Sustainable Packaging Solutions for the Retail Sector

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Abstract

Mass consumption of plastic packaging, driven by its inexpensiveness, versatility, lightweight and current 'disposable' culture, along with mankind's inability to cope with its end-of-life, is one of the most serious problems facing the world today, as it results in mismanaged waste threatening the survival of all ecosystems. As a result, the concern for sustainability has become the new trend in consumption, forcing companies, particularly the large retail surfaces, to find sustainable packaging solutions to meet demand. Reusable packaging systems has been considered a possible solution to tackle the problem based on the success of this practice in zero packaging stores, providing equally balance profit generation, environmental protection, and social empowerment. However, when in recent years several companies tried to implement these alternatives in the mainstream, these have not prevailed. In this context, a complete literature review on sustainable packaging solutions is carried out to analyse the different benefits that each allow as well as the potential reasons for the ineffectiveness of those already tested, in order to find research gaps for future research of a successful solution. Then by employing transformational sustainability research methodology, understand why reusable packaging systems are not working and propose logistical scenarios until a solution is found that, in a cost-effective and convenient way, helps to mitigate the packaging waste problem.

The results have proved that it is possible to find a scenario where all root causes are mitigated and that without major strategic and logistical changes it is possible to implement it in practice. However, final results for economic viability can only be ensured according to a proper case study, this being the proposal for future work.

Keywords: Reusable Packaging Systems, Zero Waste Management, Packaging Waste, Sustainability, Retail Sector

1. Introduction

Massive consumption of plastic is one of the most serious problems the world is facing today, threatening all ecosystems, with more than 300 million tonnes of plastic being produced worldwide each year (Geyer et al., 2017). What makes this material popular is its versatility, low cost and usefulness, which has made modern life possible. Although there is still production of durable and reusable plastics, most production is for disposable and single-use products, leading to a current culture of "throwaway" that is arguably one of the greatest challenges facing the environment (Geyer et al., 2017). Much of this effect is due to packaging, with 40% of plastic production referring to packaging and its environmental impact is a major issue in the world as it is a very visible product in the waste stream, representing between 15% and 25% of the weight of household waste (PlasticsEurope, 2017). From this perspective, several studies of sustainable solutions have been analysed over the years in order to solve the problem, however, they have not succeeded in the mainstream. The closest and considered the best potentially sustainable solution studied is reusable packaging systems, not only for its environmental benefits but also from an economic point of view. According to Ellen MacArthur Foundation (2017), replacing 20% of plastic packaging into reuse models is a USD 10 billion business opportunity that benefits customers while representing a crucial element for eliminating plastic waste and pollution. Nowadays, this solution has been gaining popularity with several local stores around the world adopting this new concept of selling, and the increased interest in it from consumers indicates that despite the advantages of using disposable packaging in some products, consumers do not always prefer pre-packaged products (Mordor Intelligence, 2019). However, it is still considered a niche market and even with large retailers not discarding the idea, there are still many barriers to its full adoption by conventional supermarkets, derived from the experience of many having tested it and the concept failing in this environment. (Beitzen-heineke, 2017). In addition to figuring out how to make these systems succeed in terms of reconfiguring activities along the supply chain, it is also imperative to figure out how to change the mindset so that the systems work but, essentially, are adopted on a permanent basis. An INCPEN (2017) study shows that 88% of people consider that there are disadvantages to plastic packaging, not all of them environmental, but 68%

think that the benefits of packaging, such as hygiene, convenience, product protection and information, outweigh the benefits, thus leading to its continued use. For a proper understanding of the matters involved in view of finding a solution to this problem, a thorough literature review on both Zero Waste Management, sustainable packaging and sustainable design methodologies has been conducted.
Then, this work focuses on finding solutions to adapt reusable packing systems to the mainstream context and thus help reducing the plastic packaging waste.

2. Literature Review

Packaging has long been regarded as a waste generator and the main reason why today many products are not designed to be used efficiently and then reused, repaired or recycled. In this sense, packaging can play a key role in sustainable development (Lewis *et al.*, 2005). The visibility it provides, coupled with its importance as a facilitator for distribution, marketing and safe consumer use, creates significant challenges for advancing sustainable development in packaging. It goes beyond a hard challenge since current consumer behaviour and spending trends, as well as developments in distribution, are examples of drivers of new packaging formats and technologies, often contrary to the principles of sustainable development (James *et al.*, 2005). The current packaging trend is more focused on convenience than sustainability since one of the most pressing and far-reaching challenges in advancing sustainable development in the packaging domain is the lack of a clear understanding of what constitutes sustainable packaging (James *et al.*, 2005).
Acknowledged of the gap, in 2002, the Sustainable Packaging Alliance (SPA) was formed to provide a focal point for strategic research, technology transfer and education to sustain and facilitate the development and marketing of sustainable packaging systems, defining four principles for sustainable packaging: Effective, Efficient, Cyclic and Safe.
Acknowledged the 4 principles that define packaging as sustainable, and thus not harmful to the environment as the most used today, it is was vital to discover the studies and advances of recent years on packaging according to this perspective. Therefore, given the different four pillars and the characteristics that define them, the following four sections provide a short-detailed summary of developments in the sustainable packaging literature under each pillar perspective:

2.1 Effectiveness

By reviewing the literature on sustainable packaging, it is possible to see that while the environmental dimension remains the most addressed, not surprising as three of the four pillars of sustainable packaging focus on this dimension, the economic and social dimensions recently have been gaining interest.
The economic dimension emerges more in studies of down-stream logistics networks, where the traditional focus is on cost efficiency and productivity on reverse logistics and recovery processes. In most studies, this dimension is extensively studied along with the environmental dimension, considering the cost impacts of environmental management practices on packaging. Studies under the economic dimension focus mainly on four subjects: i) maximizing profits of the supply chain players by optimizing packaging collection routes (for e.g., Prive *et al*., 2006) etc.); ii) cost savings due to reduced use of virgin materials (for e.g. Ko *et al*., 2012 etc.); iii) cost savings due to product waste (for e.g. Accorsi et al., 2014 etc.); and iv)cost savings due to better supply chain efficiencies (for e.g. Barrera et al., 2014 etc.).
In terms of the social dimension, it is the least addressed with fewer studies in the last decade (Meherishi et al., 2019). In brief the social impacts of packaging include product safety, ethical trade and impact on workers i.e. the society involved (Beitzen-Heineke et al., 2017).
About the environmental dimension, there are several studies identifying the negative impacts of packaging practices with focus on emissions, energy sources, non-renewable resources and water use, end-of-life treatment and packaging, as well as the benefits of sustainable packing adoption, which will be detailed in the literature review of the following sections on other three sustainable packaging principles. and the benefits of sustainable packing adoption (Beitzen-Heineke *et al*., 2017). Still, there are many studies that present the three dimensions and how the three interact with each other like Verghese *et al*. (2012) that presents the new opportunities and challenges for business of adopting sustainable packaging.

2.2 | Efficiency

As far as efficiency is concerned, any sustainable packaging should continue to provide its function but with the least waste of resources, time and effort (James *et al*., 2005).
In terms of eco-design literature, Williams *et al*. (2008) studied how packaging design that focus on food waste reduction help to increase consumer satisfaction and, at the same time, reduce the environmental impact of the food-packaging system. Manfredi *et al*. (2015) presented the environmental savings from an eco-design for fresh milk packaging by applying an extra antimicrobial coating that enable to reduce milk waste and extend the shelf life, given the coating's life cycle. About stakeholder collaboration, Leppelt *et al*. (2013) found that the scope of corporate environmental strategies focused on packaging design not only achieves improved internal environmental performance but also reduces the environmental footprint of the product chain when in collaboration with all stakeholders along the supply chain. Hanssen *et al*. (2017) also demonstrated that fact by showing that reducing the size of packages can reduce transport costs, energy consumption, and greenhouse gas emissions, while Obrecht and Knez (2017) explained how eco-design principles can determine carbon

emissions savings by dematerialisation (i.e. reducing material usage) in eco-friendly container designs.

Besides the packaging design process, many other authors examined how the adoption of sustainable packaging practices turned out to increase the efficiency of the processes along the supply chain. The studies are concentrated on examining the effect of introducing new packaging practices that are sustainable, the motivation and benefits of adopting sustainable packaging practices as well as the internal and external changes in perspectives and processes required by players and organizations along a supply chain.

Some particular examples are, Hardy and Curran (2009) by a re-design of secondary packaging to eliminate the need for transit packaging with reusable secondary packaging or the total disposal of the secondary packaging layer to reduce associated waste streams in supermarket. Further, Torretta (2013) focused on the environmental benefits of incentivising sustainable behaviours in the supply chain by raising consumer awareness of uncapped water consumption, concluding that it enable to reduce to about one fifth of estimated CO_2 emissions as well as reduce of waste and the consumption of raw materials. Beitzen-Heineke *et al.* (2017) studied the concept of zero packaging grocery stores with the issue of food and packaging waste being able to be controlled in retail stores and the acceptance that has been gaining in practice. A simple praticle example is the approach of the the company Unilevar that explored product redesign by shifting to more concentrated liquid detergents requiring less packaging and being more efficient to transport (Unilever, 2019b).

2.3 | Cycling

The Cyclic Principle is aimed at ensuring that materials used in sustainable packaging should provide for waste reduction through natural or technical systems for optimum recovery by minimising material degradation and/or the use of improvement additives. In term of materials, there are eco-friendly packaging materials that by themselves make the forward processes of packaging competence more sustainable, whereas in term of systems, there are two possible cyclic loop systems available to collect and recover packaging: recycling or reusing (Meherishi *et al.*, 2019).

As far as cyclic loop systems for packaging are concerned, the best known is recycling, with hundreds of studies on the environmental benefits compared to other waste treatment systems such as incineration or landfill. However, in recent years, most studies have focused on the inefficiencies and barriers of this process as well as new improvement solutions.

As far as reuse practices are concerned, while these are laudable and should be encouraged, there is still no radical effect on the impact of packaging (Lewis *et al.*, 2001). Thus, in the past decade there has been a consistent focus on improving the reusability of packaging and the processes supporting it within the supply chain (Meherishi *et al.*, 2019). Kamarthi & Gupta (2011) demonstrated how reuse is a significant saving for materials and manufacturing, and for the collection and disposal operation since a multi-use product can compensate the cost with increased utilisation and an overall reduction in materials consumption.

A very detailed study was conducted by Lofthouse *et al.* (2009) in which reusable packaging systems were addressed on the possibilities they offer to the consumer and the environment by the analysis of several different types of refillable systems in terms of the success factors associated with each (from both a consumer and a business perspective) and the types of prejudices that these systems might have to face. associated with the negative consumer experience (e.g. inconvenience, cumbersome maintenance, poor quality packaging, incompatibility between systems, poor product quality) need to be actively removed from

There are also many studies focused on comparing different systems or products to reusable ones. One example is Ross and Evans (2003) and Bernstad Saraiva *et al.* (2016) showing that reuse practices for plastic packaging system are environmentally preferable as compared non-reusable packaging systems. Although all these studies have demonstrated the potential of these systems, Lofthouse *et al.* (2009) highlights that these solutions might create even more waste if not well implemented. If packages, designed to be refilled, be discarded in the traditional way, followed by the collection of a new parent pack results in the loss of any potential sustainability benefit and may in fact contribute to an increased use of resources and energy compared to traditional packaging (Lofthouse *et al.*, 2009). For example, Koskela *et al.* (2014) proved that the recyclable corrugated box delivery system for bread delivery is much more environmentally friendly as compared to the reusable plastic delivery system because of this reason. To prevent this from happening, some studies emphasised the importance of multiple actors in return and reuse practices, such as standardisation of packaging (Ko *et al.*, 2012), collaboration between supply chain stakeholders in return packaging management (Li *et al.*, 2014) and asset sharing (e.g. reusable packaging) between different actors across different supply chains (Zhang *et al.*, 2015).

2.3 | Gap Analysis

From the review it is revealed that the literature on sustainable packaging based on the concept of ZW has been gathering pace since 2009 and is replete with such topics as return/reuse and recycling practices for post-consumer packaging, comparisons of sustainable alternatives in packaging, adoption of sustainable packaging solutions and packaging waste management. However, it is possible to identify where there is room for more research, with some gaps in the literature.

Accordingly, research on sustainable packaging is following the traditional paradigms of economy-environment trade and there is limited understanding of the social dimension. Thus, while the environmental and economic dimensions are fundamental and indispensable, in future research a focus on integrating all three dimensions of sustainability together rather than focusing on one or two dimensions is paramount. As the principle of effectiveness dictates, providing social value is just as important as economic and environmental value, and can therefore be exploited to a much greater extent in order to enforce the sustainability of packaging. Furthermore, the study of packaging alternatives has been addressed in different supply chain structures, indicating that these decisions occur at all stages of the supply chain. Likewise, other studies show the importance of collaboration between the different actors in the chain for economic and environmental sustainability, not only in the eco-design of packaging but also in the adoption of common practices (standardisation of packaging (Ko *et al*., 2012), return packaging management (Li *et al*., 2014), asset sharing(Zhang *et al*., 2015), etc.). However, although this valuable conclusion has been reached, cooperation and collaboration between all players along the supply chain is the recipe for making packaging processes more efficient, effective and thus sustainable for all, there are still no cases of packaging system alternatives designed and integrated in this way. Therefore, there is scope to address these concerns at a more integrated level, opening space for research to address further innovations in the adoption of sustainable supply chain practices concerning packaging throughout the chain and not just at some levels.

Another relevant aspect to mention is the fact that the vast majority of studies use the food and beverage industry and B2B processes (considering only secondary and not primary packaging) as the basis for the study. Consequently, there is an overriding need to consider more specific studies for other industries and especially regarding B2B processes, as concerns about sustainability and packaging needs vary between different industries and markets.

3 | Methodology and Results

When it comes to solving or finding solutions to sustainable problems, in recent times there has been great interest in studying frameworks for facilitating and guiding the process. Accordingly, several methodological frameworks have been developed and applied that have combined different methods so that actionable knowledge or, conversely, evidence-based solution options for sustainability challenges can be generated (Wiek and Lang, 2016). An example of a framework created on the basis of these guidelines is the framework, called TRANSFORM, which integrates foresight, backcasting, and intervention research (Wiek and Lang, 2016).

This framework was designed for developing solution options for sustainability problems and eventually to transform the status quo toward sustainability (Wiek and Lang, 2016). It entails two corresponding, yet reverse and complementary, research streams:

The first is foresight, in which researchers analyse and assess past and current states of the problem, as well as project the problem into the future to depict the diversity of plausible future states. These are called descriptive scenarios, i.e., scenarios describing possible developments starting from what is known about current conditions and trends (Swart et al., 2004). The second stream is backcasting, in which researchers construct and assess sustainable future visions, as well as trace these visions back to the current state of the problem (pathways). Finally, researchers design and test transition and intervention strategies that contribute to mitigating the current state of the problem, achieving the sustainable visions, and actively avoiding undesirable scenarios.

Therefore, based on these guidelines, it was a created a unique framework with different methods for this study, as presented in Figure 1.

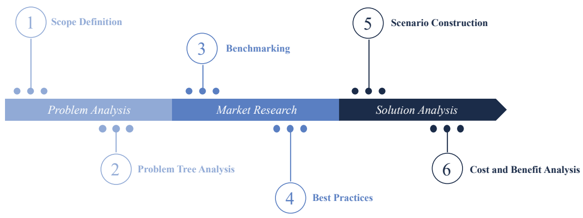

Figure 1: Methodology overview

This proposed framework follows three main categories: the analysis of the problem that includes the definition of the scope and the analysis of the problem tree, then a market research where a benchmarking will be carried out, and finally a solution proposal analysis, addressing scenario building and scenario assessment.

3.1 | Scope Definition

Starting with defining the scope, the boundaries of the problem are established by defining the packaging level, packaging material, industry/sector, and the market.

The study will be focused on primary packaging, since it is the fastest disposable category because, once used the product it contains, generally ceases to function it is disposed, creating waste. The plastic has been selected as the packaging material to be studied. The choice of this material is due to plastic production and consumption growth in the past years, which has led to high environmental impacts.

In terms of industry, the industry chosen will be the beauty, personal care and cleaning products industry since it was a gap found in the literature review according to the industries predominantly studied. Additionally, 90% of the packaging used, in this industry, is plastic and, as they are not food products, all food hygiene issues can be removed from the study.

Finally, the chosen context will be retail stores as these are the places where the majority of the packaging with these products is available and bought by the consumers, and where very few, especially successful advances, have been achieved in combating packaging waste.

3.2 | Problem Tree Analysis

Already having the scope defined, it is then possible to initiate the attempt to discover the causes of the problem characterized in earlier chapters, since it is crucial to first identify what are the root causes of the problem so that a solution can be proposed. To do so, it is thus necessary to perform a Problem Tree Analysis, following four main steps: i) Choice and characterization of a concrete problem; (2) Data collection; (3) Construction of tree; and (4)Analysis of tree.
Accordingly, the choice of the problem was translated into question: Why are the systems not adopted by the mainstream? Then, the aim was to collect important and direct causes of this problem by carrying out focus group discussions. Therefore, different causes for the different stakeholders were realised.
Although the construction of the trees has provided crucial information in terms of the various causes that prevent the implementation of these systems for each actor, many of which are rather difficult to address, it was conceivable to find a vital common pattern in the causes among the four trees. This pattern is the result of the existence of a root cause, in all of them, which depends on implementation of the system by all other actors. Accordingly, even if it is possible to tackle all the other root causes of one of the actors, apart from dependence on the others, if there are still valid reasons for not being adopted by the others, the system will not work.
This dependence thus reveals the requirement for some kind of collaboration and commitment between the different actors for this type of solution to be viable. Consequently, every root cause of each player is equally important and must be solved within the new solution, so that there is even a chance of it to work.

3.3 | Benchmarking

In this section the aim is to find and study other initiatives that promote reusable packaging systems other than the known and already studied zero waste stores. Thus, it will be analysed initiatives which, although not operating in the mainstream, have been developed in recent years to tackle the problem of packaging waste through reusable packaging.
This analysis will focus on characterising the context of each initiative, understanding whether the problems encountered in the previous section also remain and, finally, analysing what benefits each initiative offers. Finally, based on this assessment, it will be possible to identify which best practices must be a part of the reusable packaging system to be proposed, in order to ensure its success.
The Benchmark method allows to assess all these aspects in order to identify new benefits of these systems and how they can be obtained, as well as learn successful practices for the discovered causes of the problem. The analysis will follow the five steps mention in the methodology: Study Planning, Data Collection and Data Analysis.
For the Study Planning, in terms of parameters, it was identified nine problematic aspects , based on the findings of the above analysis, and four main advantages that this should offer: (1) Purchasing habits change inconvenience; (2) Time constraints; (3) high upfront investment; (4) Collaboration need; (5) Lack of incentives; (6) Lack of economies of scale; (7) Logistics complexity; (8) Safety and hygiene ;(9) Brand recognition; i) Customization; ii) Operations optimisation; iii) Brand loyalty and customer retention and iv) Reduced Waste.
Several initiatives were then analysed according to these parameters and these were the results:

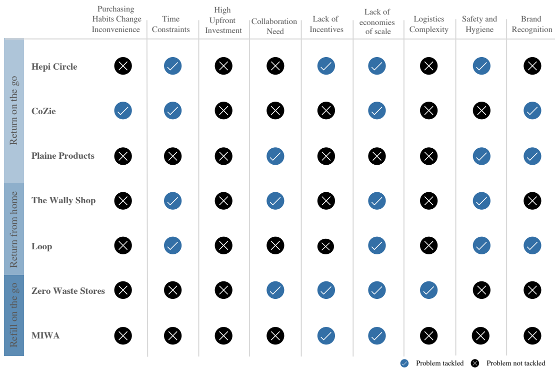

Figure 2: Systems' issues benchmark

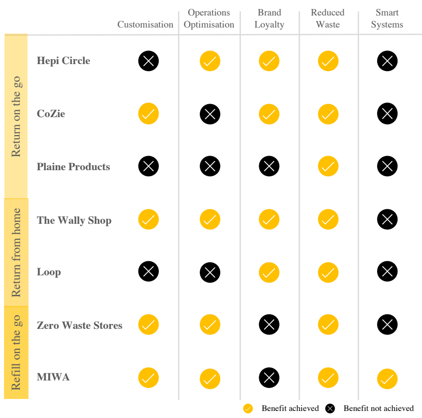

Figure 3: Systems' benefits benchmark

3.3 | Best practices

Based on the previous analysis' results, it is time to outline and recommend the essential features of reusable packaging systems that must be part of the future proposal of their implementation in the defined context. Thus, there are six lessons learned that need to be implemented:
No.1 Incentives: Implement long term rather than short term incentives policy for consumers, which leads to solving the problem of incentives, while providing brand lock in. Of the initiatives studied, the best way to provide this incentives policy is to encourage the exchange of used packaging in good

condition for discount vouchers in future purchases. This exchange does not even require human resources, as there are already deposits with a certain technology that allows for the inspection of packaging and printing vouchers (Zhou et al., 2019).

No.2 Consumption habits: Consumers want to go to the traditional stores and collect products already packed, instead of having to bring their own packages, fill the packages or replace them elsewhere out of hand. This type of solution will solve, on the one hand, the problems of inconvenience, waste of time and hygiene for consumers and, on the other hand, the complexity of logistics at some level for retailers and suppliers as the major changes to be made will be in the reverse process of the system rather than the conventional direct process.

No.3 Collection of used packaging: To avoid additional inconvenience and waste of time for consumers as well as to provide logistical ease for those responsible for the reverse process, the collection of used packaging has to take place at the retailer. If so, the collection becomes easier, since there is no need to create new channels as retailers already have direct access to consumers, while the whole return process is much more convenient for consumers, as they would already have to go there for their usual retail store.

No.4 Safety and hygiene: The washing and filling of reusable packaging must be the responsibility of entities accredited for this purpose and not the responsibility of consumers. This allows to solve the problem of safety and hygiene, as well as avoid problems of inconvenience and time for consumers, since they will not have to concern themselves with these tasks.

No.5 Type of packaging and brand recognition: The reusable packaging to be used in the system must be standardized, washable and easily transported. This way, it will be possible to ensure economies of scale and optimize operations, not only in the reverse process, but also in the direct process. However, suppliers and brands will have to explore the possible ways of washing packaging in order to differentiate packaging from different products but without hindering the optimization of washing different packaging. In this manner, it will be possible to prevail the recognition of brands with different packaging without being completely disparate in their standardisation.

No.6 Collaboration and logistics complexity: The complexity of logistics becomes somewhat immutable for this type of system owing to what must be accomplished according to lessons No. 2, 3 and 4. Accordingly, if consumer habits are to remain as normal as possible, the reverse process must be the most consumer-friendly achievable and therefore inevitably fall under the responsibility of accredited entities and not be left to consumers, as with typically zero waste shops. However, by doing so, the logistics involved becomes one of the main challenges of reusable packaging systems, since it is necessary to create a whole consumer-friendly reverse process, non-existent until now, for the collection of packaging, its inspection and washing, and its re-entry into the conventional direct process. Nonetheless, this logistics, if shared between the different players in the supply chain, can be streamlined.

On the one hand, with reverse logistics activities being shared, each player can adopt the activities that are most synergistic with its core activities, resulting in a lower logistical management requirement as well as wider cost dispersion and initial investment between the different supply chain players. However, as seen above, collaboration may be the key to the problem but also the most difficult to achieve because, while each actor has fewer activities and responsibilities, they will all become more dependent on each other and therefore only with more incentives (or suffering greater external pressure) will they enter this game of dependencies. Thus, when it comes to the complexity of logistics and collaboration, possible scenarios will have to be studied in order to find a balance that pleases all stakeholders.

3.4 | Scenario Construction

Given the identified root causes of the problem, as well as some of the crucial practices for the success of these systems, it is time to start thinking about solutions. However, with this input alone, it is not yet possible to visualize an optimal solution but several solution options. This way, three scenarios were created:

<u>Scenario 1: Switch-pool system</u>

Based on Kroon and Vrijens (1995), switch-pool systems are based on every player having their own containers and therefore being responsible for them as well as for all activities related to their management, while the carrier is only responsible for the transportation of goods between players. Thus, the first scenario can already be assumed where packaging suppliers, retailers and manufacturers have to have their own packaging and be responsible for all the reverse process activities, while transport is carried out by a 3PL. However, as identified in lesson No.4, consumers cannot be left in charge of any activities related to packaging hygiene, so this player is excluded from taking responsibility over the reverse process activities. Once these guidelines have been defined, it is time to design a concrete and realistic scenario for the actual retail context and taking into account the lessons No.1, No.2, No.3, No.4 and No.5 identified in the best practices' analysis. Hence, in order for the retailers and manufacturers have their own packaging, the proposed system is based on the flow of two types of packaging, define by "bulk" packaging (BP) and "individual" packaging (IP). Thus, in this scenario, manufacturers will buy, from bulk packaging suppliers, large packaging to fill with their product in bulk. Then, they send these containers to retailers, where they will empty them into their individual packaging, which they bought from individual packaging suppliers, for sale to the public. Then, as soon as the manufacturers' containers are empty, they are sent to the manufacturers' facilities for inspection, washing and refilling.

In turn, consumers, after consuming the products, return the individual packaging to retailers, who inspect and wash them for reuse. Thus, manufacturers are only responsible for the management, maintenance and cleaning of bulk packaging and retailers are responsible for individual packaging.

However, as the cycle also has to be closed with the packaging suppliers, in case the packaging is not suitable for reuse, retailers and manufacturers will then sell it as scrap to the suppliers, who will recycle it and transform it into new packaging, thus closing the cycle.

Scenario 2: Depot system

On the other hand, depot logistic systems consist of the reverse process being controlled by a central agency, as well as the ownership of the containers (Kroon and Vrijens, 1995). Thus, the central agency is responsible for the return of the containers and all reverse activities after they have been emptied by the recipient, whereas the other players do not need to make changes to their activities. In terms of who pays for this service, the system is coupled with deposits, thus the manufacturer pays the agency a deposit for the number of containers delivered to his site. Then, the manufacturer debits to his retailer for this deposit, who does the same in their products for also debit on consumers. At last, the moment the containers are returned, there is a refund of the deposit to the party from which the containers were collected, resulting in terms of vouchers for the consumers and a payment to retailers when they are collected by the central agency. Although the suppliers don't enter in this scheme because they supply new and not reused packaging, when the packaging is not suitable for reuse, the central agency will then sell it as scrap to the suppliers, who will recycle it and transform it into new packaging, thus closing the cycle.

Scenario 3: Transfer system

Regarding transfer systems from Kroon and Vrijens (1995), the sender is fully responsible for tracking, management, cleaning, maintenance, storage, as well as stock level of containers, that is all reverse activities, except for the transportation. Furthermore, in addition to most of the responsibilities being borne by the suppliers, they also hold the containers ownership.

Although the packaging suppliers and the manufacturers can be considered as senders from the 5 identified actors, for this scenario who will have all these responsibilities will be the manufacturers, since they will have easier and less costs in managing the reverse process because they are not at one end of the supply chain like the packaging suppliers.

3.4 | Cost and Benefit Analysis

On the basis of the scenarios created, collaboration is crucial, so this section aims to assess the benefits and trade-offs of implementing the scenarios' systems for each of the stakeholders. In a first qualitative analysis and in a second more profound quantitative analysis, in order to scale the burdens and benefits of the system for each of the stakeholders. Based on the results, it will then be possible to assess, based on the benefits versus drawback, whether the players have more to gain or lose in implementing the system and thus assess its feasibility. The ultimate goal is to find a scenario that maximises the interests of each stakeholder.

3.4.1 | Qualitative Analysis

The first approach can be classified as qualitative, seeking perceptions, and understanding of the general nature of an issue.

Overall view of Scenario 1

It follows that there is one possible beneficiary, the retailers, and one possible loser with this system, the manufacturers. However, as seen above, these systems only go forward with the willingness of all the actors involved as they are dependent on each other as found in the first analysis of this study. Thus, as retailers need products to sell, and as manufacturers do not want to lose their brand power, this scenario is hardly workable.

Overall view of Scenario 2

This scenario, as before, presents a great disadvantage for manufacturers, the loss of brand recognition through packaging. Moreover, retailers do not have great advantages by adopting this type of systems, with the advantages remaining merely for the 3PL company, making the service more expensive. Thus, although the problem of logistics complexity is solved, leaving all reverse logistics 'activities to an external company, the remaining players do not benefit greatly from the system, becoming a system unlikely to be implemented unless by the external pressure of mandatory regulations to reuse packaging.

Overall view of Scenario 3

In short, this scenario offers good opportunities as well as less good aspects for all interested parties. However, there are no crucial features for the exclusion of this scenario since it guarantees all five factors of success studied and no further major drawback for any of the players has been encountered.

Nonetheless, it is not yet possible to classify this scenario as viable since it has not been assessed whether the benefits outweigh the risks.

Accordingly, in this analysis it was possible to conclude that neither scenario 1 nor scenario 2 present considerable benefits to the different stakeholders and thus promote its implementation, mainly because several of the problems identified in the problem tree analysis remain to be solved. This leaves only scenario 3, which although it presents advantages to the various stakeholders, the question of whether it is economically feasible remains to be analysed.

Therefore, the next section will present a quantitative analysis in terms of gains and costs in order to evaluate the economic feasibility of the system.

3.4.2 | Quantitative Analysis

Based on the previous analysis, this section will serve to further analyse the feasibility of Scenario 3, since it is the only one that does not compromise the root causes identified in the problem analysis, as scenario 1 and 2 do, which makes it unfeasible.

Accordingly, the aim of this analysis is to assess if scenario 3 is economically viable by quantifying the additional variable costs and revenues from the addition of the reverse logistics, which will enable to understand their dimension. For that, a cost-benefit model of reverse logistics constructed by Chen (2012) will be employed. This model enables precise computation of the costs and benefits of reverse logistics to facilitate enterprises implementing reverse logistics to better reduce their reverse logistics costs and enhance the overall operational efficiency of reverse logistics.

Therefore, in a first stage it will be identified the variables and its components for computing the model. Hence, in a first stage it will be defined the variables and cost and revenues components for computing the model, then the characterisation and data collection process for each variable's component and, finally, the analysis of this data based on the proposed scenario.

In terms of variables, there are cost variables and benefits variables. The cost variables are:

Collection Costs (CC) – the reverse logistics starts with collection work, which results in transportation costs (CL). However, due to the characteristics of the proposed scenario, there is an additional collection cost that should also be taken into account, the cost of the return fee (CF) given to consumers depending on the good condition of the returned packaging, which corresponds which corresponds to the component of payment for residue value proposed by the author for this variable.

Testing and Classification Costs (CT) – testing and classification is an essential procedure in implementing reverse logistics, since it dictates the next stages of the items according to their classification. The more detailed the testing and classification work is, the easier the following processing can be while the higher the testing and classification costs can occur. The collected items can usually be classified into reconditionable (reusable in this case) items, renewable materials, and waste material.

Washing Costs (CW) – collection and testing in reverse logistics belong to the investment portion with no benefit reflected, but it is the preparatory work for the following remanufacturing and material recycle where benefit of reverse logistics is realized. Remanufacturing costs mainly include refurbishing costs, which, in this case, corresponds to the washing process of the packaging collected and tested as reusable.

Environmental Protection Costs (CE) – due to technological and economic reasons, non-recyclable waste will exist in the reverse logistic process, ending up in two disposal mode of the wastes: landfill or incineration. The cost of incineration (CI) refers to depreciation of fixed assets and manpower costs during the incineration, and landfill costs (CL) refers to the manpower costs and environmental penalties, etc., which vary with the grade of the wastes.

New Packaging Acquisition Costs (CP) – although not included in the list proposed by Chen (2012), in the scenario constructed, it will be necessary to change not only the composition of the packaging used but also the quantity purchased for the direct process. Thus, although it is not a direct cost of the reverse process, it depends on the reverse process as the amount of new packaging purchased will depend on the amount of packaging collected and able to reuse. So, the cost of acquisition of new packaging will also be included in the analysis.

Holding Costs (CH) – With the reverse process, retailers now have to store the collected packaging until it can be cost-effective transported to the manufacturers' premises. This storage requires space and management, so it also has to be contemplated and calculated as a cost.

In terms of benefits, according to Cheng (2012), there are three categories of quantifiable benefits of reverse logistics:

Packaging Purchasing Savings (RP) – this revenue includes the saved costs from reuse of items in production, in this case reusable packaging.

Material Reproduction Revenue (RM) – As not all packaging is suitable for reuse, some according to certain criteria may be sold as plastic scrap. Since in this case there isn't a mixture of plastics, the plastic scrap can be directly sold to plastic packaging suppliers and achieve sales revenue.

Environmental Protection Benefit (RE) – One of the most important drivers for the implementation of reverse logistics is environmental protection. The environmental protection benefit of reverse logistics is shown in the decrease of waste and the recycle of resources.

Moving on to the final stage of this analysis, the aim is to calculate for these variables and analyse the data collected and draw useful conclusions on how this system scenario can prejudice or benefit its players.

However, as outlined by what characterises a transfer system, Scenario 3, manufacturers have ownership over the system and thus responsibility for managing all system activities. However, what if there were another scenario, apart from those discriminated by Kroon and Vrijens (1995), in which retailers were not outsourced but were fully responsible for the activities they operate, assuming all costs?

Hence, a possible scenario is that all activities, even if carried out by retailers, are covered by the manufacturers, incurring all costs and profiting from

the additional revenues. This can be defined as a new scenario A.
On the other hand, as retailers will operate some of the activities, in particular the collection of packaging and its storage until its transport to the manufacturers' premises, in view of optimizing the activities and ensuring that they are being conducted as efficiently as possible, a way of creating this pressure is for the costs to be borne by the entity that is operating the activity, i.e., the retailers.
Therefore, this scenario of cost-sharing can be identified as scenario B of this analysis.
Considering these two scenarios, the results obtained can be consulted in Figure 4:

	Scenario A		Scenario B		
	Supplier	Retailer	Supplier	Retailer	
Total Costs per item processed	0.348	0	0.275	0.074	€/item processed
Total Revenues per item processed	-0.120	0	-0.120	0	€/item processed
Total	0.229	0	0.1547	0.074	€/item processed

Figure 4: Total costs per item processed

For Scenario A, it was considered that all costs were incurred by the manufacturers and the cost of the reverse process activities, already accounted with the revenues benefited, is 0.22 cents additional per processed package, i.e., entering the direct process. On the other hand, for Scenario B, manufacturers would incur an additional cost of 15 cents per packaging processed and retailers an additional cost of 7 cents per packaging purchased from manufacturers.
Although not accounted by this model, retailers will have the opportunity to increase customer retention due to this model of discounts on packaging collection. Additionally, if these discounts have an end-date they could also boost consumer consumption. Therefore, although it is difficult to account for these possible additional revenues, these additional 7 cents per package does not present a figure that prevents the system from being viable, but rather a door to test it. Nonetheless the more tangible costs taken on by retailers, the more power they will have to negotiate over manufacturers, especially now that they will be even more dependent on retailers, because without them it will not be possible to collect the packaging and this system only works if a considerable amount of packaging can be reused.
In terms of manufacturers, in order to understand better these 15 additional cents per packaging that they would have to incur, and to see if there is room for improvement, the different types of costs have been analysed.
Accordingly, it is the washing and packaging acquisition costs which entails the highest contribution for the total cost of reverse process carried by manufactures.
As far as the washing process is concerned, there is room to make the process more efficient. As all the packaging that has passed only the first inspection is washed, 30% of the washed packaging is still not reused after washing and therefore would not need to go through this process. Therefore, if the inspections could be adjusted so that only the packaging that will be reused is washed, the costs would be lower as there would be less packaging to be washed and a second inspection would no longer be necessary.
In terms of purchasing new reusable packaging, since manufacturers do not produce their own packaging, they are at the mercy of the market and can only try to find the most competitive price in the market. However, this cost, while becoming part of the reverse process, replaces a direct logistics cost, the purchase of new disposable packaging. Therefore, by performing a sensitivity analysis and varying the percentage of the price of disposable packaging from that of reusable packaging, the results show that it is possible to reduce costs considerably and even reach a level where there is no additional cost.
In short, this final analysis shows that Scenario B is the ideal one, since the costs can be dissolved by the two players, but neither of them will lose with this collaboration. While retailers will gain even more negotiating power and a new marketing strategy to retain and attract customers, producers have maneuverer for improvement and that according to the negotiation of good prices for reusable packaging, it is manageable to eliminate almost entirely the additional costs due to savings from the purchase of disposable packaging.
Therefore, the main conclusion of this last analysis is that the results obtained demonstrate that the magnitude of the additional variable costs of this proposed system are not a hindrance to starting to develop the system and to carrying out a case study in practice.

4 | Limitations, Conclusions and Future Work

Although reusing packaging seem to offer many advantages, the retail context is still hesitating and has encountered obstacles to its implementation. To bridge this gap, it was decided to study this problem, understanding why it is not put into practice and developing an innovative system for the reuse of primary packaging that mitigates all the root causes found, so that retail stakeholders have no reason not to adopt it and thus help reduce the waste of plastic packaging.
First, an analysis of the problem was carried out and it was perceived that the majority of the reasons outlined for each actor are common to all system participants and that there is pattern, in all of them, which is each actor is dependent on implementation of the system by all other actors. This dependence thus reveals the requirement for some kind of collaboration and commitment between the different actors for this type of solution to be viable. Based on the general root causes for the various actors, the market was analysed for other initiatives which in some way practise packaging reuse systems. From this reference, it was possible to conclude which best practices should be present in the system to address the root causes identified and thus achieve the desired success. The

main lesson learned is that the new system cannot require a change in consumption habits as society does not yet prevail and recognises sustainability to lifestyle inconvenience.

Thus, several system scenarios were constructed adapting the reverse logistic designs studied in the literature review according to the best practices identified and the actual context of the problem. After 3 scenarios were created, the three were evaluated qualitatively and it was perceived that the first two did not only benefit some of the players in the system, being impossible to convince the others to collaborate in a system that does not benefit them and on the contrary makes their business weaker.

However, system 3 has proven to be beneficial for all stakeholders crucial to its implementation, and a final quantitative analysis has been carried out to analyse the economic viability of the system. From this analysis, the results obtained demonstrate that the magnitude of the additional variable costs of this proposed system are not a hindrance to starting to develop the system and to carrying out a case study in practice. Moreover, it has been realised that with greater collaboration, it is possible to dissolve the costs between the actors and, in an attempt to make the processes more efficient, it even becomes possible to almost eradicate the costs to the producers' side, which is the player that holds the greatest responsibility for the process.

Nonetheless, although the results present good news for combating plastic waste, they were obtained based on many different assumptions. Due to the current state of the pandemic, it became impossible to conduct detailed interviews and a proper case study for the analysis and validation of the proposed scenario as the winner. Thus, both the root causes of the problem and the feasibility analysis of the scenario are underlying a collection of secondary and not primary data, so it will not be possible to assume 100% of the result obtained.

Accordingly, two main areas for future research are suggested. First, it should be sought to work on agile methodology and design this system together with the main stakeholders, i.e., retailers and producers. In this way, it would be possible to obtain throughout the process, and not only at the beginning, the obstacles and their opinion regarding the system that is being created. With their continuous input, besides being possible to create an improved system, it makes them part of the process and this involvement will make it easier to accept and implement the system created, since it was also created by them and with their perspective.

In addition, the validation process of the constructed scenarios should be extended to a real case study. By replacing secondary data with primary data from a real case study, it would increase the reliability of the results and allow the generalization of better-founded hypotheses. Finally, ideally the last step in order to achieve the most evidence-based results possible would be to implement the system in practice in a trial period and analyse the results obtained, in terms of the opinion of all intervening players, i.e., packaging suppliers, manufacturers, retailers and consumers.

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