content of the vehicle has not been tampered with. This is done by adding a seal to the vehicle, which is only broken upon arrival. In case of double transport, multiple seals can be used.

Secondary packaging – The possibility of eliminating shrink wrap around the secondary packaging leads to a higher instability on the pallet. As a result, a different stacking layout and height might be necessary, and more shrink wrap might be needed to increase pallet strength during transport.

Product cooling – The product needs quick cooling to result in a high quality spread, without product separation or unstable crystallisation. This happens in the cooling room, which is a large fridge with circulating airflow around and through the pallets of stacked product. To allow for internal air flow, air channels are present in the stacked layers of filled packaging. To obstruct as little airflow as possible, only a small layer of stretch wrap is added to secure the pallet. Within roughly four hours, the chocolate spreads have reached the correct temperature of about 20 °C. Thereafter, the pallet is wrapped in a proper layer of stretch wrap and stored in the warehouse at room temperature.

As can be seen, the third process stage name has been changed from “filling line preparation” to “packaging insertation”, as this was a better description of the stage. Moreover, adaptations to the filling line happen at multiple stages of the process chain, hence the necessity to alter the stage name. Additionally, it is important to note that all adaptations to the filling line are executed before the filling process starts, not as the packaging arrives at that stage.
Based on the expert input and observations, the stages have been completed through the addition of detailed activities for each stage. This way the entirety of the filling line is visualised. However, not all stages are fully defined yet. As of now, the La Vida Vegan and So Vegan So Fine are still wrapped with shrink wrap. However, this could change in the future depending on retailer preferences. Therefore the shrink wrap is left in, as the current situation of the process chain at Brinkers Food is described, not a potential future situation. However, the possibility of exclusion of shrink wrap should be regarded for the possible future scenario that includes reusable glass packaging. Moreover, the packaging consistency issue is currently dealt with through the routine QA and QC checks. However, the consistency problems at stake for a reusable glass packaging ecosystem should not be disregarded. Therefore, during comparison, this issue should be noted and accounted for once an implementation roadmap is established.

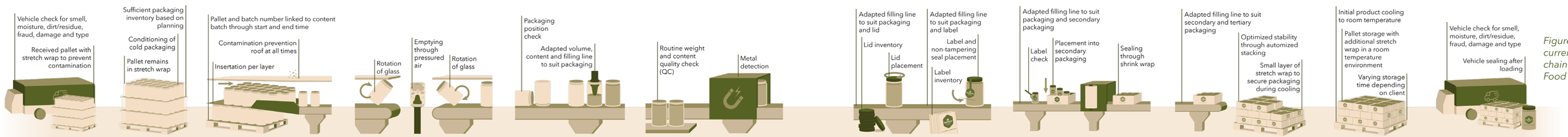


Figure 37 Final current process chain at Brinkers Food

10. REUSABLES CONFIGURATION

As identified in Part II, the configuration of the ecosystem depends on the division of responsibilities amongst the entities. Depending on the willingness of the entities present in the current ecosystem to take on these responsibilities, additional entities might be needed. To obtain a suitable ecosystem configuration which suits all entities involvend, interactive sessions are executed. Such sessions do not only give an indication on the responsibility division, but are also a means to foster discussion about the topic, which may reveal where, when and what difficulties could be at stake for each of the given responsibilities. Especially the latter is relevant, as this provides more insights on a realistic task division within the ecosystem, based on the expert experience of employees. This will lead to an ecosystem configuration that is pragmatic, which results in a reliable starting point for determining the steps for transitioning from a linear ecosystem to the defined ecosystem for reusable glass packaging.

10.1 Interactive session

Through obtaining information from expert participants in the industry, the ecosystem configuration for this particular case study will be supported by input from employees of the affected entities. Hereby, the most accurate, suitable and pragmatic ecosystem configuration that suits the ecosystem of Brinkers Food can be established.

10.1.1 Entities

Collaboration between entities is an important factor for industries to become more sustainable (Sumter et al., 2023). Regarding this research from the perspective of Brinkers Food, this entails collaboration with retailers, material and packaging manufacturers and friendly competitors. Hence, these entities are contacted to participate in an interactive session, to obtain input from different perspectives. By involving the different entities present in the ecosystem, a holistic and realistic ecosystem configuration and following implementation roadmap can be established, not only suitable for Brinkers Food, but also for the other entities involved.

Retailers

Retailers are a crucial partner for collaboration, as they purchase directly from the content producer and want to obtain a sustainable image using little to no effort (Sumter et al., 2023). Moreover, retailers often have a variety of consumers due to cultural, social and spatial differences (e.g. Dutch versus German retail). These differences shape the packaging needs, hereby leading to a diverse packaging portfolio. This can lead to difficulties regarding standardization and transitioning to more sustainable packaging. The more sustainably oriented leading retailers are, the more likely it is that smaller retailers will follow. Therefore, it is important to involve these retailers in industrial transition towards sustainability.

Material and packaging manufacturers

The material and packaging manufacturers are the key entities for creating a feasible ecosystem (Sumter et al., 2023). The possibility of creating standardised packaging that is reusable is in hands of these manufacturers. Therefore, close collaboration between the content producers and material and packaging manufacturers is important for the success of the ecosystem.

Friendly competitors

Through sharing knowledge and experience regarding sustainable transitions, small, medium and large sized enterprises can learn from each other. On one hand, smaller companies often have little experience with sustainable transitions, but often dare to experiment with this transition, hereby posing an example for larger companies. On the other hand, these larges companies are the ones that can often make an impact through scaling up sustainable solutions. Collaboration between these different sized companies, that in origin might be competitors, results in sustainable transitions on a larger scale.

Overview of participants

Based on this analysis, the decision is made to involve the content producer itself (Brinkers Food), retailers, material and packaging manufacturers, and friendly competitors in the interactive sessions. The following overview shows the different participating entities with a short description.

Glass manufacturer | A large German glass manufacturer that currently supplies Brinkers Food with the suitable glass packaging for their brands.

Content producer | *Brinkers Food* – a medium sized content producer of chocolate spreads, both private label and personal brands. This research concerns the latter, specifically the La Vida Vegan and So Vegan So Fine brands.

Retail hub | A Dutch medium sized retailer in organic products. They arrange the product distribution for organic supermarkets and multiple foodservices in the BeNeLux.

Store | A Dutch medium sized specialist strade store with 3-4 dialy employees selling organic products. Overseen by a large retail chian, with a presence of 109 stores across the BeNeLux.

For the session itself, the following expert employee positions have been decided to be suitable, as these employees have experience with the value chain and basic knowledge of the tasks protrayed on the task cards (especially for linear logistics).

- *Logistics*
- *Communication/Sales*
- *Quality Control and Quality Assurance*
- *Production manager*
- *(Store) Manager*
- *Sustainability manager/strategist*

10.1.2 Approach

The interactive session consists of two separate parts, out of which the first is informing, and the second is the actual interactive activity.

Part 1 – Background and briefing

Materials: presentation

Firstly, the relevant background information to understand the ecosystem and responsibilities is given, hereby covering:

- Concise description of the purpose of the research and session
- Concise description of single use versus reuse ecosystems
- Elaboration of the levels of involvement and the task cards

Part 2 – Interactive activity

Materials: A2 sheet: levels of involvement, 20 task cards, presentation

This part involves the different task cards, which can be placed onto the A2 sheet (figure 38) in accordance to the level of involvement from the perspective of the participants. Firstly, the participants can simply place the tasks according to their envisioned level of involvement. Their reasoning for specific placements is noted down. Thereafter, the participants will be asked to identify barriers that limit them from a high level of involvement for certain tasks. This way, a list of barriers is defined, which are used for a second scenario: If the identified barriers are removed, what influence does this have on the current task involvement? The participants can discuss about this and move tasks around based on the absence of the earlier identified barriers.

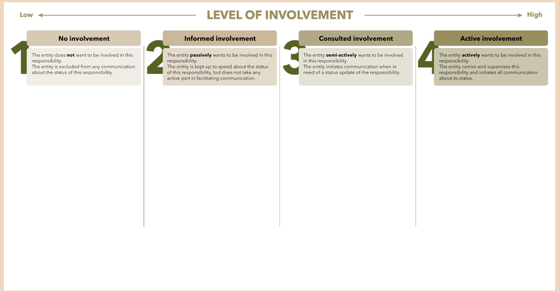


Figure 38 A2 sheet for placement of the the responsibility topic cards

The discussion between participants to place the cards can be valueable for this case study, as it reveals why certain decisions are made and what are necessary changes an entity needs for a different division of tasks. This way, the current barriers for implementation of the ecosystem are identified from a firsthand perspective of directly involved entities. Figure 40 shows a step by step session example.

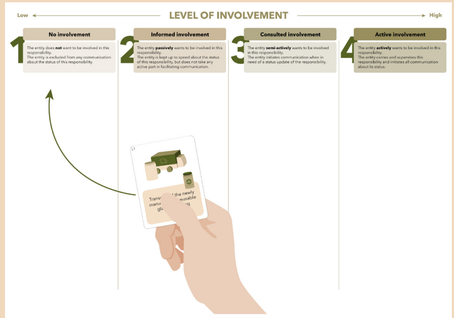
10.1.3 Levels of involvement

Different levels of involvement have been explored to create a distinct division for the participants. Based on different engagement strategies (Lee, 2023; Rupp, 2023; Tractivity, 2023), four definitions of the levels of involvement have been established (Figure 39). Choosing an even number of options ensures that the participants cannot choose a neutral level of involvement, which results in a forced choice towards either one of the extremes. The extremes in this case being no involvement and active involvement.

Figure 39 Overview of levels of involvement

No involvement	Informed involvement	Consulted involvement	Active involvement
The entity does **not** want to be involved in this responsibility. The entity is excluded from any communication about the status of this responsibility.	The entity **passively** wants to be involved in this responsibility. The entity is kept up to speed about the status of this responsibility, but does not take any active part in facilitating communication.	The entity **semi-actively** wants to be involved in this responsibility. The entity initiates communication when in need of a status update of the responsibility.	The entity **actively** wants to be involved in this responsibility. The entity carries and supervises this responsibility and initiates all communication about its status.

Step 1: The linear logistics task cards are placed in accordance with the level of involvement the participants see fit through discussion.



Step 2: After the linear logistics cards are positioned, the reverse logistics task cards are placed in accordance with the level of involvement the participants see fit through discussion.

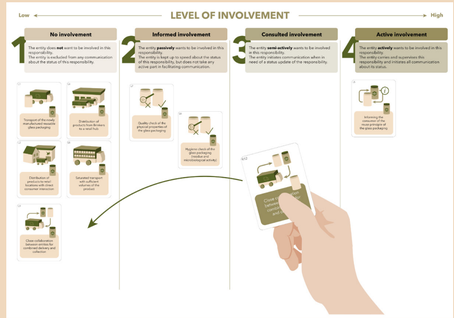
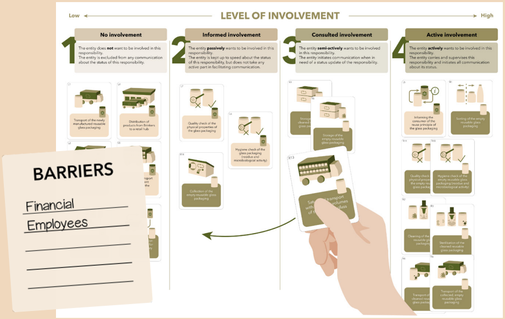
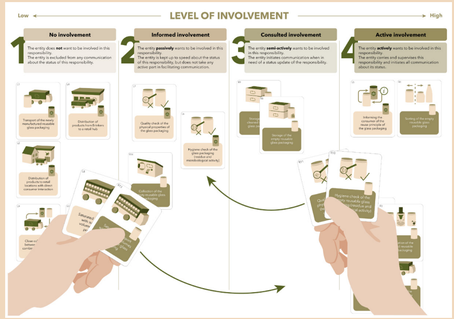


Figure 40 Exemplary execution of the interactive session



Step 3: The last card is placed in accordance with the level of involvement the participants see fit through discussion. The results are discussed and barriers are identified.



Step 4: The participants can move the cards in accordance with the level of involvement the participants see fit, after the identified barriers have been removed.

10.1.4 Tasks and task cards

In addition to levels of involvement, different tasks cards have been created, covering both internal and external tasks related to responsibilties. The reasoning for creating tasks, rather than directly using responsibilities, is to decrease ambiguity. For instance, distribution across the entirety of the value chain is unspecific, as multiple entities can be responsble for this. Therefore, this responsibility is subdivided into different seperate tasks. The same counts for the other responsibilities that are split up into multiple tasks, as this will lead to more specific feedback and opinions regarding task involvement. Some responsibilities have been combined as the corresponding tasks are closely related (e.g. transport and home delivery), hereby simplifying the session by eliminiating tasks already present. Finally, some responsibilities are completely left out, as there is only one entity that is indefinately responsible for the value chain of Brinkers Food (e.g. the filling and labelling & boxing of the packaging, which is always done by the content producer). This helps simplify the session as well as eliminate obvious choices that do not facilitate discussion.
The overviews in Figure 41 and 42 portray the tasks related to the responsibilities, subdivided in linear and reverse logistics.

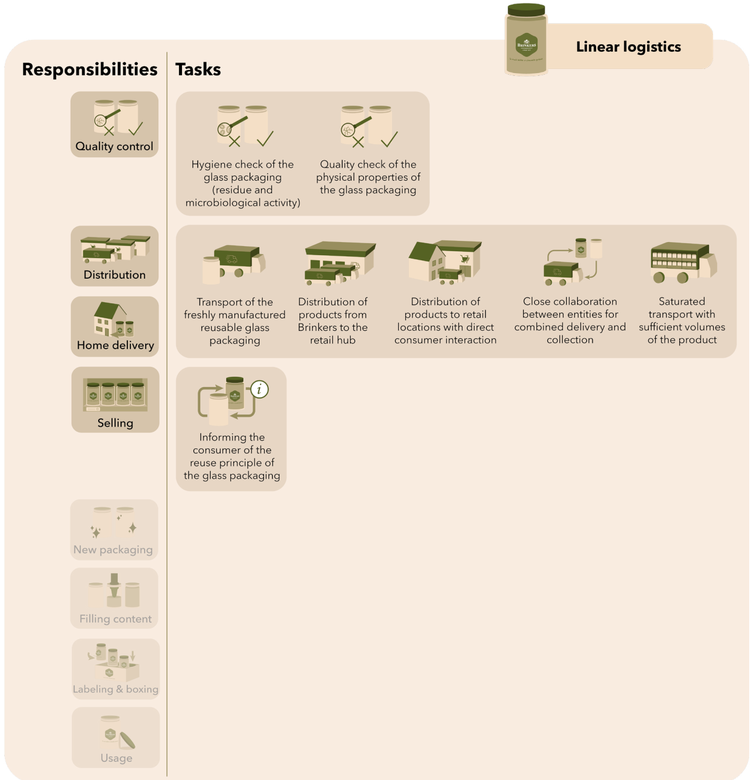


Figure 41 Responsibilities and corresponding tasks linear logistics

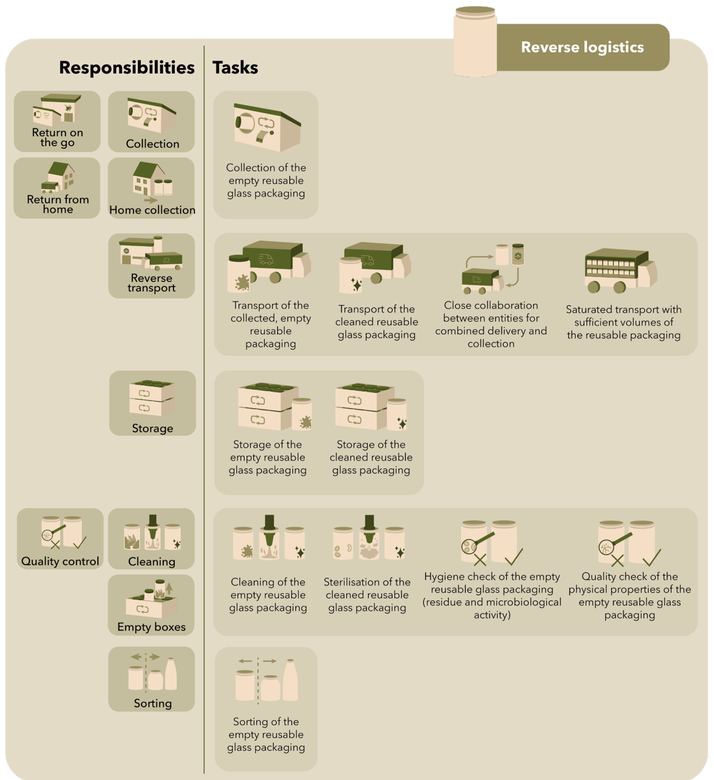


Figure 42 Responsibilities and corresponding tasks reverse logistics

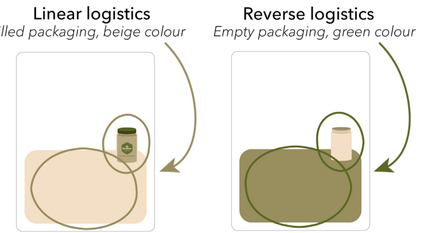


Figure 43 Task cards including linear or reverse logistics context

The tasks that are generated are placed on the task cards to be used during the session. The context of the linear and reverse logistics is added to provide clarity of the context of the tasks (Figure 43).

10.1.5 Results

The following section contains the result of the interactive sessions. In total, four sessions have been conducted, out of which two have been slightly altered to fit an online meeting environment. This has led to insights of the implications of the ecosystem for reusable glass packaging for a variety of entities involved. The results of the task placement can be found in Appendix F.

Content producer - Brinkers Food [2]

During the session executed with participants from Brinkers Food (executed as explained in Section 10.1.2), it became apparent that the attitude of Brinkers Food regarding a high level involvement in tasks was mainly oriented towards tasks present in the linear part of the ecosystem (quality of glass, distribution from Brinkers and informing the consumer). What was striking is that for most of the tasks related to the reverse logistics and hereby crucial for a circular ecosystem (all tasks associated with cleaning and collection), the participants thought Brinkers Food should not be involved at all. Most of the tasks left (transport related tasks and hygiene of the packaging) was something the participants though Brinkers Food should be informed about, but should not take on activities related to these tasks.

Overview of participants

Head of production	Sales (Germany)
Quality Assurance	Customer service
Quality Control	

[2] *Due to confidentiality, the participants of the participatory session have been kept anonymous. Instead, the global reference of Brinkers Food (2024) can be consulted.*

The reasoning for the involvement in tasks was mostly steered by barriers which were identified by the participants throughout the discussion. These barriers were indicated to be the following.

Maturity of the system

Firstly, the maturity of the ecosystem played a major role in the task division. In the case of a fully matured ecosystem for reusable packaging, the participants indicated that they wanted to be involved in more tasks. Examples were the need for consulted involvement regarding the shape, size and collection method of the packaging and the need for active involvement for cleaning and sorting. This was based on the idea that a mature ecosystem has minimized risks and the more evolved the system, the more influence they would like to have on key decisions. Hence the generally higher level of involvement for the different tasks.
On the other hand, in case of a new ecosystem that has barely taken off, the participants were much more hesitant to take on a high level of involvement regarding the tasks. Mainly because, in their eyes, an immature system results in a high burden for the responsible entity. Taking on a high involvement in tasks (such as collection or cleaning), results in a shift of focus from producing spreads to cleaning (which is not their expertise) and creates additional time consuming and costly activities, for which Brinkers Food does not have the capacity. Therefore, in the situation that the ecosystem is still in its infancy, the participants indicated that they would much rather take on a passive role in most of the tasks.

Ecosystem saturation

The participants also mentioned that in case of a higher volume of product sales, the more glass packaging would be in the system. This would result in a saturated system, in which the throughput of glass packaging would be stable and little to no waiting times to collect the required number of reused glass packaging would be experienced. In the eyes of the participants, this would increase the value of the system, which would lead to a higher level of involvement needed for the tasks, to remain relevant in the system. In case of a low saturation of the ecosystem, regarding the glass packaging, higher downtimes could be experienced if Brinkers Food were to also take collection, sorting and cleaning upon themselves. Due to this increased risk of downtime as a result of low throughput, the participants were hesitant to take on these tasks from the perspective of Brinkers Food.

Time

Time was a general barrier to become involved in the tasks related to the ecosystem. Not only the fulfilment of the tasks itself takes time, also al the preparation and man hours before that to ensure the task can be executed at all was seen as a barrier by the participants. And, as stated by the participants “time is money”. Hence, if they were to have a high involvement in tasks that are outside the current scope of Brinkers Food, these should be relatively easily integrated within the current environment.

Storage

Fulfilling certain tasks does not only take time, but also requires space. Brinkers Food currently aims to have as little inventory of empty glass packaging as possible, due to the storage space it requires. However, the collection and cleaning process leads to more storage space needed for both dirty and clean glass. This is space they currently do not have and also do not want to allocate to processes that do not directly concern their main objective: producing chocolate spreads. Hence the decision to outsource tasks related to these responsibilities completely.

Aside from these barriers, the different backgrounds of the participants resulted in interesting perspectives in the discussions. For example, there was a very clear distinction between the mindsets of the participants, which ranged from conservative to progressive viewpoints. The production and quality oriented participants were actively trying to make sense of the tasks through identifying implications associated with these tasks. These implications were often the reason they were held back in placing these tasks at a high involvement level. On the other hand, the consumer and sales oriented participants often looked at the tasks from a progressive perspective, hereby taking the portrayal of Brinkers Food and possibility for a unique selling point into consideration.

To illustrate this difference, an example of the discussion surrounding the collection of the glass is highlighted. The consumer and sales oriented participants looked at the bigger picture of implementing reusable glass packaging and the need to be involved in crucial tasks. For example, when highly involved in the process of collection, Brinkers Food would be able to regulated the processes regarding this task. For instance, the collection locations and acceptance of packaging, especially if more content producers are involved. The content producer with the most influence, and hereby the highest involvement, can control the whole ecosystem for reusable glass packaging. This is favourable for Brinkers Food, as they can portray themselves as a prominent entity regarding the reusable glass packaging ecosystem.
On the other hand, the production and quality oriented participants were not concerned with the packaging collection. They specifically mentioned that “it does not matter where the packaging comes from, as long as it reaches our facility”. The additional logistics and responsibilities coming into play when fulfilling this task were by no means worth the effort for the value gained from them, according to these participants. Hence, in their eyes, it was a matter of effort versus gained value. If the value did not exceed the efforts needed, it was not worth it. Through this difference in perspective, interesting discussions took place and led to balanced decisions for the placements of tasks over the levels of involvement.

Overview of participants
Transport manager Logistic coordinator

Retial hub

The retail hub is the overarching campany of a Dutch organic retail chain. The participants mentioned having experience with reusable glass packaging through the implementation thereof in their stores. This is a reusable glass packaging for dry goods, such as cereal, nuts and legumes.
The results of the session were very much based on the experience the participants had with their own reusable glass packaging. The value chain, as explained by one of the participants, works as follows. The packaging gets collected at the retail location, where it gets transported to the main retail hub. Here, a team of 12 people manually sorts all returned packaging. When the content producer wants to export their product, the retail hub gets informed about the amount of packaging needed. They transport the packaging to a cleaning facility, which cleans the packaging and transports it to the content producer. The reusable jars are filled and returned to the retail hub, where they are distributed over the different orcanic stores of their chains in the Netherlands. It is important to note the logistic role that the retail hub plays in this ecosystem configuration, as they are not only involved in the linear part of the value chain, but also take an active role as the intermediate entity for the reverse packaging stream.
The placement of the tasks went relatively smoothly, as both participants were often in agreement. Through having experience with reusable glass packaging, the participants had the tendency to place the tasks in accordance with their current ecosystem configuration. What was striking, was the difference in placement of the storage of the packaging. Though they are currently in charge of these tasks, they placed them at "no involvement". The participants mentioned that this was not a matter they would want to concern themselves too much about.

Store manager incentive

The store managers often experience an additional burden due to collecting and sorting reusable packaging. The lack of incentive towards the store managers results in negligence during this process, specifically sorting. According to the participants, there are two possibilities. On one hand, the store manager collects the packaging but skips the whole process of sending back the packaging. As the deposit money returned to the consumer comes directly out of the pocket of the retail hub, the store manager does not experience any financial difference, therefore, sending back the packaging only is a burden. On the other hand, the store manager only performs a minimal amount of sorting, hereby mistakenly returning packaging that is not owned by the retail hub. This results in additional sorting at the retail hub, as well as transport of the incorrect packaging to the correct content producer. Because of this, the retail hub experiences difficulties with the reusable jar ecosystem, as the pressure on their sorting department is heightened.

Foreign collection

The amount of deposit money that is returned to the consumer for returning the same packaging can differ across country borders. This did not directly happen to the current reusable jars, as these are solely sold in the Netherlands. However, it did happen for another deposit-return scheme for a different type of packaging. The packaging was bought by the consumer in the Netherlands, but as the returned deposit money was higher in Belgium, they were returned across the border. This led to a financial impact at the retail hub, as they had to pay significant amounts of deposit money that was never paid for by the consumer in the first place. Therefore, the participants stressed the importance of cross border agreements regarding the amount of deposit money. As a side note, they also mentioned that it is important that the amount of deposit money per packaging is not lower than the production costs of that packaging. Otherwise, lost packaging cannot be compensated in a financially viable manner.

Sorting

As mentioned, the packaging of the reusable jar can be placed into incorrect return transport packaging and vice versa. There is a specific yoghurt brand that makes use of reusable glass packaging that looks similar to the retail hub's reusable jar. Having such a close resemblance between two different reusable glass packaging complicates the sorting process. According to the participants, having a more standardized but unique packaging (even without the label) helps simplify sorting.

Label

The current problem faced for the reusable jar is label removal during cleaning. The current adhesive is strong, resulting in adhesive marks on the packaging or even full labels that are still present after cleaning. Currently, the retail hub is looking for a solution for this. The participants mentioned problems in their ecosystem configuration for reusable packaging are bound to occur. The reason for this is that after a few years of research, they decided to just implement the system to see what happens. The retail hub believes in the value of implementing initiatives, even though they often come with risks.

Ecosystem structure

The participants were discussing about the ideal configuration of an ecosystem for reusable glass packaging. On one hand, an ecosystem that ensures all cleaning is executed at the content producer reduces the amount of transport needed, hence leads to less emissions which is more sustainable. On the other hand, including cleaning as daily business at a content producer leads to high costs and risks, which is often not feasible for smaller businesses. Often, such smaller businesses have a higher tendency to take a leap of faith to participate in, for example, an ecosystem for reusable glass packaging that is still in its infancy. To overcome the risk of implementing a cleaning process and to increase success through involving more content producers, an external cleaning facility is a necessity. The participants concluded their discussion that both options are viable and that they are heavily situation dependent.

When posing the question about the influence of removing these barriers and creating the ideal situation, the transport manager mentioned that the retail hub would let go of all tasks related to the reverse logistics, and would focus on transport only. The logistic coordinator was a bit more nuanced and used the current return-deposit scheme for plastic packaging as an ideal example. In this system, only transport and storage of the returned packaging is the responsibility of the retail hub. All other matters are arranged by an external entity (Statiegeld Nederland for Dutch companies).
It is important to note that the results of this session are heavily influenced by the experience of the participants with reusable packaging. Aside from the organic values the retail hub has, they are highly active in experimenting with sustainable initiatives. Having such an open mind for these initiatives leads to an opinion that is likely not in line with other, larger retailers. Nevertheless, the input from the participants at the retail hub remains valuable, as they are a reseller of La Vida Vegan and So Vegan So Fine, hence, directly part of the current linear value chain of the spreads of Brinkers Food.

Overview of participants
Sales manager Sustainable strategist

Glass manufacturer

The digital session conducted with the glass manufacturer was altered a bit to fit the digital setting. The tasks were simplified through an overarching topic card (e.g. all elements regarding "cleaning" were combined, to decrease the total number of tasks). However, during the session it became clear that the participants were hesitant about their role in an ecosystem for reusable glass. Any of the tasks related to the ecosystem for reusable glass packaging were seen as unfit for a glass manufacturer. Even when suggested barriers were overcome, the participants thought that the glass manufacturer should not be involved in any of the tasks related to the ecosystem. In their opinion, after the glass packaging is produced, it is out of their hands and they are not involved anymore in any packaging related matters. This could be explained through the hypothetical nature of the session, as a glass manufacturer is rarely involved in an ecosystem for reusable packaging.
As there was quite a definitive opinion regarding the exclusion of the glass manufacturer in the ecosystem for reusable glass packaging, the original intended structure of the interactive session was abandoned. Instead, a discussion was held in which hypothetical situations were given where the glass manufacturer was involved in the ecosystem for reusable glass packaging. The first situation was involvement in cleaning and quality checks, the second was performing the quality check only. The response of the participants was noted and hereby different implementation barriers were found.

Expertise

Regarding the first situation, the participants mentioned that cleaning glass packaging is by no means their expertise. The current capacity, machines and knowledge are not tailored a high involvement in this task. The currently maxed capacity holds back any innovation regarding activities other than glass production. Moreover, the participants mentioned that they had no intention in expanding their skillset outside producing glass packaging and did not see this change in the near future.

Process suitability

Aside from having a maxed capacity, the production line is a continuous process. Though quality checks of the packaging is the expertise of the glass manufacturer, checking reusable glass packaging is not suitable for the continuous processes at their facility. A whole separate line for glass quality checks should be created to facilitate for this need, which is a high investment with a high risk, as per the participants. Additionally, returned glass packaging comes in batches of a mixed population. The many different production batches and locations cannot be checked by the quality control present at the glass manufacturer as this process is tailored to in-house produced packaging only. Other glass manufacturers might have a different material composition and mould that leads to packaging deviations, which are difficult to check with the current machinery that is completely tailored to the packaging produced only by the glass manufacturer. Hence, the participants did not see quality control at their premises as a feasible situation.

To conclude, the session was insightful, as the results strongly suggest that the glass manufacturer should not be involved in the reverse logistics process. However, it should be noted that not all glass manufacturers will have this same opinion. Nevertheless, the conclusions drawn from this session will be taken into consideration when determining a suitable ecosystem configuration for Brinkers Food.

Overview of participants
Store manager

Store

The session conducted at the organic store (chain of the retail hub) was structured like an interview, as opposed to using the task cards and levels of involvement, due to time and space constraints. The interviewee had quite some experience in store retail (nearly 40 years) and had seen his fair share of reusable packaging initiatives (e.g. refillable containers, returnable milk bottles). The reusable jar initiative has been present for over one year, during which the store manager has experienced the consequences of this implementation. Through this, he was able to adress not only his first hand experience of new tasks, but also his concerns regarding sustainability of such reusable packaging. The following barriers were described.

Sustainability claims

The participant raised his concern about the lack of knowledge regarding the actual impact difference the reusables have on the environment. In their opinion, the reusable glass packaging of Brinkers Food should be implemented only if such facts are checked. Not only does this bring certainty about the difference the packaging makes, it also helps the consumer to make a well informed decision. As mentioned by the participant, by explaining the impact difference, for instance expressed in money, the consumer might be more tempted to go for a reusable option.

Storage

There is a slight hygiene concern regarding the packaging that has been returned. There is no strict rule on whether the packaging needs to contain a lid or not. Although absence of the lid makes sorting and cleaning easier, it might lead to additional compromises of hygiene at the store premises. Any residue left in the returned packaging is openly accessible for all sorts of pests, leading to a hygiene concern. This may not happen at a store, which also sells fresh fruit and vegetables. Therefore, this risk should be eliminated to ensure a satisfactory level of hygiene at the store.

Need for standardization

According to the participant, a medium sized content producer cannot carry such an ecosystem on its own. Similar to the experience with the reusable jar, there needs to be some standardization amongst different content producers. In the case of the reusable of dairy products. As a result, the reverse logistics network of the content producer can be used. The participant could see variants these jars as a suitable option for chocolate spreads or nut spreads as well. As long as it suits a, preferably already in-use, secondary packaging. Moreover, the lower the variety of returned packaging, the lower the sorting time. Currently, one employee spends 45 minutes a day on manual collection and sorting.
On the other hand, a passerby addressed their positive affiliation with the current design of the LVV products. The packaging has a comfortable grip and is ideal for repurposing. You can even write on the lid with a chalk marker. They noted they would hate to see a change in design of the packaging. However, from a reuse perspective, there might some concessions needed regarding packaging design, to allow for standardization. Therefore, this is a point of difficulty that needs to be well evaluated.

Financial compensation

Similar to the perspective of the retail hub, the store also takes in packaging coming from across the border. This packaging has a different amount of deposit money, leading to a skewed balance. Though this is not something that the store manager experiences first hand, they do know that the overarching company does face major financial losses because of this issue.

Altogether, the participant raised concerns about the reusable packaging ecosystem. They are very willing to actively implement such initiatives and are completely fine with the additional tasks related to this implementation. However, they also believe that in order for such an ecosystem to be viable, it should not only be financially sound, but it should also be proven that usage of such reusable packaging is indefinitely the best solution from a sustainability perspective.

10.1.6 Coverage of responsibilities

Each of the tasks is related to one or more of the responsibilities that have been established in Chapter 6. Through analysing the preference of each entity regarding the level of involvement of the tasks, an initial proposition for the ecosystem configuration can be established. The tasks that were given a level of involvement 3 or higher are highlighted in Figures 44 and 45, which leads to an overview of combined results of the sessions. These are directly linked to the corresponding responsibilities. As a result, a conclusion can be drawn if all responsibilities are covered or not.

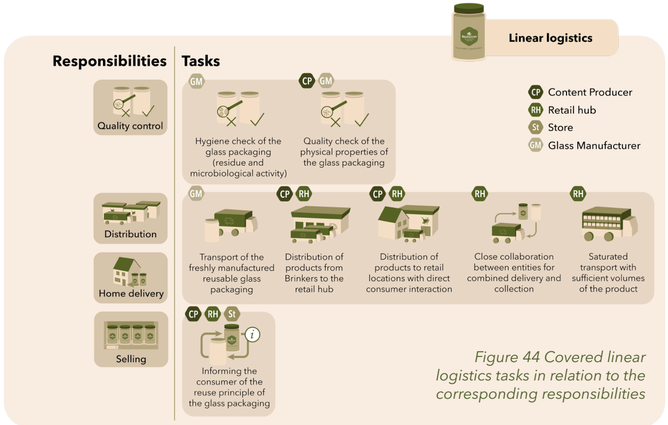


Figure 44 Covered linear logistics tasks in relation to the corresponding responsibilities

Linear logistics

From Figure 44, it becomes apparent that most of the tasks are covered. This can be explained through the experience that most entities have with these tasks. The linear part of the ecosystem is barely changed as a result of the introduction of reusable glass packaging in the value chain. The only additional task is the hygiene check during quality control. It is directly visible that the entities that have partaken in the interactive sessions are hesitant to become actively involved in this new task. Most of the reasoning for this was the idea that packaging that is used by the content producer must be up to standards. Therefore, this should be no different for reusable packaging, hence, the entity responsible for cleaning should ensure these quality standards are met. The main difference between active involvement in hygiene and physical checks, is the direct consequences of these tasks. Errors in physical properties can result in damage or breakage of the packaging in the warehouse of the content producer. This results in down time through the safety hazard of broken glass, leading to a much more impactful situation, as explained by the participants during the session at the content producer. On the other hand, hygiene is only checked through observation at the point of receival (smell, moisture, seal breakage etc.) and when the glass is rotated. As the glass they receive has not been into contact with other contents yet, hygiene risk are limited and can be controlled using this method. Reusable packaging has contained different contents, hereby, hygiene can become an issue when the packaging is not cleaned properly. Nevertheless, the content producer and the retail hub are of the impression that this is the responsibility of the entity responsible for cleaning. The packaging that enters the premises of the content producer should be up to the expected hygiene and quality standards, regardless of its preceding use or content.

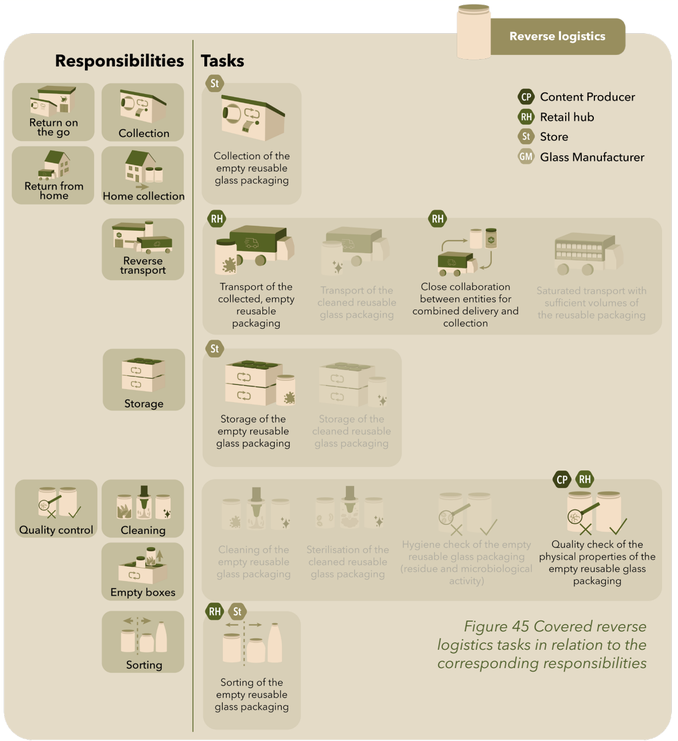


Figure 45 Covered reverse logistics tasks in relation to the corresponding responsibilities

Reverse logistics

Figure 45 presents the tasks covered during the reverse logistic part of the ecosystem. In comparison to the linear situation, a strikingly low number of tasks is covered. This can be explained by the lack of experience the entities have with tasks related to the reverse logistics. This is supported by the significantly higher number of tasks that are covered by the retail hub and store, which are the only entities with experience in reusable glass packaging. Through this experience, they might feel more confident taking on certain tasks, or are already executing these tasks in their own ecosystem for a reusable jar. It should be noted that execution of these tasks by the retail hub is out of necessity. As the retail hub has taken a gamble implementing a reusable jar, they rely on themselves for the success of the ecosystem for this reusable glass packaging. This is likely not the case for the reusable glass packaging envisioned in this case study, since there are multiple entities that carry the success of this ecosystem. Regardless of the experience and intentions of the retail hub, half of the tasks have not yet been covered by the entities that have partaken in the interactive sessions. These are predominantly transport, storage and cleaning related tasks. As a result of the lack of involvement in these tasks, an additional entity or multiple entities are needed to ensure these tasks will be covered in the ecosystem. Only then will all the responsibilities be fulfilled, resulting in a realistic ecosystem configuration for the value chain of the spreads of Brinkers Food.

10.1.7 Additional entities

From the overview of results provided in Figure 44 and 45, it becomes apparent that some tasks are preferably not fulfilled by some of the entities. The tasks left are visualised through their low opacity. It can be seen that most of these tasks are related to the amount of reusable glass packaging in the system (system saturation), storage related tasks, cleaning related tasks and quality control tasks. Overall, this means that the responsibilities of "reverse transport", "storage", "sorting", "preparation", "cleaning" and "quality control" are not (completely) covered by the entities currently present in the ecosystem. As the current entities are not likely to fulfil these responsibilities, given their attitude and arguments during the sessions, it becomes clear that a new entity or multiple entities are needed in order to create a feasible and reliable ecosystem configuration. Though the ecosystem configuration cannot be perfectly tailored to all preferences, the amount of concessions should be minimized. The addition of a new entity supports this by taking on the responsibilities that are currently not yet divided.

Looking at these responsibilities, it might be difficult to arrange for just one entity that fulfils all. Therefore, the responsibilities are grouped based on convenience and suitability of related tasks to fulfil a key component in the value chain.

One of these key components is getting the dirty glass packaging clean again to ensure it can be reused by the content producer. The responsibilities related to this are storage, cleaning and quality control.

Another key component is getting the glass packaging from the point of collection to the content producer, with possible stops in between for sorting, cleaning or other responsibility fulfilment.

In order to determine which entities might be suitable for fulfilling these key components, the entity results of chapter 5.5 are consulted. The entities identified to be present in existing ecosystems for reusable glass packaging, aside from the content producer, retail hub and store, are the consumer, logistic partner, collection hub and cleaning facility. To determine which entities are suitable to fulfil the grouped responsibilities, the following overview (Figure 46) is created evaluating this suitability based on the capability of the entities to fulfil a responsibility.

Figure 46 Overview evaluating the suitability of adittional entities

Figure 45 has revealed that in fact two entities (logistic partner and cleaning facility) are deemed suitable to fulfil the responsibilities currently not covered based on the input during the interactive sessions. Inclusion of these entities is necessary for the completion of a feasible ecosystem configuration for the introduction of reusable glass packaging into the value chain of the spreads of Brinkers Food.

Task division

To ensure all tasks can be fulfilled with the addition of the logistic partner and cleaning facilty, a new task division analysis is executed. As mentioned during the participatory sessions by different participants, often the tasks have a shared involvement. Therefore, such shared tasks have been added as well. This leads to a holistic overview of the task division envisioned for the additional entities, in which the tasks spread amongst the other entities within the ecosystem are also evaluated.

Cleaning facility

The cleaning facility tasks largely cover the cleaning process (cleaning, sterilisation and hygiene check) and additional logistic tasks (storage and (saturated) transport of the clean glasses)(Figure 47). The main tasks of the cleaning facility are cleaning, storage, and hygiene and quality control. Especially this hygiene and quality control is important to ensure the packaging fulfils the quality requirements posed by the content producer. The saturation of transport can be partially steered by the cleaning facility, as they can regulate the output of clean glass packaging, but have no control over the input returned glass packaging. Therefore, close collaboration with the glass manufacturer and content producer is needed to ensure saturation of the ecosystem is maximized. This is important, as a sufficient amount of glass packaging needs to be present to facilitate for the demand of the content producer(s).

Figure 47 Task division regarding the cleaning facility

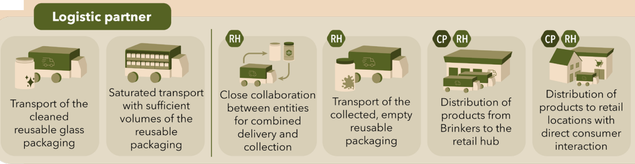
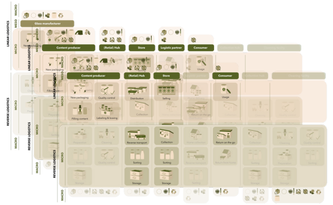


Figure 48 Task division regarding the logistic partner

Logistic partner

For the logistic partner, most tasks are shared with other entities (Figure 48). This also limits the influence the logistic partner has on these tasks, as they are rather a means than the executing entity. Therefore, most tasks in which the logistic partner is involved are the responsibility of other entities. However, when considering combined delivery and collection, and saturated transport, two situations can arise: independent and dependent logistics. If the logistic partner is completely independent, they do not have to operate in between partners within one specific value chain only. As a result, the different routes per driver are planned by the logistic partner, making collaboration to fulfill these tasks difficult. If there is a dependency on the entities within the value chain, collaboration regarding combined delivery and collection and saturation of transport can be a more feasible. Nevertheless, vehicles often contain more than one delivery, resulting in a complex system if such transport efficiency is considered. Therefore, it is important to note that these tasks are not a necessity for the introduction of reusable glass packaging in the value chain, though it does provide an additional environmental benefit. Moreover, allocating full responsibility of these tasks to the logistic partner is unrealistic due to the dependencies on other entities.

Results of the interactive sessions



Combining the results

Establishing an overarching ecosystem configuration

Figure 49 Transition from the results of the interactive sessions to an overarching ecosystem configuration

10.2 Reusables ecosystem - External

Based on the results of interactive sessions, the entities present in the ecosystem and the corresponding responsibilities have been defined. For each of the entities, an (partial) ecosystem configuration is established, using the framework presented in Section 7.1. Through combining the different (partial) configurations (Figure 49), the results of the comparison and conclusions of the interactive sessions forged into an overarging ecosystem configuration for reusable glass packaging suitable for the value chain of Brinkers Food (Figure 50). This ecosystem configuration can then be compared to the ecosystem configuration of the current value chain (Chapter 9), to establish an implementation roadmap suitable for the entities in the ecosystem as a whole (Macro and Meso level), and Brinkers Food specifically (Micro level).

To better understand the role of each of the entities regarding the proposed ecosystem configuration through using the framework, each of the responsibilities of the entities will be elaborated upon. Firstly, the entities that have an active role in the linear part of the ecosystem are highlighted, thereafter, the entities that take part in the reverse logistics system are furhter explained.

As can be seen, the necessity for the additional entities of the logistic partner and cleaning facility have been added in the ecosystem configuration as well.

Figure 50 Overview of the reusables ecosystem configuration of the value chain of the spreads of Brinkers Food

10.2.1 Entities and responsibilities

The entitities on Meso level are highlighted including their connection to Macro level entities and Micro level responsibilities (Figure 51-52).

Glass manufacturer

As can be seen, the glass manufacturer is added as one of the entities involved in this ecosystem. Though they do not partake in the circular cycle of the reusable glass packaging, they are an important entity regarding the saturation of the ecosystem. Moreover, it is important to highlight that, even though it could be a possibility, the glass manufacturer does not want to be involved in any of the reverse logistics responsibilities needed for the ecosystem to function. To illustrate this, the decision is made to include the glass manufacturer in the overview as an entity that is only involved in the linear processes in the value chain. Regarding the involvement of Macro level entities, the legislative institutions and food safety standards associations oversee the glass packaging production. Other Macro level entities are the environmental organisations, which can provide a slight social pressure to improving the sustainability of the glass production process, and the end of life solutions, which handle any glass and waste material not suitable for recycling.

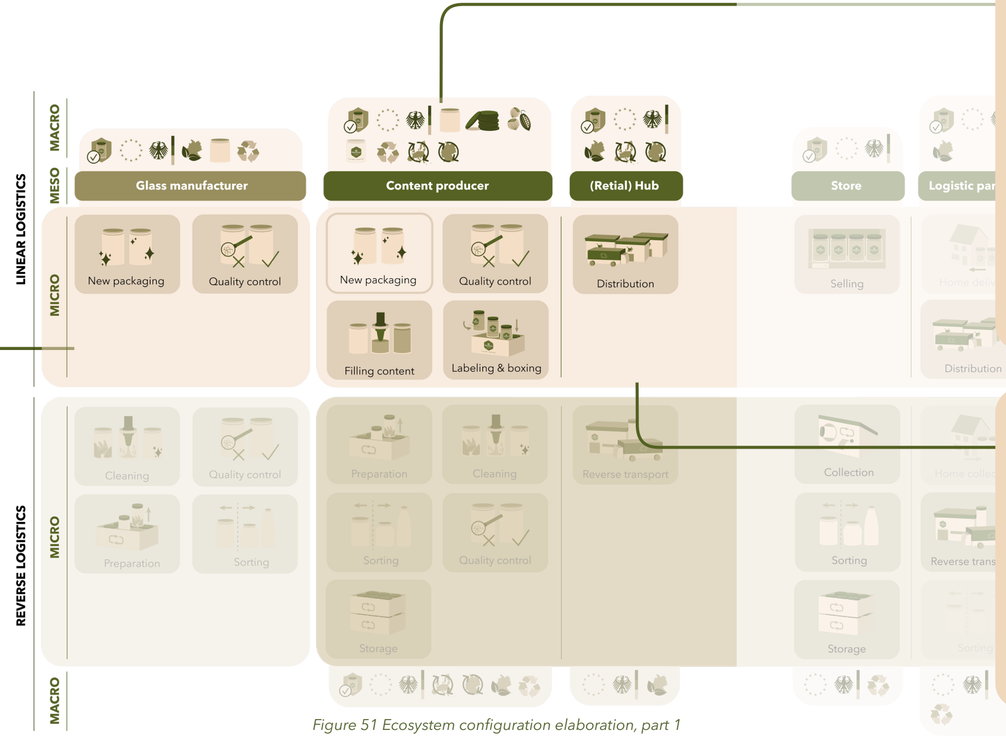


Figure 51 Ecosystem configuration elaboration, part 1

Content producer

The content producer will take an active role in the linear processes in the value chain. They will ensure the packaging is filled, labelled and checked before sending it to the retailer. The implications of the introduction of the reusable packaging are seemingly minimal, looking at the general responsibilities. However, the introduction of reusable glass packaging does result in implications at the warehouse. This will be visualised through elaborating on the current allocated requirements and corresponding tasks. This analysis will be further discussed in section 10.3, which highlights the reusables ecosystem from an internal perspective at Brinkers Food. The Macro level entities present are the legislative institutions and food safety standards associations, which oversee the production and filling process, but also to stimulate the introduction of reusable packaging through the implementation of regulations (e.g. the Packaging and Packaging Waste Regulation (PPWR) in 2026). Additionally, the reuse and environmental organizations can drive the content producer to start implementing reusable packaging. Ultimately, in the case of the brands La Vida Vegan and So Vegan So Fine, Brinkers Food arranges which type of packaging they would like their brand to be presented in, therefore, they are one of the initial entities that can stimulate the introduction of reusable packaging. However, Brinkers Food is ideally not the only content producer involved, hence design agreements should be made. Also, the content producer is involved with suppliers for glass, lids, labels and ingredients to ensure they can produce their spreads. The end of life solutions are involved to handle the waste products and materials at the premises of the content producer.

(Retail) hub

Contrary to the results of the participatory session, the retail hub will only take an active role in the linear process of the reusable glass packaging. This is as the perspective of the retail hub is largely forged by their reusable jar, and the personal interest the retail hub has in this initiative. The introduction of reusable glass packaging across the value chain of Brinkers Food has a different setting, as multiple retailers are involved. Considering this, it is unlikely that one retail hub will take on the hassle of the reverse logistics (e.g. initial sorting and transport), while the others can “sit back and relax”. Hence, the step for reverse logistics via the retail hub is left out. Instead, the reverse logistics will be largely carried by the store, logistic partner and cleaning facility. The retail hub is overseen by legislative entities and food safety standards associations, to ensure good manufacturing practices. Other Macro level entities are the environmental and reuse organisations, which can provide a slight social pressure to support the introduction of reusable glass packaging. Moreover, the environmental organisations can put pressure on the need for more environmental friendly transport options.

Store

The store is actively involved in both the linear and reverse logistics within the ecosystem for reusable glass packaging. Firstly, the store ensures the products La Vida Vegan and So Vegan So Fine reach the consumers. Therefore, they are an important entity in informing the consumer about the reuse principle. Moreover, legislation regarding reuse (e.g. the PPWR) can increase the pressure at the store to collect reusable packaging. Therefore, the introduction of reusables should be carefully arranged, to ensure the burden for the store to collect, sort and store the packaging is minimized. Especially as stores are forced to take back similar packaging to other reusables free of charge, as per the PPWR. The reusable glass packaging for LVV and SVSF products are not a mandatory introduction through the well-established recycling system for this material. Hence, introduction of this type of packaging should be smooth and well-integrated with current collection, sorting and storing methods. During collection and sorting of the packaging it can be determined that some of the packaging is not deemed suitable for reuse and therefore needs to be disposed of. Therefore, the store is also connected to the end of life solutions to ensure recycling of the packaging.

Logistic partner

The logistic partner facilitates the transport in between entities. This entails all product distribution that is not covered by the (retail) hub, and all reverse transport between entities. This means close collaboration between the distributing and receiving entities, and the logistic partner. As mentioned in the previous chapter, the logistic partner has a limited influence on the content they transport. Therefore, the overarching tasks, such as the saturation and combined delivery and collection cannot be executed by this entity, and therefore should be distributed amongst other entities. As a result, the involvement of the logistic partner only covers the transport itself. Macro level entities involved are the legislative institutions and food safety standards associations, to ensure the transport follows the food safety norms. The other Macro level entity is the environmental organisations, which can provide a slight social pressure to improving the sustainability of the transportation process.

Consumer

The responsibilities of the consumer are limited to product use and return of the packaging. Though these responsibilities seem quite minor, the consumer is the key component in the return of the packaging. Hence, the consumer should be motivated to bring the packaging back to a collection point. The Macro level entities that the consumer is connected with is the input of reuse organisations playing in on the consumers sentiment to become more sustainable through using reusable packaging. The other entity on Macro level are the end of life solutions, in case the consumer does not return, but instead disposes of the packaging.

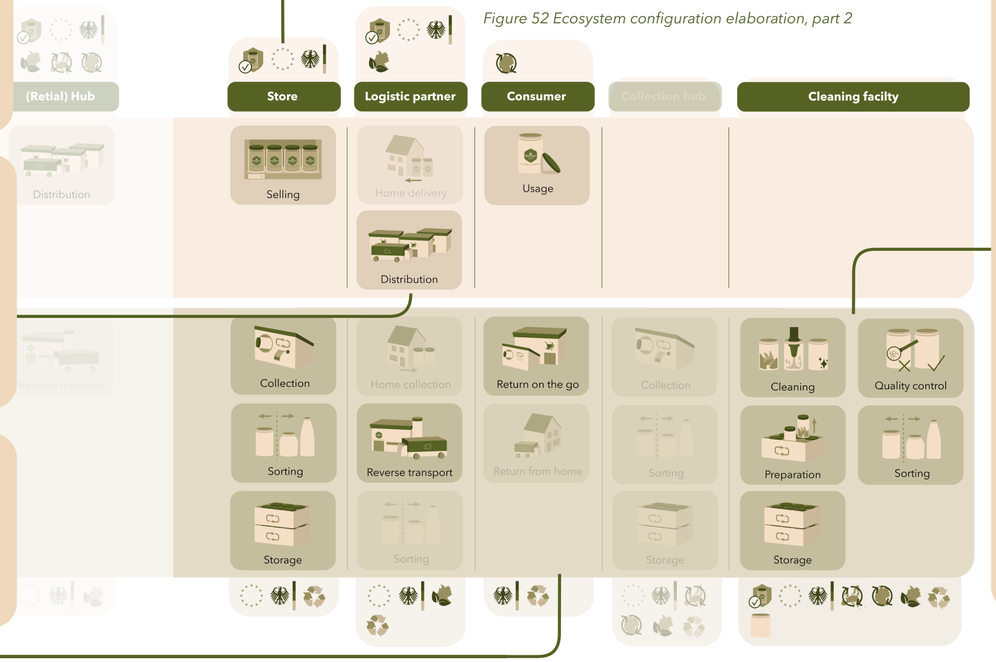


Figure 52 Ecosystem configuration elaboration, part 2

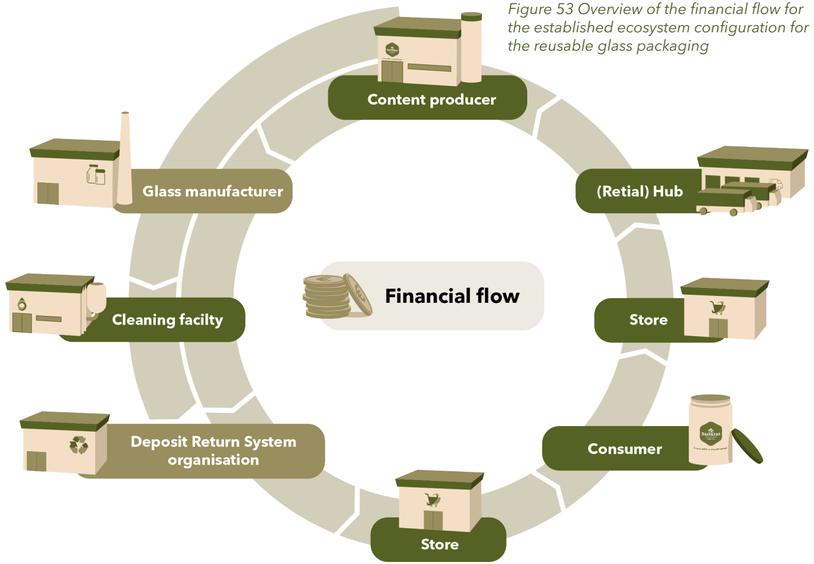
Cleaning facility

Lastly, the cleaning facility covers all necessary responsibilities regarding cleaning. This entails, storage, sorting, preparation, cleaning and quality control. Especially the latter is an important step, as the cleaning facility is responsible for providing clean glass packaging that meets the standards described in the quality contract between the cleaning facility and the content producer. To relief the burden of additional checks by the content producer, the cleaning facility should perform checks on each glass packaging to ensure the quality standards are met. The Macro level entities that are at play here are the legislative institutions and food safety standards associations which control the safety standards needed for food contact packaging. Moreover, reuse organisations and environmental organisations are involved in supporting the ecosystem, and hereby the cleaning facility, as the ecosystem heavily relies on the proper functioning of this entity. Furthermore, the cleaning facility and glass manufacturer both provide glass packaging to the value chain. Hereby they could be seen as competitors. To make the reusable glass packaging a viable option, the cleaning facility should keep a close eye on their throughput and the necessity of new glass in the ecosystem to ensure ecosystem saturation.

10.2.2 Ecosystem flows

Aside from the ecosystem configuration, a financial and packaging flow structure is established. This structure provides a clear overview of the deposit return fee (Figure 53) and corresponding packaging flow (Figur 54). As can be seen, the inclusion of a Deposit Return System organisation is a necessity. This organisation regulates the changes in source regarding the deposit return fee. This is further elaborated upon in the explanation of the financial flow.

Figure 53 Overview of the financial flow for the established ecosystem configuration for the reusable glass packaging



Financial flow

When a glass packaging is produced, the glass manufacturer pays a deposit return fee to an overarching Deposit Return System organisation. This allows for compensation to the store once the packaging is returned. However, when the glass packaging starts their reuse cycle, the cleaning facility replaces the role of the glass manufacturer. As a result, one entity within the financial flow changes. However, both the glass manufacturer and cleaning facility coexisist in this ecosystem, and therefore a Deposit Return System organisation is needed. This organisation arranges the financial deposit return fee compensation for the stores that have received the returned glass packaging. The amount of compensation is determined by the amount of collected glass packaging at the store.

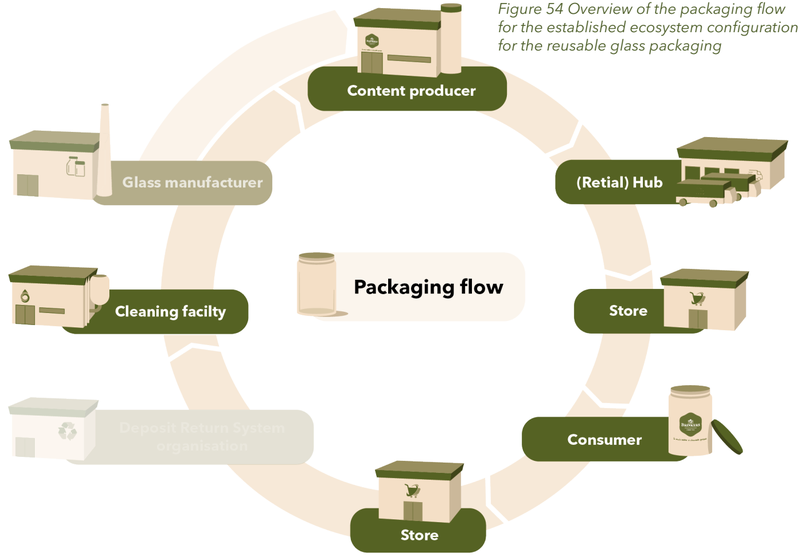
Once the cleaning facility has obtained the reusable glass packaging, they can sell it to content producers. As the system is closed loop, due to the overarching organisation and standardisation of the packaging, only content producers that are a member of this ecosystem can make use of the packaging.

The deposit return system between the other entities works through mutual exchange, where the packaging is passed on in change for the deposit return fee. This means that the packaging changes ownership throughout the system.

Packaging flow

The reusable packaging, as mentioned, travels from entity to entity, based on which entity has compensated this production with the deposit money. As can be seen, the glass manufacturer is partially left out in this system. In the first cycle, this entity is present, but in all cycles following, this entity does not parttake in the ecosystem anymore. Instead, the cleaning facility takes on its role as glass packaging provider. Therefore, it should be noted that the main portrayal of this packaging flow is for a glass packaging that undergoes multiple cycles. In case a glass packaging does not comply with the quality and safety standards, it gets removed from the system. As a result, the lost glass packaging needs to be compensated for by new produced packaging. As the glass manufacturer is responsible for this, it is evident that the presence of this entity is not completely removed. Therefore, in the necessary cases, the packaging flow does include the glass manufacturer.

Figure 54 Overview of the packaging flow for the established ecosystem configuration for the reusable glass packaging



10.2.3 Ecosystem saturation

In order for the ecosystem to work accordingly, there should be enough reusable glass packaging present. This ecosystem saturation can be achieved by:

1) producing enough glass packaging when the ecosystem is setup
2) keeping track of the return rate of the glass packaging

By ensuring there is a sufficient amount of reusable glass packaging to begin with, the loss of packaging during the numerous cycles can be compensated. Through monitoring the return rate of the reusable glass packaging, this loss can be monitored and additional production of the glass packaging can be arranged when the saturation of the glasss packaging in the ecosystem cannot satisfy the demand anymore. The amount of packaging needed for an ecosystem to be saturated, should be set up through trial and error, as the return rate and loss through damage or breakage cannot be predicted beforehand.

10.2.4 Ecosystem relations

The relations between ecosystem entities are highlighted and explained (Figure 55).

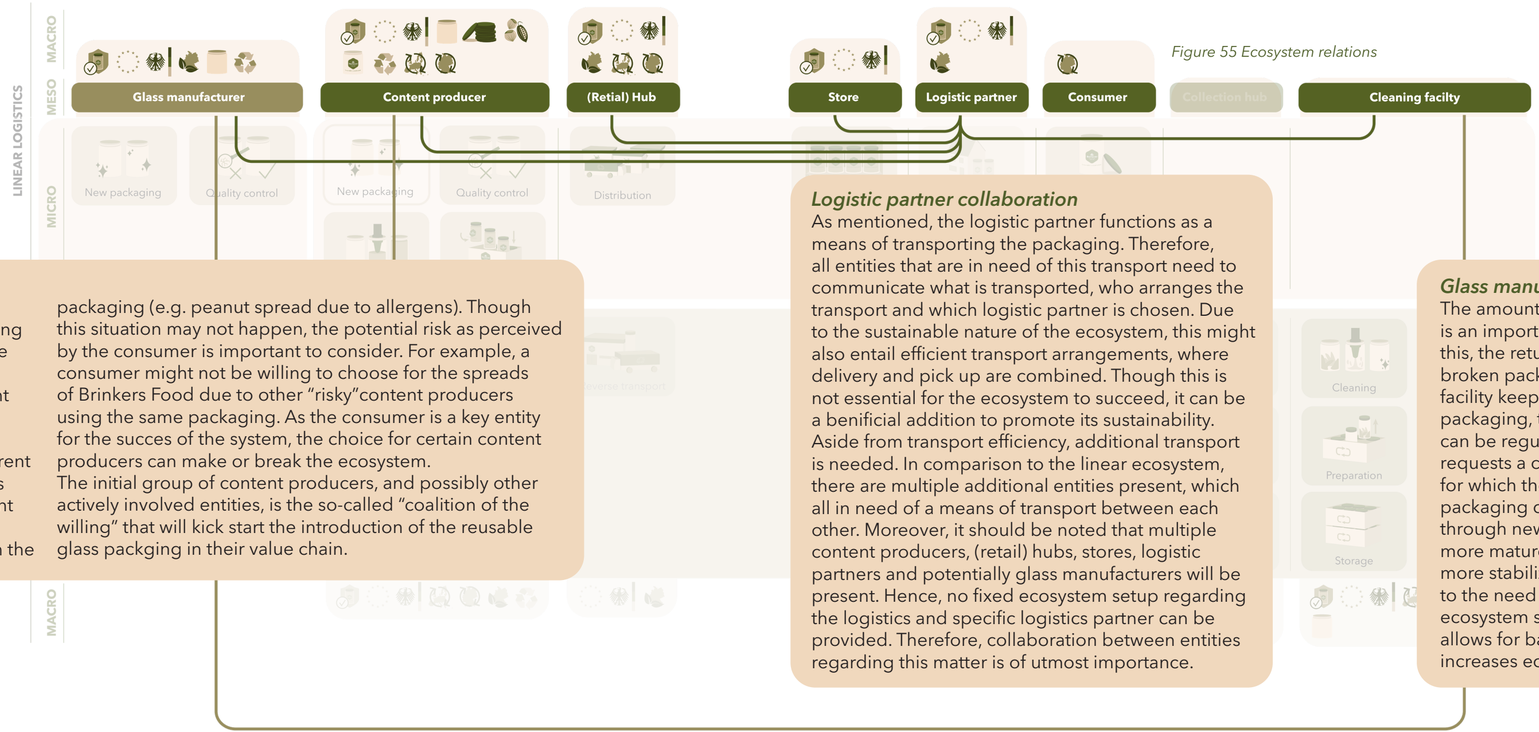


Figure 55 Ecosystem relations

Content producer collaboration

Multiple content procucers need to work together to normalise the use of the specific reusable glass packaging within the value chain. To ensure a saturated system, one content producer cannot carry the throughput of glass alone, hence the need for multiple collaborating content producers. In order for this collaboration to work, one unified and standardized packaging type needs to be established that satisfies the different needs of the different content producers. If Brinkers Food is one of the entities that establishes this ecosystem, the collaborating content producers should be chosen carefully. Some content producers might pose additional risks if residue is left in the packaging (e.g. peanut spread due to allergens). Though this situation may not happen, the potential risk as perceived by the consumer is important to consider. For example, a consumer might not be willing to choose for the spreads of Brinkers Food due to other "risky"content producers using the same packaging. As the consumer is a key entity for the succes of the system, the choice for certain content producers can make or break the ecosystem.

The initial group of content producers, and possibly other actively involved entities, is the so-called "coalition of the willing" that will kick start the introduction of the reusable glass packging in their value chain.

Logistic partner collaboration

As mentioned, the logistic partner functions as a means of transporting the packaging. Therefore, all entities that are in need of this transport need to communicate what is transported, who arranges the transport and which logistic partner is chosen. Due to the sustainable nature of the ecosystem, this might also entail efficient transport arrangements, where delivery and pick up are combined. Though this is not essential for the ecosystem to succeed, it can be a benificial addition to promote its sustainability. Aside from transport efficiency, additional transport is needed. In comparison to the linear ecosystem, there are multiple additional entities present, which all in need of a means of transport between each other. Moreover, it should be noted that multiple content producers, (retail) hubs, stores, logistic partners and potentially glass manufacturers will be present. Hence, no fixed ecosystem setup regarding the logistics and specific logistics partner can be provided. Therefore, collaboration between entities regarding this matter is of utmost importance.

Glass manufacturer and cleaning facility

The amount of packaging present in the system is an important factor ecosystem saturation. For this, the return rate and number of damaged or broken packaging is necessary. If the cleaning facility keeps track of the amount of returned packaging, the overall saturation of the ecosystem can be regulated. Once the content producer requests a certain amount of reusable packaging for which the cleaning facility cannot suffice, the packaging deficit needs to be compensated through new packaging. Once the ecosystem is more matured, the amount of packaging becomes more stabilized, as the return rate can be related to the need for additional packaging, which makes ecosystem saturation more managable. This also allows for backup in case of peak fluctuations and increases ecosystem efficiency (Hesseling, 2022).

10.3 Reusables ecosystem - Internal

When considering the external ecosystem configuration only, the content producer does not receive additional responsibilities they should cover. Nevertheless, there will be some consequences as a result of the introduction of reusable glass packaging. These will be elaborated upon in this section. Firstly, the responsbilities, as described in section 6.1, are evaluated and the possible changes in comparison to the current situation are adressed. Thereafter the internal situation is proposed.

10.3.1 Responsibilty evaluation

Brinkers Food has been determined to be in charge of four responsibilities. These responsibilities and corresponding guidelines are evaluated and the possible influence on the internal situation at Brinkers Food are identified.

New packaging | For the reusable glass packaging scenario, the possible differences at stake are the amount of glass packaging per layer and per pallet and the packaging design itself (size, weight, strength, virgin to cullet ratio). The latter can influence the inserts needed for the filling line and the processes such as filling, capping and labelling. The process of adding the glass packaging does not change, therefore the secondary and tertiary packaging should remain the same, compared to the current situation

Filling content | Regarding the filling procedure of the content, it will remain the same. The filling line is prepared according to the packaging type, similarly to the current change neccesary to go from a La Vida Vegan or So Vegan So Fine packaging to a different brand and packaging. This means filling line adaptations regarding filling volume, height and packaging dimensions. Furthermore, the ecosystem should be saturated, meaning that enought glass packaging should be present at the content producer to ensure a batch of content can be filled.

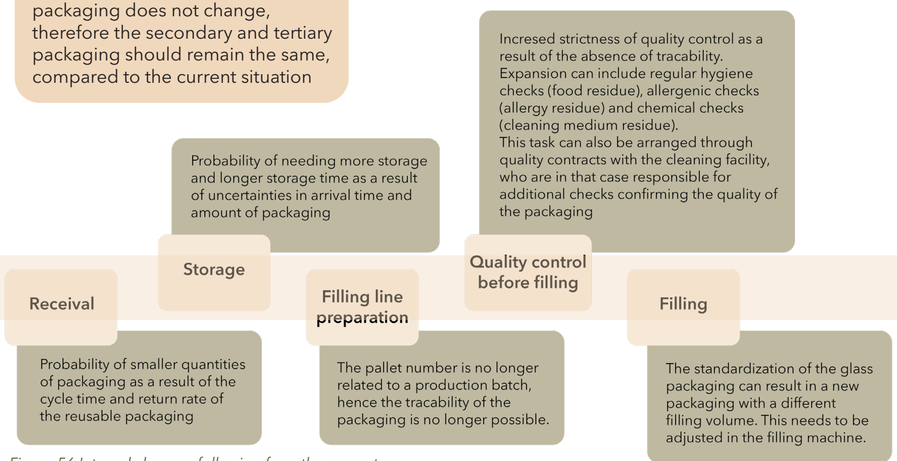


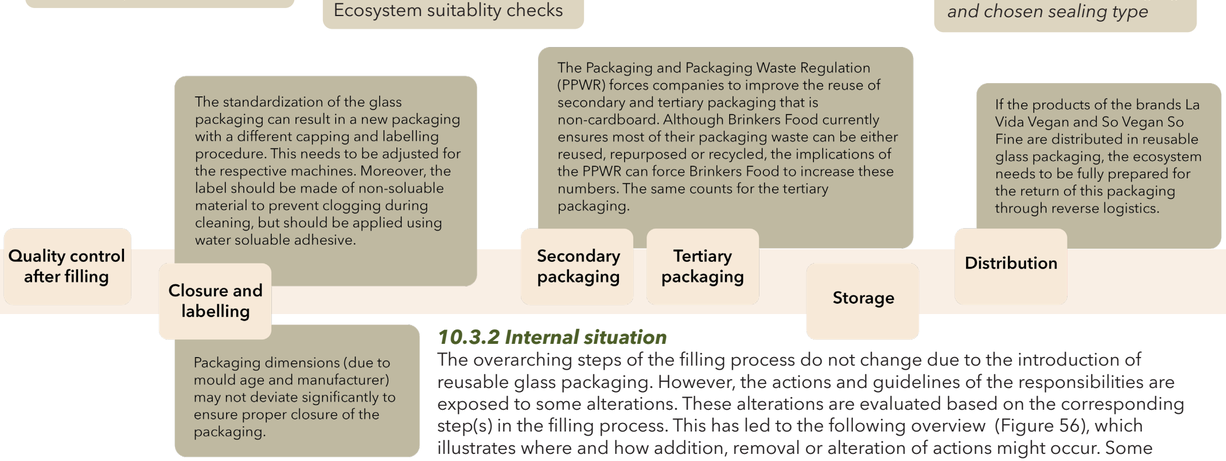
Figure 56 Internal changes following from the ecosystem configuration proposed in section 10.2

Quality control | In the current situation, Brinkers Food has to ensure an absence of dust particles and impurities (compressed air, metal detection), the implementation of reusable packaging goes paired with additional checks to minimize food safety risks. They are not necessarily performed by Brinkers Food. However, they are noted, as they are part of the responsibility of keeping the quality of the packaging and the food up to standards.

Alterations necessary	*Currently not present*
Damage and scuffing checks Traceability checks	Residue checks Reuse cycle checks Ecosystem suitablity checks

Labelling and boxing | The labelling and boxing procedure differs slightly from the current process. Depending on the packaging design, more or less adaptations might be necessary. The following possible adaptations should be taken into consideration.

Alterations necessary	*Currently not present*
Labeling machine to suit new labels Lid closure/capping machine should suit new lids	New label design *- suitable for new packaging and cleaning method* New lid design *- suitable for new packaging and chosen sealing type*



10.3.2 Internal situation

The overarching steps of the filling process do not change due to the introduction of reusable glass packaging. However, the actions and guidelines of the responsibilities are exposed to some alterations. These alterations are evaluated based on the corresponding step(s) in the filling process. This has led to the following overview (Figure 56), which illustrates where and how addition, removal or alteration of actions might occur. Some process steps do not face any consequences, others might consume more time due to additional tasks related to the introduced reusable glass packaging.

11. IMPLEMENTATION ROADMAP

The framework has served as a basis for analysing the current and reusables situation for the value chain of Brinkers Food. However, to get from the current situation to the ideal ecosystem configuration that facilitates the implementation and use of reusable glass packaging, a roadmap needs to be established. This roadmap should entail the steps needed to be taken by the participating entities in general, and for Brinkers Food specifically. For this roadmap to be established, the current and future ecosystem configurations should be compared. Their differences should be evaluated and from this a roadmap should follow that ensures smooth transition from the current to the future situation.

11.1 Comparison

The comparison between the ecosystem configurations will firstly be executed on the external level, thereafter on the internal level. This way, overarching, ecosystem broad differences are identified first and only thereafter, a detailed comparison on Micro level is executed, hereby taking into consideration Macro and Meso level influences that could potentially be exerted. Both comparisons are necessary, as the external level comparison will highlight cooperation and collaboration between entities on Macro and Meso level, and the internal (Micro) level comparison will result in a in depth portrayal of consequences of implementation of reusable glass packaging within the warehouse of Brinkers Food.

11.1.1 Comparison - External

For this comparison, all components earlier defined to be necessary for the establishment of the ecosystem configuration for reusable glass packaging for highly viscose and solid food are elaborated upon.

General observations

Looking at the established ecosystem configuration, an immediate difference can be observed in the presence of the responsibilities associated with the reverse logistics. Moreover, the end of life entities that have been addressed specifically in the linear ecosystem, have been excluded in the circular ecosystem. It does not mean that these entities are not present in the latter, but the focus in that particular ecosystem configuration is placed on reusing the glass packaging, hence the entities that partake in the circular part of the ecosystem. Nevertheless, the presence of the end of life solutions is still visible through the recycling icon at the Macro level entities. Lastly, the glass manufacturer is specifically highlighted in the ecosystem configuration for reusable glass packaging. This is as this entity has shown particular resistance to involvement in the ecosystem for reuse. It should therefore be noted that the responsibilities of this entity in the linear and circular ecosystem do not change. The only difference might be the type of packaging produced.

Entity specific differences

For each of the entities that become involved in the reverse logistics of the system, some changes might be needed as a result of the additional responsibilities. This next page will address the altered or new responsibilities that are allocated to each entity.

Store

The store obtains the additional responsibilities of collecting, sorting and storing the glass packaging. In Germany, stores are experienced with the deposit return system, collecting various types of packaging (Bouliane, 2024). Therefore the addition of another packaging can be a hassle. As mentioned during the interactive session at the store, it is most convenient if the packaging matches the already existing secondary packaging. However, this can result in a more tedious sorting process, as multiple different packaging ends up in the same crates. It is important for the success of the ecosystem that sorting difficulty is decreased. For this collection, sorting and storing process, financial investments and space is needed. The former is often regarded to be worth it. The recent introduction of a deposit fee on metal cans in 2023 in the Netherlands illustrates that supermarkets are willing to adopt this change. It should be noted that a large push from the government has partially influenced the supermarkets to “voluntarily” join (Zwerver, 2023).
Regarding space, plastic bottles and metal cans are compacted and therefore take up little space (Schwartz, 2021). However, this is not possible for glass packaging, as it needs to be returned whole. This means that both the weight and space is more comparable to the bottles of the beer and dairy industry. Depending on the throughput of returned packaging, a certain amount of space is needed. For smaller stores, the collection, sorting and storage happens on a smaller scale. If the store is bigger more packaging will be collected and changes are generally more expensive and time consuming. Take for example the difference between informing employees about changes in collection (small store) versus needing to update automated collection points (middle to large store). Therefore, the efforts related to the change from single use glass packaging to a reusable alternative differs for each store.

Logistic partner

The logistic partner currently only covers the linear part of the ecosystem process. When introducing reusable glass packaging to the ecosystem, there will be more transport needed, as there will be more entities present within the ecosystem. This does not change much about the current responsibilities of the logistic partners present in the ecosystem. The only difference that will take place is the need for more transport from and to different locations. If the current logistic partners cannot accommodate this, the involvement of an additional logistic partner might be necessary.

Consumer

Consumers now obtain an additional duty to store and bring back the glass packaging. They are stimulated to do so through the deposit return fee that is paid for the glass packaging. The consumers need to allocate additional storage space for collecting glass packaging and need to regularly return the packaging at participating stores.

Cleaning facility

The cleaning facility is a completely new entity. Therefore, the full entity should be established. As the responsibilities of the entity are sorting, preparing the glass, cleaning, quality check and storage. It is important that this entity has expertise on all of these responsibilities. There are existing entities that already take on the responsibility of cleaning (e.g. PAKT or Circujar). These could either serve as an example, or even as a collaborating entity. However, it should be considered that these cleaning facilities are operating using their own ecosystem configuration, hence the suitability for this particular ecosystem configuration is low. To illustrate: PAKT has a return from home principle and operates in central Netherlands, and Cirjucar has not yet matured, uses predefined packaging design, labels and lids and operates in the south-eastern part of Germany. Collaboration will lead to compromises due to constraints, which can be a possibility if it is difficult for a new cleaning facility to be established.

Flow specific differences
An additional reversed circular deposit return fee flow is necessary. It is overseen by the Deposit Return System organisation, which due to its packaging focussed nature, is not visualised in the framework. Nevertheless, this organisation is a necessary entity for the financial part of the ecosystem. In the Germany, companies can choose their own clearing service providers to arrange the necessary deposit return fee compensations across their partners (DPG Deutsche Pfandsystem GMBH, 2024). In the Netherlands, there is an overarching organisation, Statiegeld Nederland, which arranges the refunds for the returned packaging (Statiegeld Nederland, 2024). Having different options, a decision should be made which specific Deposit Return System organisation is suitable for this ecosystem configuration. This depends on the entities involved and the existing connections they may have with such organisations.

Packaging saturation specific differences
The saturation of the current ecosystem is arranged by the amount of packaging required for a particular batch of content. Depending on the delivery time, the amount of packaging ordered at the glass manufacturer. For the ecosystem that includes reusable glass packaging, there will be a different order structure present. Here, the content producer firstly contacts the cleaning facility. In case of a saturated system with a high return rate, the cleaning facility can satisfy the demand. In case of insufficient packaging, compensation is necessary. If this is the case, the glass manufacturer should be contacted, to satisfy the remaining demand. This does mean that the content producer might to order their glass packaging earlier compared to the current situation, as the possibility of acquiring all packaging from the cleaning facility can vary significantly. Moreover, there is a price difference between the new and returned packaging. eusable glass packaging. While setting up contracts with retailers, this should be considered by the content producer, as it is uncertain which packaging type is used.

Relation specific differences
The relation between the different entities is somewhat different. These differences will be explained below.

Content producer collaboration
In the current situation, the content producers often do not have any connections with each other. When introducing a shared and standardized packaging, cooperation is unavoidable. Therefore, an initial group of content producers, a “coalition of the willing” is needed to kick start the introduction of the reusable glass packaging. They will carry the ecosystem and invest in its success. When fully matured, it can be a possibility to expand the ecosystem, hereby including different content producers or other entities. The coalition of the willing needs to discuss a suitable packaging design. For this, each entity likely needs to compromise on their current packaging. Not only should the design be agreed upon by the content producers, the cleaning facility needs to ensure the packaging can be cleaned properly (e.g. limited curvature at the edge of the glass (Wester & Verweij, 2022), particular labels and sealing that can be used Circujar, 2023b), and the glass manufacturer needs to be able to produce the packaging itself.

Glass manufacturer relations
Another relation that changes is that of the glass manufacturer and content producers. Where the content producers used to rely on the glass manufacturer for their packaging, the ecosystem configuration includes a cleaning facility that can distribute the (cheaper) glass packaging amongst the content producers present in the ecosystem. Therefore the glass manufacturer needs to prepare itself for a lower demand by the content producers that partake in the ecosystem for reusable glass packaging. While the ecosystem is stabilizing regarding its saturation, there will still be a significant demand for new glass packaging. However, once the ecosystem is more matured, this demand will decrease due to the available glass packaging coming from the cleaning facility.

11.1.2 Comparison - Internal
Due to the introduction of reusable glass packaging, there will be some implications on internal level as well. This section will highlight the Micro level differences between the current and future situation where glass packaging is introduced. For each of the different steps in the filling process, an evaluation is executed regarding the consequences of introducing a reusable glass packaging to the filling line, but also to overarching processes (e.g. financials and warehouse logistics). Additionally, the changes are divided amongst responsible departments within Brinkers Food, which are further elaborated upon on the following pages.

Production planning
The risk of smaller packaging quantities directly affects the production planning. If insufficient packaging is present, the produced content cannot be filled in the correct glasses. As a result, the glass packaging should be ordered longer beforehand (e.g. four weeks instead of two). This leads to additional storage of empty packaging waiting to be filled, which directly influences the warehouse logistics.
Depending on the glass packaging design, the filling line might need alteration. Currently, there are nine different packaging types. It would be ideal if the reusable glass packaging suits the filling line configuration of another existing packaging. However, it should be noted that Brinkers Food is not the only content producer involved in this ecosystem. Therefore, the chances of needing an altered filling line as a result of the chosen packaging design are probable. Changing the filling line entails both digital and physical changes. Digital changes could be the filling volume and speed. Physical changes are the guidance inserts for the glass packaging and the capping and labelling procedure. It should be noted that for reusable glass packaging there might be different labels needed that are water proof, but of which the adhesive is easily solved in water (Circujar, 2023b).
Moreover, over time the mould of the packaging will be worn out. In a linear system this results in slightly altered batches of glass packaging. However, since all glasses come from the same batch, only one alteration to the filling line is needed to compensate, as all glasses often have the same deviation. In the case of reusable packaging, glass packaging from different production batches, and perhaps production facilities, will be mixed in one population. This means that if there is a slight deviation, it does not automatically mean that all packaging has this same deviation. Therefore, the packaging tolerances should be reviewed and sharpened. Though this is not something Brinkers Food can change by themselves, they should be aware of the possibility that there can be slightly deviating glass packaging in the received batch of reused packaging.

Quality Control and Quality Assurance

It could be the case that as a result of introducing reusable glass packaging, it is expected that more checks are needed regarding the safety and quality of the packaging. Therefore, a possible expansion of quality control is necessary. Though the glass packaging arriving at Brinkers Food should be up to standards, it can be imaginable that Brinkers Food also wants to confirm this. Through adding, for example, a visual check and chemical or allergenic test for each arriving glass batch, the risks of contaminated packaging is minimised.

Financial department

Due to the possibility that too little glass packaging is present at the cleaning facility, there could be occasions where reused packaging is exchanged for new packaging. This increases the costs of the packaging, and ultimately the costs in the contract between Brinkers Food and the brand at stake. Therefore, the financial department should take these deviating costs into account. When initially implementing the reusable glass packaging, this is difficult to determine. However, when the ecosystem is more matured, there will be a better balance of the spread of reusable glass packaging across the system, making financial predictions possible.

Warehouse logistics

Due to the uncertainty regarding the delivery of enough glass packaging, a risk of increased storage time for the packaging emerges. Due to varying volume of glass packaging that can be delivered, it could occur that the allocated space for glass packaging is only partially filled, whereas other times it might be completely full. It is important to find a balance between the needed space, the delivery times and the uncertainty of delivery so only the minimal amount of warehouse space is reserved for empty glasses. As a solution, the content producer can consider compensating the lack of glass packaging with new packaging, which is more expensive, but ensures there is no packaging deficit.

Sustainability department

The PPWR will be introduced mid 2026 (as of now), which forces companies to improve the sustainability of their packaging. Though not essential for the introduction of the ecosystem, but important for future development for Brinkers Food, the secondary and tertiary packaging should be reviewed regarding their sustainability. To ensure a holistic implementation roadmap which does not only cover the ecosystem itself, but also other external influences, the consequence of the to be introduced regulation for the envisioned ecosystem configuration must be evaluated as well.

Figure 57 portrays the identified differences within the process chain at Brinkers Food. Only the differences are highlighted. All key components that are needed for the process to function are still present, but will remain unchanged, regardless of the implementation of reusable glass packaging. Hence the decision to give these a lower opacity, so the focus is placed on the differences, instead of the full process chain.

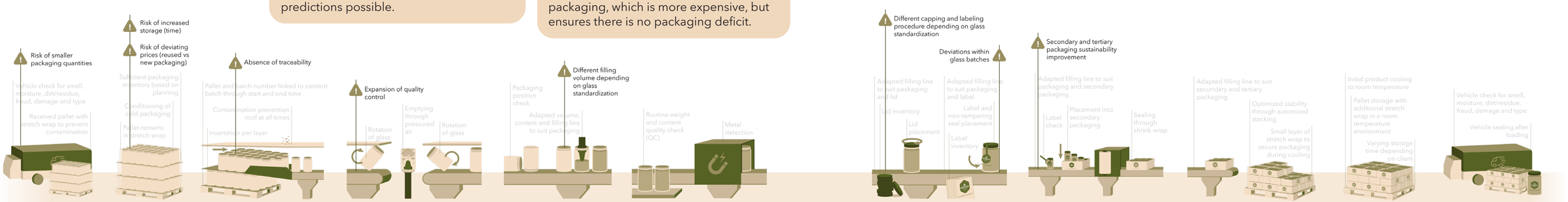


Figure 57 Difference between the current and reusable glass packaging ecosystem within Brinkers food

11.2 Implementation roadmap

Based on the comparison and the identified needs of the ecosystem, an implementation roadmap can be created. As the establishment of the ecosystem configuration requires close collaboration between entities, an approach for getting these entities together to form the "coalition of the willing" is considered in the implementation roadmap as well. The ecosystem configuration is particularly tailored to the value chain of Brinkers Food. Therefore, their role in this roadmap will be signification. However, they are not able to take on all tasks related to the establishment of the ecosystem. To accommodate for this, this section will establish a well-balanced roadmap where the role of Brinkers Food and other involved entities will be visualised. Firstly, the implementation roadmap for the external ecosystem (Macro and Meso level) will be established. Thereafter, the internal (Micro level) implementation roadmap is presented.

11.2.1 Implementation roadmap - External

This section will elaborate on the implementation roadmap on Macro and Meso level regarding the established ecosystem from a Brinkers Food perspective. The envisioned roadmap consists of five phases. These phases give a step by step approach on how the ecosystem configuration can be established, implemented and expanded. Firstly, the roadmap will be shortly explained (Figure 58). Thereafter, each phase and corresponding steps in the implementation roadmap will be elaborated upon in more detail.

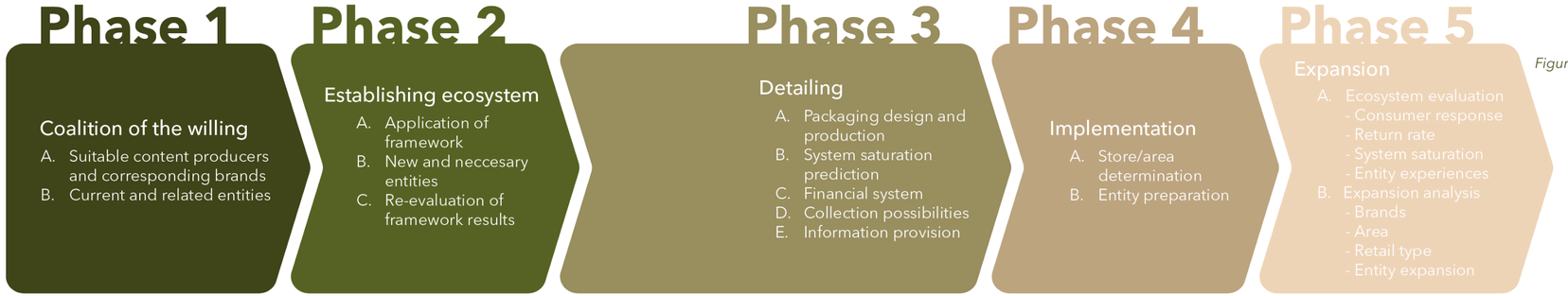


Figure 58 Implementation roadmap

Phase 1 | Coalition of the willing

Implementation of the ecosystem into the value chain does not happen overnight. A group of like-minded entities, who are willing to put in effort to aid the transition from a linear to a circular value chain, should be established to make implementation of the ecosystem possible. This group of entities, the "coalition of the willing", includes entities from different backgrounds in the value chain (e.g. content producers, retailers, logistic partners). The coalition of the willing are the initiators of the ecosystem for reusable glass packaging. The goals of this coalition of the willing are the following:

- to establish a foundation for the ecosystem logistics (e.g. transport, collection)
- to establish a standardized packaging sufficing the needs of different entities involved
- to establish a responsibility division amongst participating entities
- to establish and/or introduce (new) entities (e.g. multiple content producers, cleaning facility, Deposit Return System organisation)
- to involve experts on topics with limited knowledge (e.g. glass manufacturer, cleaning experts)

To create a successful coalition of the willing, the members of this group should have a matching mindset. During the interactive sessions, it became clear that some entities are very enthusiastic about the introduction of this reusable glass packaging. The common factor between these entities is whether they are willing to take a risk. As an example, the retail hub mentioned that they had done extensive research on the introduction of their reusable glass packaging, but they were never fully finished when implementing the packaging. Evaluation and review takes a very long time and the implementation is always different than expected. As a result, it is sometimes better to just start the implementation and learn as you go. This suggests that the coalition of the willing should be intrinsically motivated to introduce reusable glass packaging, regardless of the risk it may have. Therefore, entities deemed suitable must have a mindset that matches this motivation. In the case of this particular ecosystem, it is likely that Brinkers Food will be one of the entities present in the coalition of the willing. Not only have they initiated this research, they are heavily organic and sustainability oriented and are in active pursuit to reduce the impact of their packaging. Moreover, they are willing to spend resources on the introduction of this packaging.

However, a coalition of the willing cannot consist of just one entity. Therefore, entities with comparable viewpoints have been explored. As it is important for Brinkers food to have other content producers by their side to help increase the viability of the ecosystem, an analysis is executed covering content producers that have their own brands present in specialist trade stores. The latter is chosen since specialist trade stores, as opposed to larger supermarkets, are smaller scaled, often have manual collection and sorting of deposit return packaging and the sold brands, employees and customers share the same organic and environmentally aware viewpoints. Following this, the introduction of a reusable glass packaging can be better controlled. Firstly, due to the smaller scale on which the reusable glass packaging is implemented, but also through the general positive attitude towards such packaging from a consumer and employee point of view, provided that the packaging is indeed proven to be better for the environment compared to alternatives. The analysis has resulted in a number of content producers that could be suitable for forming the coalition of the willing (Appendix E).

The overview of content producers (Appendix E) is evaluated regarding the highest potential to join the coalition of the willing, based on the following.

- the entity is a medium sized, independent content producer
- the entity has a positive attitude towards sustainable initiatives
- the entity has a presence in German specialist trade stores
- the entity has a brand identity that has no dependency on the shape of the packaging

A total of 8 organic content producers (visible on this page) have been deemed suitable to become part of the coalition of the willing or the early adopters of the reusable glass packaging. Another important factor is the willingness of the content producer to spend financial resources on establishing the ecosystem for reusable glass packaging (Coelho et al., 2020; Hesseling, 2022). It is difficult to determine whether these entities are willing to allocate these resources, therefore this should be further investigated when executing the implementation roadmap.

Alnatura, Dennree, Bio Märkte, REWE...

La Selva
Products: Spreads, sauces and vegetable preservatives
Market: Italy, Germany, Switzerland, Austria, Scandinavia, France, Benelux, Poland, Czech Republic, Latvia and Japan
Notes: Originally founded by the German Karl Egger. Its main content production sites are in Italy, but the headquarters is situated in Gräfelfing, Germany.

Alnatura, Dennree, Bio Märkte, REWE...

Zwergenwiese
Products: Spreads, sauces and dips
Market: Europe
Notes: Active using green energy. Have a large variety of products.

Alnatura, Dennree, Bio Märkte, Udea...

Allos
Products: Sweet and savoury spreads
Market: Germany
Notes: Have improved the sustainability of their labels in 2017, support biodiversity projects and fair trade initiatives.

Alnatura, Dennree, Bio Märkte, REWE, Udea...

Byodo
Products: Sauces and dips
Market: Germany, Austria, France, Italy and Switzerland
Notes: Active in sustainable packaging development, not yet for glass

Alnatura, Dennree, Denn's Bio, Pro Bio...

Mani Bläuel
Products: Olive based products
Market: World
Notes: A family owned company which its content production facility situated in Greece.

Alnatura, Bio Märkte, REWE, Udea...

Bio-Verde
Products: Vegetable preservatives and dips
Market: World
Notes: Larger than Brinkers Food (230 employees) but has a limited product range. Also sells their products in Dutch organic stores.

Dennree, REWE, Pro Bio...

Maintal Konfituren
Products: Marmelade
Market: Europe, Asia, Africa and North America (30 countries total)
Notes: The market coverage is comparable to Brinkers Food and the produced products are of limited risk regarding allergens. Also produces non-organic marmelade for their other brands.

Alnatura, Dennree, Udea...

Petersilchen Naturwarenhandel
Products: Sauces and spreads
Market: Germany
Notes: Originally a larger organic retailer that as of 1995 also has a content production facility for products in the Asian cuisine (Sanchon brand).

Maintal Konfituren Sanchon Mani Bläuel La Vida Vegan

Figure 59 Epmhasised packaging designs compared to La Vida Vegan.

The benefits of working together with for example Maintal Konfituren, the Sanchon brand and Mani Bläuel is that these content producers have a packaging that is similar to that of the Brinkers brands La Vida Vegan and So Vegan So Fine (Figure 59). Therefore, finding a middle ground regarding packaging design could be easier compared to other content producers. Nevertheless, the conventions of a suitable packaging design for reuse need to be considered as well. Therefore, it is likely that trade-offs are necessary.

The coalition of the willing should not only consist of content producers. Retailers and logistic partners are equally important for the introduction of the ecosystem. Therefore, the coalition of the willing should be expanded with multiple different entities that make the ecosystem viable. As each of the different content producers likely has similar and different retailers and logistic partners, there is no fixed configuration of the coalition of the willing. However, to simplify the implementation of the ecosystem in the value chain, each of the content producers should establish an overview of their current related entities (retailers, stores, logistic partners). These overviews can be compared to find common shared entities. These entities can be selected and evaluated regarding the suitability and potential willingness to join the coalition of the willing. Once agreed, the coalition of the willing is formed and next phase can be started.

Phase 2 | Establishing ecosystem

To establish the ecosystem, the coalition of the willing should discuss the division of responsibilities though applying the framework. The framework will serve as a guidance to establish this task division, leading to an initial ecosystem configuration. It is important that all decisions related to the ecosystem configuration are documented (e.g. responsibility division, commitment to the ecosystem). This way, a baseline is established which can be updated if necessary and can be consulted to solve conflicts. This also means there is a necessity for a democratic structure, in which all initial involved entities can contribute to the establishment of this baseline.

The case study has resulted in an initial ecosystem configuration. However, this has been based on the input of four entities. In case of the coalition of the willing, it is likely that more entities are involved (e.g. additional content producers, retailers, stores and logistic partners). These entities should review the ecosystem configuration from their perspective using the framework. Each of the additional entities in the coalition of the willing can establish their own version of the ecosystem configuration, which can then be combined to obtain one final ecosystem configuration. It is likely that there are still responsibilities that have not been distributed yet. In this case, these responsibilities should be reevaluated. If none of the current entities is willing to take on these responsibilities, there is a need for another additional entity. As concluded in the case study, the cleaning facility is a necessary entity. The presence of such a cleaning facility reduces hygiene risks, as these facilities are specialised in cleaning, as opposed to having a smaller in-house cleaning installation at the content-producer, which does not have cleaning as a primary objective (Last et al., 2023). To introduce such an entity to the ecosystem, there are two different options (right).

Collaboration with an existing cleaning facility | The most easy option is to collaborate with an existing cleaning facility. These cleaning facilities could be, for example, the partners of established ecosystems for glass packaging reuse (e.g. Pieter Pot, PAKT or Circujar), or cleaning facilities that focus on cleaning other packaging (e.g. beer pool solutions (bottles), Sykell and Interzero (plastics)). The required amount of effort is relatively low, compared to starting from scratch, as logistics, collection and cleaning is already arranged when collaborating with an existing cleaning facility. However, the influence a content producer can is limited, as everything is already set in stone.

Establishing a cleaning facility | If it is impossible to collaborate with an existing entity, the coalition of the willing should establish their own cleaning facility. For this, cleaning machine manufacturers should be consulted. Their expertise will support the establishment of a cleaning facility. However, setting up a fully functioning additional entity requires high effort, and is therefore undesired. The coalition of the willing still have their regular production or retail business to run, and therefore have limited resources to allocate to this development.

For either of these options, the quality control is of utmost importance. After cleaning, the packaging should be checked on technical, microbiological, chemical and allergenic residue, both visually and through testing, in order for it to comply with the food safety standards (BRCGS, 2022; IFS Food, 2021). Though the standards are not necessarily tailored to reusable packaging, the food safety still needs to be guaranteed, therefore these tests are necessary. In the future, there might be better guidance from these standards regarding reusable packaging. Therefore, the development of these standards should be followed.

When the cleaning facility is introduced to the coalition of the willing, the ecosystem configuration should be reevaluated to see if all responsibilities are taken care of. If not, the entities should find compromises to make the ecosystem work. Once the final ecosystem configuration, using the framework, is established, the next phase of detailing can be started.

Phase 3 | Detailing

The third phase is the detailing phase. There are different topics that need to be addressed and discussed between relevant entities.

Packaging design | All initially involved entities

The reusable packaging is ideally used by multiple different content producers, hereby stressing the need for standardisation (Coelho et al., 2020; Hesseling, 2022; Morgan et al., 2022). Therefore, the content producers should find common ground on the following requirements.

- Glass packaging size(s) (suitability for existing filling line)
- General glass packaging shape (suitability for existing filling line)
- Glass packaging tolerances (based on closure mechanisms)
- Means of closure (material, sealing possibilities) (Circujar, 2023a)
- Means of labelling (material, adhesive) (Circujar, 2023b)

The development of this packaging design can be quite complex. Not only should the design be suitable for the brand identity, it should also be somewhat compatible with the current filling process present at the content producer facilities. If many adaptations are necessary for the new packaging, its viability drastically decreases. Moreover, the glass manufacturer and cleaning facility should evaluate the design regarding producibility and cleanability. Examples of consideration are amount of recycled content (British Glass, 2019) and wall thickness to account for strength of the packaging during reverse transport (Isbouts et al., 2023), and a corresponding secondary and tertiary packaging that is suitable for the reverse logistics. Regarding cleanability, neck broadness, glass finish and labelling decisions should be evaluated. If the neck is as wide as the jar itself and the surface has a smooth finish, the chance of residue after cleaning is minimized (Wester & Verweij, 2022). The Macro level entity of food safety standards influences these decisions based on the standards they provide. To avoid loosening of the lid, there should be an extension of the body that prevents the lids from touching on the filling line (Brinkers Food, 2024). Moreover, it should be evaluated if the packaging design is identifiable in a population of mixed packaging. Additionally, the cleaning facility should be involved in the labelling decision, as certain label and adhesive material can result in clogging of the cleaning machines (Circujar, 2023b).

As a matter of illustration, a potentially suitable packaging design is developed. This highlights not only the possibilities, but more importantly, the hurdles that content producers might face when trying to find common ground in the packaging design.

The proposed exemplary packaging design is visualised in Figure 60. The technical specifications and corresponding substantiation of this packaging design can be found in Appendix G. The packaging design is analysed based on the impact it may have on the filling line. The compatibility of the packaging with the current filling line possibilities at Brinkers Food is used as the baseline of constraints for this specific packaging design.

Figure 60 Exemplary reusable glass packaging design

Content and volume | The content of the packaging is 270 grams, the same volume as the current La Vida Vegan (LVV) and So Vegan So Fine (SVSF) most sold products. This means alterations to the filling volume are not necessary. However, the filling height of the new packaging is slightly different, compared to the current settings (81.5 mm and 77-78mm respectively).

Filling line | The outer diameter of the packaging is comparable to the current LVV and SVSF packaging. As a result, the same filling line inserts can be used, which decreases the needed investment. However, due to the necessity of a straight inner wall to faccilitate proper cleaning (Wester & Verweij, 2022), additional external extrusions are necessary. Firstly, to avoid loosening of the lid on the filling line and, secondly, to strengthen and stabilize the packaging during the filling processes and throughout the reverse logistics (Brinkers Food, 2024). Therefore, this packaging should be tested if the compatibility prediction with the current filling line inserts is actually correct. Moreover, if the decision is made to choose for different packaging dimensions, it is important that the database of Brinkers Food (and other content producers) is consulted to check what filling line inserts are present for which packaging dimensions.

Lid | The lid that can be used for this packaging is a different sized lid compared to the curent lid for LVV and SVSF. The current lid dimensions are not suitable for a packaging designed for the current filling line insert dimensions, while still maintaining a straight inner wall. To illustrate this: the diameter for the lid of the regular LVV packaging is smaller than the diameter of the body. This means that if this design is kept, it can never have in a straight inner wall. Therefore, either the main body diameter needs to be chosen as a starting point, or the lid diameter, to ensure only a minimal amount of the filling process steps has to be adapted. Therefore, the decision should be made if the packaging is tailored to the lid design or to the main body of a LVV packaging (or a different packaging compatible with the filling line at the Brinkers Food premises. For this particular design, the decision is made that the body diameter is used as a baseline for the packaging design. It should be checked if the current estimated corresponding capping dimension (TO77) is compatible with the capping process at Brinkers Food.

Non-tampering seal | For the label design, practical decisions have to be made. For LVV and SVSF, the label partially functions as a non-tampering seal. For reusable packaging, such sealing is most suitable, as it does not cause any residue on the top edges of the packaging. However, such sealing must be attached well. Due to the extrusion on the side of the packaging, the seal can be attached in two ways. The seal can be stretched (Figure 61a) or flat on the glass (Figure 61b). The latter is desirable, as this ensures the sealing cannot be teared during logistics. However, this requires an altered sealing method, as the labels needs to be pushed against the glass, which is impossible with the current labeling process at Brinkers Food.

Figure 61a and 61b stretched and flat non-tampering seal

Figure 62a-d Differences in size of the non tampering seal visualised on an exemplary packaging

To minimize further alterations, the current label dimensions of LVV and SVSF are taken into consideration. To ensure the-non tampering seal is secured underneath the regular label, the 600g non-tampering seal can be used, which has 9mm spare, compared to the 270g non-tampering seal which is 3mm too short (Figure 62a and 62b). The 9mm should be sufficient, given the current LVV and SVSF overlap of a 6-12mm. Moreover, size of the non-tampering seal for the 600g jar is more suitable compared to the 270g jar with regards to the lid size (Figure 62c and 62d respectively).

Figure 63a and 63b Spacing of a regular label on a similar packaging

Label | For the regular label, the 270g label can be used. With a space of 69mm on the glass, the current LVV and SVSF label, with 50mm in height, has 9.5 mm spare on both the top and bottom. This should be sufficient, as similar packaging from Hotel Chocolat and Yummy's (Figures 63a and 63b respectively) uses 9mm of space.

As can be seen, there are many design considerations influenced by the current state and possibilities of the filling line. This example only illustrates the hurdles faced from a content producer point of view. Likely, more hurdles will be faced when evaluating this design from a glass manufacturer and cleaning facility point of view.

System saturation | Coalition of the willing & glass manufacturer
The saturation of the ecosystem is difficult to predict. The presence of a reward system that can drastically increase the return rate (Šuškevičė & Kruopienė, 2021). However, as presented in the research from Wester and Verweij (2022), it became apparent that 88% of people was willing to participate in their reuse ecosystem. Therefore, it is more likely that, especially at the start of the ecosystem, the return rate will be lower. Moreover, before the packaging returns, it needs to be emptied, which could take weeks or months. During this time, only new reusable glass packaging can be used until packaging is returned. This results in a deficit of glass packaging, which means that the packaging volume within the ecosystem will fluctuate, especially during the first years of introducing the ecosystem. Therefore,the glass manufacturer should be ready to produce sufficient amount of packaging, and (an entity of) the coalition of the willing should establish a means for monitoring the ecosystem saturation, so fluctuations can be compensated adequately. This can be done manually, if the ecosystem is introduced on a smaller scale, however, when upscaled, it is likely that this becomes automated.

Financial system | All entities
The financial system has already been proposed in section 10.2.2. Nevertheless, when the ecosystem configuration is actually introduced, all entities need to be informed about this financial system. Moreover, the Deposit Return Scheme organisation should be involved. This ensures financial independency and creates one responsible entity for communication. Though this takes time to setup, there are multiple independent organisations that can take on this responsibility, depending on the needs of the ecosystem entities (DPG - Deutsche Pfandsystem GMBH, 2024).

Collection possibilities | Retailers, stores & cleaning facility
Depending on the area of introduction, alterations have to be made to existing means of collection. In the envisioned case for Brinkers Food, these alterations will be minimal. The specialist trade stores currently have a manual means of collection. Through training the employees, the transition of the additional reusable glass packaging will only need limited resources. However, stores that have an automatic means of collection need a system update that ensures the new packaging will be recognized. Therefore the corresponding impact of introducing the reusable glass packaging to a store relying on automized collection should be taken into consideration. This will be a direct consequence of the chosen location of implementation.

Information provision | Coalition of the willing, retailers & stores
It is important to inform the consumer about the reuse principle and the sustainability of the packaging. (Coelho et al., 2020). The switch to reusable packaging should be made clear to the user through well substantiation. Packaging differences can throw the consumer of guard. If paired with undesired consequences, such as annoyanced during or after usage (e.g. the Dutch governmental decision to attach the cap to the packaging of all beverage containers (Kassa - BNNVARA, 2024)), consumers will obtain negative associations with a product or brand, hereby making them less prone to use this.
Additionally, the ease of returning the packaging is highly relevant for the success of consumer participation in the ecosystem (Hesseling, 2022). It is suggested that the convenience and accessibility of the reverse vending machines or the logistic collection services is mandatory for the consumer to actively participate (Bocken et al., 2022). Inconvenient systems and unavailable means of collection show a significant decrease in participation (Coelho et al., 2020). Therefore, in order for people to really adopt this system, a short and concise explanation should quickly inform the user how to participate (do Valle et al., 2004).
The presence of the sustainability information offers an incentive for consumers to participate in the ecosystem through returning the glass packaging. It triggers the consciousness of the consumer to contribute to a better environment (Bocken et al., 2022; Corsini et al., 2018; Junquera et al., 2001), as well as portrays certain social norms which can increase participation (Escario et al., 2020). Altogether, proper information provision does not only increase the awareness of the reusable glass packaging, but it also creates transparency about the reuse.
Additionally, the sustainability claims should be evaluated. Even though reusable glass packaging can result in a significantly reduced environmental impact compared to single-use alternatives (Ingarao et al., 2017; Isbouts et al., 2023; Noto, 2023), the actual reduction of the reusable glass packaging of this specific ecosystem should be evaluated. Sustainability claims can be over exaggerated resulting in greenwashing. If this is spotted by the consumer, it can result in negative associations with the brands, hereby affecting the consumer-brand relationship (Ioannou et al., 2022). To avoid this from happening, the information claims made should be checked and supported by independent research. An example could be conducting an LCA for the reusable glass packaging in the value chain.

Phase 4 | Implementation

The implementation requires a decision that should be made on the area of implementation. Moreover, the entities need to be prepared to fulfill all additional responsibilities. The reusable packaging cannot simply be implemented immediately. This section will highlight the necessary preparations of the entities.

Area of implementation

After the ecosystem configuration is determined and the details have been established, the reusable packaging can be introduced. A dense collection network and infrastructure is needed for a feasible ecosystem (Bocken et al., 2022). Therefore, a suitable area of implementation must be chosen, as this ensures optimization of distribution, such as ensuring close distances from collection to washing to filling (Jiang et al., 2020). When scaling the system, complexity increases, which results in more logistics needed in the ecosystem. Coelho et al. (2020) suggests to start an ecosystem locally and after it becomes locally successful, expansion can be the next step. In order to create a well-established network, proper communication and collaboration is essential. Based on the content producers, retailers and stores, the area of implementation will be chosen. This choice can be based on the societal attitude of a region, the presence of the brands of the coalition of the willing at a certain retailer/store or the possibility of close proximity of entities (e.g. cleaning facility, store and content producer).

Entity preparation

Before the implementation of the reusable packaging starts, the different entities should be ready to introduce the reusable packaging. The implementation itself requires preparation. All entities need to be ready to perform the additional responsibilities that are at stake when the packaging is introduced.

Glass manufacturer | The glass manufacturer should produce the reusable glass packaging up to the defined standards and should be ready to produce additional packaging in case of volume fluctuations. Additionally, the glass manufacturer should define a sales price for the packaging, based on the manufacturing, labour and material costs, and a chosen profit margin.

Content producers | Content producers need to be ready for filling line and storage adaptations, a possible fluctuating volume of incoming packaging (Brinkers Food, 2024) and collaboration with other content producers, even competitors. To achieve this, Brinkers Food (and the other content producers), planning, test runs with the new packaging and evaluation of quality (checks) are required. For example, the responsibility of delivering packaging that is up to standards is in the hands of the cleaning facility. However, the content producer still might want perform random tests of each batch for confirmation. The decision for these tests should be evaluated by the QA/QC team of the content producer, but more importantly, also amongst the entities.
Moreover, financial choices should be established internally. The buy-in costs of the packaging can differ due to its origing (new or reused). As a result, the packaging costs for ordered products can differ, depending on the available returned packaging. To avoid losses, a margin should be added to the packaging price of a retailer contract to cover any fluctuations in incoming packaging.

Stores and retailers | The reusable packaging must be available in stores once the ecosystem is actively promoted towards the consumer. This also means proper communication between the content producers, retailers and stores to set a fixed introduction date. Retailers need to adapt their product range according to the area of implementation. Furthermore, stores will need to adapt their collection methods through updating their reverse vending machines (if needed) and by increasing storage space for collected reusables (Kramer et al., 2021).

Logistic partners | The logistic partners face more trips, and therefore they need to be able to facilitate this increased need of transport. This could mean the need of additional employees or efficient planning where delivery and collection is combined. This results in a more complex logistic system, which all entities are involved in. In advance, (contractual) agreements should be arranged, covering who is charge of arranging transport for each transaction between entities.

Cleaning facility | A new cleaning facility should emerge or an existing cleaning facility should adapt their cleaning processes and storage space to suit the reusable glass packaging. This cleaning process should comply with the food safety standards in force at that moment. This also requires close collaboration with the conent producers, who might have different visions on which standards are important to meet. A general concensus should be achieved which indicates which standards are met from the end of the cleaning facility, so the content producers know what to expect. Any additional entity that decides to join the ecosystem should comply with these same, ecosystem-wide standards.
Moreover, the glass manufacturer should establish a suitable sales price for the packaging, that covers the costs of cleaning, leaves a profit margin and is cheaper compared to the new glass packaging to make it attractive for content producers to buy.

Figure 64 Distinction through label, icons and packaging shape

All entities | As there is local introduction only, the majority of the content will still be packaged in the old packaging, leading to increased logistic complexity. This calls for clear distinction between the two, in the warehouse, between entities and towards the consumers, which can be achieved through using unified icons, text and visuals on the label, marketing, and the packaging design itself (Figure 64). Moreover, all entities active in the ecosystem should actively acknowledge their assigned responsibilities. Through contractual agreements the ecosystem will have a solid basis where each entity takes their responsibilities seriously.

If all aforementioned preparations are arranged, the reusable glass packaging can be intrudoced in the value chain.

Phase 5 | Expansion

Once the ecosystem configuration is fully implemented in the value chain it takes a while for it to stabilize. Once more matured, the entities involved can determine whether to expand the ecosystem or whether to abandon the experiment. The time it takes for this ecosystem to be able to undergo expansion is difficult to predict, as the introduction of an ecosystem similar as described in this case study has never been done before. However, an evaluation can be executed whether it is viable to continue the experiment. The following topics should be addressed.

Consumer response | The response of the consumer is an important factor. They are the most influential entity when regarding the return rate and ultimately the system saturation. Therefore, the satisfaction and experience of the consumer regarding the reusable glass packaging should be evaluated. If positive feedback on the ecosystem and the reusable glass packaging is measured, it is a possibility to expand the system, as the crucial consumer entity shows active participation.

Return rate | Following from consumer participation is the return rate. A high return rate means a more successful ecosystem. Ideally, a return rate of 95% is met (Searious Business & Zero Waste Europe, 2023), but consumer participation takes time (Nederlandse Brouwers, 2024). After a year of deposit money on metal cans in the Netherlands, a return rate of 65% is measured. In Denmark and Norway, it has taken 8-11 years to obtain a return rate of 90% on these same metal cans. It should be noted that the scale and target group of these ecosystems are very different to that envisioned for the introduction of the reusable glass packaging in this case study. Nevertheless, this does indicate that for a return rate to be determined as fruitfull, it can take years.

System saturation | Due to the instability of the return rate, it is difficult to determine what packaging volume is needed for the ecosystem to be saturated. The more mature the ecosystem becomes, the better such predictions can be made. Nevertheless, at the start of introduction, many new packaging needs to be manufactured to account for the need of the content producers. After a while, the reusable glass packaging is returned, and enters a new cycle. As a result, less new packaging is needed. However, through the maturing phase of the ecosystem, these volumes can vary a lot, depending on consumer usage time, return time and breakage rate. Therefore, these factors should be monitored well and a reserve supply of glass packaging should be kept at hand to compensate for sudden volume fluctuations.

Entity experience | Finally, the entities that have introduced the glass packaging into the value chain and have been affected by this process need to evaluate their experiences. Has the financial input been rewarded with sufficient sales, increased brand awareness, a positive brand image and/or sustainable improvement? Through weighting the losses and gains a conclusion can be drawn if it is viable to continue the ecosystem or if it should be abandoned. Depending on the opinion of the majority of the entities, the ecosystem will be further adopted or completely stopped.

If a satisfactory conclusion is drawn regarding the mentioned evaluation topics, the entities can expand the ecosystem. This expansion can happen through different ways.

Brands | The entities can choose to expand the ecosystem through involving new brands. These can be own brands from current content producers, but also from new content producers.

Entity expansion | To take it one step further, retailers and private labels can be approached. If their products are produced by a content producer that is already involved in the ecosystem, the step to switch to reusable glass packaging can be a viable option for these new entities. Especially if the ecosystem is proven to be successful, as this takes away uncertainties such as a lack of consumer participation and governmental support (Kramer et al., 2021; Tura et al., 2019).

Area | The area of introduction can be expanded. However, this area expansion should consider the presence of infrastructure to create a dense collection network (Bocken et al., 2022), close proximity of entities (e.g. collection to cleaning location) (Jiang et al., 2020), and the ability of entities to cope with the increased ecosystem complexity (Coelho et al., 2020). In the case of Brinkers Food, the ecosystem could be expanded to a second Bundesland, or the choice can be made to introduce the ecosystem to the Dutch market.

Retail type | Lastly, the initial focus of the introduction of the reusable glass packaging are the specialist trade stores. The ecosystem expansion could also be focused on the type of retail: from specialist trade stores to regular supermarkets. This is, however, a very drastic step. Not only the scale increases, but the ecosystem becomes much more complex. Aside from needing to update the often automatic reverse vending machines present in these stores, the logistics from a retail perspective become more challenging. In the case of Brinkers Food, they export their So Vegan So Fine (SVSF) products to the warehouse of a large retailer (Brinkers Food, 2024). This large retailer distributes the SVSF to their stores accordingly. If the reusable glass packaging is only introduced in a specific area, these warehouses need to separate the SVSF products packaged in reusable glass packaging and the same products packaged in the regular packaging, leading to increased complexity in warehouse logistics. There could be argued that simply all packaging should be changed to the reusable glass packaging. However, each reusable glass packaging is significantly more expensive due to additional material needed and increased strictness of tolerances, which leads to a financial undesirable situation. Therefore, the distinction between the different packaging types needs to be apparent, but at the same time may not result in negative impact on the brand image. In short, introducing the reusable glass packaging to regular supermarket retail is a big step and can perhaps only be executed realistically if introduced in all stores at once.

After it is decided how to expand the ecosystem, introductory steps can be taken to prepare the new brands, entities or area of implementation. These are similar as described in Phase 4. Once the ecosystem is matured again, Phase 5 can be consulted to further expand the ecosystem. This leads to a process of continuous development, where the ecosystem is expanded until it reaches its desired size and market.

11.2.2 Implementation preparation - internal

The internal introduction of the reusable glass packaging within Brinkers Food happens more sudden. As described, Brinkers Food will become part of the coalition of the willing. Most of the activities regarding this coalition of the willing will be executed on Meso level between entities, and therefore have little to no influence on the work floor (Micro level). However, there will be some changes, as depicted in section 11.1.2, that should be taken into consideration. As most changes will happen at the moment of introduction and will adapt over time, as they are dependent on the actual experience of the implemented ecosystem, there is no fixed step by step plan that can be followed. However, the following preparation and monitoring is needed to prepare for the introduction of the reusable glass packaging, based on the departments present at the premises.

Purchase and planning | Head of purchase and planning

The head of purchase and planning will experience increased job complexity. Firstly the fluctuating packaging volumes should be accounted for. Therefore, the cleaning facility should be contacted prior to contacting the glass manufacturer. The number of packaging which the cleaning facility cannot deliver can then be compensated with new glass packaging. Such fluctuations should be monitored to allow for better future predictions. Therefore, the planning process will face some changes regarding the moment of purchase (e.g. from four weeks to six weeks beforehand). Depending on the agreement with the cleaning facility, the storage time of the glass packaging can be determined. Either the cleaning facility puts the glass packaging on hold and delivers them at a regular time (max. two weeks prior to filling), or Brinkers Food needs to increase their packaging storage in preparation for longer storage time and fluctuating volumes (Brinkers Food, 2024). The latter should be executed by the head of production, which manages the warehouse space allocation.

Filling line adaptations | Head of production, Head of purchase and planning

When introducing a new packaging, the filling line needs to be adapted (Brinkers Food, 2024). However, Brinkers Food can try to ensure the packaging dimensions are suitable for the current filling line configurations, which decreases downtime when introduced. Nevertheless, the planning could become more complex. Especially if the same brand and content are filled in both the regular and reusable packaging after one another. In that case, proper separation is of the essence. This can be done through visual differences in secondary packaging design that makes the reusable glass packaging batches easily separable from the single-use glass packaging batches. Also, the separation in storage location can ensure that the different packaging types do not get mixed.

Tolerances | Head of production

As mentioned, the tolerances of the packaging design should be sharpened to ensure that the capping procedure should not be altered throughout the filling process. Especially as the packaging population is mixed, it may not be possible to have packaging deviations that result in alterations to the capping machine settings. Therefore, if Brinkers Food receives a fresh batch of glass packaging of which the technical requirements, such as tolerances, are not met, this batch may not be introduced to the ecosystem. If they are introduced, it will cause deviations within the population and result in significant downtime due to capping problems when refilling, which is undesirable. Therefore, the checks for incoming packaging should be expanded with tolerance tests to ensure the packaging that is in stock can actually be used for the filling procedure.

Quality Control and Quality Assurance | Team of QA/QC

Other additional checks of incoming packaging might be required to ensure full product safety. Even though the cleaning facility is fully responsible for delivering packaging that is up to standards, Brinkers Food can issue additional tests for arriving batches to check the technical, microbiological, chemical and allergenic requirements of the packaging. This will put an additional pressure on the QA/QC department. Depending on the extent to which they trust the tests of the cleaning facility, they can determine the right amount of tests for the incoming packaging. Such tests are difficult to predict beforehand and depend on the quality contract, the declaration of compliance and the good manufacturing practices standards agreed upon with the cleaning facility (BRCGS, 2022; IFS Food, 2021). Therefore, the QA/QC team need to be prepared to perform additional tests if necessary as a result of the introduction of the reusable glass packaging.

Sustainability | Sustainability department

As there is a continuous development in the legislative domain, the sustainability department within Brinkers Food should keep a close eye on alterations made. For example, the definitive version of the PPWR in 2026 might change specifications regarding reusable glass packaging. It is likely that the ecosystem configuration is not introduced by then. Therefore, it is important to update its design based on changes in legislation. Similarly, if food safety standards, such as the BRCGS and IFS include standards for reusable packaging, these should be evaluated. Depending on the suitability, these guidelines can make introduction of the reusable glass packaging easier. Therefore, all external influences on Macro level should be monitored and implemented within the ecosystem where necessary.

Finances | Financial deparment

The new reusable packaging is predicted to be more expensive compared to the single-use packaging. However, the cleaned, reusable glass packaging is predicted to be less expensive compared to the single-use glass packaging. As a result, a financial difficulty arises. Since the number of reused glass packaging is difficult to predict, the price offerings to retailers to buy a certain product can deviate. As an example, if the packaging costs are estimated to be the price of new reusable packaging, Brinkers Food will gain a profit if they use reused packaging. The only problem that is faced is convincing the retail entity of the relatively high product price. The opposite situation is much more stressing. If the reused packaging costs are set as a basis for product price determination, Brinkers Food can face losses if they have to compensate with new reusable packaging due to volume fluctuations. Therefore, a middle ground needs to be found, where an average packaging price is used that can compensate for a possible need of new reusable glass packaging. However, finding this balance takes time. Therefore, the financial uncertainties paired with introducing the reusable glass packaging should be prepared for, by, for example, additional packaging storage or financial backup.

12. LIMITATIONS

An ecosystem configuration and a corresponding implementation roadmap have been established through applying the framwork to a case study. However, to draw a conclusion on the suitability and applicability of the framework, the case study is evaluated, hereby identifying possible limitations that could have influenced the results. The following sections elaborate on these limitations and the consequences thereof.

12.1.1 Framework application

During the case study, it was aimed to apply the framework as a means to support and facilitate discussions. As discovered during different conversations with experts, in an ideal setting, none of the entities would take on any additional responsibilities. This meant that if the task was given to a singular entity to divide the responsibilities amongst all entities in the value chain, most responsibilities would be distributed to other entities, leaving the participating entity with barely any additional tasks. As a restult, the conclusion was drawn that direct implementation of the framework in an internal setting would lead to unrealistic results. For this reason, the framework itself has not been used by any of the participants. Instead, the interactive session with task cards has been established. The results from this session have been translated to fit the framework. However, this does leave the question whether or not the framework can be used to support the establishment of an ecosystem configuration for introducing reusable glass packaging into the value chain. It is proposed that, in a setting where multiple entities are present, each entitiy can provide input whether or not they can take on a responsibility, leading to a more realistic distribution of the results. Nevertheless, this hypothesis has not been tested, as only internal discussions were executed using the interactive session method.

12.1 Limitations

The case study has been exposed to some limitations. These limitations are the following: application of the framework during the case study, suitability of participants lack of sample diversity and lack of entity involvement on Micro level.

12.1.2 Suitability of participants

The establishment of the current ecosystem configuration for the case study was based on the opinion of four entities. Unfortunately, there was no luxury of choosing specifically suitable entities for the interactive sessions. As a result, mainly Dutch entities were involved, whereas the case study was scoped to Germany. Even though German entities have been contacted, only a limited response was obtained (glass manufacturer). For the viability of the results, it would have been beter to involve entities that represent the value chain scope chosen for this case study. Due to lack of response from contacted German entities, the decision was made to also involve entities that are not present in the specified area, as complete uninvolvement of entities would result in too much speculation and assumptions. Hence the necessity to involve entities, even if they were Dutch instead of German. This means the results generated during the case study might not be particularly suitable for the given scope. For this reason, additional German entities present in the value chain should be involved in future research. This will result in a better suitable and more reliable ecosystem configuration and implementation roadmap that is tailored to the German part of the value chain of Brinkers Food. However, during the case study the involvement of German participants proved to be difficult. Therefore, it can also be considered to alter the scope of the case study to the Dutch part of the value chain of Brinkers Food, hereby focus on involving additional Dutch entities to increase the reliability of the results.

12.1.3 Sample diversity

Although the four entities involved all have a different position in the value chain, the entirety of the value chain of Brinkers Food has not been covered. For example, the retailer and store that have participated in the interactive sessions showed intrinsic motivation to implement reusable packaging, regardless of the risks it might have. This is due to their organic values and their environmentally conscious consumer base. Consideriong the other retailers and stores Brinkers Food comes into contact with, not all will share this sustainable vision. If these entities had been involved in the interactive session, the results might have been different. For example, the division of responsibilities and the level of involvement for different tasks. During the development of the ecosystem configuration, this difference in attitude has been taken into consideration. However, this is all based on assumptions, and therefore actual input from these entities is necessary to establish a final and feasible ecosystem configuration. Additionally, only one glass manufacturer has participated in the interactive session. The hesitant response has led to the exclusion of the glass manufacturer in the reverse logistics process. However, it is entirely possible that one of the other glass manufacturers of Brinkers Food is willing to take on a role in the reverse logistics. Yet again, the participating entities in the interactive sessions have steered the result of the ecosystem configuration, and have in this way limited the applicability of the result. Unfortunately, no other entities were available for involvement in the development process, hence the difficulty in determining the suitability of the established ecosystem configuration for the entirety of the value chain.

12.1.4 Entity involvement on Micro level

The internal situation of Brinkers Food is analysed, making it possible to identify differences on a Micro level, between the current and future situation. Unfortunately, this knowledge is not available for the other entities present in the value chain, as such insights were not accessible due to confidentiality and lack of participating entities. Though an estimation of the current procedures and the suitability of the ecosystem configuration as a whole has been made based on the interactive sessions, the actual impact on internal processes cannot be concluded. This case study only provides one example on the impact the ecosystem configuration can have on an internal level. However, ideally the impact on an internal level would be analysed for all entities present. Not only does this give a more holistic understanding of the ecosystem configuration that is developed, it also provides more substantiation regarding the suitability of the ecosystem configuration for the specific entities involved.

PART IV

EVALUATION
OF CASE STUDY RESULTS

Part IV evaluates the results established from applying the framework to a case study, presented in Part III. This evaluation aims to highlight the suitability and relevance of the framework (results) and implementation roadmap and provides recommendations to further improve the framework to enhance its employment in the industry.

13. DISCUSSION

The case study has provided an example on how the proposed framework can serve as a means to aid the introduction of a reusable glass packaging in a originally single-use packaing oriented value chain. This chapter aims to discuss the usability and application of the framework in this context and the implementation roadmap that is generated as a result of the application of the framework.

13.1 Framework

The usability and applicability of the framework has been tested through the case study. By applying the framework to a real life context, several points of weakness and adoption obstacles were discovered, such as framework incompleteness, inconsideration of secondary packaging, missing support for country expansion, lack of intuitiveness, absence of real life implementation, and difference between content producer versus retailer push. The following sections will elaborate on these points of weakness and Chapter 14 aims to provide recommendations to overcome these.

13.1.1 Framework incompleteness

During the case study it became apparent that not all entities have been covered in the initial proposed framework. For example, the glass manufacturer was identified as a new Meso level entity. In the ecosystem configuration for the case study, this entity only covers responsibilities associated with the linear part of the ecosystem. However, it can be a possibility that for a different context, a different responsibility division is generated by the involved entities. Perhaps with a result of a glass manufacturer becoming involved in the reverse logistic part of the process after all.
Another entity discovered during the case study is the Macro level entity of the Deposit Return Scheme organisation. To allow for fair and correct deposit fee compensation, this entity is determined to be a necessity.
Moreover, when using the framework for a large number of entities in a value chain, it becomes more difficult to reach consensus between similar entities. For example, not all content producers, retailers, stores and logistic partners are able to take on the same role with the same responsibilities. To illustrate this, the example of stores is taken. One stores might have an automated means to collect returned packaging, while another uses a manual method. Taking this context into consideration, the effort and financial investment necessary for the introduction of a new glass packaging type is considerably higher for the first store (automated) compared to the second store (manual). As a result, their responsibility division could be very different, which poses problems when creating a combined overview. If the responsibility division for entities in the same category is different, this cannot be visualised in the proposed framework. As a result, the framework shows only limited applicability for a value chain with highly diverse entities (e.g. financial means, number of employees, number of sales, level of innovation).
This illustrates that the framework is far from complete. The entities present in the current framework offer a generic overview, but when subjecting this to a real life scenario, details can be missed. Therefore, the framework is limited in its application.

13.1.2 Secondary packaging ecosystem

The framework is currently tailored to primary packaging only. However, for an ecosystem for reusable packaging, it is often the case that specific secondary (and corresponding tertiary) packaging is necessary for the reverse logistics (e.g. reusable crates). The current framework does not cover the inclusion of such additional packaging. Moreover, the necessity of adding this feature is debatable. On one hand, if the secondary packaging is immediately considered while creating an ecosystem configuration for the primary packaging, the logistics for both packaging flows can be integrated. However, there are many existing, well-arranged pooling systems for such secondary packaging. To avoid overcomplication, usage of such existing pooling systems can be a suitable solution, provided that a suitable secondary packaging is available. Regardless of using an existing pooling system for secondary packaging, or developing a new one, the possibility to integrate these systems in the framework is still absent. The secondary packaging requires additional logistic services to accommodate for transport and monitoring of ecosystem saturation. The usability of the framework would be enhanced if such additional responsibilities are integrated, to ensure entities can take all factors, including secondary packaging, into consideration.

13.1.3 Country expansion

When changing the target country, the framework can provide support to a limited extend. The Meso and Micro level entities are fully defined, but the Macro level entities present are only identified. Their influence on the ecosystem can not be determined solely from the results of the framework. This is due to the fact that the specifics of the Macro level entities can be different for each country. For example, the legislation, food safety standards and organisations are not necessarily the same for each country. For European countries, compliance with the European regulations is mandatory, however, each country can have supplementary regulations or directives providing additional strictness. As a result, for each change in target country, these country specific Macro level entities should be reevaluated. Currently, the framework does not provide any guidelines on how to execute this and which regulations should be considered. Partially because in the duration of this thesis it is impossible to provide an overview of al legislation, food safety standards and organisations for each possible country for which this framework could possibly be applied. More importantly, the regulations are constantly changing, especially in the area of reuse. Therefore, at the moment the information is required, an analysis should be executed to ensure this information is up to date. However, supplementary guidelines on how to execute this analysis can increase the usability and applicability of the framework, as it ensures standardisation in the results that can be obtained from the framework.

13.1.4 Intuitiveness

While implementing the framework, it has become apparent that the intuitiveness of usage is limited. The framework itself has not been used during the interactive sessions. Through using a different method, entities are less likely to divide responsibilities in an unrealistic way (e.g. refraining from any responsibility and dividing these amongst all other entities). The alternative method, determining the level of influence for tasks and ultimately responsibilities, results in a more balanced result, where responsibilities that are not covered are not directly forced upon other involved entities. However, this two step method had to be executed with a supervisor that could moderate the session and gather the reasoning behind choices, and thereafter translate the results into the framework. The necessity for a supervisor limits the intuitiveness of the framework drastically. The framework is aimed to be used by entities to come up with a suitable ecosystem configuration, without the necessity of a supervising person or entity. The framework design as it is now cannot serve this purpose, as additional guidance is essential for correct usage.

13.1.5 Real life implementation

The framework has been used to provide an ecosystem configuration to aid the process of evaluating the introduction of reusable glass packaging into a specific value chain from a singular entity perspective. The framework, in that sense, has fulfilled its purpose in providing support and clarity during the initial phases of establishing. However, the correctness of the obtained ecosystem configuration cannot be determined as of yet. For this, actual implementation of the ecosystem configuration is necessary. Due to the lack of participating entities during the development phase, the ecosystem configuration obtained during the case study is not confirmed to be indefinitely suitable for the value chain. For this, additional review of entities present in this value chain is necessary. Moreover, none of the phases of forging the coalition of the willing, detailing and preparation for implementation have been started. As a result, the impact of implementing the ecosystem configuration and hereby introducing reusable glass packaging into the value chain can only be estimated. The actual impact can only be measured while executing these phases.

Being only in its infancy, the determination of the added value of the framework is limited. The framework has proven to aid the determination of an ecosystem configuration, but the suitability and usability of these results should be evaluated through further research that actually implements these results in a real life environment. This requires time, effort and above all, financial resources, which is in the duration of this thesis unfortunately unavailable.

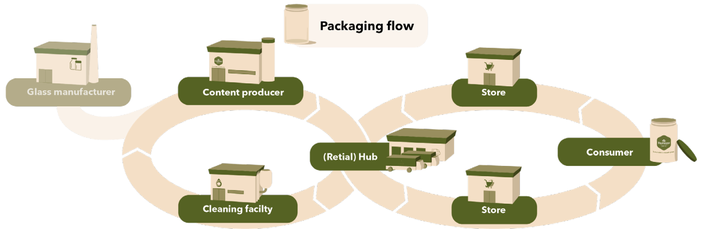


Figure 65 Packaging flow within ecosystem of the retail hub regarding their reusable jar

13.1.6 Content producer(s) versus retailer push

The case study has tested the applicability of the framework for the determination of an ecosystem configuration pushed by a content producer. Content producers often have a smaller influence in the value chain, especially if they are oriented towards a specific product type, which is often the case. Looking at the average content producer, their financial means are smaller and their reach often does not go much further than the glass manufacturer, logistic partner, retailer and in the most unusual cases specific stores. One very important entity, crucial for the ecosystems viability, is barely reached: the consumer. Only through marketing, content producers can get in touch with this entity. Of course there are some exceptions, where a content producer has faced rapid growth and popularity, making it a world leader in its product domain. For example, the billion dollar content producer Ferrero Group, which produces Nutella chocolate spread, creates a similar product type as Brinkers Food. The Nutella brand is a world leading hazelnut spread for consumers worldwide. To illustrate this: each 2.5 seconds a Nutella jar is sold (Vozza, 2014; Zima, 2018). Through clever branding and social proof, the brand has gained a significant consumer loyalty, and hereby is an indispensable product in stores. If Nutella were to switch to a reusable packaging, retailers are forced to join in. On the other hand, if a smaller sized content producer tries to do the same, there are unable to exert such force onto retailers. Moreover, due to their size, the resources for kick starting an ecosystem for reuse is completely different. Where Brinkers Food is dependent on other content producers, Ferrero has the means and power to introduce this on their own. Consequentially, the result of the framework might look different, as there is one entity that pushes the introduction, rather than a combination of entities, such as a coalition of the willing.

A similar situation can happen when a different entity becomes the pushing factor. Instead of a content producer, a retailer can take matters into their own hands and introduce a reusable packaging. Retailers, quite similar to power brands, have a larger financial means compared to the smaller sized content producers. Moreover, due to their unique position, they can force both content producers and stores, and ultimately consumers, to make use of their reusable packaging. Without retailers, the content producers have a lack of production and export and the stores will have no products to sell. Another beneficial element is the large network of stores, which enables the retailer to immediately make a high impact through switching to a different packaging. Additionally, through introducing reusable packaging for a number of private label products, the reusable packaging immediately takes a prominent presence in stores. As a result, standardization and organisation is simplified, as one specific entity leads this process, the retailer in this case, instead of having multiple entities that need to collaborate. The downside for the content producers is a lack of influence, due to the (partial) exclusion of the ecosystem establishment.

In addition to managing the ecosystem, it is likely that there is also a change in the financial flow, packaging flow and packaging ownership. In the ecosystem configuration obtained during the case study, the ownership of the packaging changed. In contrast, by having one managing entity (retailer), the packaging remains owned by said retailer. This also leads to increased responsibilities that are covered by the retailer. To illustrate this change in ownership, the example of the retail hub that was participated in the interactive session and their reusable jar is taken. In 2022, the retail hub has introduced the reusable jar in their stores. The whole ecosystem behind this is developed and implemented by the retail hub themselves. The financial means this retail hub has makes it possible to convince entities and limits the consequences from associated risks. Although the linear logistics are quite similar to that of the value chain depicted through the case study, the reverse logistics are significantly different (Figure 65). After the reusable jar is collected by the store, it goes back to the retailer, where it gets sorted. Thereafter, it gets stored at the retailers premises, and once necessary, it is transported to the cleaner followed by the content producer. This way, the packaging can be managed through almost all steps by the retailer (except from the consumer). Having a different control structure results in a very different implementation of the ecosystem.

As the framework has not been applied in these different scenarios, the actual impact, usage and relevance is difficult to determine. To provide some additional insights, a short comparison reveals there might be differences in suitability and application. Both ecosystem configurations of the different scenarios can be represented in a simplified manner using the framework. However, the applicability and purpose changes. In the event that a variety of entities are necessary to establish the ecosystem, the framework can be a valuable addition to provide support during discussions regarding the division of different roles and responsibilities to obtain a viable ecosystem. However, in the case of a large entity, the variety of entities and the involvement thereof might be different. Due to the presence of a dominant entity with a large influence on ecosystem decisions, the freedom of entities to have a say in the division of roles and responsibilities can be limited. Therefore, the framework primarily functions as a means to visualise the tasks division, rather than to facilitate discussion. Though the latter is not ruled out completely, it should be considered that in this context the application of the framework can be quite different.

13.2 Implementation roadmap

It is difficult to predict what will actually happen if the ecosystem is introduced. All entities can prepare to the best of their ability, but in reality, implementation always goes differently as planned. There is a high dependency on the concessions necessary for packaging design choices, unpredictiveness of the return rate, the actual forging of the coalition of the willing, cleaning and sorting process excecution, cross country expansion and macro level entity involvement. As a result many predictions and assumptions have been made to overcome these uncertainties and establish the implementation roadmap. Through their influence on the reliability of the implementation roadmap, these uncertainties are discussed in the following section.

13.2.1 Concessions influencing packaging design

The packaging design is not yet defined. Although an example has been provided, this is by no means a definitive design. That is as the influence of current content producer processes limits the choices for packaging possibilities. These limitations, such as available filling line inserts, filling line dimensions, and capping and labelling procedures, can provide constraints for the packaging, drastically decreasing packagin design possibilities. However, due to the undefined nature of the coalition of the willing, the specifics of these limitations an concessions necessary cannot be predicted. Moreover, additional constraints are present as a result of limitations in reverse logistics, cleaning processses and user experience and recognition of the packaging. As a result, there is a very specific suitability window with constraints for which the packaging can be designed. Once the final product is actually defined, a suitable secondary and tertiary return packaging needs to be established with a possible corresponding pooling system. However, the designed packaging does not guarantee success, but rather provides a starting point for physical tests to evaluate its suitability for the entities present in the ecosystem

13.2.2 Unpredictiveness of return rate

The return rate is dependent on the willingness of the consumer to partake in the ecosystem. However, due to the free will of the consumer, they can be difficult to predict (Gabriel & Lang, 2006), resulting in varying return rates over time. Factors that influence this are incentives, such as a reward system (Jiang et al., 2020; Šuškevičė & Kruopienė, 2021) or sustainability proof (Bocken et al., 2022; Corsini et al., 2018; Junquera et al., 2001), and convenience, such as ease of returning method (Bocken et al., 2022; Hesseling, 2022) or minimized storage space (Kramer et al., 2021). Though such methods can be consulted, a guaranteed return rate can never be predicted. Moreover, the time it takes for the ecosystem to reach maturity and hereby stabilisation in the packaging and financial flows, is also difficult to determine. A variable return rate for a longer period of time directly influences the financial flow of the system due to the fluctuating volume of reusable packaging that is returned. This increases the complexity of the financial flow, resulting in added difficulty while setting up contracts between retailers and content producers. This financial
uncertainty cannot be removed until the ecosystem is actually implemented and the actual return rate can be determined.

13.2.3 Coalition of the willing

The introduction of this ecosystem is dependent on the willingness of entities to participate. This willingness presents itself in the intrinsic motivation of entities to join. This intrinsic motivation can be due to a certain sustainable vision (e.g. Brinkers Food) or previous experience with similar initiatives (e.g. the retail hub). Unfortunately, companies often do not share this vision.
For most companies, it comes down to a weighting of the financial or losses. Often, there are high investment costs associated with changing from single use to reusable packaging (Coelho et al., 2020; Hesseling, 2022). This is mainly through the processes in ecosystems that are completely optimized based on single use packaging. Process adaptation is needed when switching from single use to reusable packaging, for which the associated costs are often estimated to be of significant value (Bocken et al., 2022; Brinkers Food, 2024). These process changes affect both the external as well as the internal processes.
From an external perspective, a reorganization of the value chain and relationships between entities are a necessity. These could be major barriers due to increased value chain complexity, reflected in the additional need of of reverse logistics and alteration of communication strategies (Gardas et al., 2019).
Additionally, technological barriers and incompatibility with the current processes may limit, for example content producers, to make use of reusable packaging (Hesseling, 2022; Hina et al., 2022; Tura et al., 2019). Machines are an expensive investment, and adaptation to these machines can result in high costs, let alone changing the full filling line due to a switch from single use packaging to reusable packaging.
Moreover, the proposed need for standardisation (Coelho et al., 2020; Hesseling, 2022; Morgan et al., 2022) drastically limits the ways a brand can be identified from its competitors. As a result of implementing the standardised packaging, visual recognition can only be implemented on the label of the packaging, since altering the packaging itself is off-limits. Decrease in possible brand recognition can result in a decrease in sales, leading to a financial risk.
Additionally, it does not only pose a financial risk, but establishing a full ecosystem takes time and effort, for which the returned value is never certain. As seen, some ecosystems introducing reusable packaging have difficulties maintaining their existence, with high financial consequences (e.g. Pieter Pot who went bankrupt but due to crowdfunding can now restart (Thole, 2024)). Naturally, this does not serve as a positive example for industries that are already hesitant.
Due to the (financial) risks paired not only with establishing, but even with joining an ecosystem that is still in its infancy, many companies will refrain from participating. Here lies a challenge for Brinkers Food: to find entities that are willing to put these risks aside and spend resources on the development and implementation of the ecosystem in the value chain. The presented possible content producers that might be willing to join the ecosystem are a starting point, but it is entirely possible that none of them is willing to take this step. Consequently, the whole ecosystem cannot be established, due to a lack of entity support.

13.2.4 Execution of sorting and cleaning process

The process of sorting has been minimally addressed. Appendix C provides some guidance regarding the sorting, preparation and cleaning responsibilities, however, these guidelines have not been tested as of yet. This limits the feasibility of the implementation roadmap due to the uncertainty of succes. For example, currently, it is assumed that through visual sorting the packaging can be identified. However, it is possible that that misplaced packaging will end up at the store or cleaning facility. This results in additional sorting time. Having a packaging that can be easily identified simplifies this process and minimizes mistakes. Nevertheless, the current ecosystem does not account for these misplaced packaging. In case of single use packaging, it can be recycled. However, if reusable packaging is misplaced, additional transport is needed to get this packaging to the correct cleaning location. This results in a more complex and less efficient logistic system, which is difficult to avoid due to the likelihood of human error.

Another example is the cleaning itself, which is, again, highly dependent on the packaging design. It is advised to create a packaging with a straight inner wall to minimize remaining residue (Wester & Verweij, 2022). Also, the packaging should withstand the forces associated with the linear and reverse logistics. Since there is no fixed packaging design at this moment, the whole cleaning process cannot be determined. Starting points are identified from similar cleaning processes in section Appendix C, but these will not necessarily work for all packaging designs. Based on the chosen packaging, a suitable cleaning process needs to be established.

For both the sorting and cleaning, a dependency on the packaging design is identified. As the packaging design should be determined by the coalition of the willing, and hereby multiple different content producers, the results of this case study do not include specifics on the sorting and cleaning process. Although the basics have been established in section Appendix C, the details of these responsibilities can only be determined after the packaging design is established.

13.2.5 Cross country expansion

The ecosystem expansion phase which is defined is still quite broad. As the ecosystem is not yet implemented and matured, this phase contains only generic steps that can be executed. Therefore, any predictions for ecosystem expansion could be rendered inadequate based on the experience of the initial ecosystem introduction or changes in standards and legislation. Moreover, if expanding to a country other than Germany, different legislation is present which needs to be complied with. Therefore, the ecosystem configuration and corresponding implementation roadmap is limited to the current four entities that have been involved for the chosen area of implementation. Any expansion calls for a re-evaluation of the ecosystem configuration and its implementation.

13.2.6 Macro level entity involvement

The possibility of implementing the ecosystem configuration is significantly dependent on the Macro level entities. For example, the government and food safety standards highly steer what is happening in industries, as compliance with such regulations and standards is often required for exchange of goods between entities (Brinkers Food, 2023). This can be problematic, as these regulations and standards do not accomodate for reusable packaging (yet). Take for example the food safety standards, which currently provide limited to no guidance for implementing reusables (BRCGS, 2022; IFS Food, 2021; IFS Food, 2023). Instead, measures that are deemed impossible for reusable glass packaging, such as traceability, are a necessity for ensuring food safety. Although it has been proven that traceability is not indefinately necessary (e.g. the beer industry (Grolsch, 2023)), the additional checks needed to compensate for this lack of traceability lead to a high financial investment. In the case of Brinkers Food, such investment is impossible. Therefore, collaboration with other entities is crucial, or the government and food safety standards organisations have to establish guidelines that enable small to middle sized enterprises to better deal with such issues.

14. RECOMMENDATIONS

Following from the identified limitations, a set of recommendations is provided to improve the framework and implementation roadmap. These recommendations will ensure the applicability, usability and validity of the framework is enhanced and aid future research on this topic.

14.1 Framework recommendations

Section 13.1 discusses the points of weakness of the framework, based on the experiences during the case study. Based on this discussion, this section aims to provide recommendations to improve the framework.

14.1.1 Framework completion

The framework has been determined to be incomplete, as Macro level guidance and Meso level entities were missing, and Micro level details were absent. To ensure the framework does not have a lack of guidance, these elements should be accounted for. Firstly, an additional step by step plan for Macro level analysis is necessary. In case of, for example, country expansion, the framework currently does not provide any details on what additional information should be acquired regarding these Macro level entities. For instance, how the evaluation of regulations or food safety standards should be approached. To increase the usability of the framework, such details should be provided.
Additionally, the glass manufacturer and end of life solutions should be reevaluated regarding the necessity of their implementation. The case study has revealed these entities are present to a certain extend in the valule chain, hence the reconsideration of their implementation in the framework.
Moreover, the absence of the secondary packaging should be accomodated for in the framework. For this, the moments of interaction between the ecosystem and the secondary packaging should be identified. However, this should only be evaluated for reusable secondary packaging, as such packaging is in need of reverse logistics as well, resulting in ecosystem overlap. In case of single use packaging, there is no reverse logistics system present, hence the continuation of exclusion of that particular type of packaging.

14.1.2 Framework intuitiveness

The inability of the framework to be a stand-alone tool has limited its usability. Too high of an effort to understand and use the framework can lead to the unwanted scenario in which the focus is placed on framework understanding, rather than using it as a guidance tool for estabilishing an ecosystem configuration. All effort necessary for understanding and using the framework is taken from the effort needed to discuss and visualise a suitable ecosystem configuration. Therefore, the framework needs to afford for intuitive usage an increased understanding of the topic. It is suggested that through interactions, such intuitive usage can be stimulated. By using different options of interaction, information can be provided, a realistic responsibility division can be obtained, and an overall review of the ecosystem connections can be executed. However, even though the intuitiveness of the framework might lead to stand-alone usage, it can be a possibility that a mediator is still necessary. Not for the purpose of explaining the usage of the framework, but to efficiently mediate discussions and to ensure a mutual agreement is reached regarding the framework's results.

14.1.3 Framework implementation

The framework has not been tested by actual entities, due to its earlier identified complexity and tendency for unrealistic results. By improving the intuitiveness of the framework as proposed in section 14.1.2, the framework can actually be tested with participants.
For this, it is recommended that the initial testing solely evaluates the understandability of the interface, rather than using it for the purpose of establishing an ecosystem configuration. This ensures the intuitiveness of the framework can be evaluated, and once sufficient, the framework can be applied for its actual purpose: providing support in establishing a simplified visualisation of an ecosystem configuration for introducing reusable glass packaging into the value chain.

14.2 Framework Improvement

Based on the recommendations, the framework is adapted to improve the usability, applicability and validity. The improvements cover the reviewed additional entities, intuitiveness, guideline for Macro entities and secondary packaging.

It can be seen that the framework itself (Figure 78) is expanded with the entities discovered during the case study. It can be a possibility that during future applications of the framework, other entities are identified. In that case, the framework should be adapted by adding the missing entities and corresponding Macro level entities and Micro level responsibilities. This is not a feature in the interactive framework as of yet, as it might lead to the user to accidentally creating new entities, which might lead to unrealistic framework results.

Moreover, it is assumed that the entities currently present in the framework are sufficient for establishing an ecosystem configuration. Not only due to the applicability of the framework for the case study, but also through the exemplary subjection of existing ecosystems to the framework in section 7.2.

Figure 78 Improved interactive framework

The decision is made to create an interactive version of the framework. This increases intuitiveness as framework features can be easily accessed with minimal effort and the user receives immediate feedback (Kelsey, 2024). Moreover, as the framework is interactive, the users are able to follow a step by step process during which they firstly get in touch with the different levels within the ecosystem. Thereafter they can create an ecosystem configuration though selecting responsibilities. The obtained configuration can be reviewed more in depth in the last step, by going through the connections within the ecosystem. These three steps can be accessed via a menu pane, which is always available on screen (left hand side). Each of the framework workflow options will be elaborated upon in the following sections.

The first option is the “information view”, which allows the user to retrieve details on entities or responsibilities. This allows all users to obtain a basic understanding of all entities and responsibilities present in the ecosystem without needing a supervisor for elaboration. An example of the Macro level entity “country specific legislation” is portrayed in Figure 79). This illustrates on only the necessary information about the entity, but also covers what additional analysis is needed to obtain sufficient understanding of the entity. For the legislation, food safety standards and organisations, this is particularly important, as for different countries this is not necessarily the same.

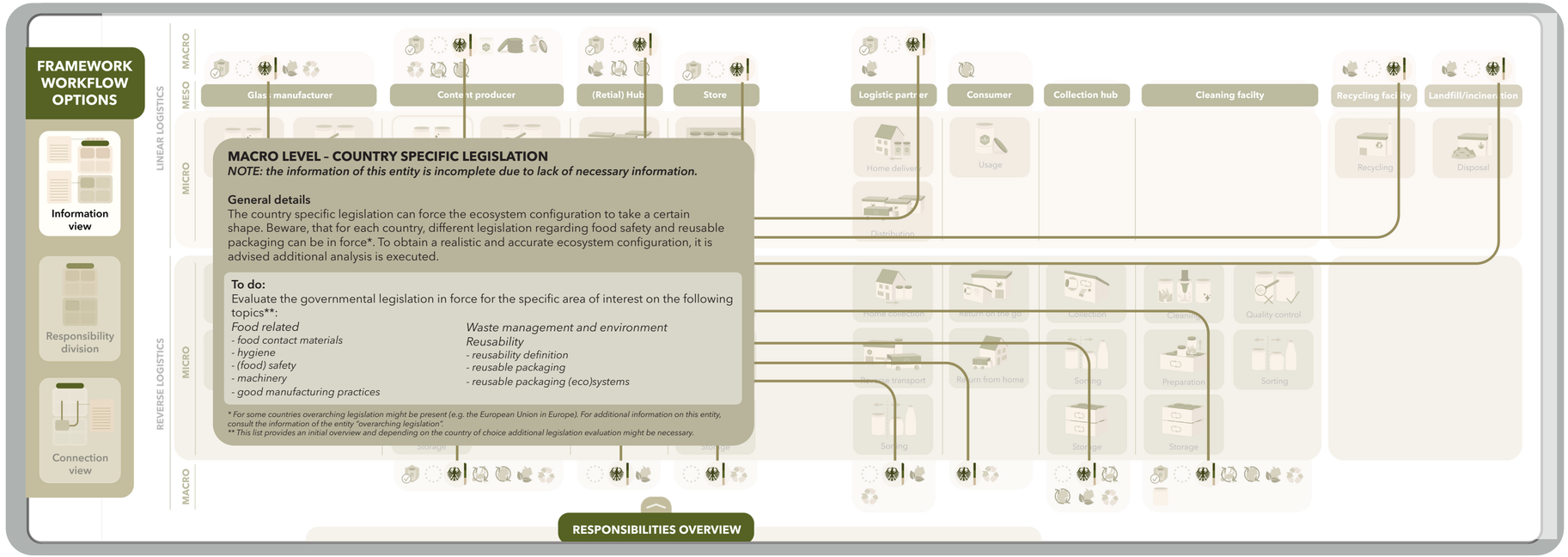


Figure 79 Framework: Information view

When the knowledge of entities and responsibilities is sufficient, the framework can be filled in through the workflow option “responsibility division” (Figure 80). The user can select one of the responsibilities and activate it for a specific entity. Some responsibilities can be covered by multiple entities. When such an entity is selected, the other entities lose the responsibility of this entity, which is visually shown through a change in transparency. If multiple entities take on a responsibility, this responsibility can be reactivated through clicking on it and activating it (Figure 81). This way, the user receives immediate feedback on which responsibilities have been covered and which responsibilities still need to be divided. A more clear overview of this feature can be obtained through the optional “responsibilities overview” on the bottom of the screen.

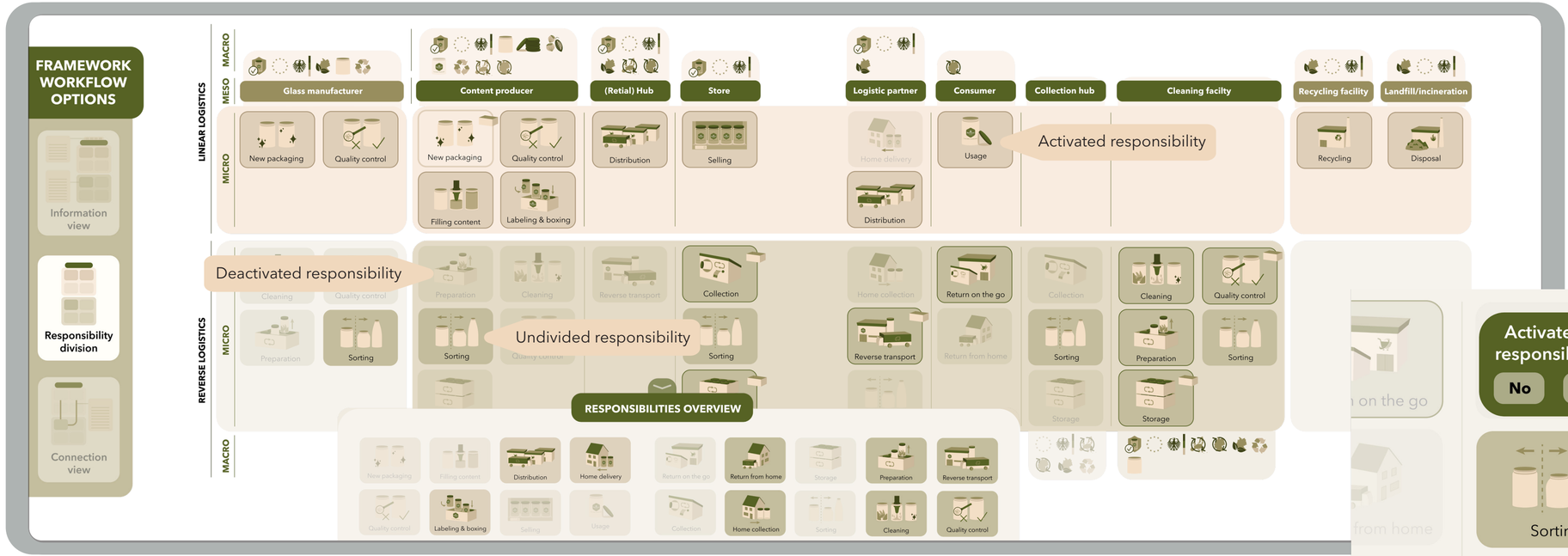


Figure 80 Framework: Responsibility division

Figure 81 Responsibility activation

After an ecosystem configuration is created, it can be further evaluated using the “connection view” (Figure 82). This option helps in understanding how certain entities and responsibilities are connected. For example, it can be quite difficult to grasp which responsibilities and entities are influenced by the food safety entity. By selecting that entity, the flows are highlighted, which result in an increased understanding of the ecosystem for all levels (Figure 83).
Moreover, if a responsibility might be related to secondary packaging, an additional icon gets attached to the responsibility (Figure 84). This aids the understanding of the presence of secondary packaging throughout the system, Additionally, it can help further on when defining the details of the ecosystem configuration to take this secondary packaging into consideration, as the packaging flow is already partially defined.

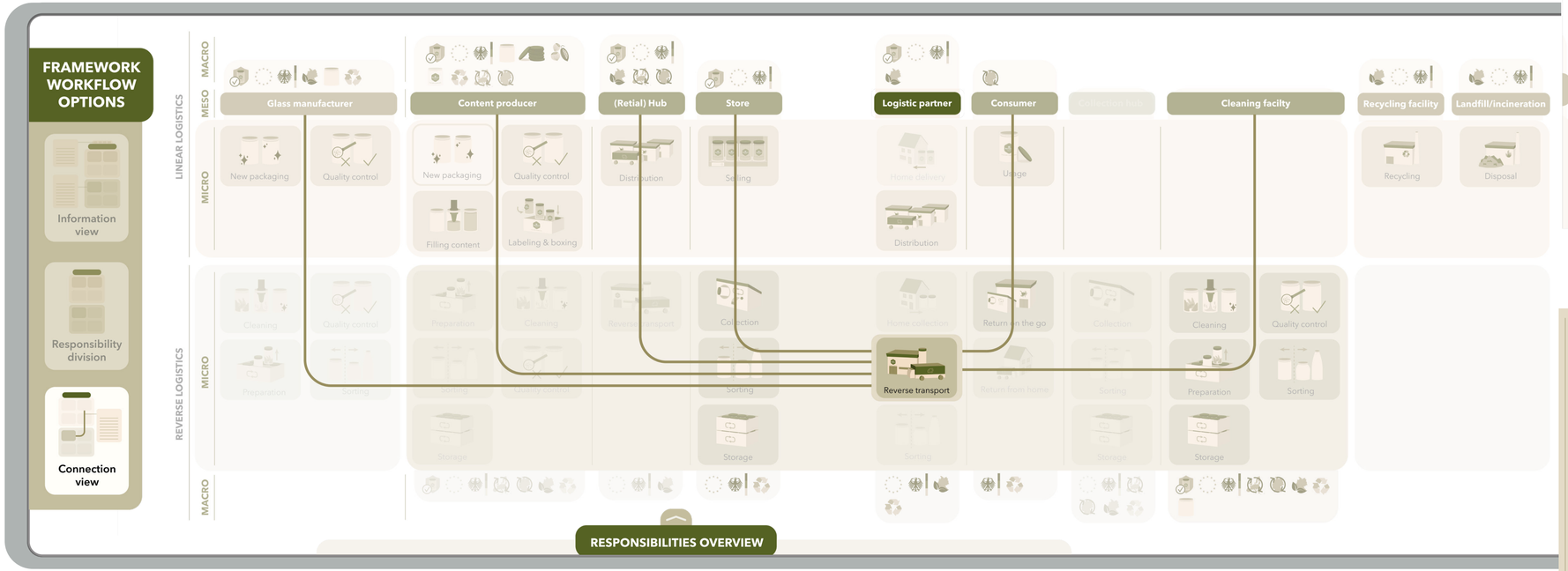


Figure 82 Framework: Connection view

Through making the framework interactive, the intuitiveness and hereby the usability have likely been improved. However, it should be noted that the framework in this setup has not yet been tested, and therefore its intuitiveness and usability cannot be guaranteed.

Figure 83 Connections of food safety standards regarding the content producer

Figure 84 Secondary packaging connections

14.3 Implementation roadmap recommendations

It can be concluded from the discussion in section 13.2, there are a number of dependencies and uncertainties that that limit the reliability of the implementation roadmap. The implementation itself is difficult to predict, as crucial elements have not yet been defined. As a result, the following recommendations are made to improve the implementation roadmap, and for Brinkers Food to stress certain steps that need to be well defined before the implementation itself can actually happen.

14.3.1 Finding partners

It is of utmost importance that Brinkers Food finds suitable partners to work with. This suitability is dependent on not only the sustainable vision of these partners, but also their ability to adapt to changes resulting from choices regarding the ecosystem configuration and implementation. The partners need to be actively involved in all decisions necessary to create a suitable ecosystem configuration. As stressed, forging the coalition of the willing is crucial for the introduction of reusable packaging in the value chain. Improper execution of this step will result in an ecosystem that is unfit for the value chain.

14.3.2 Detailing

The absence of a fixed packaging design results in uncertainties throughout the ecosystem establishment and implementation. Currently, only generic assumptions regarding filling, usability, returnability, sorting, cleaning and transport can be made. As long as these are unspecified, whole responsibilities and even entities (e.g. cleaning facility) remain undefined. Therefore, once the coalition of the willing is forged, the focus should not only be on establishing the ecosystem configuration, but also on detail development. Moreover, each of the implications this detailing phase has influences the preparation of entities for the implementation of the ecosystem. As a result, phase 2 through phase 4 of the implementation roadmap are not as strictly seperated as initially presented. It is possible, and even recommended, that once a coalition of the willing is established and a number of additional entities have become involved, the detailing and preparation phases can be started alongside the ecosystem development. Especially, due to the time consuming nature of these steps. For example, coming up with a standardised design that is suitable for current content producer processes, testing this design for the reverse logistics steps and evaluating its sustainability, and forging cleaning facility collaboration, which can additionally influence the choice for the area of implementation. The coalition of the willing should collaborate and divide their resources to ensure all entities remain actively involved with a fair division of the workload for all these activities.

14.3.3 External influences

To ensure a realistic implementation of the ecosystem configuration, it is not only important to prepare well, but also to continuously evaluate the developments in governmental and organisational entities. For instance, the identified issue with the tracability has a major impact on the viability of the ecosystem. Any changes from a food safety point of view can make implementation of the ecosystem easier, but potentially also more difficult. Through following external influences and any changes they may bring, issues can be prevented through taking timely action and anticipating on upcoming regulation and standardisation alterations (e.g. the PPWR in 2025).

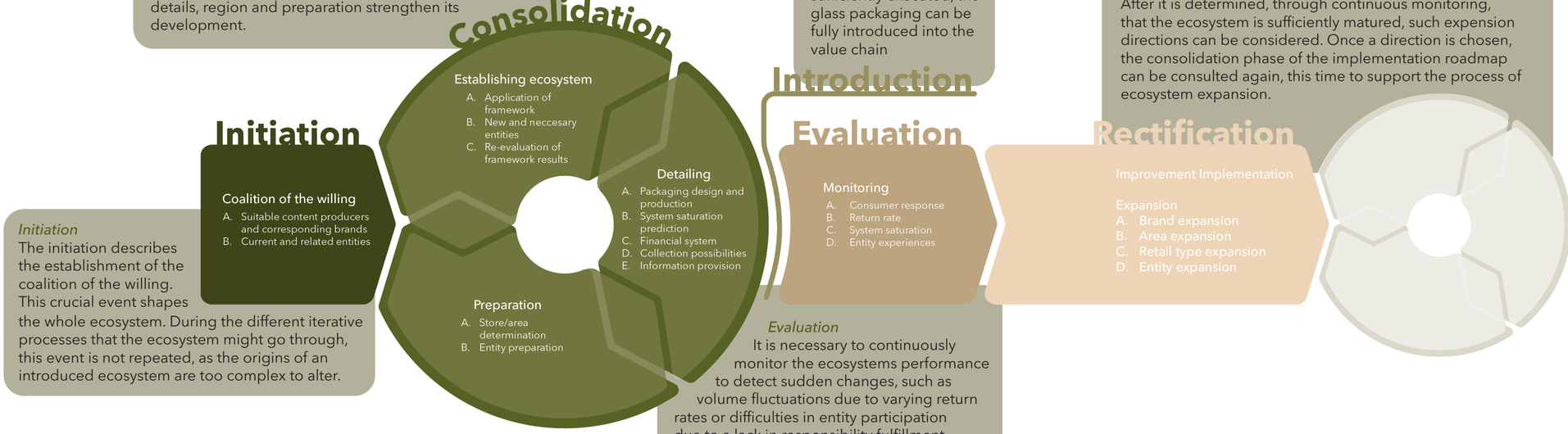
14.3.4 Monitoring

Once the ecosystem is implemented, the predictions made during the development of the ecosystem configuration can be monitored. For example, the predicted return rate, which influences the ecosystem saturation. In the current implementation roadmap, this evaluation happens in phase 5 only, leading to think that it is only a necessary step when willing to expand the ecosystem. However, this evaluation should start after the introduction of the ecosystem, to keep track of not only the return rate, but also the consumer response and experience of the entities involved. This allows for direct response should anything drastically change, regardless of whether expansion is in the picture.

Consolidation
To strengthen the ecosystem, the initial phases 2-4 are combined in an iterative cycle. As identified, there are interrelations between the ecosystem establishment, detailing and preparation, leading to a simultanious execution. This leads to a consolidation of the ecosystem configuration, where the entity input and corresponding details, region and preparation strengthen its development.

Introduction
The moment a full ecosystem configuration and all detailing and preparation is sufficiently executed, the glass packaging can be fully introduced into the value chain

Rectification
During the monitoring phase, it is possible that improvement of the ecosystem is necessary. The rectification aims to implement such improvements, and hereby initiates a new implementation roadmap. This roadmap again follows the iterative consolidation process. As a result, a refined and upgraded version of the ecosystem can be established. The rectification phase also includes expansion possibilities. After it is determined, through continuous monitoring, that the ecosystem is sufficiently matured, such expension directions can be considered. Once a direction is chosen, the consolidation phase of the implementation roadmap can be consulted again, this time to support the process of ecosystem expansion.



Initiation
The initiation describes the establishment of the coalition of the willing. This crucial event shapes the whole ecosystem. During the different iterative processes that the ecosystem might go through, this event is not repeated, as the origins of an introduced ecosystem are too complex to alter.

Evaluation
It is necessary to continuously monitor the ecosystems performance to detect sudden changes, such as volume fluctuations due to varying return rates or difficulties in entity participation due to a lack in responsibility fulfillment. Moreover, any external changes (e.g. regulations, food safety standards) should be monitored, to ensure adaptation if necessary.

14.4 Implementation roadmap improvement

Based on the recommendations, an improved implementation roadmap is established, which aids the establishment, implementation and monitoring of the ecosystem for reusable glass packaging. Though the actions remain the same, the phases during which these actions are required have changed slightly. The alterations are addressed in Figure 7.
The most apparent difference is the elimination of naming specific phases. These phases implicate a stage gate appraoch, whereas, as concluded in the evaluation of sections 12.1 and 12.2, the phases are actually not that strictly seperated. Instead, five events are identified with corresponding goals that support the process of implementation. This section will elaborate on the depicted events.

Figure 76 Improved implementation roadmap

The improved implementation roadmap includes an iterative process, leading to the inclusion of interconnections and dependencies between different goals that should be achieved. However, it should be noted that this implementation roadmap is yet to be tested. Therefore, the succes and accuracy of this implementation roadmap is currently uncertain.

14.5 Reflection and future recommendations

Both the framework and implementation roadmap have faced adaptations as a result of the implementation of recommendations. The applied improvements have not yet been validated. Therefore, the following section reflects on these improvements and suggests future recommendations to determine the current employability of the framework and the accuracy and suitability of the implementation roadmap.

14.5.1 Framework development

The framework has been improved based on the identified limitations. However, these changes have not been implemented throughout all options of the framework. In order for the framework to be completely usable, all possible selection options need to be identified. Moreover, for each of the entities and responsibilities, the descriptions in chapters 4-7 need to be evaluated, to create short and concise descriptions suitable for the framework.
Additionally, all possible interconnections within the ecosystem need to be evaluated. So far, these have only been identified on Meso level (section 10.4.2), whereas the connections on Macro and Micro level and in between levels are equally important. To approach this, the actor network theory, emerged in the 1970s, can be consulted, as this obtains interconnections regardles of proximity and order relations between entities and responsibilities (Latour, 2017). Actor network theory stresses that actant connections are necessary for the stability of the network (Dankert, 2012). Therefore, it is crucial that these interconnections are defined. By evaluating all possible connections, perhaps even additional entities that have currently not been considered can be identified. Through interactive sessions, not only with the Meso level entities, but also with Macro level entities, these connections can be better identified. Moreover, additional interactive sessions with entities in different value chains and initiatives for reusable packaging can provide insights on the details necessary for the concise descriptions of entities and responsibilities. This way, the information for the framework is obtained from various perspectives. This increases the reliability of, not only the framework itself, but also the outcomes of the framework.
Furthermore, the interactive framework, once completed, should be tested with a suitable target group (e.g. content producers, stores, retailers and logistic partners). This way, the actual improvement of the usability of the framework can be evaluated. More importantly, it can be concluded if the interactive version of the framework can be used as a stand-alone tool, as opposed to needing a supervisor. Without a supervisor, the framework will not cost any additional financial resources, making it a more viable option to be actually used as a tool during the development of an ecosystem for reusable glass packaging, as most entities are not willing to spend a significant amount of their financial resources on this development.

14.5.2 Implementation and validation

To determine the validity of the results of the framework, the ecosystem configuration has to be tested. This entails application of the framework for the full value chain of the chosen case study, as well as additional case studies to determine the applicability in different context.

Varying contexts | To obtain a better understanding of the applicability of the framework for different contexts, additional case studies should be executed. It would be interesting to use contexts similar as described in section 13.1.6, where it is suggested that different entities that push the ecosystem's establishment will use the framework differently: as a means for discussion or as a means for ecosystem clarification. However, it can be quite difficult to find entities willing to take this step. Therefore, current entities, such as the retail hub, can be asked to evaluate their ecosystem configuration through application of the framework. Being further in the process of implementation allows for a quicker conclusion of the applicability and suitability of the framework. Again, this process is subjected to bias, which should be taken into account.

Country validation | The implementation roadmap is currently tailored to the German part of the value chain of Brinkers Food. However, perhaps a reevaluation of this scope can be benificial. Even though from a sales perspective, Germany is a suitable choice for Brinkers Food, from a reusable packaging approach, perhaps the Netherlands is a better choice. The willingness of entities to participate in a low effort interactive session was significantly higher from the contacted Dutch entities, perhaps reflecting the entities in the Dutch food industry might be more ready for such a change. Moreover, the logistic network might be more complex in Germany compared to the Netherlands, due to larger distances and a less dense road network. Less complexity makes for a more viable ecosystem and is therefore desireable (Coelho et al., 2020; Hesseling, 2022). Hence, a reevaluation of country choice is necessary for further inclusion of entities to verify the ecosystem configuration and a to reach successfull implementation.

Implementation validation | To validate the case study outcome, it is recommended that the ecosystem is implemented in the value chain of Brinkers Food. For this, the implementation roadmap should be followed to finally reach the introduction of the reusable packaging. Only through actual implementation, it can be seen whether the ecosystem configuration as obtained from the framework provides a correct representation of reality. Through continuous monitoring, the accuracy of the implementation roadmap that has followed from the ecosystem configuration can be confirmed. However, this process can take multiple years, as the implementation of the ecosystem and reaching maturity requires stabilisation and consumer normalisation requires time. Therefore, it is suggested to reach out to existing content producers or other smaller sized entities that are further in the process of the introduction of reusable glass packaging (e.g. PAKT, Pieter Pot or Circujar). By subjecting these entities and their ecosystem partners to the framework, the ecosystem configuration can be defined and compared to the actual situation.
The same counts for the implementation roadmap, which can be setup independently, to ensure limited bias. This implementation roadmap can be compared to the actual implementation roadmap. If there is overlap, a conclusion can be drawn to which extend the framework provides a realistic and accurate representation. However, it should be noted that this process is subjected to bias, as the entities involved have likely experienced a similar process when establishing the initial ecosystem configuration. Therefore, the results can give an indication on the applicability of the framework, but cannot provide a definitive conclusion.

15. CONCLUSION

This thesis has explored the topic of introducing reusable glass packaging into a specific value chain. Through developing a framework, guidance is given during the process of establishing an ecosystem configuration tailored to a chosen value chain. Through following a multilevel approach, the framework takes not only the direct entities into consideration, but the indirect entities and the possible responsibility division are integrated as well. The application of this framework has been tested through a case study for a chocolate spread content producer, Brinkers Food. In addition to the development of an ecosystem configuration, a corresponding implementation roadmap based on the outcome of the framework has been established. Through the case study, both the usability and suitability of the framework as well as the implementation roadmap have been evaluated. Through developing, testing and evaluating the framework for a real life context, a conclusion can be drawn on the main research question:

"To what extent can a framework based on existing solutions for reusable glass packaging support the introduction of a reusable glass packaging in a currently linear, single-use packaging-oriented value chain in the food industry with multiple actively involved (industrial) entities?"

The multilevel analysis has revealed Macro level entities can have a different presence and influence on the ecosystem, for instance, the steering influence of governments and food safety standards onto the ecosystem, versus the introduction of the ecosystem exerting influence on product suppliers. Through evaluating 6 current ecosystems that make use of reusable glass packaging, a total of 7 Meso level entities and 17 Micro level responsibilities have been identified as enablers of the ecosystem. Through combining these results into a simplified representation of crucial ecosystem elements, a visual framework is developed. To evaluate the ability of the framework to represent an ecosystem configuration of a value chain, for both the current (single-use) context as well as the future (reuse) context a case study has been executed. For this, a total of 4 entities in the current value chain have been involved in interactive sessions. These have revealed a suitable division of responsibilities and presence of Meso level entities which represent the current and possible future value chain. Through using the framework, simplified ecosystem configurations have been established.

As a result, it can be stated that the framework has functioned as a supportive tool to obtain and visualise such complex ecosystem configurations in a simplified and concise manner, through involving entities in the value chain and supporting discussions between them. The obtained ecosystem configuration is tailored to the abilities and needs of these entities currently present in the value chain of Brinkers food.
Moreover, the framework has also shown to be a useful tool to setup an implementation roadmap suitable for the determined ecosystem configuration. By comparing the generated current and future ecosystem configurations, a concrete 5-step plan has been established to facilitate the transition between both. Even though this implementation roadmap has not yet been executed, it is directly derived from the ecosystem configuration and combined with the current context of the value chain. Additionally, the implementation roadmap considers both external as well as internal implementation, and hereby provides a multilevel guidance for the entire value chain. Even though the framework has proven its employability for this particular case study, it should be noted that several limitations could have influenced the reliability of the results. As a result of a small sample of participating entities, the ecosystem configuration is limited in its accuracy in representing a suitable solution for the entirety of the value chain. Additionally, the framework has not been applied directly during the case study. Through additional desk research and elimination of extremes, an attempt is made to increase the reliability of the results. For this reason, the framework is sufficiently substantiated to provide an ecosystem configuration that can serve as a usable starting point for Brinkers Food to conduct further research to improve accuracy of the ecosystem configuration and implementation roadmap.
In conclusion, the framework proves to establish a solid foundation for the transition of a value chain dependent on single-use packaging to a value chain implementing reusable glass packaging. The resulting ecosystem configuration and implementation roadmap following from using the framework can provide the support and clarity during the complex transition process. To increase employability of the framework, additional research in the form of case studies and interactive sessions are necessary to confirm the established conclusion and increase the reliability of the framework and its results for future use.

The suggested additional research necessary to validate the framework and implementation roadmap is summarized as the following:

Framework usability | An improved framework has to be generated to afford for intuitive usage. Although a suggestion has been made (Section 14.2), the full extend of the framework has not been updated as of yet. Therefore, additional research confirming these alterations and increased intuitiveness is necessary. For this, user testing is essential.

Standardization | Through providing a baseline of necessary responsibilities in relation to possible entities, the framework provides the initial basis of standardizing the establishement of ecosystems for reusable glass packaging. However, due to limited validation, there is only little feedback from the industry regarding possible adoption of the framework and acceptance of this standardization. Therefore, additional evaluation and application of the framework is necessary across different value chains in the food industry. Through using a diverse sample, a reliable conclusion can be drawn regarding employment of the framework and the influence thereof on the food industry.

Designs, systems and processes | The results of this reserach are build on a number of assumptions (e.g. suitability of the involved entities, accuracy of the ecosystem configuration, and the establishment of the coalition of the willing, a packaging design, a financial system, collection possibilities, cleaning...). As a result of such assumptions, not only the validity of the ecosystem configuration, but also the possibility to reach a realistic implementation is difficult to determine. For this, the involvement of entities is crucial, as this can confirm or confute the accuracy of the ecosystem configuration. Moreover, through taking these first steps, the consolidation phase can be started, where essential details are defined, such as the packaging design, financial system, cleaning process and collection possibilities. It is suggested to perform additional research on these detailing elements to obtain a broad understanding of the possibilities. This way, a better decision can be made which designs, systems and processes are most suitable.

Added value

Through combining knowledge obtained from the practical field during the interactive sessions, with the academic knowledge generated through literature review and expert discussions, a realistic yet innovative framework is established. As both practical and theoretical knowledge is used, both fields can benefit from the results of this thesis. Firstly, the framework bridges the knowledge gap on how to introduce reusable glass packaging into a value chain that has no experience in this area as of yet. It can hereby aid future introduction processes of reusable glass packaging in the food industry by providing a starting point for entities in a value chain. Moreover, this thesis has highlighted that the current food safety standards and legislation lack provision of guidance to support introducing reusable glass packaging into a value chain. Through addressing this concern, not only Meso level entities, but also Macro level entities are called upon. From an academic perspective, the framework can offer future research a solid starting point when analysing the introduction of reusable packaging in the food industry. This thesis has also revealed that there is still much to investigate, which gives researchers another topic to dive into, such as the influence of the implementation of the reusable glass packaging on participating entities or the benefit of using the framework as a tool for supporting this transition. Altogether, this thesis has successfully bridged the knowledge gap between academic knowledge and industry practice through the development of a framework to aid the introduction of reusable glass packaging into the value chain.

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APPENDIX

Appendix A – Overview of COM/2022/677

The following figure presents the definition for reusable packaging and the accompanying requirements, according to the European legislative proposal COM/2022/677.

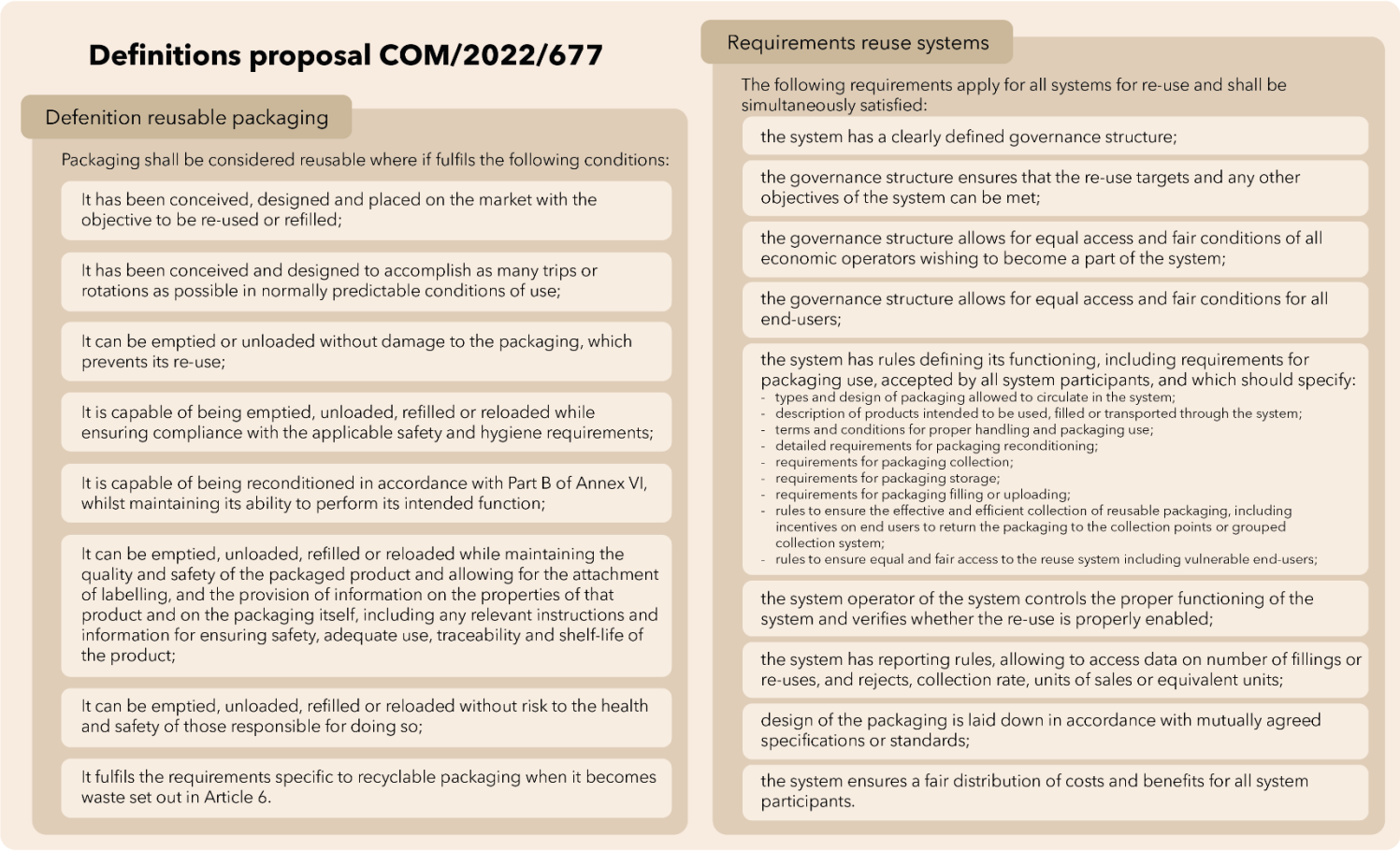

Figure A1 Definition of reusable packaging, adopted from the law proposal COM/2022/677, Art. 6 and Anx VI Part A,

Appendix B – Analysis of existing ecosystems

This appendix provides the elaboration of the different ecosystem configurations for reusable glass packaging (1a-3b) presented in section 5.3.

Ecosystem 1a – Return on the go – Direct return

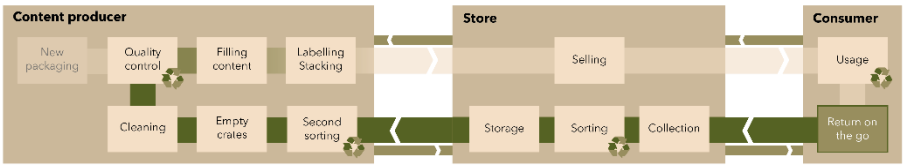

Figure B1 Ecosystem 1a with a direct return on the go principle

This ecosystem (Figure B1) has a direct link between the content producer and the store. This brings the benefit of direct communication between the content producer and the store, and leads to an ecosystem with as little entities as possible to enable reuse. However, by having a limited amount of entities, each entity involved carries a high responsibility. The content producer must have an in-house cleaning process and the store should sort the packaging to ensure they are delivered at the correct entities involved. This ecosystem relies on the return on the go principle, as proposed by the Ellen MacArthur Foundation (2019), which means that the consumers need to bring the packaging to a store with a participating reverse vending machine. To stimulate the return of the packaging, a deposit return system is included, where deposit is paid to the previous owner of the packaging (indicated by the financial flow). An example for which such an ecosystem is in use, are stores that sell local produce in reusable packaging, such as milk, yoghurt or bottled water.

Ecosystem 1b – Return on the go – Return via hub

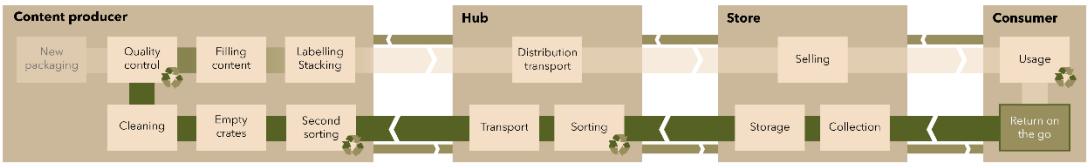

Figure B2 Ecosystem 1b with a return on the go principle via a hub

This ecosystem (Figure B2) includes a hub where the packaging, including content, is collected and distributed to the correct stores. As opposed to Ecosystem 1a, during the reverse logistics, the hub is responsible for sorting the reusable packaging. As a result, store can focus solely on the collection and short-term storage of the packaging, whereas the hub can put their focus on sorting. As the hub collects reusable packaging from multiple stores, the large quantity of packaging can be best sorted through an automated processes. This eliminates the manual labour previously needed in stores, where automated processes are limited, as sorting reusable packaging is by no means their core business. The downside of having an additional entity is the complexification of the system; the more entities are present, the more complex communication might be. Similar to Ecosystem 1a, this ecosystem includes a deposit return scheme, to motivate people to return the packaging on the go in one of the participating stores. Examples where this ecosystem is used is in the beer industry, but also in the early adoptions of the German MMP system (Bielenstein, 2023).

Ecosystem 2a – Return on the go – Outsourced cleaning

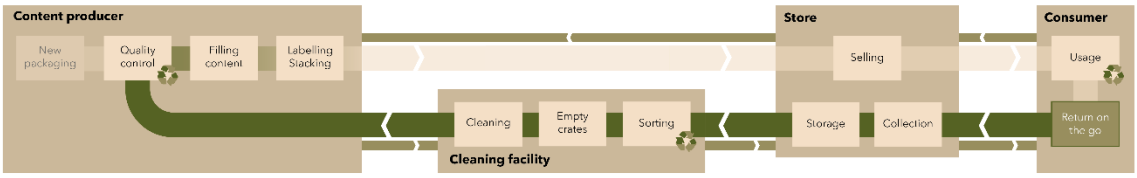

Figure B3 Ecosystem 2a with a return on the go principle with outsourced cleaning

This ecosystem (Figure B3) has an outsourced sorting and cleaning process. Both of these processes is accounted for by a third party, specialized in reuse of (glass) packaging. This allows for professional and automated sorting and cleaning and gets rid of the responsibility of cleaning and sorting for the content producer, so they can really focus on producing their product. Having one central location for sorting and cleaning ensures that the cleaning is executed according to one standard, as opposed to having varying cleaning methods for each different content producer. It might also lower the threshold to join such an ecosystem, as the cost of cleaning and sorting is outsourced, and therefore the risk of joining the system could be minimized. It could be possible that a hub is present in between the content producer and store, but for simplification reasons this has been left out. Examples where this ecosystem is used are Circujar and the recent adoption of the MMP system, both present in Germany (Alnatura, 2023; Bielenstein, 2023).

Ecosystem 2b – Return on the go – External collection hub

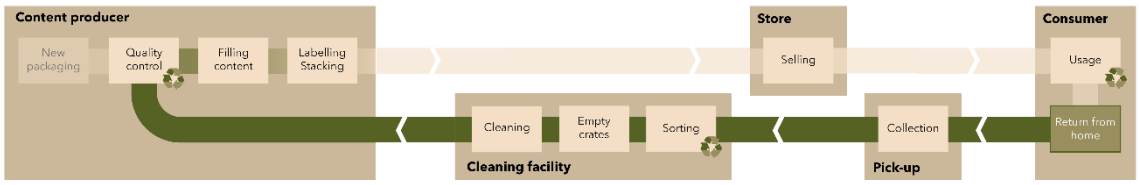

Figure B4 Ecosystem 2b with a return on the go principle, outsourced cleaning and an external collection hub

This ecosystem (Figure B4) is similar to ecosystem 2a, the only difference being the outsourced collection and storage. This completely removes the burden of the stores to collect the packaging. Instead, a self-sufficient collection reverse vending machine is placed in or outside the store where consumers can buy the product in the reusable packaging. This collection hub could be realised in collaboration with the cleaning facility, which creates one responsible entity for the full reverse logistics loop. As a result, the other entities needed for a functioning ecosystem have to change little to nothing to their current processes, hereby, potentially making them more prone to join this ecosystem. The downside is the need for a complete new entity. The American initiative Loop makes use of this principle (Loop, 2024).

Ecosystem 3a – Return from home – In-store buying

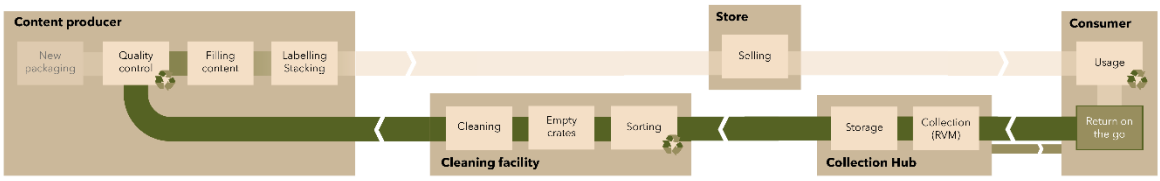

Figure B5 Ecosystem 3a with a return from home principle, outsourced cleanging and in-store buying

This ecosystem (Figure B5) is centralized around the possibility to return the packaging from home. This involves more entities, as the logistic partners are of utmost importance. The consumer buys the product in store, hereby a variety of products and brands are possibly bought. This means that the picked up packaging can contain non-reusable packaging, hereby creating a larger burden on the sorting process, as they could end up with large quantities of packaging that needs to be recycled instead of reused. This means more storage and a logistic stream to account for the recycling of the non-reusable packaging. In this ecosystem, consumer participation is promoted by personalized pick up moments that consumers can choose themselves. A logistic partner picks up the packaging and delivers it to a third party, which is responsible for the sorting and cleaning of the packaging (similar to ecosystem 2a). Having a pick up possibility at the home of the consumer removes the burden to sort the packaging at home and return the reusable packaging at the store. An example of this ecosystem in use is the Dutch initiative PAKT (Wester, 2023).

Ecosystem 3b – Return from home – Logistic partner

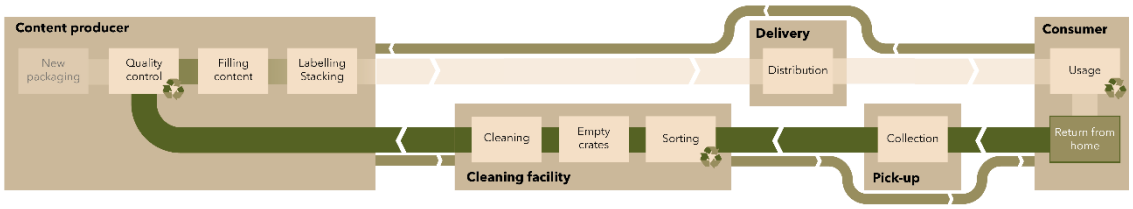

Figure B6 Ecosystem 3b with a return from home principle, outsourced cleaning and delivery/pick-up

The last ecosystem (Figure B6) is similar to ecosystem 3a, with the first difference being a deposit return scheme which is added for brand loyalty as well as to stimulate the return of the packaging. As can be seen, the deposit is not transferred to the logistic partners. This is as they are only a means of transport, and do not make use of the packaging itself. For this particular ecosystem, the design of the deposit return scheme could differ, depending on the needs and responsibilities of the entities involved. The second difference is the absence of the product in the store. Instead, home delivery is used. This increases brand loyalty, as the consumer cannot deviate from the brand, as well as adding convenience to the consumer. Nevertheless, it could be possible that a product is also present in a store, which will then lead to a slightly different deposit return scheme. For this particular ecosystem, collaboration with logistic partners is of utmost importance, as lack thereof can result in both delivery and pick up problems, leaving the consumer highly unsatisfied. An example where this ecosystem is used is for the Dutch initiative Pieter Pot (Derkse, 2021).

Appendix C – Responsibility guidelines

For the identified responsibilities, additional guidelines are generated, which provide the prerequisites necessary to take on the responsibility. These results are based on the analysis of existing ecosystems and the specific responsibilities, as well as through consulting experts. These guidelines do not only show who and what is necessary to ensure a functioning ecosystem, but also provides a means to analyse if a given entity can possibly be suitable to take on the responsibility. It does not necessarily mean that if an entity does not achieve all guideline elements, it cannot take on the responsibility. However, it does illustrate that, in that case, (drastic) changes might be necessary to be able to fulfil the necessities associated with the responsibility.

Figures C1-C8 present the guidelines for the linear logistics responsibilities, whereas Figures C9-C17 provides the guidelines for the reverse logistics responsibilities.

Linear logistics responsibilities

New packaging

New glass packaging is received by the **content producer**. In a linear ecosystem, all the glass packaging that is needed comes directly from the glass manufacturer. In case of presence of reverse logistics to ensure reusability of the glass packaging, less new packaging is needed, as the used packaging is returned to the content producer.

The responsibility of new packaging covers not only the packaging design itself, but also the production and logistics needed to realise this task. Therefore, the following guidelines have been established:

New reusable packaging design – The packaging design is made suitable for reuse, hereby the packaging:

- should withstand forces associated with the reverse logistics loop for a set number of cycles (e.g., thicker at contact points, balance between weight and strength) (Isbouts et al., 2023). Hereby the liability lies with the glass manufacturer (Wester, 2023).
- should have a suitable virgin to cullet ratio (depends on colour, required quality, availability of cullet and presence of impurities in cullet) (British Glass, 2019).
- should have a standardized design that suits the needs of the entities in the ecosystem (Coelho et al., 2020). The standardized design should consider ease of transport, suitable secondary packaging and stackability for efficient usage of space during reverse logistics.
- should have a limited number of different standardized packaging types to minimize complexity of the ecosystem.
- should ensure the packaging meets the technical specifications as set by the content producers.
- should have a means of identification to ensure the reusable glass packaging can be distinguished from single-use packaging and reusable packaging from other reuse ecosystems.

Packaging check – The packaging needs to meet predefined standards. Therefore the packaging:

- should have an absence of dust particles.
- should have an absence of impurities in the material, <25g per 100,000g (Canrinus-Moezelaar, 2017).
- should be traceable.

Saturated system – Throughout the ecosystem there should be sufficient volumes of the packaging to ensure there will be no shortage in times of varying need (Hesseling, 2022).

Correct stacking – Layered palletising that suits the efficient filling procedure of the content supplier (Brinkers Food, 2023) AND which ensures the packaging does not come in contact with external contaminants.

Figure C1 New packaging guidelines

Quality control

Quality control is always present at the facility of the **content producer**. This ensures the packaging is usable. All glass packaging that is not up to standards (blemishes, incorrect materials etc.) will be eliminated and recycled for creating new (recycled) glass packaging. This check happens at the facility of the content producer, but might also happen already during initial sorting.

The responsibility of quality control covers an extensive packaging check which ensures the packaging can safely be used for food content. Therefore, the following guidelines have been established:

Packaging check – The packaging needs to meet predefined standards. Therefore the packaging:

- should have an absence of dust particles.
- should have an absence of impurities in the material, <25g per 100,000g (Canrinus-Moezelaar, 2017).
- should have an absence of residue, in case of packaging originated from the reverse logistics loop (Isbouts et al., 2023).
- should be within the limit of the number of reuse cycles as defined by the glass manufacturer (Wester, 2023).
- should be suitable for the specific reuse ecosystem.
- should not be damaged.
- should be traceable.
- should have limited scuffing.

Figure C2 Quality control guidelines

Filling content

The content is filled at the facility of the **content producer**. Regardless of having a linear or reverse logistics system present, this filling process should be continuous. Therefore, enough glass packaging stock should be present at the facility, meaning that the overall ecosystem for reuse needs to be saturated, rather than having glass packaging on demand only.

The responsibility of filling content covers the filling procedure of the content from the perspective of a reusable packaging that is used for filling. The filling procedure itself has requirements as well, but these are left out of the scope of this research, as these will not change drastically for a different packaging type. In light of this, the following guidelines have been established:

Content production and filling – Presence of the prepared content, correct amount of reusable packaging and corresponding filling machines and process to fill the glass packaging.

Filling line adaptation – Process is fully adapted to suit the reusable packaging design (Brinkers Food, 2023), hereby taking into consideration:

- Filling height.
- Filling volume
- Reusable packaging dimensions.

Saturated system – Throughout the ecosystem there should be sufficient volumes of the packaging to ensure there will be no shortage in times of varying need (Hesseling, 2022).

Figure C3 Filling content guidelines

Distribution

The packaged products will be transported to a **hub** and from thereon, the product will arrive at the proper locations. It can be a possibility that the transport is arranged from the content producer directly to the store. In this case, the distribution will take place via a **logistic partner**.

The responsibility of distribution covers the transport between the content producer and the point of sale. Therefore, the following guidelines have been established:

Efficient transport – There should be efficient transport across the whole ecosystem (Last et al., 2023), hereby considering:

- Combining delivery and collection (Wester, 2023).
- Dense distribution network with minimized distances between entities and localisation where possible (Bocken et al., 2022; Isbouts et al., 2023; Jiang et al., 2020)

Safe transport – The packaging should not be damaged during transport.

Saturated system – Throughout the ecosystem there should be sufficient volumes of the packaged product to ensure there will be no shortage in times of varying need (Hesseling, 2022).

Figure C4 Distribution guidelines

Labeling & boxing

At the end of the filling process of the **content producer**, the filled glass packaging is labeled and boxed. Labeling is important, as this allows the consumer to see any tampering with the product and this indicates whether the glass packaging is reusable, in case of the presence of a reverse logistics system for reuse.

The responsibility of labelling and boxing covers the procedures to make the product ready for transport to the retailer. Therefore, the following guidelines have been established:

New label – The label design is made suitable for the reusable glass packaging (Circujar, 2023b), hereby the label:
- should fit the dimensions of the reusable glass packaging.
- should be wet and alkali stable, to ensure it remains intact during cleaning/removal to avoid clogging during the cleaning process.
- should be easily removable.

Labelling machine – The labelling machine should be adapted (if needed) to suit the new labels.

New lid – The lid design is made suitable for the reusable glass packaging (Circujar, 2023a), hereby the lid:
- should fit the dimensions of the reusable glass packaging.
- should have the correct seal (in accordance with the content and brand).

Lid closure machine - The lid closure machine should be adapted (if needed) to suit the new lids.

Saturated system (secondary packaging) – The secondary packaging used for transport for the filled reusable glass packaging should be sufficiently in stock.

Figure C5 Labelling & boxing guidelines

Selling

In case the product is *retrieved on the go*, the consumer will go to a **store** where they can buy the product. The store can be either a supermarket or a specialist trade store when looking at LVV and SVSF solely, but could be different for other types and brands of content. This type of retrieval is likely paired with a return on the go system, but this does not necessarily have to be the case.

The responsibility of selling covers the transfer of the product from a physical store to the consumer. Therefore, the following guidelines have been established:

Information provision – The consumer should be well informed about the reusable glass packaging, hereby the following should be provided in a short and concise manner(do Valle et al., 2004):
- Elaboration on the reward system (Coelho et al., 2020; Šuškevičė & Kruopienė, 2021).
- Elaboration on the environmental contribution, hereby activating associations of social pressure (Bocken et al., 2022; Corsini et al., 2018; Kramer et al., 2021).
- Elaboration on and experience of convenience (Coelho et al., 2020).

Clear deposit system – The collaboration between parties regarding the deposit reward should be made clear.

Figure C6 Selling guidelines

Usage

In the use phase, the **consumer** makes use of the product as intended. In this case, using the content to their desire. Once the packaging is empty, it can be returned for reuse through the appropriate reverse logistics channel, if one is present. In case of a linear ecosystem, the glass packaging will be recycled, or, in the undesired cases, be disposed of through incineration or landfill.

The responsibility of usage covers the experience of the consumer with the packaging. Therefore, the following guidelines have been established:

Convenient usage – The consumer needs to be able to interact with the packaging in a convenient manner (Kramer et al., 2021), keeping in mind the following:
- Usage should not create discomfort for the user.
- Usage should be intuitive for the user.
- Emptying of the packaging to a satisfactory level for collection should not be a burden for the user.

Minimized storage space – Storage of the empty packaging at home should be convenient regarding size of storage space needed (Kramer et al., 2021).

Figure C7 Usage guidelines

Home delivery

In case the product is *received at home*, the consumer will stay at home and order the product online. This product is then delivered at home by a **logistic partner**. This type of recieval is likely paired with a return from home system, but this does not necessarily have to be the case.

The responsibility of home delivery covers the transfer of the product from a delivery service to the consumer. Therefore, the following guidelines have been established:

Convenient timing – The consumer should experience as little waiting time as possible in the allocated delivery timeslot (Kramer et al., 2021).

Quick delivery – The consumer should receive the product in the shortest possible time span.

Information provision – The consumer should be well informed about the reusable glass packaging, hereby the following should be provided in a short and concise manner(do Valle et al., 2004):

- Elaboration on the reward system (Coelho et al., 2020; Šuškevičė & Kruopienė, 2021).
- Elaboration on the environmental contribution, hereby activating associations of social pressure (Bocken et al., 2022; Corsini et al., 2018; Kramer et al., 2021).
- Elaboration on and experience of convenience (Coelho et al., 2020).

Clear deposit system – The collaboration between parties regarding the deposit reward should be made clear.

Figure C8 Home delivery guidelines

Reverse logistics responsibilities

Collection

The collection of the glass packaging takes place through vending machines at a **participating store** or **collection hub**. The store can make use of the current reverse vending machines but should ensure that the new packaging is recognized by the system. The collection hub can be a self-sufficient location which collects and stores the glass packaging.

The responsibility of collection covers the means of how the packaging is collected at a physical facility, such as a return hub or store. Therefore, the following guidelines have been established:

Clear method of collection – There might be different methods of collection, such as a reverse vending machine or at the cashier. For these methods, the following should be considered:

- The method of collection should be understandable and accessible to ensure the consumer can easily return the empty reusable packaging (Bocken et al., 2022; Coelho et al., 2020).
- The method of collection and its associated actions should be understood by the employees (e.g., understanding of the deposit reward, initial sorting, loading secondary packaging).
- In case of the presence of a reverse vending machine, it should be updated to recognize the reusable packaging (Isbouts et al., 2023).

Packaging check – The collected packaging should be suitable for reuse. This check can be checked manually or through automation (e.g., a reverse vending machine). Hereby, the empty packaging:

- should be suitable for the specific reuse ecosystem.
- should have minimized residue and/or incorrect content (Isbouts et al., 2023; Wester & Verweij, 2022).
- should be within the limit of the number of reuse cycles as defined by the glass manufacturer (Wester, 2023).
- should not be damaged.

Saturated system (secondary packaging) – The secondary packaging used for transport and storage of the empty reusable glass packaging should be sufficiently in stock.

Figure C9 Collection guidelines

Return on the go

In some cases, the **consumer** can *return the product on the go*, which means they will have to visit a participating store or collection hub that makes use of reverse vending machines for the collection of the used glass packaging.

The responsibility of return on the go covers the experience the consumer has with the return of the reusable packaging. Therefore, the following guidelines have been established:

Convenient size – The size and weight of the empty packaging should be convenient for a consumer to transport on the go (Kramer et al., 2021)

Understandable collection system – The method of collection should be easily understood by the consumer.

Figure C10 Return on the go guidelines

Return from home

In some cases, the **consumer** can *return the product from home*, which means they can stay at home and book a time slot in which the packaging will be retrieved from their doorstep by a logistic partner.

The responsibility of return from home covers the experience the consumer has with the return of the reusable packaging. Therefore, the following guidelines have been established:

Convenient timing – The consumer should experience as little waiting time as possible in the allocated pick-up timeslot (Kramer et al., 2021).

Quick pick-up – The consumer should be able to schedule a return moment in the near future to minimize storage time of the empty packagin at home.

Figure C11 Return from home guidelines

Home collection

The home collection of the glass packaging is facilitated by a **logistic partner**. This logistic partner collects the packaging and ensures that it is transported to the next entity in the ecosystem. This can be a cleaning facility, a hub or perhaps even the content producer itself, depending on the design of the reverse logistics of the reuse ecosystem.

The responsibility of home collection covers the means of how the packaging is collected at the consumers home. Therefore, the following guidelines have been established:

Efficient transport – There should be efficient transport across the whole ecosystem (Last et al., 2023), hereby considering:

- Combining delivery and collection (Wester, 2023).
- Striving for saturated transport of primary packaging (Hesseling, 2022)
- Dense collection network with minimized distances between entities and localisation where possible (Bocken et al., 2022; Isbouts et al., 2023; Jiang et al., 2020)

Safe transport – The packaging should not be damaged during transport. Therefore, the usage of secondary packaging is a necessity.

Packaging check – The collected packaging should be suitable for reuse. Hereby, the empty packaging:

- should be suitable for the specific reuse ecosystem.
- should have minimized residue and/or incorrect content (Isbouts et al., 2023; Wester & Verweij, 2022).
- should be within the limit of the number of reuse cycles as defined by the glass manufacturer (Wester, 2023).
- should not be damaged.
- should be sorted during collection.

Saturated system (secondary packaging) – The secondary packaging used for transport for the empty reusable glass packaging should be sufficiently in stock.

Figure C12 Home collection guidelines

Storage

When the empty packaging is collected, it takes up storage space. The collection locations, which are **store** or a **collection hub**, should ensure they have space allocated for the empty glass packaging that is collected.

The responsibility of storage covers the necessities needed for storing the collected packaging. Therefore, the following guidelines have been established:

Storage of collected packaging – There should be enough room for the collected empty packaging to be stored at the collection premises.

Storage of secondary packaging – There should be enough room for empty secondary packaging, in which the collected empty packaging will be stored, at the collection premises.

Figure C13 Storage guidelines

Sorting

The sorting process can take place at the **store**, **cleaning facility** or at a **hub** that redistributes different types of reusable packaging to different content producers. This sorting process can range from sorting boxes of the same packaging to loose empty packaging.

The responsibility of sorting covers the selection of glass packaging that is suitable for the particular ecosystem for reusable glass packaging. Therefore, the following guidelines have been established:

Packaging check – The collected packaging should be suitable for reuse. This check can be done manually or through automation. Hereby, the empty packaging:

- should be suitable for the specific reuse ecosystem.
- should have minimized residue and/or incorrect content (Isbouts et al., 2023; Wester & Verweij, 2022).
- should be within the limit of the number of reuse cycles as defined by the glass manufacturer (Wester, 2023).
- should not be damaged.

Type selection – The packaging should be sorted into the correct type and size. Therefore the sorting procedure:

- should separate the reusable glass packaging from all other collected packaging. In the case that all packaging looks very similar, the reusable packaging suitable for this ecosystem should have a means for identification, even when the label is removed.
- should distinguish the different volumes of reusable glass packaging suitable for this ecosystem.

Figure C14 Sorting guidelines

Preparation

The glass packaging that is collected is emptied from the boxes in preparation for cleaning. This happens at the **cleaning facility** or **content producer**. This solely depends on the design of the reverse logistics of the reuse ecosystem. It is important to have the glass packaging removed from the protecting transportation box, to ensure the labels and residue can be removed properly.

The responsibility of emptying the secondary packaging covers the preparation of the glass packaging for cleaning. Therefore, the following guidelines have been established:

Packaging check – The collected packaging should be suitable for reuse. This check can be done manually or through automation. Hereby, the empty packaging:

- should be suitable for the specific reuse ecosystem.
- should have minimized residue and/or incorrect content (Isbouts et al., 2023; Wester & Verweij, 2022).
- should be within the limit of the number of reuse cycles as defined by the glass manufacturer (Wester, 2023).
- should not be damaged.

Residue removal – The secondary packaging should be emptied and the empty glass packaging

Label removal – The labels should be removed before cleaning to avoid clogging of the washing machine. This can be done manually or through automation.

Preparation for cleaning – sThe packaging should be positioned accordingly to the cleaning method (e.g. upside down).

Figure C15 Preparation guidelines

Cleaning

The empty glass packagings are cleaned using pressurised heated water (65°C for cleaning, >80°C for desinfection). This can be done through a continuous system or via batches in industrial dishwashers. This process happens at a **cleaning facility** or at the **content producer**, depending on the design of the reverse logistics of the reuse ecosystem.

The responsibility of cleaning covers the process needed to get from an emptied packaging to a clean and reusable one. Therefore, the following guidelines have been established:

Packaging check – The collected packaging should be suitable for reuse. This check can be done manually or through automation. Hereby, the empty packaging:

- should be suitable for the specific reuse ecosystem.
- should have minimized residue and/or incorrect content (Isbouts et al., 2023; Wester & Verweij, 2022).
- should be within the limit of the number of reuse cycles as defined by the glass manufacturer (Wester, 2023).
- should not be damaged.

Fixed position – The empty packaging should have a fixed position during cleaning to avoid washing liquid buildup in packaging that has rotated throughout the process (Last et al., 2023).

Quality control – The cleaning process should result a reusable glass packaging that is safe, hygienic and of good quality. This means the cleaning process:

- should clean and sterilise the reusable glass packaging. For cleaning, lower temperatures can be used (60-65 °C), for sterilisation, higher temperatures are needed (short rinse with 80-85 °C) (Isbouts et al., 2023; Last et al., 2023).
- should be executed with water that meets quality standards.
- should ensure the cleaned packaging meets the safety and hygiene checks.
- should ensure the cleaned packaging meets the technical specifications as set by the content producers.

Proper drying – The cleaned packaging should be properly dry before rotated to avoid washing liquid residue (Last et al., 2023).

Correct stacking – Layered palletising that suits the efficient filling procedure of the content supplier (Brinkers Food, 2023) AND which ensures the packaging does not come in contact with external contaminants.

Figure C16 Cleaning guidelines

Reverse transport

The reverse transport is present throughout the full reverse logistics of the ecosystem for reusable glass packaging. The transport can be done by **logistic partners** or be overseen by the **hub** that connects the content producer to the store and cleaning facility.

The responsibility of reverse transport covers the transport between the point of collection to the content producer and all necessary entities in between. Therefore, the following guidelines have been established:

Efficient transport – There should be efficient transport across the whole ecosystem (Last et al., 2023), hereby considering:

- Combining delivery and collection (Wester, 2023).
- Striving for saturated transport of primary packaging (Hesseling, 2022)
- Dense collection network with minimized distances between entities and localisation where possible (Bocken et al., 2022; Isbouts et al., 2023; Jiang et al., 2020)

Safe transport – The packaging should not be damaged during transport. Therefore, the usage of secondary packaging is a necessity.

Saturated system – Throughout the ecosystem there should be sufficient volumes of the packaging to ensure there will be no shortage in times of varying need (Hesseling, 2022).

Figure C17 Reverse transport guidelines

Appendix D – Suitability Study

To compare the potential suitable countries, a comparison is made between the readiness and suitability of the ecosystem within the market of the countries and the current market penetration of the targeted products (So Vegan So Fine and La Vida Vegan) in these countries. The subject countries are chosen to be Germany, the Netherlands and France, as these are countries active in sustainable development in the sector of reusable packaging, as well as current target countries of Brinkers Food.

The appendix is split up into three parts (D1-D2), which all cover a different part of the suitability study.

Appendix D1

Analysis of current initiatives for reusable packaging

Appendix D2

Analysis of the societal attitude of the inhabitants

Appendix D1 – Market analysis of initiatives for reuse

The market in each of the countries shows a different approach to including more sustainability in the packaging streams. The speed of these developments has increased significantly since the introduction of the proposal for Packaging and Packaging Waste Regulation COM(2022)677 (PPWR) by the European Union. Even though this proposal had not yet been officially implemented, European countries have responded by implementing their own laws based on the PPWR. For instance, the new added directive §33 to the "VerpackG" Packaging law in Germany (Bundesamt für Justiz, 2023), the directive §6a to the "Besluit beheer verpakkingen 2014" in the Netherlands (Infrastructuur en Milieu, 2023) and the French law concerning "la lutte contre le gaspillage et à l'économie circulaire" (La ministre de la transition écologique et solidaire, 2020). This has resulted in additional costs for disposable packaging and the establishment of companies focussing on reusable packaging.

For each of the three countries an analysis is executed regarding the current presence of reuse initiatives and ecosystems, to identify their current state of reusable packaging. It must be stated, that, even though all countries have been extensively researched, some initiatives could be missing. However, this analysis is executed to get an impression of the market in the three subject countries regarding reusable packaging to finally determine the suitability of the countries for an ecosystem for reusable glass packaging.

Germany

In Germany, most reuse initiatives are focused around reducing the amount of single use plastic. The popular solutions are cups and bowls made from hardened plastic material, which is sturdy enough to be washed multiple times. Though most of these initiatives come with some sort of return system and collection machines, often a full ecosystem does not yet exist. For example, Crafting Future, Keep In and Vytal (Figure D1), produce reusable packaging, but only have limited arrangements regarding a full ecosystem that includes collection, cleaning and logistics. Most often only advice for potential collaborators for the collection, cleaning and logistics is given. Some companies do offer a fully established ecosystem to clients, such as Sykell, which works together with Interzero to create a full functioning ecosystem and digital overview by means of an ERP system. Sykell is established to give support to companies who have recently started using reusable packaging, for example, as a result of the newly implemented European directive on Single Use Plastics (EU 2019/904).

Figure D1 Reusable plastic containers. Left: Crafting Future, from https://www.craftingfuture.de/, Centre: Keep In, from https://www.keepin.org/en/home, Right: Vytal, from https://en.vytal.org/b2c

One of the more remarkable companies is Circujar (Figure D2). This company makes use of the current return-deposit system for collection of their own created reusable jars. Currently, there are 2 million of the jars in circulation for biologic and sustainable brands such as Fairfood Freiburg, Pfandwerk, Allerliebe und Manusso Eis. The results of the Circujar initiative are limited, as the jars have entered the market in March 2023.

Figure D2 The Cirujar initiative. Left: brandless Cirujar, from https://circujar.com/, Right: Pfandwerk and Fairfood Freiburg using the circujars, from https://www.biojournaal.nl/article/9509006/nieuwe-statiegeldpotten-nu-verkrijgbaar-bij-alnatura/

	Company	Sector	Reuse glass	Reuse plastic	Reuse cleaning	Reuse system	Associa-tion	(Digital) label	Deposit system	
DE/NL	Recircle	Food		●		●			●	return on the go
DE	Zerooo	Cosmetics	●			●			●	return on the go
DE	Fritz Kola	Beverages	●			●			●	return on the go
DE	Circujar	Food/beverages	●			●			●	return on the go
DE	Crafting Future	Industries/food		●				●		return on the go
DE	Keep In	Industries/food		●						
DE	Vytal	Industries/food		●						return on the go
DE	Sykell	Industries/food		●		●				system based
DE	Mehrweg	Industries/beverages	●			●	●	●	●	system based
DE	Interzero	Industries				●			●	system based
DE	Blauer Engel	Industries					●			
DE	Taretag	Industries					●			
			4	5		7	3	2	6	

Figure D3 General overview of the German reuse market

The overview of the general analysis of the German market can be found in Figure D3. Aside from distinctions between content type, material and different systems already present, the different principles of the reusability of the packaging have been analysed. These are based on the principles by the Ellen MacArthur Foundation (2019), which are illustrated in Figure D4. In addition to these four principles, a fifth description is added called "system based". This indicates that the ecosystem is adapted to the circumstances chosen by the company making use of the ecosystem. For example, Sykell, which offers plastic products and a system for cleaning. However, companies that make use of this system can choose whether they prefer to collect and clean the products themselves or whether they make use of the system Sykell offers (Hinkeldey, 2023).

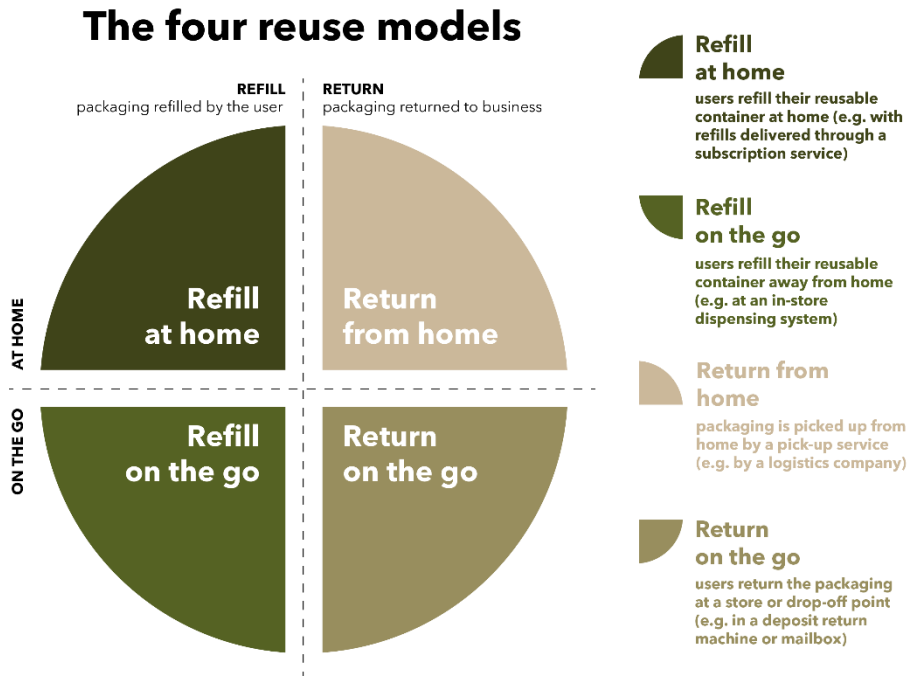

Figure D4 The four reuse models, adapted from Ellen MacArthur Foundation (2019)

To stimulate the consumer in bringing back their packaging, deposit-refund systems are used. These systems are well established in Germany through implementation in the beverage packaging sector since the 1920s (Bouliane, 2024) and have been expanded up until today, where in January of 2024 the plastic milk bottles will be introduced to the 2003 German Pfand system (DPG - Deutsche Pfandsystem GMBH, 2023). This is also visible in the adaptation of the return on the go principle to collect the used packaging. However, the deposit-return system in Germany is currently under pressure because of the new European legislation (PPWR) and the German response to increase the amount of reusable packaging to 70%. This leads to an increase in storage space needed for collected reusables and potential conversion to ensure the collection machines can take in the new packaging (Gesellschaft für Verpackungsmarktforschung, 2020).

Even though there is a cooperation between some parties, there is not a fixed ecosystem that is in use. However, the Pfand system is rooted in the behaviour of German inhabitants (Oltermann, 2018) and can therefore provide a promising means of collection for the upcoming reusable packaging initiatives.

The Netherlands

The Dutch market shows somewhat of a different approach (Figure D5). The existing deposit-return system shows success (Buurman, 2022), though a fraction less than the German Pfand system, but is however not used for all cases of the reuse initiatives. This can be explained by the possibilities to return from home or refill at home initiatives. Pieter Pot and PAKT (Figure D6) ensure that the collection of used packaging collection is the responsibility of the company, not the consumer. This way, even packaging without any deposit-return money as intrinsic motivation for collection is gathered for reuse.

	Company	Sector	Reuse glass	Reuse plastic	Reuse cleaning	Reuse system	Associa-tion	(Digital) label	Deposit system	
DE/NL	Recircle	Food		⬢		⬢			⬢	return on the go
NL	Pieter Pot	Food	⬢			⬢			⬢	return from home
NL	PAKT	Food	⬢			⬢				return from home
NL	Wellmark	Cosmetics/home	⬢			⬢				refill from home
NL	Packcontrol	Industries				⬢				system based
NL	KIDV	Industries					⬢			system based
			3	1		5	1		2	

Figure D5 General overview of the Dutch reuse market

Figure D6 Left: Pieter Pot, from https://www.pieter-pot.nl/, Right: PAKT, from https://www.paktpackaging.com/

In comparison to Germany and France, the amount of initiatives is limited. The initiatives show a variety of means to tackle the reuse of packaging. Even though this shows an elaborate amount of possibilities in the Dutch market, there must be said that because of the limited amount of initiatives, the success of these initiatives is not guaranteed. Especially as most of them are still in a pilot or start-up phase.

France

	Company	Sector	Reuse glass	Reuse plastic	Reuse cleaning	Reuse system	Associa-tion	(Digital) label	Deposit system	
BE/FR	Reusable Weck Pots	Food	●			●			●	return on the go
BE/FR	Cozie	Cosmetics	●			●			●	refill on the go
FR	Bout à Bout	Beverages	●			●			●	return on the go
FR	Bocoloco	Food/beverages	●			●		●	●	return on the go
FR	Fourgon	Beverages	●			●			●	return from home
FR	Bibak	Industries				●				system based
FR	Citeo	Industries				●				system based
FR	Uzaje	Industries	●		●	●		●	●	return on the go
FR	Réseau Vrac & Réemploi	Industries					●			
			6		1	8	1	2	6	

Figure D7 General overview of the French reuse market

In France it becomes apparent that most of the reuse systems find themselves in the sector of glass (Figure D7). The systems mostly rely on a return on the go principle and some are even refillable in stores. What is striking is that most of the initiatives rely on a return-deposit system or voucher to stimulate the consumer to bring back the used packaging. In contrast to the German and Dutch return-deposit system, the similar French system is only introduced on regional level, such as the Bout' à Bout' initiative (Figure D8). France does not have a nationwide return-deposit system, which leads to a variety of systems for the same principle (KIDV, 2022). For example, companies such as Bibak, Citeo and Uzaje, which provide a whole ecosystems for reusable packaging, including collection, cleaning and logistics (Figure D9). These companies hope to stimulate food and beverage producers to increase national implementation and normalisation of reusable packaging. Nevertheless, most of the reusable glass packaging initiatives have their own reuse system, causing a diverse market for collection, cleaning and logistics.

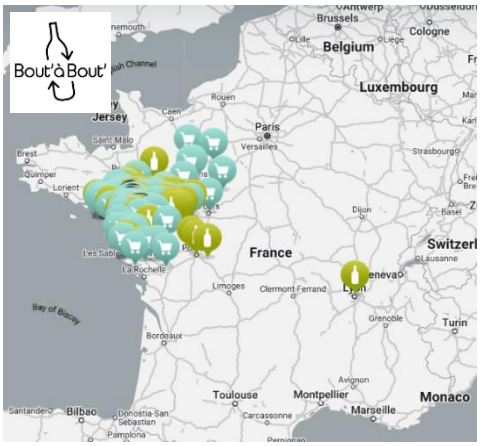

Figure D8 Coverage area of Bout' à Bout', from http://www.boutabout.org/

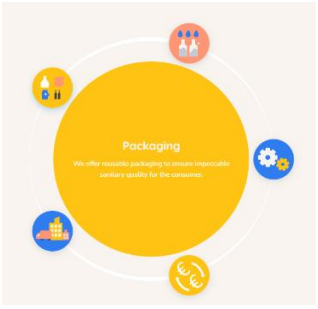

Figure D9 French return systems for reusable packaging, Left: Bibak, from https://www.bibak.fr/, Right: Uzaje, from https://uzaje.com/en/

Conclusion

Looking at the different countries, the following conclusions can be drawn:

- Germany has a well-founded Pfand system that can be used for the collection of the used packaging. Additionally, the Circujar initiative looks promising for kick-starting reusable glass packaging in the food sector in Germany.
- The Netherlands has a wide variety of initiatives that can function as inspiration for an ecosystem that suits Brinkers Food. However, as the amount of initiatives is limited, little can be said about the reliability and feasibility of these systems.
- France has multiple examples for reusable glass food packaging. Nevertheless, the backbone of the collection, cleaning and logistics is only focused on a regional level and therefore could lack nationwide viability.

This means that out of the researched countries, only Germany has an existing reuse ecosystem that can potentially be used for reusable glass packaging for solid and highly viscose food. However, the suitability of this initiative could be limited if the current market penetration of Brinkers Food in Germany is low. Therefore, this should be analysed as well to ensure a well-considered choice for the target country.

Appendix D2 – Societal attitude

There is a trade-off at stake when choosing either Germany or the Netherlands. Choosing for Germany has the potential advantage of making use of the current deposit-return systems, which, in Germany are quite advanced and rooted in society. Additionally, the presence of initiatives, such as Circujar or the return of the MMP system can be beneficial for Brinkers, as the latter can either join them or use them as a basis for a different ecosystem for reusable glass packaging.

On the other hand, the Netherlands has the benefit of being a small country, which can cause an increase in viability, as the larger the area covered by an ecosystem, the more difficult it may be to maintain. Therefore, as the Netherlands covers a smaller area, the success of the implementation of an ecosystem for reusable glass packaging could be higher. Nevertheless, it should be considered that the attitude of the entities involved is of high importance for such an ecosystem to work.

As it is inconclusive if Germany is indeed the best choice, a final analysis is executed, comparing Germany to the Netherlands regarding the environmental attitude of the society. One of the key components of reuse is the return rate, which is largely dependent on the consumer's intrinsic motivation to return the packaging to a collection point (Searious Business & Zero Waste Europe, 2023). Environmental attitudes have a positive association with reuse and recycling (Escario et al., 2020), which means that if the environment of a consumer has a sustainable attitude, it is more likely that such an ecosystem for reuse will be adopted. Therefore it is important for the success of an ecosystem for reusable glass packaging that the environmental attitude in Germany and the Netherlands is compared.

To determine the attitude towards reusable glass packaging, results of the Telos Sustainability Monitor Method (TSMM) are consulted. The results of this method show the sustainability of a society based on its ecological, socio-cultural and economic situation (Zoeteman, van der Zande, Smeets, et al., 2015).

Telos Sustainability Monitor Method

According to the TSMM, sustainability is composed of the three ecological, socio-cultural and economic capitals, which each have different "stocks" that contribute to the overall score of each capital. The score of each stock is determined by 5-6 indicators. The extend to which the indicators are achieved is measured in percentage, which finally results in a score per stock, which leads to the score of each capital. The scores of all capitals result in an overall score for sustainability for the subject-region. The method is visualised in Figure D10.

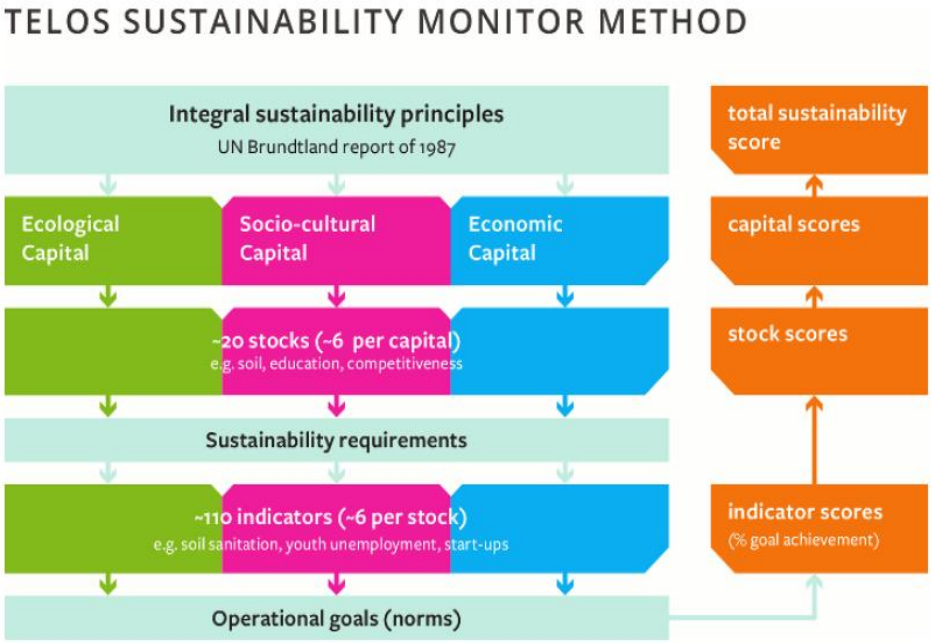

Figure D10 Telos Sustainability Monitor Method, from Zoeteman, van der Zande, Smeets, et al. (2015)

As the TSMM consists of many different elements to obtain a value for sustainability, the following example (Figure D11) is shown to illustrate how the scores for a stock for both the ecological and socio-cultural capitals are determined.

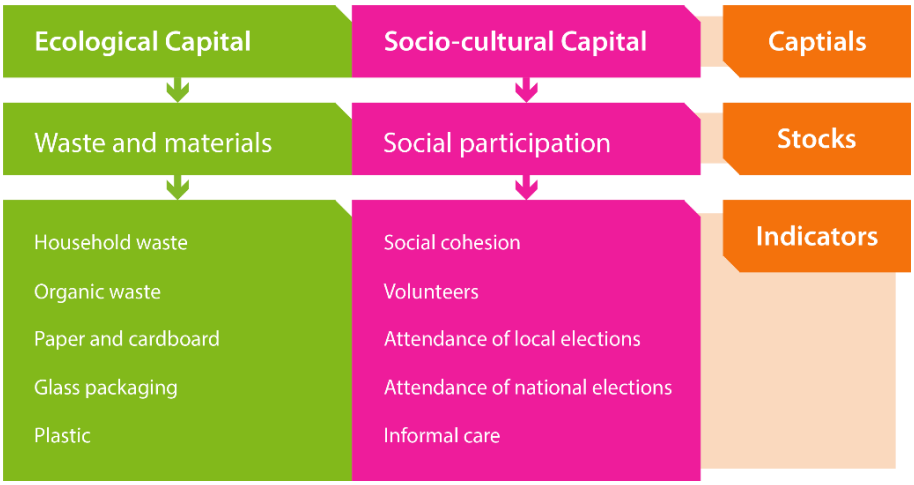

Figure D11 Detailed illustration of one of the stocks of the Ecological and Socio-cultural capitals, based on Zoeteman et al. (2016)

It can be seen that the *waste and materials* and the *social participation* stocks each have five indicators that establish the total stock-score. For each of these indicators, the regional value is measured. For instance, for all the different waste possibilities, the total kg per inhabitant is calculated and for the volunteers, attendance to elections and informal care, the regional percentage is determined. For social cohesion, a scoring system is used. Combining the indicator scores results in the stock-score, combining the stock-scores results in the capital score and combining the capital scores results in the overall score for sustainability.

Country evaluation

For both Germany and the Netherlands the Telos Sustainable Monitor Method is executed by research of Zoeteman, van der Zande and Smeets (2015) and Zoeteman, van der Zande, Smeets, et al. (2015). Regarding Germany, a total of ten cities have been evaluated. In contrast, a full analysis is done in the Netherland, evaluating each of the separate municipalities. Both analyses will be evaluated to draw a conclusion on the overall attitude the German and Dutch society could have towards sustainable initiatives.

Germany

The research executed for Germany (Zoeteman, van der Zande, & Smeets, 2015) consists of an analysis of the following ten German cities: Bremen, Essen, Frankfurt, Freiburg, Hamburg, Hannover, Magdeburg, Munich, Munster and Nuremberg. The sustainability scores of each of these cities has been visualised in Figure D12. The colour coding illustrates the scores given, which can be directly translated into percentages. This means that Munich has a sustainability score between 60% and 100% (62% exactly), whereas Magdeburg has received a sustainability score of 48-52% (49% exactly). However, these scores on their own are difficult to interpret. Therefore, when comparing the different cities, it can be concluded that the north-western part of Germany seems to be generally more sustainable than the north-eastern part. Also, the centre and south of Germany has multiple cities that score well regarding sustainability.

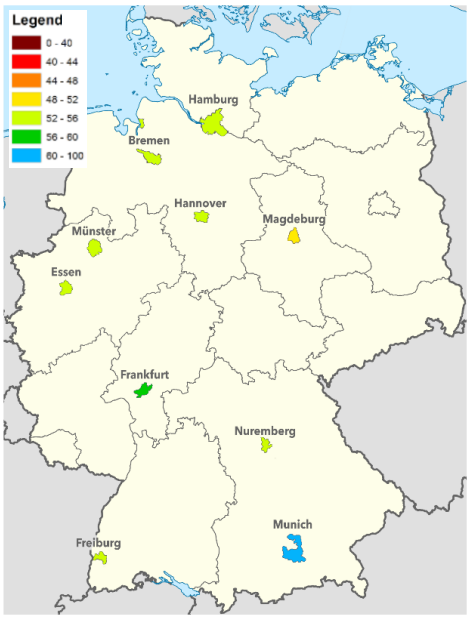

Figure D12 Sustainability of subject-cities in Germany, based on Zoeteman, van der Zande and Smeets (2015)

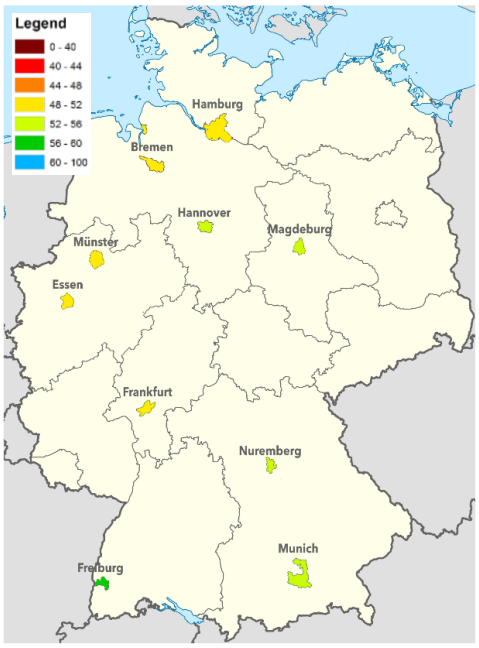

Figure D13 Ecological Capital scores in Germany, based on Zoeteman, van der Zande and Smeets (2015)

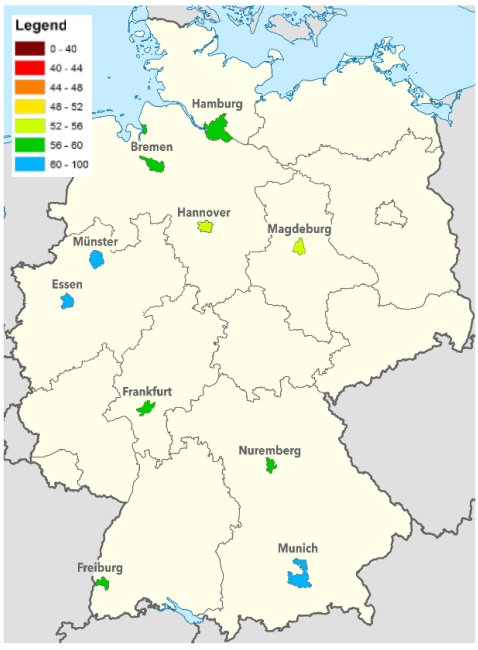

Figure D14 Socio-cultural Capital scores in Germany, based on Zoeteman, van der Zande and Smeets (2015)

The ecological and socio-cultural capitals have been analysed as well. The ecological capital largely covers the quality and resilience of nature, hereby including, for instance, air quality, nature and landscape, soil and water and waste and materials. The socio-cultural capital focuses on physical and mental well-being of inhabitants, which is measured through, for example, social participation, residential environment and safety. Both capitals are visualised in Figure D13 and Figure D14, respectively.

As can be seen in Figure D13 and Figure D14, the scores for the two presented capitals are relatively different. In general, the ecological capital scores averagely lower compared to the socio-cultural capital (53% versus 59%). Nevertheless, a trend similar to the overall sustainability scores can be observed, where the northern part of Germany scores relatively lower compared to the southern part.

Looking at the population distribution in Germany, it can be stated that the inhabitants are mostly settled in the urban areas around the south-west of the country (Blätgen, 2021). Additionally, the dispersion of the specialist trade stores and supermarkets, which are the sales points for SVSF and LVV respectively, can be found relatively equally distributed across the country, in proportion to the number of inhabitants at that city/location (Schwarzkopf & Bischof, 2021). This means that most SVSF and LVV points of sale are present in the locations with the highest population. To obtain knowledge of the attitude of inhabitants at the points of sale, an additional comparison is made, plotting the number of inhabitants against the sustainability scores for the different capitals (Figure D15).

Figure D15 Sustainability scores in relation to number of inhabitants in the German subject-cities, based on Zoeteman, van der Zande and Smeets (2015)

The plotted trend lines indicate that the city size does not majorly influence the ecology capital score of a city. Additionally, the larger the city gets, the higher the socio-cultural capital score, as well as the economic capital score are. This leads to the conclusion that the attitude of the target market in Germany is relatively equally distributed. This means that the more densely populated an area is, the more sustainable the attitude of the inhabitants might be. This is also visualised n Figure D16, where the overall sustainability scores are plotted, including a trendline. Here, the number of inhabitants has been split up into four categories: small (50,000-100,000 inhabitants), medium (100,000-250,000 inhabitants), metropolitan (250,000-1,500,000 inhabitants) and large metropolitan (more than 1,500,000 inhabitants)(OECD, 2022).

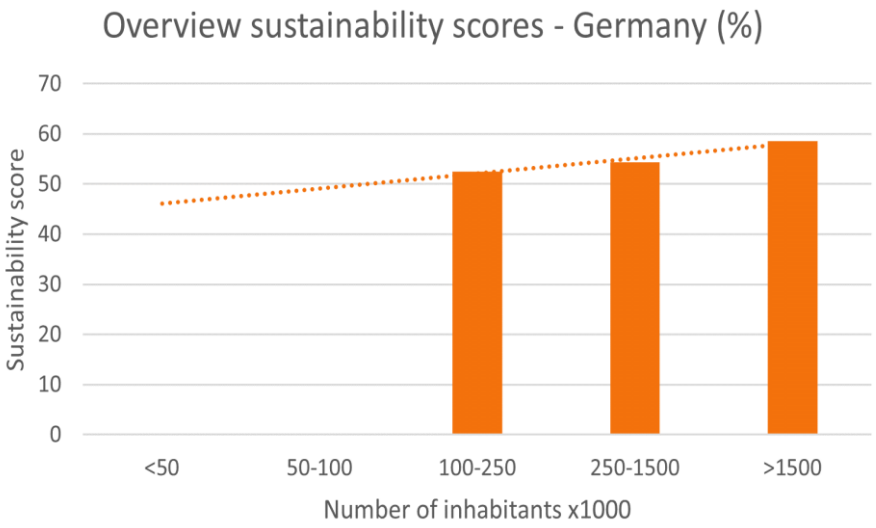

Figure D16 Overall sustainability score in relation to the number of inhabitants in the German subject-cities, based on Zoeteman, van der Zande and Smeets (2015)

The plot shows a similar trend compared to sustainability scores of the capitals. What can be concluded is that the larger the city, the higher the sustainability score, and hereby the environmental attitude of the inhabitants.

The results obtained in the research from Zoeteman, van der Zande and Smeets (2015) are limited, in a sense that they do not cover the full area of Germany. Therefore, the conclusions drawn from this research could be inaccurate. Nevertheless, they help to give an indication on the attitude of the inhabitants towards sustainable development. This leads to a more informed decision that can be made on the feasibility of adoption of an ecosystem for the reuse of glass.

The Netherlands

The execution of the Telos Sustainability Monitor Method (TSMM) in the Netherlands is focused on 393 municipalities. As this covers the full area of the Netherlands, the results create an extensive overview of the sustainability of the whole of the Netherlands (17). Again, the sustainability scores are given from 0-100%. The results in Figure D17 illustrate that the centre of the Netherlands seems to be the most sustainable. The north-eastern part and south western part portray the other extremity, where sustainability seems to lack.

In addition to the overall sustainability score, the ecological capital and socio-cultural capital scores are explored as well (Figure D18 and Figure D19).

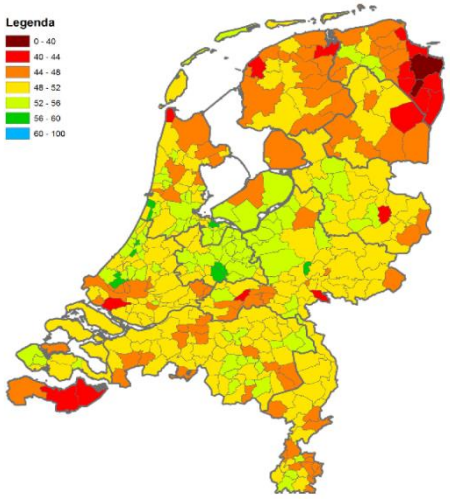

Figure D17 Sustainability of 393 municipalities in the Netherlands, from (Zoeteman, van der Zande, Smeets, et al.,

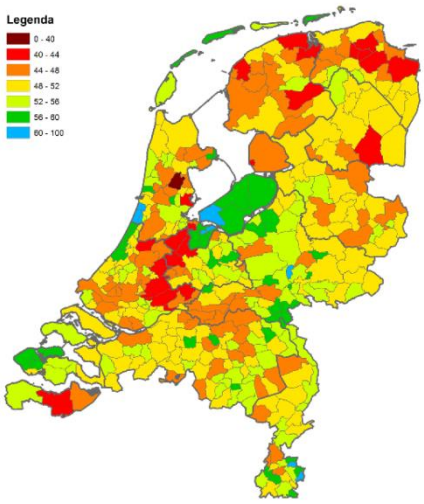

Figure D18 Ecological Capital scores in the Netherlands, from Zoeteman et al. (2016)

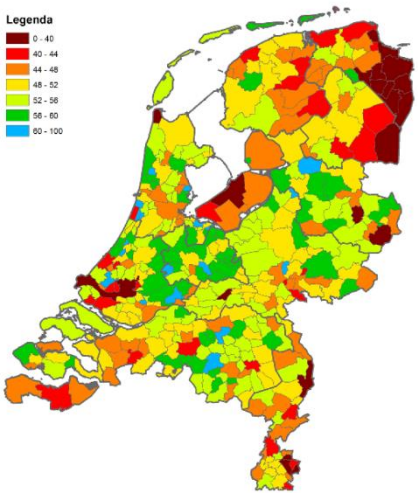

Figure D19 Socio-cultural Capital scores in the Netherlands, from Zoeteman et al. (2016)

The capital scores have different distribution compared to the overall sustainability. Even though the extremities are still located in the north-eastern and south-western part of the country, the results in the centre of the country vary per capital. The ecological capital shows a lower score around the bigger cities in the Netherlands. On the other hand, the socio-cultural capital scores high in these areas. This can be explained through, for example, the lower stock scores for waste management in the more densely populated areas, causing a decrease in the ecological capital score in those areas (Zoeteman, van der Zande, Smeets, et al., 2015). On the other hand, the more densely populated areas in the Netherlands score higher for social and economic participation, labour and infrastructure, hereby increasing the socio-cultural capital score in that area.

Similar to Germany, the supermarkets and specialist trade stores that sell LVV and SVSF, are centred around the more densely populated areas in the Netherlands (AlleSupermarkten, 2024; CBS, 2020). Therefore, the exploration of the attitude of people in densely and sparsely populated areas should be evaluated as well. This leads to the following plot (Figure D20) which compares the capital scores to the number of inhabitants.

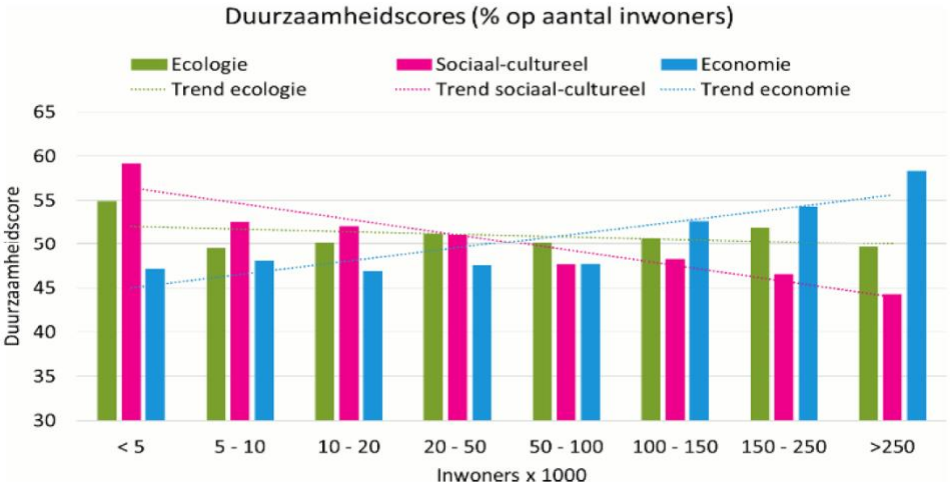

Figure D20 Sustainability scores in relation to number of inhabitants in the Dutch municipalities, from Zoeteman, van der Zande, Smeets, et al. (2015)

The trend line for the ecology is barely influenced by the size of the municipalities. What is striking is the decreasing trend of the scores for the social-cultural capital once the number of inhabitants in a municipality increases. The opposite happens for the economic capital, for which the score increases proportionally with the number of inhabitants of a municipality.

In order to relate these results to the German scores, a plot is created of the overall Dutch sustainability scores (Figure D21). There can be concluded that the sustainability score barely increases if there is a higher population in an area.

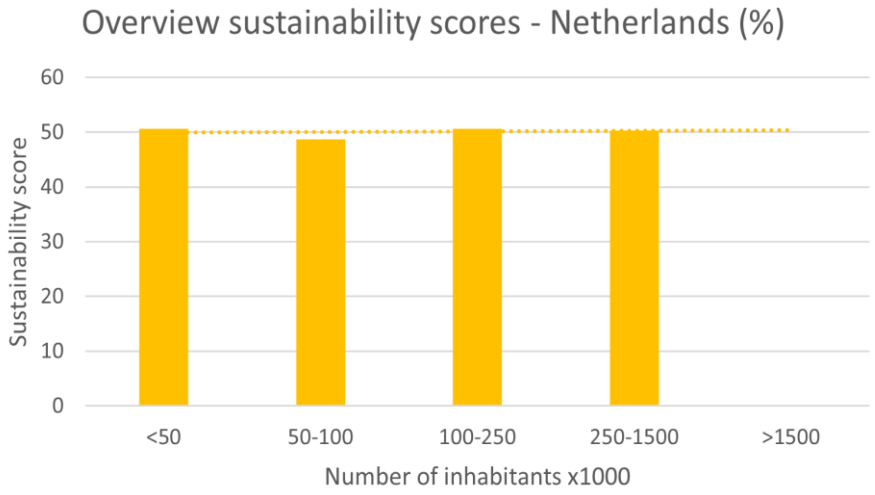

Figure D21 Overall sustainability score in relation to the number of inhabitants in the Dutch municipalities, based on Zoeteman, van der Zande, Smeets, et al. (2015)

Comparison

To draw a conclusion about the suitability of both countries in terms of environmental attitude, the results are presented in a combined chart (Figure D22).

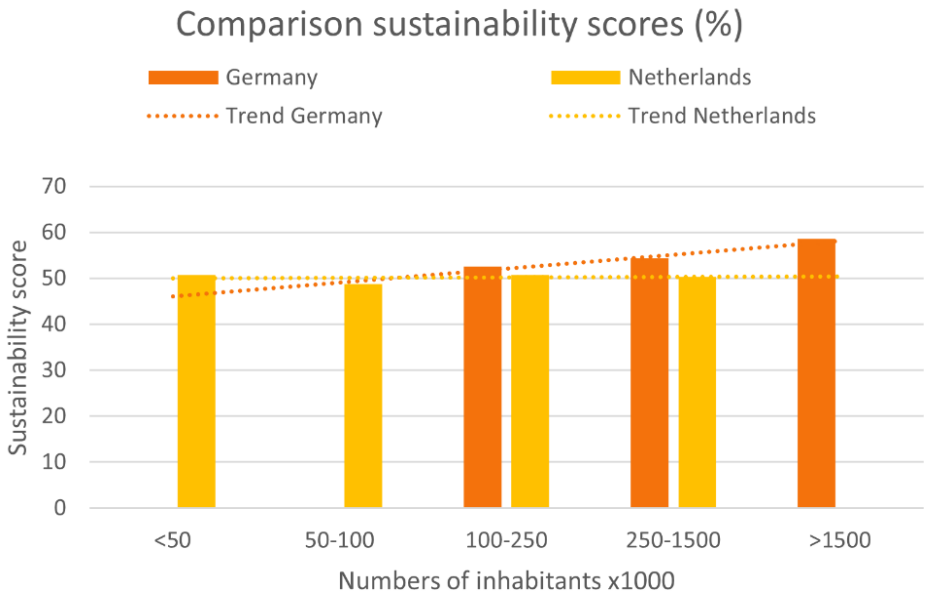

Figure D22 Comparison of sustainability scores, Germany and the Netherlands, based on Zoeteman, van der Zande and Smeets (2015) and Zoeteman, van der Zande, Smeets, et al. (2015)

As can be seen, the sustainability score is averagely higher for Germany in the occasion where an area has 100,000-250,000 and 250,000-1,500,000 inhabitants, when compared to the Netherlands. Looking at the trend lines for both countries, there can be seen that for sparsely populated areas, the Netherlands seems more sustainable and hereby more suitable for implementation of the ecosystem for reusable glass packaging. However, as sparsely populated areas generally have less points of sale, compared to the more densely populated areas, this is an unfavourable option. Successful implementation of the ecosystem can best be focused on areas with a higher amount of sales points, which are the more densely populated areas. Therefore, when looking at the sustainability scores for areas with a higher number of inhabitants, the conclusion can be drawn that Germany does not only have a higher sustainability score for these categories, additionally, the trend line shows that the higher the number of inhabitants in a city, the more sustainable the area. Therefore, regarding sustainability of the area, and hereby the attitude of the inhabitants, is more suitable in Germany, as opposed to the Netherlands. Therefore, implementation of an ecosystem for reusable glass packaging might find its best success in Germany.

Conclusion

In conclusion, based on the analyses of the current initiatives, market penetration and societal attitude, Germany seems to be the best market to target. The following reasoning applies.

- Germany has a well-established deposit-return ecosystem which is ingrained in the lives of the German inhabitants. By using the existing deposit-return ecosystem, the new ecosystem for reusable glass packaging can be seamlessly integrated within the habits of the inhabitants.
- The existing deposit-return ecosystems for, for example, beverages does not only target the motivation of the consumer, but the ecosystem as a whole also includes transportation and cleaning. The knowledge and infrastructure of these existing ecosystems can be used to implement the new ecosystem for reusable glass packaging for the solid and highly viscose food.
- The brands of Brinkers Food (SVSF and LVV) are most popular on the German market. Moreover, keeping ecosystem expansion in mind, Brinkers Food already has relationships with German external private label brands which could potentially be suitable partners for future ecosystem expansion.
- The environmental attitude is reflected in the sustainability score, which is most promising in German
- The sustainability score for the areas with the most points of sale (densely populated areas) is highest for Germany. Additionally, rather than having a similar sustainability score for all differently sized municipalities (Netherlands), the sustainability score increases proportionally to the amount of inhabitants in an area in Germany. A high sustainability score reflects the environmental attitude of the inhabitants, hereby creating a suitable environment for implementation of an ecosystem for reusable glass packaging.

Discussion

The difficulty in choosing Germany might find itself in the limited presence of well-established initiatives for reusable glass packaging for food products. Circujar is well on its way in being a promising solution for Brinkers Food, but is also the proof that a lack of participating companies makes it difficult to create a viable ecosystem. The more companies participate, the more popular the reusable glass packaging might become, which is needed for the ecosystem to work, as a return rate of over 95% is desirable to make such a system economically viable (Searious Business & Zero Waste Europe, 2023).

Additionally, the deposit-return system is currently under pressure, due to the new packaging regulations, which causes an increased need for storage space in stores for collected reusables and adaptations of collection machines to suit the new packaging. On the other hand, initiatives such as Circujar already prove that usage of existing deposit-return systems is possible for new ecosystems. Nevertheless, the current pressure on the deposit-return system should not be disregarded, as this can be a significant hurdle for the implementation of the ecosystem.

Appendix E – Current process chain Brinkers Food

The following appendix provides an overview of the determination of the internal ecosystem configuration for Brinkers Food. Firstly, the process chain based on the first internal observations is depicted (Figure E1), thereafter the updated process chain is shown, based on the input of the expert interviews (Figure E2).

Initial observations – Process chain

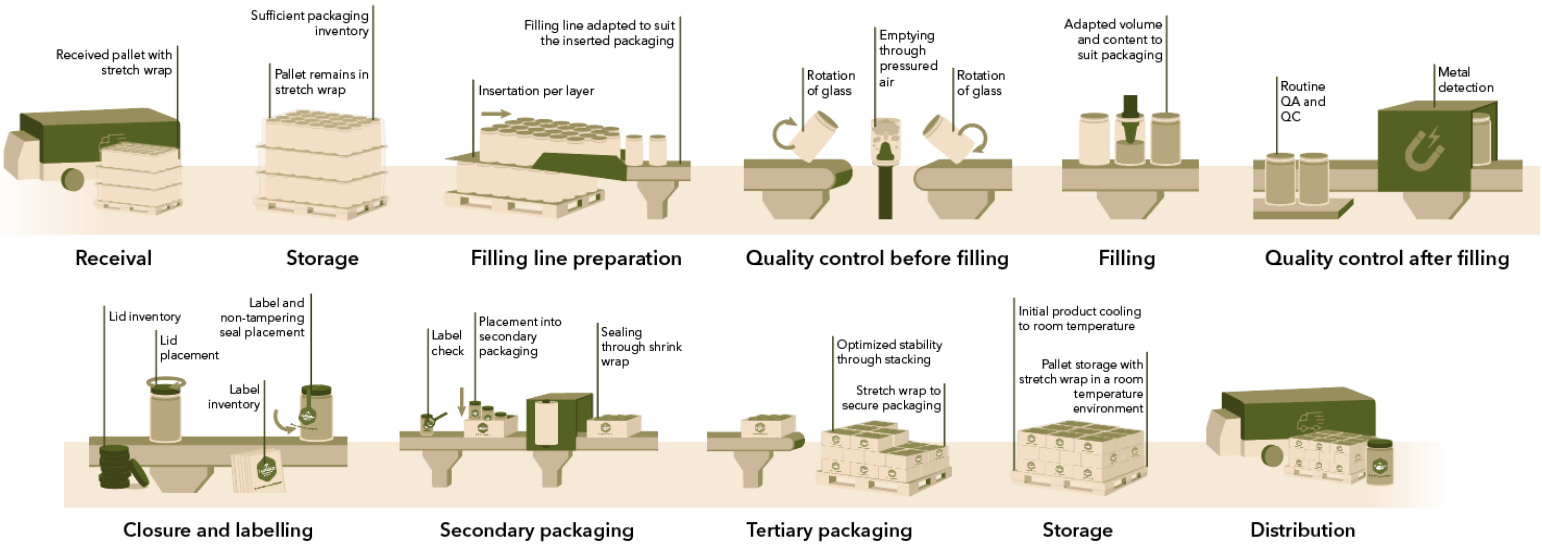

Figure E1 Process chain at Brinkers Food after initial observations

Expert interviews – Process chain

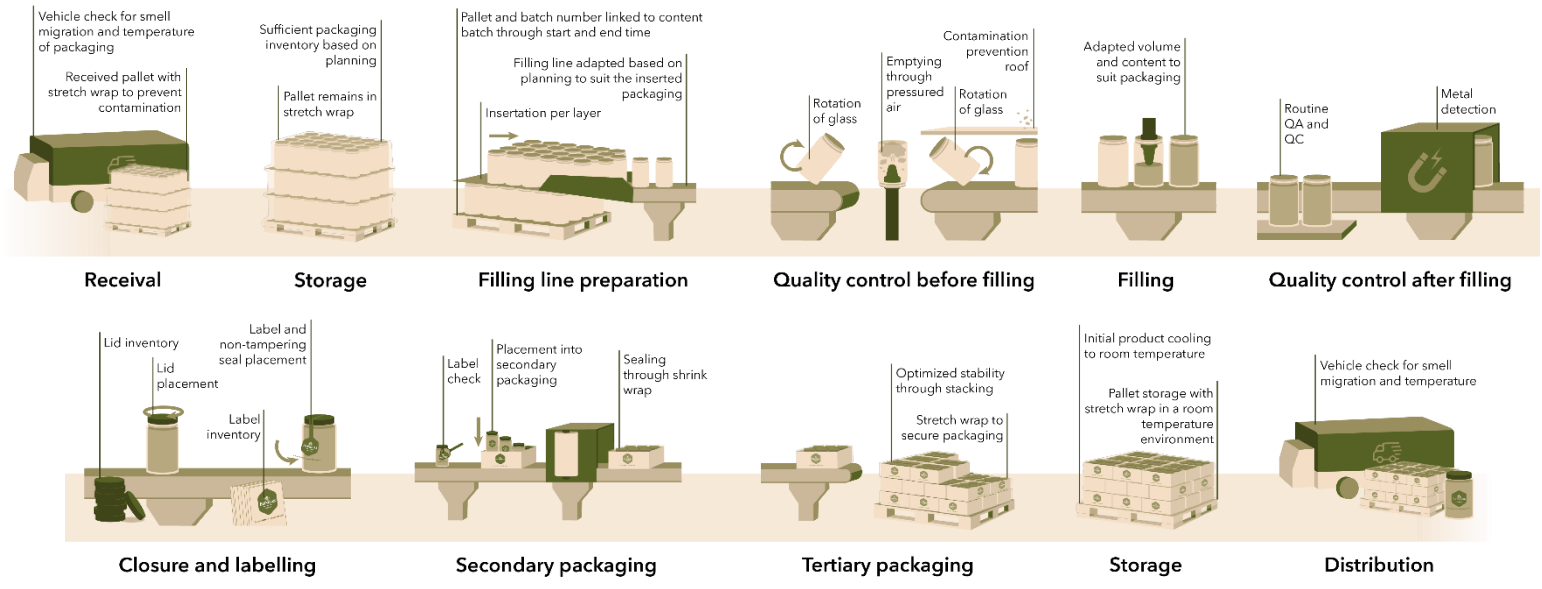

Figure E2 Process chain at Brinkers Food after expert interviews

Appendix F – Results Participatory Session

The following Appendix covers the results of the participatory sessions conducted in Chapter 10. For each of the sessions the notes and the final division of the tasks is presented. The appendix is split up into four parts (F1-F4), which all cover the results of the session with each of the entities.

Appendix F1
Content Producer
Brinkers Food

Appendix F2
Retail hub

Appendix F3
Glass Manufacturer

Appendix F4
Store

Appendix F1 – Content Producer | Brinkers Food

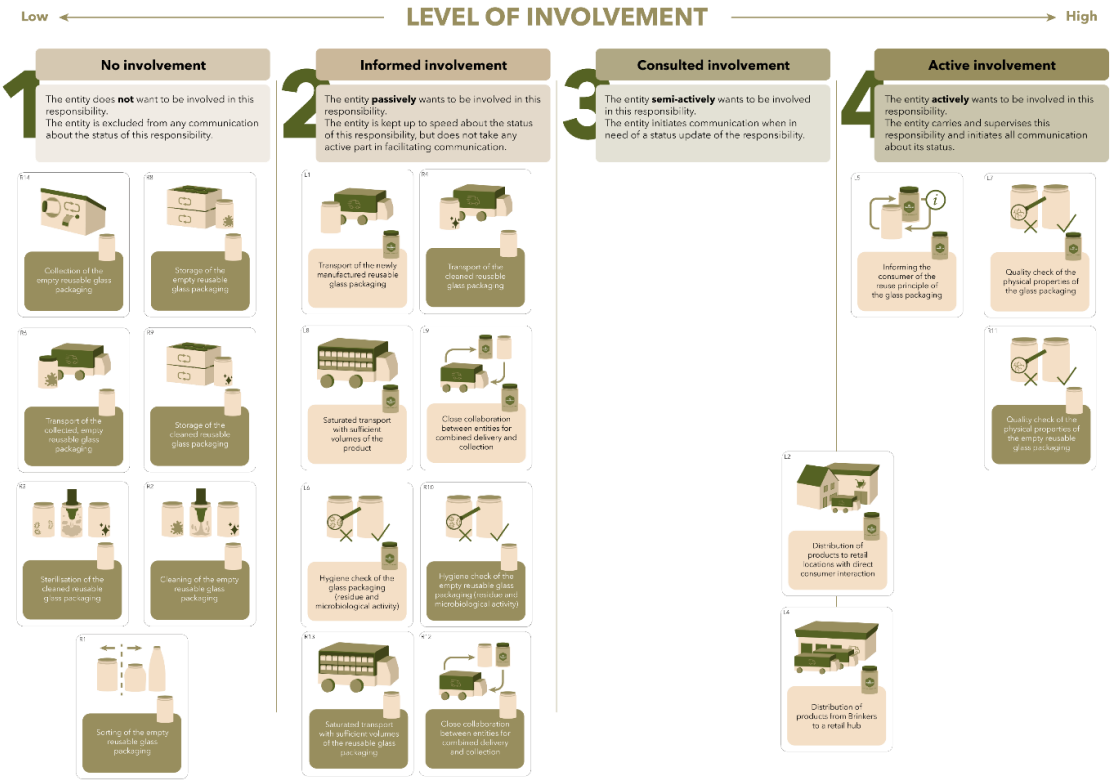

Figure F1 Placement of tasks by participants of Brinkers Food

Appendix F2 – Retail hub

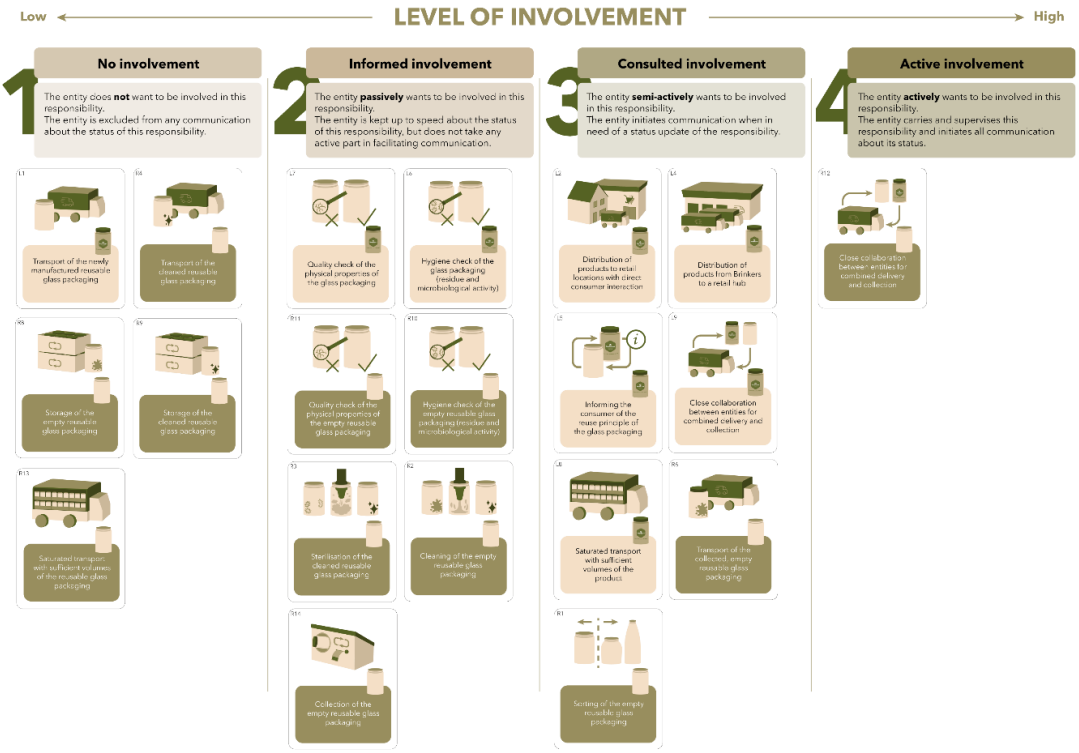

Figure F2 Placement of tasks by participants of the retail hub

Appendix F3 – Glass Manufacturer

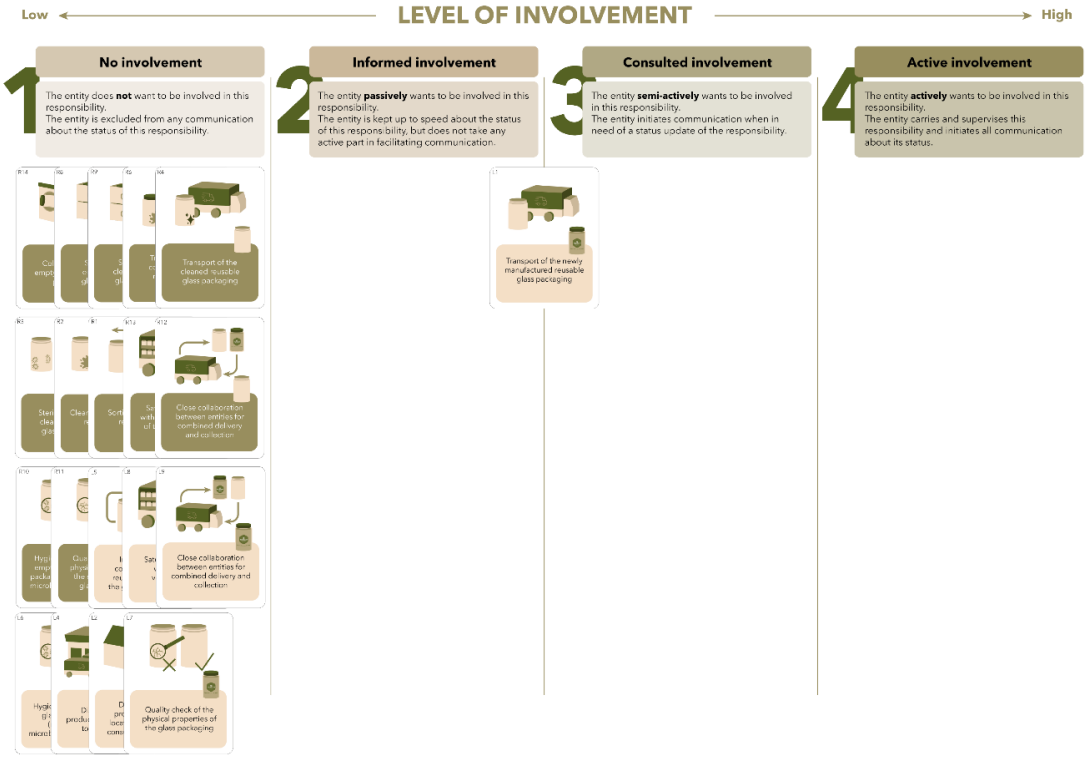

Figure F3 Predicted placement of tasks by participants of the glass manufacturer

Appendix F4 - Store

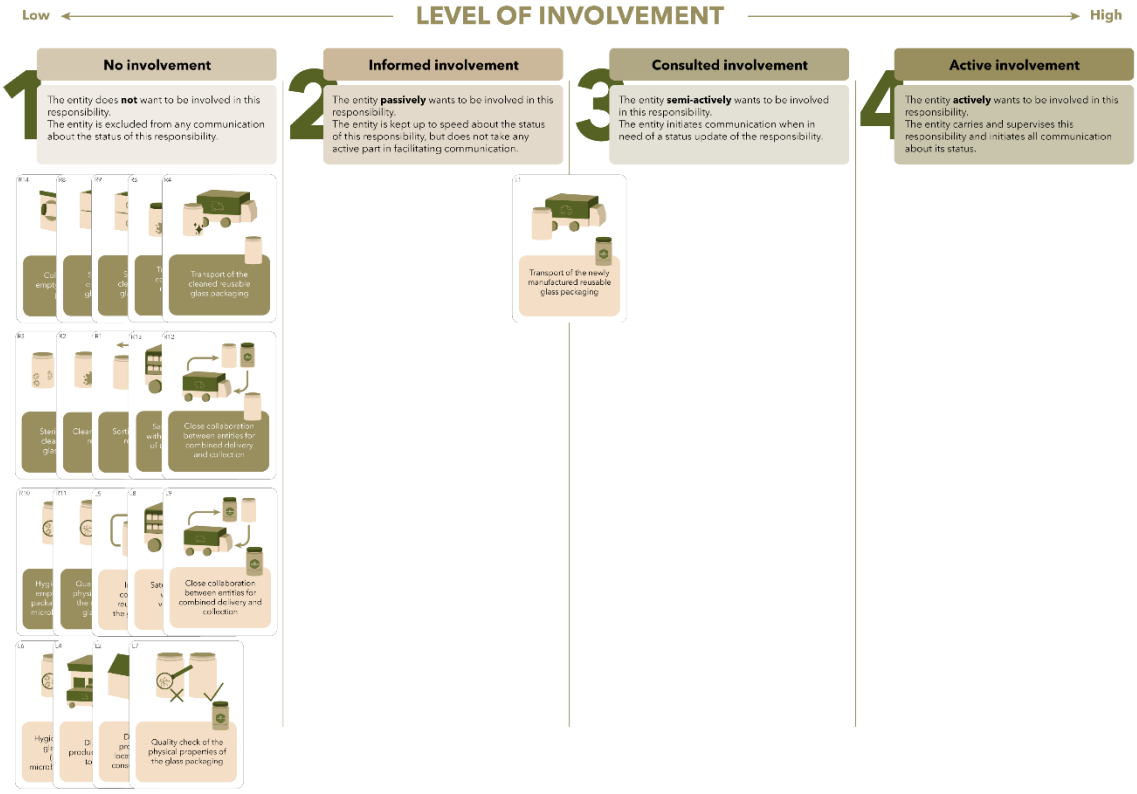

Figure F4 Predicted placement of tasks by participants of the store

Appendix G – Packaging design example

The following example is made illustrating a possible packaging design for the La Vida Vegan (LVV) brand of Brinkers Food. The content volume that fits in this packaging design is in accordance with the current most sold volume of LVV: 270g. It should be noted that this example is merely an indication of what the packaging could look like, and is by no means a fixed solution.

Impression

The following images (Figure G1 and G2) give an impression on the design of the packaging, both with and without label, lid and content.

Figure G1 Render of the La Vida Vegan Hazelnut Chocolate Spread in the exemplary reusable glass packaging design

Figure G2 Render of the empty exemplary reusable glass packaging design

Technical drawings

The following technical drawings (Figure G3) have been established to illustrate what a possible reusable glass packaging design for the ecosystem might look like. The details of the design choices are explained below.

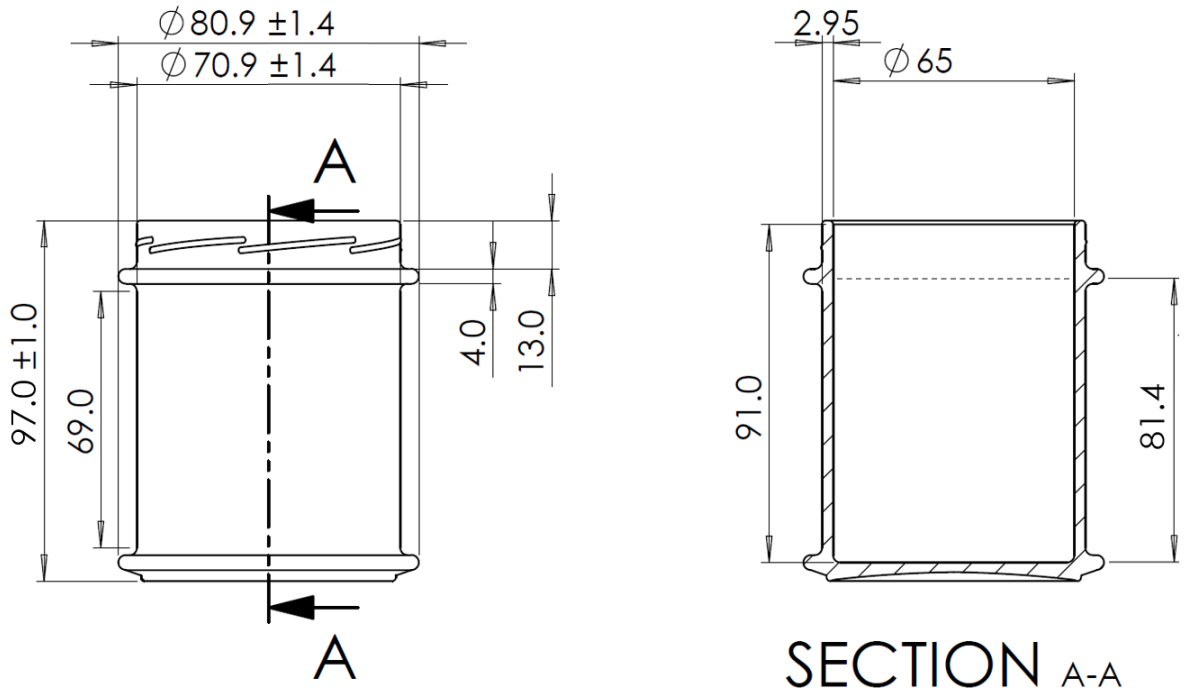

Figure G3 Technical drawings of the exemplary reusable glass packaging design

Width

The width of the glass packaging at the centre is comparable to that of the 270g LVV packaging (70.9±1.4 mm). At the additional top and bottom extrusion, the external width is 10mm larger. If the filling line inserts have touch points at the centre of the packaging, the filling line inserts of the LVV 270g packaging can be used. If the guidance elements stretch over the full height of the packaging, the dimensions need to be adapted or new filling line inserts need to be installed.

Internal width

The internal width is larger than that of the 270g LVV packaging (65 mm and 60 mm respectively).

Height

The height of the packaging is slightly taller than that of the 270g LVV packaging (97.0±1 and 92.5±1 respectively).

Wall thickness

The minimal wall thickness of the 270g LVV packaging is 1mm. For the example of the reusable glass packaging, this thickness is a little under 3 times as thick.

Additional top and bottom extrusion

The additional extrusion on the top and bottom is added for two reasons:

1) The extrusion prevents lids from touching on the filling line, therefore ensuring the packaging remains closed.
2) The addition of a bottom extrusion distributes the forces to which the glass packaging is exposed on the filling line, during linear and reverse transport and during cleaning (e.g. scuffing).

The thickness of this extrusion is 4mm and it extends 5mm.

Lid height space

The height space for the lid is comparable to that of the 270g LVV packaging (13 mm)

Label placement

The space available for the label is comparable to that of the 270g LVV packaging (67.5 mm needed, 69.0 mm available)

Tolerances

The tolerances for height and width are comparable to that of the 270g LVV packaging (1.0 and 1.4 respectively)

Filling height

A filling height of 81.4mm results in 270g of chocolate paste in the packaging.

Production and analysis

This example is merely a visual illustration on what a suitable reusable glass packaging might look like. It is important to note that this packaging has not yet been analysed regarding strength and stresses, as it is out of the scope of this specific research. Therefore, additional simulations should be executed. For example, the internal stresses present due to varying material thickness should be evaluated and possible solutions to minimized this (e.g. annealing (ten Klooster, 2008; Xuzhou Huihe International Trade Co., 2024)) should be considered. Additionally, the manufacturability, manufacturing process (e.g. blow-blow or press-blow (ten Klooster, 2008)) and associated production costs of the packaging should be evaluated as well.