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Review Article

A literature review and analytical framework of the sustainability of reusable packaging

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A B S T R A C T

Over 161 million tonnes of plastic packaging is produced annually, yet only a small fraction of plastic packaging is recycled. To help eliminate unnecessary plastic packaging and its associated pollution, interest is growing in reusable packaging systems, such as returnable and refillable packaging. However, it cannot be assumed that reusable packaging systems will be more sustainable than single-use alternatives. This article conducts a literature review of 107 articles on reusable packaging to develop an analytical framework that identifies 22 major factors which influence the sustainability of reusable packaging systems. This framework helps readers to better understand the complex interplay between the environmental, economic, social and technical aspects which affect the implementation and scale-up of reusable packaging solutions. The findings highlight that customer acceptance and retention is key to unlocking long-term sustainability. In addition, improving the return rate of reusable packaging, shortening the supply chain and increasing system standardisation are important factors for enabling sustainability. Switching from single-use to reusable packaging systems involves a complex systems change that requires greater collaboration between industry stakeholders, as well as greater academic collaboration between different disciplines. To progress the field, the authors call for future research to incorporate more multidisciplinary perspectives, which may include perspectives from product-service system design, circular design and policy roadmapping.

Contents

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1. Introduction

Plastics are ubiquitously used in packaging because of their lightweight, durable, low-cost and protective properties. However the negative environmental and socio-economic impacts of single-use packaging are of growing concern. According to estimates by the World Economic Forum (2016), plastic production accounts for 4–8 % of global oil production. Of this, single-use plastic packaging accounts for 40 % of all plastic produced, with over 161 million tonnes produced annually (Parker, 2018). Coupled with the rapid growth of e-commerce, the use of single-use plastic packaging is predicted to increase over the next decades (Escursell et al., 2021). This is a problem since in Europe, only 80 % of plastic packaging is recovered and 40 % of plastic packaging is recycled (Eurostat, 2022). Globally, it is estimated that almost a third of plastic packaging leaks from collection systems, polluting the environment (WRAP, 2022). Plastic packaging that leaks into the environment poses a major threat to planetary boundaries, leading to changes to carbon and nutrient cycles, habitat changes within soils, sediments, and aquatic ecosystems (MacLeod et al., 2021). Preventing unnecessary single-use plastic packaging waste is key to meeting UN Sustainable Development Goals (SDG) 14 and 15 which respectively focus on the protection of seas and oceans, repairing ecosystems on land, as well as SDG 12 on enabling sustainable consumption and production (United Nations, 2022).

Conventional efforts to reduce single-use plastic packaging have focused on material substitution i.e. switching petroleum-based plastic for less harmful materials. In this respect, significant attention has been paid to the development of alternative materials such as bioplastics. A bioplastic may include a biopolymer that is biobased, biodegradable or both (Nandakumar et al., 2021). It a common misconception is that bioplastics can be disposed and degradation is guaranteed. However, not all bioplastic are biodegradable. For example, bioplastics such as Bio-PET are considered bioplastic because they are biobased as the monomers are produced from corn, but the polymer has the same properties as conventional PET, which makes the resulting polymer non-degradable (Prieto, 2016). Some biodegradable materials require specific conditions to start the degradation process. As such, bioplastics must be separated from conventional plastic waste to achieve the optimal rate of degradation, which causes further challenges in waste management.

In the search for more radical solutions, the Circular Economy has been identified as a key strategy to tackle single-use plastic pollution (Johansen et al., 2022). The Circular Economy is defined as "a regenerative system in which resource input and waste, emission, and energy leakage are minimized by slowing, closing, and narrowing energy and material loops" (Geissdoerfer et al., 2017). The model of the Circular Economy defined by the EMF shows that the maximum value of resources can be achieved when focusing on inner material loops such as product life extension or reuse, when compared to remanufacture or recycling (MacArthur, 2013). The Circular Economy is also commonly associated with the decoupling of economic growth from resource consumption through the implementation of Product-Service Systems (PSS) (Kühl et al., 2018). PSS are business models that enable the delivery of products and services, through which providers can create and capture value without increasing product sales (Tukker, 2004). In the packaging context, it is believed that the Circular Economy and PSS could help to enable alternative packaging solutions, such as reusable packaging.

Reusable packaging is "packaging which has been conceived, designed and marketed to carry out multiple trips in its lifetime by being refilled or reused for the same purpose for which it was conceived" (EUR-lex, n.d.). The Living Landscape of Reusable Packaging Solutions (n.d.) database now including over 800 global reusable packaging solutions. For example, LOOP, a global platform for reusable packaging, which has partnered with several major retailers in the US, UK, France and Japan to deliver returnable packaging solutions for a range of food, grocery, beauty and homecare products (Loop, 2022). In Chile, start-up Algramo has launched an affordable, smart technology refill system that helps to eliminate single-use plastic sachets (Marchant, 2021). Similarly, Packoorang is a Norwegian company that offers a closed-loop reusable packaging for e-commerce providers, using an Internet of Things (IoT) track and trace system (Ecobahn, 2020). To this extent, e-commerce could catalyse innovative alternatives to single-use plastic packaging through the creation of a new PSS and business model.

Whilst reusable packaging is gaining momentum, it cannot be assumed that all reusable packaging will necessarily lead to sustainability benefits (Coelho et al., 2020). Circular rebound effects may emerge whereby unintended consequences undermine sustainability (Zink and Geyer, 2017). According to Castro et al. (2022), the recirculation process may actually increase energy and material inputs, or even lead to increased consumption behaviours, whereby consumers will be more of a product if they know there is a possible recirculation route. For instance, it is possible that reusable packaging systems may reduce waste, but lead to increased energy use during transportation, sorting and cleaning. In other cases, the various dimensions of sustainability may not be fully aligned. For example, some forms of reusable packaging may lead to environmental benefits, but may not be sustainable from a socio-economic perspective. For example, D'Adamo and Lupi (2021) introduce the concept of the circular premium, which describes the difference between the circular price and the normal price. There is no guarantee that consumers will be willing to pay a circular premium for reusable packaging, which may undermine the sustainability of these circular systems. It is clear then that potential negative impacts and sustainability trade-offs need to be fully considered across the reusable packaging life-cycle. Measuring circular rebound effects has mainly extended to the application of Life Cycle Assessments (LCA) in order to conduct so-called environmental footprints (van Loon et al., 2021). However, this tends to overlook economic and social aspects that are pre-requisites to sustainability.

The state-of-the art on reusable packaging fails to properly address the issue of circular economy rebound effects, especially beyond consideration of environmental impacts (Coelho et al., 2020). This is a problem since there is the risk that reusable packaging solutions may lead to unintended negative sustainability impacts that undermine the circular economy. Hence, in order to better tackle potential circular economy rebound effects associated with reusable packaging systems, this study aims to identify the factors that constrain and enable the sustainability of reusable packaging systems, considering environmental, economic, social and technical dimensions. This research is critical to the effective implementation and scale-up of reusable packaging systems. The study begins by synthesising disparate knowledge from across the field by conducting a literature review of the academic literature. It provides a review of extant work on reusable packaging systems, revealing important findings to support the adoption, implementation and scale-up of reusable packaging solutions. The paper is structured in the following way. First, we explain the methods used to collect and analyse the existing literature. Second, we present a descriptive analysis based on the article meta-data. Then, we present a detailed content analysis of the literature, which results in an analytical framework of the factors that influence the sustainability of reusable packaging systems. Finally, we discuss the findings and set out a future research agenda, which includes areas for further research.

2. Methods

To conduct a robust literature review, the authors consulted guidance from PRISMA (Page et al., 2021). To gather relevant papers, the following search terms were used in Scopus: ("Reusable packaging", "Refillable packaging", "Returnable packaging", "Returnable containers", "Refillable containers", "Returnable containers", and "Refill and reuse"). This resulted in a total of 384 journal papers, conference papers and reports, which were subject to the inclusion and exclusion criteria set out in Table 1. The data collection methods aimed to identify the widest range of literature possible on the topic of reusable packaging systems, and therefore no exclusion criteria was set for the publication date. Initially all the titles and abstracts were reviewed in full to see if the article met the criteria. 294 articles were excluded as they did not meet the criteria. This included articles that described the reuse of packaging for a new purpose. It was determined that these articles described the phenomenon of repurposing and were not relevant to reusable packaging. For pragmatic reasons, the authors limited all search results to English which excluded a limited number of articles in German and Spanish. The authors also removed any non-peer reviewed source in order to concentrate on the scientific literature. This meant that recent reports on reusable packaging, such as reports from EMF or Greenpeace, were not included in the formal analysis which may be considered as a limitation of the study.

Following a full-paper review of the academic literature, 17 articles were included through snowballing. As a result of this process, a total of 107 relevant articles were identified (see Fig. 1).

To begin with, article meta-data was exported from Scopus into an excel spreadsheet, including title, authors, year of publication, source title. All of the papers were analysed to extract the following information: type of reusable packaging model (e.g. refillable primary, returnable primary or returnable secondary/tertiary), industry focus (e.g. food, drink, beauty and personal care, household cleaning), geographic context (e.g. country of study), methods (e.g. survey, case study, Life Cycle Assessment), article perspective (e.g. brand/retailer or consumer perspectives), study aims and main findings. Initially, the first author used a first cycle of descriptive coding as a way to extract data from the literature (Saldaña, 2021). Particular attention was paid to identify factors that enable or constrain the sustainability of reusable packaging systems i.e. “sustainability influencers”. Descriptive coding provided a basic theme for each coded segment. For example, the following sentence from Lofthouse and Bhamra (2006) “In order to ensure that refillable packaging systems are viable, it will also be important for the packaging design to clearly communicate to the consumer how it should be dealt i.e. which system it belongs to and how it should remain in that system.” was initially coded as “communication”. The articles were annotated line by line in adobe acrobat, and then the codes for each article were documented in a database in MS Excel. To improve reliability of the coding process, multi-author coding was conducted (Weston et al., 2001). The second author read a 20 % sample of the literature, selecting articles with the greatest number of citations. The second author coded the sample articles line by line, and then added to the article database created in MS Excel. Discrepancies between the authors' codes were discussed until consensus was reached. Codes were then further grouped and refined through several rounds of thematic coding by the first and second author (Saldaña, 2021). For example, the previous coded segmented: “In order to ensure that refillable packaging systems are viable, it will also be important for the packaging design to clearly communicate to the consumer how it should be dealt i.e. which system it belongs to and how it should remain in that system.” was relabelled from “communication” to “consumer awareness”. To further group the codes, the influencers were then categorised as being related to either environmental, economic, social or technical aspects of sustainability. In the example given, the coded segment was coded as a social factor, since it related to aspects of user experience. This process resulted in a total of 22 factors and 72 sub-factors that influence the sustainability of reusable packaging systems.

Table 1
Inclusion and exclusion criteria.

Inclusion criteria
1. The literature is focused on reusable packaging i.e. packaging used for the same purpose for which is was conceived
2. The literature is focused on primary, secondary or tertiary packaging
3. Peer reviewed journal article or conference paper, i.e. **not** a report**,** press release, blog post or website
4. Literature is published in English

3. Results

This section will first provide an overview of the literature based on the article meta-data. This includes an analysis of the article focus, context, industry, data collection and analysis methods. Second, we will present the main factors that that sustainability of reusable packaging systems which are identified in the literature.

3.1. Overview of the literature

The literature identifies three main reusable packaging models (see Table 2):

(1) **Primary refillable packaging**. Consumers either refill their packaging on-the-go (i.e. in shops or in public spaces) or purchase pouches that can be decanted into their reusable packaging at home.

(2) **Primary returnable packaging.** Consumers return their packaging to the brand/retailer after use so that it can be sorted, cleaned and replenished.

(3**) Secondary/tertiary returnable packaging**. This packaging is used to protect goods during its transportation and is returned after delivery is completed in order to be replenished.

The results show that almost 75 % of articles on reusable packaging have been published within the last 10 years (see Fig. 2). Whilst the majority of articles focus on secondary/tertiary packaging ($n = 72$), there has been a recent increase in articles focused on primary packaging ($n = 36$). Of these, only handful explicitly differentiate between primary refillable ($n = 9$) or returnable packaging ($n = 3$). This overall trajectory indicates that both academia and industry are looking towards reuse as a viable option to reduce resource consumption.

The meta-data also shows that articles with a secondary/tertiary packaging focus primarily rely on quantitative data and collection methods such as Life Cycle Assessment (LCA) ($n = 13$) or system modelling ($n = 40$) e.g. mixed integer programming modelling, fuzzy logic or network modelling analysis, as shown in Fig. 3. Whilst these methodologies allow for measurable success indicators to be set, they are largely theoretical and stem from several assumptions which are not validated through case studies. Social sustainability is often overlooked. Further investigation, including through qualitative methods, is required to ensure consumer behaviour and attitudes, are considered within the design of reusable packaging systems. In comparison, articles focused on primary packaging tend to use case studies ($n = 14$), surveys ($n = 10$), and focus groups, interviews and workshops ($n = 4$), however the size and scope of these studies is fairly limited.

Overall, we find that technical perspectives are driving the research agenda. This is by majority of articles representing the fields of environmental science and sustainability (25.2 %); engineering, manufacturing and design (21.5 %); business and management (15 %) and logistics and operations (12.1 %) (see Fig. 4). There is limited representation from the fields of social sciences, arts and humanities. Design perspectives covered tend to focus on systems design or packaging design, and do not include user experience design or service design. The authors believe that this is a core deficiency in the current literature, and further work in urgently needed in these fields to advance research on reusable packaging.

The majority of articles fail to identify a specific industry or context study, with many articles discussing reusable packaging systems in abstract or theoretical domains. Out of the 52 of 107 articles which identify a specific industry-focus, the majority focus on food and drink ($n = 28$) and the automotive sector ($n = 11$) (see Fig. 5). These areas have been

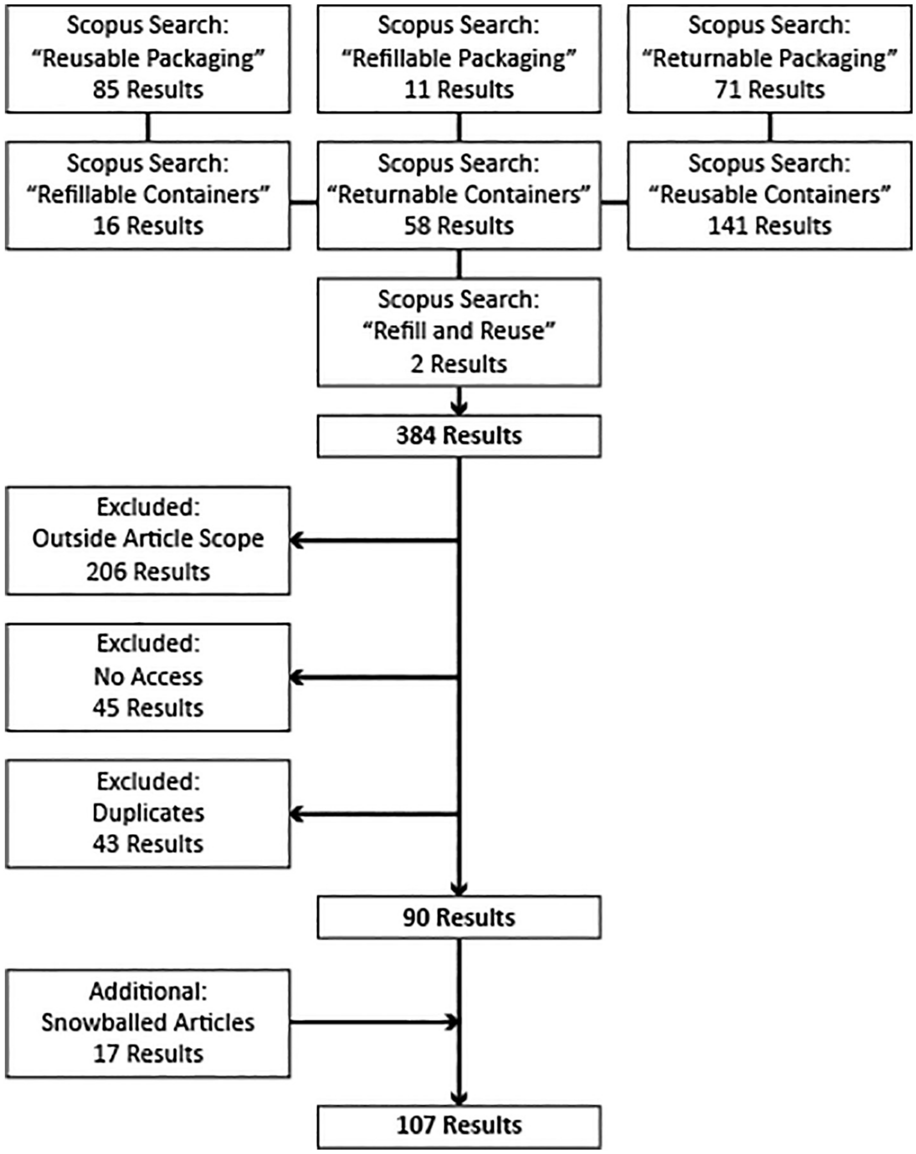

Fig. 1. Database search method.

identified as sectors with high potential for reusable packaging systems. However, with interest from pharmaceutical, homecare, and maritime industries, the authors suggest that a wider range of sector studies is needed to define the opportunities for reusable packaging. When evaluating the context of the articles, we find that the literature represents mainly high-income countries, with US (n = 23), UK (n = 13) and Italy (n = 12) representing almost half of all articles (see Fig. 6). Additionally, the top 6 contributing countries are associated with the G7, where members have committed to limit carbon contribution through the use of policy integration and technology innovation to achieve net zero by 2050 (DEFRA, 2021). It is speculated that further roll-out of local green initiatives, policies and legislation will motivate academics and private industry to advance work on reusable packaging.

3.2. Factors that influence the sustainability of reusable packaging systems

Based on the analysis of the literature, the authors present an analytical framework of the factors that influence the sustainability of reusable packaging systems (see Table 3). This framework identifies 22 environmental, social, economic and technical factors, which will be presented in the following section.

3.2.1. Environmental factors

3.2.1.1. Material selection and manufacturing. Materials used in reusable packaging and their associated manufacturing processes significantly impact environmental sustainability. Many articles highlight the importance of material selection to ensure that reusable packaging meets requirements for product durability, longevity and weight (Lofthouse, 2007; Levi et al., 2011; Greenwood et al., 2021). Both packaging weight and consumable weight are identified as key factors impacting environmental sustainability (Copeland et al., 2013). Light weighting can make reusable products more environmentally friendly (Silva et al., 2013; Lialiuk et al., 2019; Zimmermann and Bliklen, 2020). Mannur and Moreau (1992) point out that maximum allowable weight for transport should be considered during the design of reusable packaging. Copeland et al. (2013) also highlight that reusable containers can minimise the environmental impact when manufactured using lighter materials as opposed to heavy duty plastic. Zimmermann and Bliklen (2020) find that when low-density materials such as Polypropylene (PP) are used in reusable packaging, they result in fewer carbon emissions per cycle when compared to single-use alternatives.

Table 2
Focus of articles in the literature review.

Primary refillable and returnable	Beitzen-Heineke et al. (2017), Bortolini et al. (2018), Cleary (2013), Coelho et al. (2020), Ertz et al. (2017), Escario et al. (2020), Fuentes et al. (2019), Greenwood et al. (2021), Grimes-Casey et al. (2007), Hekkert et al. (2000b), Kunamaneni et al. (2019); Lisińska-Kuśnierz (2001), Langley et al. (2011), Lialiuk et al. (2019), Lindh et al. (2016), Long et al. (2020), Madria and Tangsoc (2019), McCarthy (1993), McGlynn et al. (2003a), McGlynn et al. (2003b), Muranko et al. (2020), Muranko et al. (2021), Ratnichkina et al. (2021), Tassell and Aurisicchio (2020), Tsiliyannis (2008), Wascher and Barcia (1996)
Primary refillable	Ferrara and Plourde (2003), Lofthouse and Bhamra (2006), Lofthouse (2007), Lofthouse et al. (2009), Lofthouse et al. (2017), Mills et al. (2018), Nessi et al. (2014), Nessi et al. (2015), Numata and Managi (2012), Sujai and Juwana (2021)
Primary returnable	Copeland et al. (2013), Doorsselaer and Lox (1999), Rasmussen (1984)
Secondary/tertiary returnable	Accorsi et al. (2020), Accorsi et al. (2014), Accorsi et al. (2022), Afif et al. (2007), Afif et al. (2009), Atamer et al. (2013), Baruffaldi et al. (2019), Böröcz (2022), Camps-Posino et al. (2021), Capistrano and Buluran (2021), Castillo and Cochran (1996), Chan (2007), Cheng and Yang (2005), Cobb (2016), Cordella et al. (2008), Dang and Chu (2016), Dubiel (1996), Duhaime et al. (2001), Ech-Charrat and Amechnoue (2016), Ech-Charrat et al. (2017), Fan (2019), Giubilato et al. (2019), Glock (2017), Goellner and Sparrow (2014), González Boubeta et al. (2018), Goudenege et al. (2013), Guzman et al. (2021), Hekkert et al. (2000a), Huang et al. (2008), Hurley et al. (2017), Ilic et al. (2009), Itsuki (2012), Jarupan et al., 2004, Katephap and Limnararat (2015), Katephap and Limnararat (2017), Kelle and Silver (1989), Kim and Glock (2014), Koszorek and Huk (2021), Kroon and Vrijens (1995), Lampe and Strassner (2003), Legiędź and Huk (2021), Levi et al. (2011), Mahmoudi and Parviziomran (2020), Maleki and Meiser (2011), Maleki and Reimche (2011), Mannur and Moreau (1992), Martínez-Sala et al. (2009), Mason et al. (2012), Menesatti et al. (2012), Mensendiek (2015), Mollenkopf et al. (2005), Moreno et al. (2011), Na et al. (2019), Pålsson et al. (2013), Prochazka et al. (2007), Rajae et al. (2018), Rigamonti et al. (2019), Roch et al. (2015), Ross et al. (2010), Silva et al. (2013), Singh et al. (2006), Singh et al. (2011), Singh et al. (2016), Smoljan et al. (2020), Thoroe et al. (2009), Tornese et al. (2021), Twede and Clarke (2004), Vöröskői et al. (2020), Yang et al. (2018), Zhang et al. (2015), Zhao et al. (2019)

Similarly, Copeland et al. (2013) find that reusable PP containers have a lower environmental impact when compared to single-use polystyrene (PS) foam. However, Nessi et al. (2015) find that switching from single-use polyethylene terephthalate (PET) bottles for reusable glass bottles (1 l, average mass of 475 g) with 100 uses can create an additional 5.644 t of waste. When considering packaging weight, it is typical to jump to the conclusion that an increased use of material in reusable packaging will result in an increased weight. However, there are some techniques which can be used to maximise the efficiency of reusable packaging through design features such as light weighting. This can result in system benefits, such as the limitation of transport emissions, reduced production impact, reduced shipping costs and optimised packaging performance (Copeland et al., 2013; Lialiuk et al., 2019; Greenwood et al., 2021).

In addition to material type, packaging weight and consumable weight, the literature identifies the percentage of recycled content within reusable packaging is a key factor impacting the environmental sustainability. Zimmermann and Bliklen (2020) highlight a reduction of the break-even of returnable packaging from 82 to 32 cycles due to the inclusion of recycled materials. Similarly, Greenwood et al. (2021) associates return model efficiencies with product recycled content and Camps-Posino et al. (2021) identify a correlation between recycled content and the reduction of production impact. When the recycled content is increased to 50 %, a 60 % reduction in overall impact is established (Camps-Posino et al., 2021).

3.2.1.2. Use. The usage volume is identified as an additional factor impacting environmental sustainability. Refillable (loose) detergents may require greater consumption due to lower quality, since more detergent is required per wash than single-use alternatives (Nessi et al., 2015). The size of the container can influence the amount of food being wasted (Camps-Posino et al., 2021). Aspects that make it easier to open, pour and re-seal influence how much of the packaged product will be consumed and not wasted in households, thus also affecting the potential environmental impact (Lindh et al., 2016).

3.2.1.3. Shrinkage. For returnable packaging, asset shrinkage is determined by the return rate (i.e. the percentage of containers returned by end users), the loss rate (i.e. the percentage of containers that are lost or mishandled during transportation) and the deterioration rate (i.e. the percentage of containers that are defective or broken).

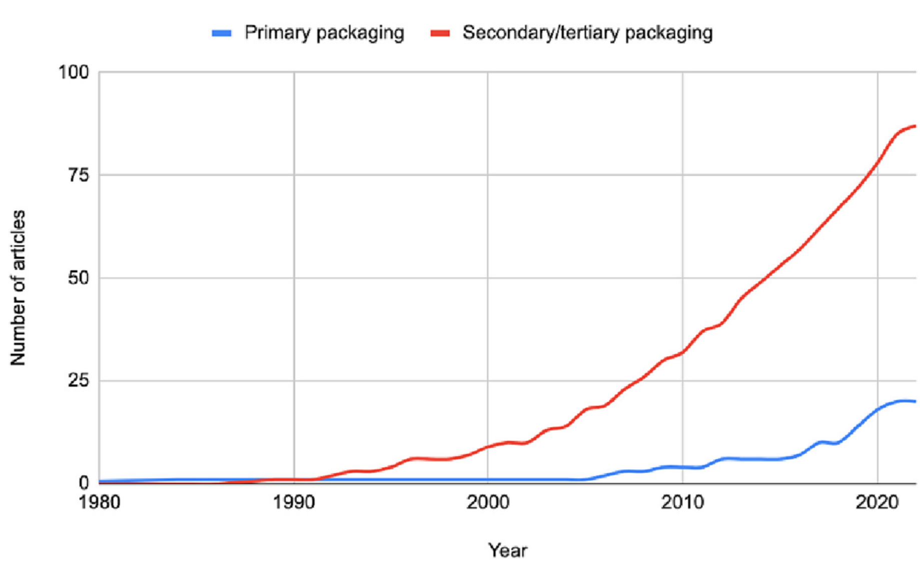

Fig. 2. Article focus on primary packaging versus secondary/tertiary packaging over time.

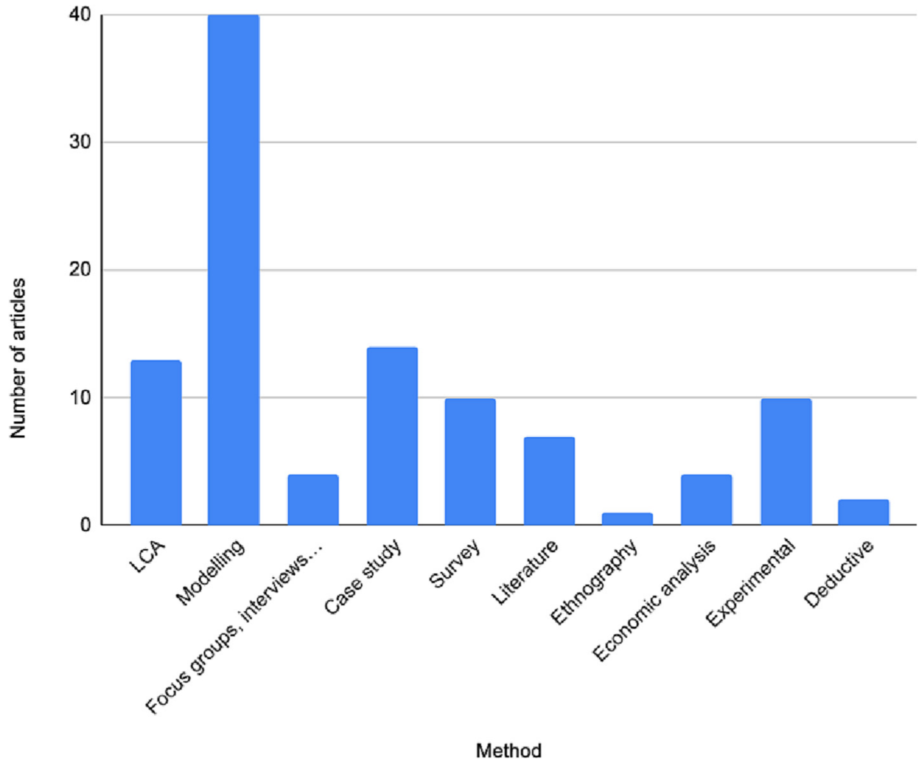

Fig. 3. Articles by main data collection and analysis methods.

It is vital that the pre-defined cycle-rate is satisfied to ensure the environmental benefits of adopting reusable packaging is met (Lofthouse and Bhamra, 2006; Kunamaneni et al., 2019). The more the user return rate increases, the greater the system's environmental benefits (Grimes-Casey et al., 2007; Katephap and Limnararat, 2017). However, user return rates are more vital for longer distances travelled due to the increased transportation impacts exhibited (Doorsselaer and Lox, 1999). Additionally, as the system is dependent on meeting the stakeholders' demand, system viability becomes dependant on sufficient return rates to ensure container volume is maintained (Atamer et al., 2013). For example, Tsiliyannis (2008) identifies that a reduced return rate of refillable glass bottles from 89.5 % to 87.5 %, can limit the system's ability to meet demand, emphasising the sensitivity of reusable packaging systems.

Whilst deterioration along the supply chain is inevitable, the rate of deterioration can be limited to ensure the optimal product life and cycle-rate is met. Damage to containers can result from the misuse, mishandling and poor transportation (Capistrano and Buluran, 2021). For example, Camps-Posino et al. (2021) shows a 30 % reduction in the lifetime of reusable food containers leads to an increased emission contribution of 14 %. Much like a reduction in product life, product misplacement or loss can also contribute to the delayed environmental benefits of a reusable system (Zimmermann and Bliklen, 2020). Increased container loss rates can be attributed to the poor management and lack of employee training within the supply chain (Maleki and Reimche, 2011; Fan, 2019; Capistrano and Buluran, 2021). To mitigate these issues, many techniques for improving efficiency are discussed, such as improving packaging traceability to reduce product shrinkage (Maleki and Reimche, 2011), and product standardisation to streamline management and logistic practices (Duhaime et al., 2001).

3.2.1.4. Sorting and cleaning. It is noted that a reduction in waste does not automatically imply a reduction in the overall energy impacts (Nessi et al., 2015). Energy and water use during cleaning can negatively impact environmental sustainability. Camps-Posino et al. (2021), determine a 50 % reduction in energy consumption during the washing

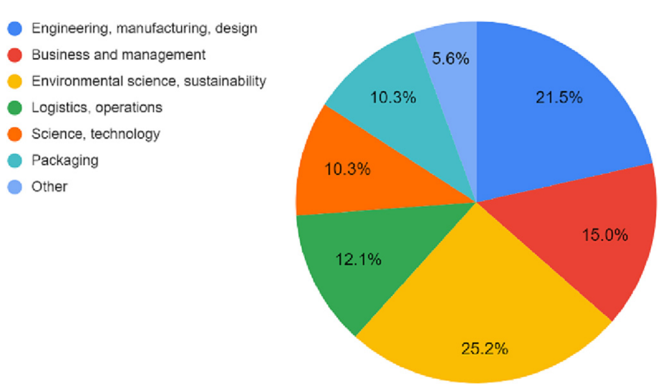

Fig. 4. Articles by field of study.

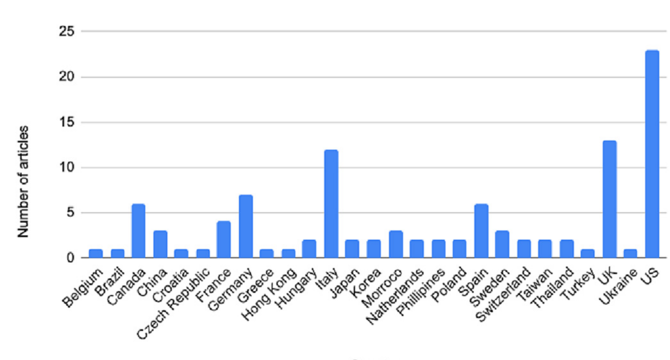

Fig. 5. Country of first author's institution.

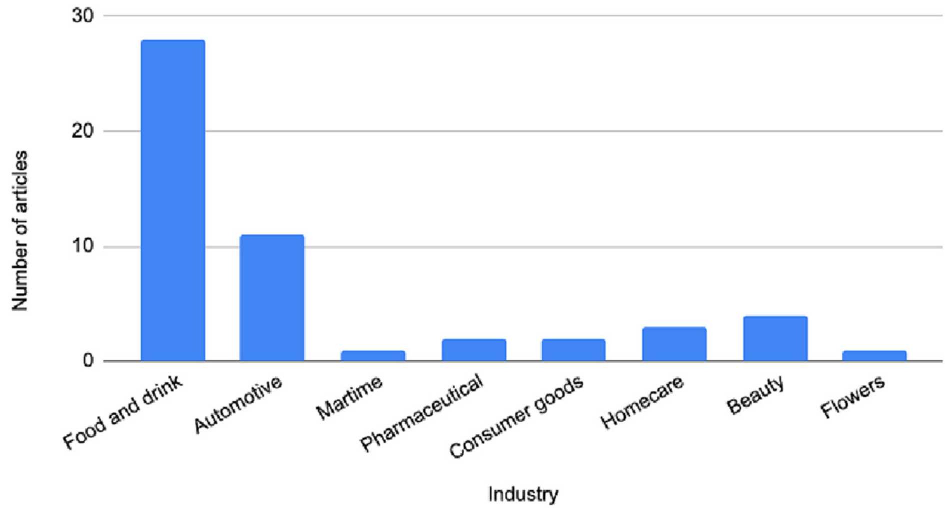

Fig. 6. Articles by industry focus.

phase of reusable food containers, can lead to a 24 % overall reduction in total emission contribution.

3.2.1.5. Transportation. It is widely recommended to maximise the transportation capacity to limit the transportation impact (Lindh et al., 2016). Increasing the product packaging volume ratio has a positive environmental influence through increased efficiency during storage and transportation (Lindh et al., 2016; Chan, 2007). For instance, Nessi et al. (2014) finds larger containers increase waste prevention for laundry detergent and fabric softeners by maximising product volume. According to Copeland et al. (2013), form and volume can also have an impact on the environmental contribution.

According to Accorsi et al. (2014), the transportation phase dominates the environmental impact of the reusable packaging system. Reducing distances travelled can improve the sustainability of reusable packaging networks. Glock (2017) points out that over long distances single-use packaging may be preferable to returnable packaging, with Cleary (2013) clarifying that shorter distances are preferable for heavier products.

3.2.1.6. End-of-life. Container and packaging loss is not restricted to the supply chain. The ability to appropriately dispose at the end of life is important to avoid the negative consequences of improper disposal. When determining the environmental impact of reusable packaging, it is vital to take into consideration the mode in which the product is disposed (Accorsi et al., 2014; Muranko et al., 2021). To limit the environmental impacts, packaging should be designed for re-manufacture, reuse or re-processing, blending into current end of life strategies to minimise improper disposal habits (Lisińska-Kuśnierz, 2001; Muranko et al., 2021). Not only can recycling at the end of life lead to reduced waste costs, circular activities can lead to an increased consumer satisfaction due to the lower waste contribution (Silva et al., 2013).

3.2.2. Social factors

Six main factors are associated with social sustainability. Within this section there is a clear emphasis on convenience, consumer perception, and consumer behaviour.

3.2.2.1. Convenience. When we examine reusable packaging from a consumer perspective, it is important to note that consumer uptake of reusable packaging is reliant on the convenience of both the use and accessibility of the system. Lofthouse and Bhamra (2006), explain how high inconvenience can result in a lower adoption rate, with current refillable solutions dependant on consumer memory (Lofthouse and Bhamra, 2006; Lofthouse et al., 2009; Fuentes et al., 2019). While convenience in its own right is an influence of consumer behaviours and perception, additional actions such as cleaning and maintenance, service location, and access and availability, play a role in convincing consumers to adopt reusable packaging systems. Particularly due to the increased actions required for facilitating the cleaning process and the current limitations in accessing deposit return locations (Lofthouse and Bhamra, 2006; Muranko et al., 2021).

3.2.2.2. Consumer perception. Consumer perception may be influenced by the functional and aesthetic design of reusable packaging, as well as the overall service experience. Lofthouse et al. (2009) advocate for a 'fun' refill experience that encourages repeat purchases and brand loyalty. Furthermore, by increasing the value added through unique interactions, greater user uptake can be achieved be achieved (Lofthouse and Bhamra, 2006; Lofthouse et al., 2017).

With regards to functional design, there is evidence to suggest that material selection can be an influencing factor when consumers are determining product usability, with consumers looking for a balance between product quality, cost and usability. Greenwood et al. (2021) explores consumer attitudes, with 37 % of consumers presenting a preference for glass products, compared to a <5 % preference for flexible plastics, films and foils. Furthermore, Lialiuk et al. (2019) show how material sustainability can influence product uptake, with consumers identifying which materials they perceive as good for the environment. They find that consumers prefer glass (33 %), cardboard (26 %), and plastic (11 %), with 27 % stating that the packaging does not impact their decision. Additionally, Lindh et al. (2016) identify packaging size, colour, information, packaging open and reseal features are key attributes. Consumers are driven to reuse by packaging aspects rather than packaging contents (Greenwood et al., 2021) and if the packaging is useful to the consumer, the consumer will reuse the packaging (Madria and Tangsoc, 2019). In terms of aesthetic design, greater emphasis on aesthetics which can increase consumer-producer attachment (Kunamaneni et al., 2019). Packaging should adopt eye-catching graphics to increase user uptake/interest, with packaging placement also impacting uptake rates (Hurley et al., 2017). Notably, 70 % of the purchasing decisions are taken by the consumer directly at the point of purchase (Lialiuk et al., 2019). For example, Kunamaneni et al. (2019) finds a reduced consumer uptake when products are non-recyclable, with Lindh et al. (2016) emphasising how pre-conceived material knowledge can determine consumer engagement.

Product quality and value for money also influence consumer perceptions of reusable packaging (Lofthouse et al., 2017). Defects in the

Table 3
Analytical framework of the factors that influencer the sustainability of reusable packaging systems.

	Factor	Sub-factor
Environmental	1. Material selection & production	1.1.Recycled content 1.2 Material type 1.3 Packaging weight 1.4 Consumable weight
	2. Use	2.1 Usage volume
	3. Sorting and cleaning	3.1 Energy and water use
	4. Transportation	4.1 Packaging: volume ratio 4.2 Distance
	5. Shrinkage	5.1 Return rate 5.2 Deterioration rate 5.3 Loss rate
	6. End of life	6.1 Disposal scenario
Social	7. Convenience	7.1 Convenience 7.2 Cleaning and maintenance 7.3 Service location, access and availability
	8. Usability	8.1 Service usability 8.2 Product usability
	9. Awareness	9.1 Labelling 9.2 Marketing
	10. Consumer perception	10.1 Functional design 10.2 Aesthetic design 10.3 Service experience 10.4 Value for money 10.5 Product quality 10.6 Hygiene 10.7 Sustainability
	11. Customer behaviour	11.1 Consumer knowledge and education 11.2 Familiarity of product/ service 11.3 Availability of low waste alternatives 11.4 Peer pressure 11.5 Market trends 11.6 Type of reuse model 11.7 Product category
	12. Consumer characteristics	12.1 Lifestyle 12.2 Culture 12.3 Education level 12.4 Age 12.5 Gender 12.6 Disposable income 12.7 Attitudes and values
Economic	13. Policies and legislation	13.1 Strategies to increase producer responsibility 13.2 Strategies to increase consumer behaviour change 13.3 Strategies to increase technical viability 13.4 Economic incentives
	14. Material, infrastructure and operational costs	14.1 Storage costs 14.2 Transportation costs 14.3 Operational costs 14.4 Infrastructure costs 14.5 Material and manufacturing costs 14.6 Consumable costs
	15. Labour	15.1 Handling 15.2 Sorting, cleaning and maintenance 15.3 System management
	16. Customer retention	16.1 Customer retention 16.2 Brand loyalty 16.3 Financial incentives 16.4 Deposit return schemes 16.5 Loyalty schemes /subscription services
Technical	17. Logistics	17.1 Supply chain management 17.2 Supply chain complexity 17.3 System cycle time 17.4 Standardisation (of the system) 17.5 Third party providers
	18. Management	18.1 Information flow 18.2 Stakeholder collaboration
	19.Maintenance and infrastructure	19.1 Inspection and refurbishment processes 19.2 Retail space
	20. Technology	20.1 Tracking technology
	21. Product features	21.1 Standardisation (of packaging) 21.2 Product protection
	22. Standards and protocol	22.1 Hygiene standards 22.2 Contamination 22.3 Quality standards

packaging can impact the sales volume (Lialiuk et al., 2019), as consumers are concerned by container flaws and stains (Numata and Managi, 2012). Some consumers may relate inferior quality of packaging with lower consumable quality (Mills et al., 2018). Additionally, consumers can be concerned about the hygiene of reusable containers (Grimes-Casey et al., 2007; Numata and Managi, 2012). Respondents may think that the more times a bottle has been refilled the dirtier the bottle is, thus discouraging them from purchasing the refilled bottles (Numata and Managi, 2012). Decreasing consumer perception of contamination is thus associated with increased product sales (Ertz et al., 2017). Grimes-Casey et al. (2007) also note that consumers may be unwilling to return packaging when the value of the packaging is deemed greater than the deposit. Consumers may be reluctant to invest in sustainable products if there is a perception of lower quality (Kunamaneni et al., 2019). Although lowering the price of reusable packaging may be an incentive for consumers, it could portray a lower product value (Lofthouse et al., 2009), with consumers left questioning the product quality (Numata and Managi, 2012). Consumers may also be unwilling to return packaging when the value of the packaging is deemed greater than the deposit (Grimes-Casey et al., 2007).

3.2.2.3. Awareness. Increasing consumer awareness via labelling and marketing is identified as key factor impacting the uptake of reusable packaging. According to Hurley et al. (2017) branding contributes to 92 % of purchase decisions. Consumers assume that packaging is environmentally friendly if product is environmentally certified (Lindh et al., 2016). Poor marketing and labelling messaging can result in consumer mistrust and reduced future engagement. Several authors highlight the importance of marketing strategies (Kunamaneni et al., 2019; Lialiuk et al., 2019; Muranko et al., 2020). Clear communication of system benefits and function is required to ensure the intended consumer behaviours are adopted (Lofthouse and Bhamra, 2006; Lofthouse et al., 2009; Long et al., 2020).

3.2.2.4. Usability. Usability can be considered with respects to the service and product usability. A positive consumer experience at the initial interaction with the system can encourage users to engage in repeat purchases and establish greater brand loyalty (Lofthouse et al., 2009; Lofthouse et al., 2017). This continued interaction between consumer, brand and product ensures that consumers are part of a culture and community (Lofthouse et al., 2009). Through providing a reliable service, consumers can be satisfied with a greater quality of service which meets their needs (Duhaime et al., 2001). The familiarity of the product or service can also play a large influencing factor in consumer uptake. By adopting processes or actions which are familiar, consumers can evoke a sense of safety, reliability and comfort. For example, Tassell and Aurisicchio (2020) present the notion of mimicking current recycling practices in reusable packaging systems. This technique may prove fruitful as consumers can be hesitant to adopt new behaviours (Greenwood et al., 2021). Kunamaneni et al. (2019) further acknowledges that changing behaviours is a current challenge for transitioning from single-use to reusable packaging systems. It is suggested that providing a system that reinforces current habits will increase consumer accessibility.

3.2.2.5. Consumer behaviour. Several consumer behaviours may impact the social sustainability of reusable packaging systems. For instance, consumer knowledge can play an important role in moderating behaviour (Lindh et al., 2016). Lindh et al. (2016) point out that many consumers care about the environmental impact of packaging but they think it is just a matter of material. Consumers may also perceive recycling as more environmentally friendly when compared to reuse due increased familiarity with recycling (Kunamaneni et al., 2019). Hence, the availability and preference for recycling may reduce uptake of reusable packaging (Greenwood et al., 2021). As discussed earlier, enhancing the familiarity of the product and service is identified as key factor for enabling social sustainability. Reusable packaging should have similar designs to well-known brands to improve consumer uptake. If an unfamiliar design is implemented, producers should offer new functional benefits (Kunamaneni et al., 2019).

It is also noted that consumer behaviours may vary depending on market trends and peer pressure. Consumers motivation to uptake reusable solutions can be encouraged through peer uptake (Escario et al., 2020). Lialiuk et al. (2019) notes that consumer demands and trends are constantly changing so upgrading packaging may be necessary. Finally, consumer behaviour willingness to adopt reusable packaging may vary depending on the type of reuse model and product category. Greenwood et al. (2021) note that consumers are more willing to repurpose and refill packaging than to return packaging, with 13 % of consumers willing to engage with reusable packaging and 6 % of consumers are willing to embrace refillable solutions. Ertz et al. (2017) also observes how a change in context can change western consumer perception on reusable packaging. Lofthouse (2007) finds that consumers are open to products with more diverse usage or multi-purpose packaging. In a large survey of consumers in the UK, Greenwood et al. (2021) find that consumers are most willing to refill handwash and dishwasher tablets or to return glass bottles for milk.

3.2.2.6. Consumer characteristics. The literature also notes that there are several consumer characteristics which may determine the success of reusable packaging systems. Lifestyle, culture, education level, age, gender, disposal income, and attitudes and values are all identified as factors that may influence the sustainability of reusable packaging systems. Lofthouse et al. (2009) observe that lifestyle changes have increased demand for convenience and have led to increased packaging consumption. Beitzen-Heineke et al. (2017) find that a third of consumers are willing to pay more to protect the environment. Whereas, Lofthouse and Bhamra (2006) suggest that a feel-good factor is not enough for consumers to adopt and invest in reusable packaging. Environmental attitudes are believed to be linked to reuse behaviours (Escario et al., 2020). Apart from this, Escario et al. (2020) notes that individuals between 54.1 and 59.6 years are more likely to adopt reusable packaging. Historically, Rasmussen (1984) finds that higher educated responded are willing to pay 10 cents more for reusable packaging. However, this is contested in later studies (Lofthouse and Bhamra, 2006). Finally, Ertz et al. (2017) compares Asian and Western consumers and finds that Asian consumers are influenced by the context to increase reusable container consumption through motivations, whereas western consumers are influenced by attitudes.

3.2.3. Economic factors

Factors that influence the economic sustainability of reusable packaging are related to material, infrastructure and operational costs, labour, policies and legislations, and customer retention.

3.2.3.1. Material, infrastructure and operational costs. Operating reusable packaging systems involves several costs related to storage, transportation, operations, infrastructure, material and manufacturing. It is widely assumed that the increased costs result from the return journey (Chan, 2007). These costs, however, can be influenced through storage location, product weight, and capacity transported (Goudenege et al., 2013; Menesatti et al., 2012). Lower shipment costs can also be incurred due to standardisation of packaging (Katephap and Limnararat, 2017). According to Menesatti et al. (2012) reverse logistics represents 17 % of the reusable container total costs and 20 % of the logistical cost.

Twede and Clarke (2004) note that operational costs can increase if the system is poorly managed. Similarly, Koszorek and Huk (2021) consider that optimal product management can minimise the operational costs. Batching larger orders can help to reduce costs through scheduling containers to coincide with predicted container returns, minimising the safety stock required (Mensendiek, 2015). According to Duhaime et al. (2001) speeding up reverse logistics can reduce operation costs and increase the availability of containers to its customers. Failure to return products can deter producers from investing in reusable packaging and cleaning infrastructure (Grimes-Casey et al., 2007). In a study by Menesatti et al. (2012), comparing reusable and single-use shipping containers for transporting flowers, they find that reusable containers involve an initial investment but become comparatively more cost-effective from year two, with the costs related to the return collection of the items. Chandoul et al. (2009) argue that the investment cost of returnable containers is amortised over their life cycle. Despite this, high initial investments can deter producers (Twede and Clarke, 2004; Zimmermann and Bliklen, 2020). To minimise investment costs and to integrate reuse within current systems, reusable packaging design should avoid new tooling investments for handling (Chan, 2007). Implementation costs of technology to improve traceability of containers can also be high (Itsuki, 2012).

Costs associated with material and manufacture can also impact a supplier's decision to adopt reusable packaging. For example, if the manufacturing costs are lower than the transportation costs, then the return journey is not economically beneficial for the supplier (Vöröskői et al., 2020). This supports Böröcz (2022), who identifies 0.5 l PET bottles as disposable and 0.25 l glass bottles as reusable, based on economic viability. In the event that return rates are low, suppliers will naturally prefer disposable alternatives to minimise costs. Additionally, the movement of packaging increases storage and transportation costs, due to the increased handling and asset management required to maintain effective container flow (Chandoul et al., 2009). For both the producer and the consumer of the containers, the cost of storing the containers is a very critical component (Ross et al., 2010).

3.2.3.2. Labour. Labour costs result from handling, sorting, cleaning and maintenance, and system management. Time is needed for inspection, cleaning and repair of returned containers (Kelle and Silver, 1989). It is widely accepted that closed loop systems are more labour intensive through collection, cleaning and transportation (Castillo and Cochran, 1196). It is also noted that reusable packaging can be large and unwieldy making it difficult to manage at some stages on the supply chain (Legiędź and Huk, 2021). There is a trade-off between increased volume and the increased handling time, however in a study by McGlynn et al. (2003a, b) reusable packaging has been shown to hold 4 times more food and increase process time by only 1.4 to 2 times as long. Hence handling efficiency is a key factor driving economic sustainability.

3.2.3.3. Policies and legislation. Strategies to increase producer responsibility, to increase consumer behaviour change, to increase technical viability, and economic incentives play a role in determining economic sustainability. Specifically, stricter laws and regulations on the amount of packaging waste generated across the supply chain could encourage adoption of reusable packaging (Beitzen-

Heineke et al., 2017). Environmental laws should incentivise supermarkets to reduce packaging waste, with legislation increasing producer responsibility to reduce the use of packaging (Kroon and Vrijens, 1995; Grimes-Casey et al., 2007; Martínez-Sala et al., 2009). Similarly, Camps-Posino et al. (2021) suggest that policy can support the transition from single-use to reusable packaging systems. However, legislation should be enacted alongside tax reliefs to drive research and increase producer responsibility. To be successful, legislation should focus on the development of new technology, materials and packaging techniques, allowing for companies to utilise newer waste management processes (Lisińska-Kuśnierz, 2001).

A similar approach can be endorsed for consumers. By enforcing laws and policies, a change in consumer behaviours may be observed (Ertz et al., 2017), with policies designed to encourage user uptake and to influence consumer return rates (Ferrara and Plourde, 2003). This can be done by moulding policies and regulation around consumer behaviours, consumption patterns and inferred costs (ibid). Coupled with this, government strategies should allow for consumers to internalise and change their behaviours willingly, adapting to reuse and recycling habits (Escario et al., 2020). Rigamonti et al. (2019) and Twede and Clarke (2004) further suggest that economic incentives should be provided to companies to encourage reusable packaging uptake.

3.2.3.4. Customer retention. Consumer retention relies upon consumer willingness to utilise and interact with packaging for a set duration, this change in behaviour and attitude can be difficult to achieve (Kunamaneni et al., 2019). Throughout current literature there are a number of techniques which have been highlighted to secure this engagement. For example, Deposit Return Schemes are widely discussed to encourage lower lead times and greater container collection through increasing consumer liability and accessibility (Copeland et al., 2013; Cobb, 2016; Escario et al., 2020). Specifically, deposit return schemes rely upon a monetary aspect to incentivise consumers to return containers but must navigate the consumers economic restraints and the consumers value-for-money perception. For example, if a product is deemed to be worth more than the deposit, lower return rates and consumer uptake can be expected (Dubiel, 1996; Grimes-Casey et al., 2007). On the other hand, when providing lower deposits, consumers are less likely to return containers due to the presentation of low product-value (Grimes-Casey et al., 2007). This shrinkage of container volume within in the supply chain increases the economic burden on suppliers and producers, as the container break-even has not been met. As such, the consideration of both perceived product value and product replacement cost should be evident when determining the deposit amount to maintain the systems feasibility (ibid).

To build on this further, financial incentives can be provided to consumers to drive consumer uptake (Lofthouse and Bhamra, 2006; Ertz et al., 2017). Ratnichkina et al. (2021) identifies cost reduction as a possible motivator for consumers to adopt returnable packaging, however Kunamaneni et al. (2019) acknowledges the difficulties of changing consumer behaviour to reuse packaging multiple times. Lofthouse and Bhamra (2006) goes on to explain how lower economic relief within new systems can deter consumers from adopting refillable systems, however if an introductory offer is implemented, an adverse disposal behaviour may occur. Alternatively, loyalty schemes can provide personal experiences for consumers, whilst encouraging sustainable behaviours through limited consumer behaviour change (Tassell and Aurisicchio, 2020; Ratnichkina et al., 2021).

3.2.4. Technical factors

Finally, technical factors that impact the sustainability of reusable packaging systems are related to logistics, maintenance and infrastructure, management, and technology.

3.2.4.1. Logistics. Supply chain management is key to ensuring the technical sustainability of reusable packaging systems. The degree of supply chain complexity, system cycle time, standardisation and presence of third party suppliers also influences the technical sustainability of systems. González Boubeta et al. (2018) point out that the location of implementation can increase complexity, and Ross et al. (2010) observe that in-house closed-loop systems are easier to maintain when dealing with local transportation networks. More frequent collections from distributors and more frequent filling schedules can decrease cycle times (Cobb, 2016). Furthermore, system standardisation can increase productivity and efficiency (Kroon and Vrijens, 1995; Dubiel, 1996; Duhaime et al., 2001). Zhang et al. (2015) point out that a shared infrastructure between stakeholders is necessary to optimise reverse logistics. However, Greenwood et al. (2021) discuss how standardisation makes it harder for brands to market themselves, and retailers are unwilling to collaborate. It is suggested that third party providers can help to support standardisation by increasing supply chain productivity and efficiency (Duhaime et al., 2001; Zhang et al., 2015). These third party suppliers can reduce financial risk as well as operational costs (Kroon and Vrijens, 1995; Chan, 2007).

3.2.4.2. Maintenance and infrastructure. Resources for inspection and refurbishment may also impact the viability of reusable packaging systems. It is commonly accepted that reusable containers require greater maintenance throughout their life and that damaged containers need replacing or repair (Cheng and Yang, 2005). Hence, inspection of containers is required to ensure reuse is viable (Thoroe et al., 2009). Furthermore, reusable packaging demands additional retail space. Traditional stores may not be able to facilitate refillable and reusable products due to their limited infrastructure (Kunamaneni et al., 2019).

3.2.4.3. Technology. In order to effectively monitor and track packaging across the supply chain, many articles refer to the use of technologies such as Radio Frequency Identification (RFID), WiFi, GPS, and barcodes. Such technologies can help to reduce handling times (Giubilato et al., 2019) and increase supply chain predictability, however naturally involve higher investment costs (Kim and Glock, 2014). It is argued that these technologies will improve the sustainability of reusable packaging systems, by improving the predictability of container flows and encouraging customers to return packaging (Kim and Glock, 2014).

3.2.4.4. Management. The degree of information flow and stakeholder collaboration are identified as key factors that influence technical sustainability. Systems are required to monitor and trace supply chains; improving forecasting, planning and delivery (Capistrano and Buluran, 2021). Shared information between stakeholders is necessary to optimise traceability (Silva et al., 2013), and tracking containers is necessary to match supply and demand (Maleki and Reimche, 2011). Chan (2007) also notes that reusable packaging requires greater cooperation between shareholders. All stakeholders must work together to meet consumer demand (Legiędź and Huk, 2021), where a lack of coordination between actors can produce uncertainties (Dubiel, 1996; Accorsi et al., 2022). Competitive businesses may find it counterintuitive to share information and collaborate for decision making, yet both are required for successful reverse logistics (Grimes-Casey et al., 2007).

4. Discussion

Reusable packaging offers a promising alternative to single-use packaging systems, to help reduce plastic waste and associated pollution. However, as this review has shown the sustainability of reusable packaging systems cannot be taken for granted. The literature has identified multiple factors which must be considered in order to avoid unwanted circular rebound effects. It has also brought to light several deficiencies in current knowledge, which raise key areas for further research (see Table 4).

4.1. Future research directions

Multiple authors allude to the systems transformation that is needed to transition from single-use to reusable packaging systems (Coelho et al., 2020; Beitzen-Heineke et al., 2017). Stakeholder collaboration is highlighted as a key enabler for increasing the sustainability of reusable packaging systems (Chan, 2007). However, existing research is fragmented between different field and lacks a systemic approach. For instance, the majority of articles tend to focus on provider perspectives on reusable packaging with only a limited number of studies considering consumer perspectives (e.g. Ertz et al., 2017; Escario et al., 2020). To move the field forward, there is a need for multi-stakeholder perspectives that takes into account the whole packaging value chain (Lofthouse and Bhamra, 2006). This includes both industry stakeholders, such as retailers, manufacturers and logistics companies, as well as policy makers, non-profit organisations and consumers. A systemic approach also entails consideration of how existing business to business (B2B) secondary/tertiary reusable packaging infrastructure might support nascent business to consumer (B2C) primary reusable packaging solutions. In total, there are limited studies focused on the primary packaging context. As highlighted in the results, this context is fraught with challenges and must be prioritised for future research. A promising line of enquiry may consider how best practice from the B2B context could inform B2C solutions.

Methodologically, the field is also dominated by quantitative analysis approaches and the authors call for new contributions from the social sciences, arts and humanities to complement existing research. For instance user experience design clearly has an important role to play in enhancing sustainable packaging solutions (Coelho et al., 2020), however most studies in this domain are from an engineering perspective. Furthermore, case study and trial data is rarely reported on, with exceptions from Lofthouse and Bhamra (2006) who evaluate their pilot study reusable packaging designs, Twede and Clarke (2004) who compare two reusable container solutions in the automotive and grocery sector and Menesatti et al. (2012) who quantitatively analyse data from a study of reusable packaging for the floral industry. In contrast, many studies conduct analysis based on abstract and theoretical scenarios. For instance, Kim and Glock (2014) provide a valuable contribution in terms of modelling the use of RFID on closed loop supply chains of reusable packaging systems, however do not apply this to a particular context or industry. The authors welcome more mixed methods approaches to analyse and compare case studies that are grounded in data from reusable packaging trials. As an example, this may integrate research on stakeholder behaviour, alongside supply chain and logistics analysis.

Building on the importance of context-specific studies, it is evident that sustainability of reusable packaging systems depends a great deal on the product type and the particular reuse model (Greenwood et al., 2021). However, apart from some initial reports in the grey literature (Institute of Grocery Distribution, 2021) the scientific research provides limited understanding about what works best in what context. A relatively under-explored area is how e-commerce might enable the development of innovative reusable packaging business models (Coelho et al., 2020). Future academic research should also consider how reusable packaging models might be adapted for different products and geographical contexts e.g. high income versus low income, urban versus rural settings. It should be pointed out that there are scarce articles that study reusable packaging systems in low-income countries or

Table 4
Key gaps and areas for future research.

Thematic area	Research gaps	Future research areas/research questions
Focus	- Research has mainly focused on reuse in secondary/tertiary packaging, and there are a limited number of studies focused on reuse in primary packaging. - Research is fragmented between different fields and lacks a systemic approach.	- Explore how best practice and models from reuse in secondary/tertiary packaging could be adapted for the primary packaging context. - Explore systemic and multi-disciplinary approaches that include industry stakeholders from across the packaging value chain.
Methods	- Research is dominated by quantitative analysis approaches. There is limited representation from social sciences, arts and humanities. - Case study and trial data is scarcely reported on. Research is mainly based on abstract and theoretical scenarios.	- Mixed methods analysis of reusable packaging pilot studies. - Comparison of reusable packaging case studies (successes and failures).
Context	- Research fails to specify or compare the impact of different reusable packaging models (e.g. e-commerce versus in-store). - Research does not compare the impact of reusable packaging for different product categories. - Limited research from Low income and low-middle income countries.	- Compare the sustainability of different reusable packaging models and product categories. - Explore how reusable packaging systems might be adapted for different geographical contexts e.g. high income versus low income, urban versus rural.
Environmental factors	- For primary packaging, further research is needed to determine the relationship between the break-even point, return rate, loss rate and distribution distance. - Life Cycle Assessments do not integrate insights from behavioural research, for example on return rates. - Limited attention has been paid to broader environmental impacts of reusable packaging on planetary boundaries (beyond carbon emissions)	- Explore how the break-even point for returnable primary packaging varies depending on the distribution distance, return and loss rate (taking into account behavioural insights) - Investigate the impacts of reusable packaging on planetary boundaries e.g. climate change, land-system change, freshwater use etc.
Social factors	- Research considers aspects of packaging design but does not address user experience and product-service system design of reusable packaging systems. - Research does not fully address how demographic factors, including culture and identify impacts consumer behaviours. - Research fails to address issues of social equity and inclusion.	- How do demographic factors (e.g. age, gender, identity) impact consumer behaviour and attitudes towards reusable packaging systems? - How can reusable packaging products and service-systems be designed to enhance social equity and inclusion?
Economic/political factors	- Limited research on reusable packaging that concerns Circular Economy business models. - Research on policy and legislation is undeveloped. In particular it does not address (financial) incentives for retailer collaboration and standardisation. - Research on reusable packaging does not integrate broader policy agenda on Circular Economy, such as Deposit Return Schemes	- What circular economy business models can support the mainstreaming of reusable packaging systems? - What are the policy drivers and barriers for manufacturers, retailers and providers to implement and scale up reusable packaging systems?
Technical factors	- Research on how digital track and trace technologies, such as RFID, enable reusable packaging systems have not been explored in the primary packaging context.	- How might digital technologies enable the effective implementation of reusable packaging systems for primary packaging? What sustainability trade-offs or rebound effects might occur?

emerging economies. Of these, articles only include studies of the B2B secondary/tertiary packaging context. For example, Silva et al. (2013) conducts analysis of a reusable packaging system for high-value manufacturing in Brazil, and Katephap and Limnararat (2017) conducts a supply chain analysis of Toyota Motor Thailand's reusable containers. Limited attention to the B2C primary packaging context in emerging economies is clear deficiency in the literature, which must be addressed in future studies.

Focusing on the environmental dimension, the literature suggests that reusable packaging systems will be most sustainable when packaging loss rates are minimized, and supply chains are localised (Ross et al., 2010; González Boubeta et al., 2018). The literature review included thirteen LCAs of reusable packaging, which adopt various methodologies and system boundaries. Accorsi et al. (2014) notably point out that the LCA literature on packaging does not agree upon a single best practice for the assessment, which limits the direct comparability of studies. However, among the studies it is generally agreed that the transportation phase is the most dominant phase of the reusable packaging life-cycle, and that the washing treatment does not significantly affect environmental impact. It is also agreed that the greater number of times that reusable packaging can be used, the lower the environmental impact. However the break-even point (i.e. the number of times that reusable packaging must be reused) varies between 2 and 50 depending on the case and context. Here the relationship between the break-even point, loss rate and distribution distance also matter a great deal. The authors speculate that reusable packaging is likely to be most feasible where consumable supply chains are local and consumption is sufficiently frequent. However, further research is needed to determine how the break-even point varies depending on the distribution distance, return and loss rates, which considers consumer behaviours.

Limited attention has also been paid to the broader environmental impacts of reusable packaging on planetary boundaries. An exception is, Levi et al. (2011) who compares the environmental impacts of single-use versus reusable packaging for Italian fruit and vegetables, finding that reusable packaging can lead to lower eco-toxicity; increased resource conservation; and, reduced acidification and eutrophication. Cleary (2013) also observes that a decrease in municipal waste could lead to a reduced human health impact. Further studies that consider a full range environmental impacts are needed to validate this work. Further work may also consider the use of material flow and systems analysis, to better understand potential circular rebound effects for dynamic systems. Finally, whilst the consensus is that reusable packaging will significantly reduce the landfill waste, regardless of the type of packaging used (Mannur and Moreau, 1992; Lisińska-Kuśnierz, 2001; Ferrara and Plourde, 2003), further investigation is needed into the end-of-life impact of thin-film and hard to recycle pouches that are often used in refillable packaging (Coelho et al., 2020).

In general, the social sustainability of reusable packaging systems is currently under-researched as compared with environmental and economic dimensions. The review makes it clear that until reusable packaging is socially and cultural accepted by consumers, these systems will not be able to realise their full environmental and economic potential. Asides from some notable studies by Lofthouse et al. (2017) and Kunamaneni et al. (2019) in the academic literature, we are surprised that relatively little attention has been paid to the design of reusable packaging products and service systems. In industry, the role of design in enabling effective point-of-handoff, point-of-return, washing and sanitising, and inventory management is well recognised (Closed Loop Partners, 2022). Similarly, WRAP (2022) highlight that reuse models must be designed to offer an accessible and convenient experience for both consumers and companies. Further academic research from product and service-system design is needed to complement and advance industry outputs. Research does not fully address how demographic factors, including culture and identify impacts consumer behaviours. Notably, Ertz et al. (2017) finds that the drivers of consumer engagement with reusable packaging are significantly varied for Asian and Western consumers, the latter group being more influenced by attitudes. A study by Escario et al. (2020) also sheds some light on the impact of age, education and gender on consumer behaviours. However these studies are geographically limited, and do not explore a wide range of demographic, cultural and identify factors which may impact consumer attitude and behaviours. Moreover, the literature does not fully consider issues of social equity and inclusion within the development of reusable packaging solutions. More broadly, circular economy research has been criticised for failing to consider social pre-requisites and implications (Corvellec et al., 2022). There has been a bias in Circular Economy research towards technocentric perspectives, that do not pay attention to issues of inclusion or other socio-economic aspects (Niskanen et al., 2020). The concern that current reusable packaging solutions are not inclusive has been more recently highlighted by Corsini and Ceschin (2022). Further research could meaningfully address these issues by studying how reusable packaging PSS might enhance social equity and inclusion. Relevant design methods may include design thinking and circular design methods.

The overall economic sustainability of reusable packaging systems requires balancing operational and infrastructural costs, and driving growth through customer retention. Within the literature, the authors note the large disparity between estimated cost savings. For example, Katephap and Limnararat (2017) estimate a cost saving of 61 %, Mannur and Moreau (1992) estimate between 15 % and 20 %, and Chan (2007) calculates a 1.3 % saving. Again, these studies highlight that viability depends on packaging return rates and related collection and transportation costs. It is suggested that achieving a stable consumer return rate is a key strategy to maintain stable costs, and to avoid the need for surplus safety stock (Cobb, 2016). Streamlining logistics and supply chain management through increased standardisation (Duhaime et al., 2001) is also particularly important for enabling businesses to minimise their operational costs, thus providing an affordable option for consumers. Existing research on economic sustainability has mostly focused on applying traditional Life Cycle Costing (LCC) methods to analyse economic viability (Accorsi et al., 2014). In comparison, there is relatively limited research on potentially disruptive Circular Economy business models that may support the mainstreaming of reusable packaging systems.

From a policy perspective, how to incentivise brands and retailers to collaborate effectively to adopt a standardised system remains unclear. We speculate that this is an area where research on policy and legislation could be further developed to better understand the full range of incentives. We also echo calls from Camps-Posino et al. (2021) for further policy research on the drivers and barriers to mainstreaming reusable packaging, noting recent policy interest in the development of Deposit Return Schemes that will undoubtably influence the development of any reusable packaging systems (Escario et al., 2020). As a next step, we suggest that a systematic comparative review is undertaken to compare and evaluate international policies related to reusable packaging. We also encourage researchers to consider the use of policy roadmapping (e.g. Miedzinski et al., 2019) and participatory research techniques, which incorporate the perspectives of policy makers.

Finally, we find that the role of technology in increasing the closed-loop supply chain of reusable packaging is relatively unexplored, yet could unlock great potential benefits. In the secondary/tertiary B2B context, Maleki and Meiser (2011) compare a range of RFID and barcode technologies for reusable containers. Mason et al. (2012) find that the use of RFID can reduce the shrinkage rate of reusable gas canisters by 66 %. Similarly, Lampe and Strassner (2003) find RFID improves asset management, traceability and maintenance of reusable kegs in the alcohol industry. Yet, the potential of these technologies in the primary packaging B2C context remains unknown. The EU's announcement that all regulated products should have a Digital Product Passport (European Commission, 2022), and the UK government's support for mandatory digital waste tracking (Gov.uk, 2022) set precedent for how digital technologies could help to drive the circular economy for packaging, and enable reuse. A recent whitepaper by Young (2022) states that recent innovations in low-cost flexible electronics means that smart reusable packaging for mass market B2C products is now increasingly feasible. The authors believe that such tagging technologies could unlock significant sustainability gains, however they also caution that the introduction of any additional technologies to packaging systems must be carefully managed to avoid unwanted resource consumption and waste electrical and electronic equipment. Future research could therefore explore how digital technologies might enable the scale up of B2C reusable packaging systems, and evaluate potential circular trade-offs or rebound effects.

4.2. Limitations of the study

This research significantly advances knowledge in the field, however the authors acknowledge the following limitations of this study. Firstly, it should be noted that the authors limited all search results to English for pragmatic reasons. Secondly, some article perspectives were not explicitly defined in the literature and were therefore deduced by the authors during the analysis. For example, some articles, from a primary perspective, refer to 'reuse' in general, without clarifying whether the study referred to refill or return processes. This may have limited the insights derived from the review. Finally, this literature review combines insights from both a primary packaging and secondary/tertiary perspective. Whilst the differences between these systems have been highlighted, our analysis has used a deductive approach to identify key insights that could be relevant to both perspectives. We believe this approach is worthwhile since reusable packaging has been more established in the secondary/tertiary context and this literature provides valuable insights for implementing reusable packaging in the primary packaging context.

5. Conclusions

This study conducted a literature review of 107 articles in order to synthesise disparate knowledge on reusable packaging. This resulted in the development of an analytical framework of the environmental, economic, social and technical factors that influence the sustainability of reusable packaging systems. It highlights that although reusable packaging may support sustainability gains, this cannot be taken for granted. To avoid unwanted circular economy rebound effects, reusable packaging systems must be carefully managed and adapted according to the context. Further research could build on this study by validating these findings with industry stakeholders from across the packaging value chain. Exploring the interrelationships between the factors in the analytical framework would also enhance our understanding of circular rebound effects in reusable packaging systems. It is expected that this framework will support industry stakeholders with planning the implementation and scale-up reusable packaging systems. In addition, several gaps in the literature were also identified, with respect to article focus, context, methods and content. In particular, it was highlighted that further research on reusable packaging is needed for B2C primary packaging applications, which have been less studied to date. Future research should also incorporate more multidisciplinary perspectives that consider social dimensions. In order to achieve a systems transition from single-use to reusable packaging systems, greater collaboration is required between industry and academia is required. Particular perspectives which may enrich the debate include both design and policy research. Design clearly has an important role to play in enhancing the user experience of packaging products and service systems, and this academic work should be developed alongside the development of circular economy business models. Relevant design perspectives may include product-service system design, design thinking and circular design. Further policy research is also needed to determine practical strategies and targets which are most effective in different contexts, in order to develop an enabling ecosystem for reuse. Combining participatory research and policy roadmapping techniques may also lead to fruitful results.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.spc.2023.02.009.

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