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Review

Sustainability governance and contested plastic food packaging – An integrative review

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ABSTRACT

Based on an integrative literature review, this article investigates the reasons for the difficulties in governing sustainability of plastic food packaging. By integrating the results from different disciplinary fields, ranging from material sciences to behavioural and social sciences, the article sheds light on the contestations between different sustainability goals and interests that relate to food packaging and it shows that there are trade-offs between them. With an in-depth analysis of the sustainability issues related to different phases of the life cycle of plastic food packages, the article identifies how the attempts to govern individual sustainability problems as part of circular economy policies create tensions with other sustainability issues. The analysis shows that while the circular economy covers the entire life cycle of a food package, the beginning and the end of the life cycle have gained the most attention and only limited number of policy measures focus on the consumption phase. As a conclusion, we claim that the different functions of plastic food packaging need to be acknowledged better in environmental policy design.

Contents

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1. Introduction

The modern food system – characterised by its geographical spread, and by global value chains – would not function without packaging. Food packaging is essential; for example, for the containment and protection of food, convenience and communication (Marsh and Bugusu, 2007). However, during recent years, the negative environmental impacts of packaging, including food packaging, have raised increasing concerns, both in public media forums and in the cabinets of policymaking (European Commission, 2018). One reason for this is the need to tackle the urgent marine plastic pollution caused by the 4.7–12.8 megatonnes (Mt) of mismanaged plastic waste that end up in the oceans every year (Jambeck et al., 2015). Despite increasing awareness, the marine plastic litter problem has escalated to a global crisis. Marine plastics derive from several origins and sources, and packaging, in particular, food and drinks packaging, has been identified as a major source of pollution (Miller et al., 2018). Several policy measures and voluntary actions have been launched by public and private bodies to address the problems caused by plastic food packages. These actions include policies and regulations to reduce or ban single-use plastics (European Commission, 2019) and voluntary measures, like collaborative commitments (Ellen MacArthur Foundation, 2020) and pacts (European Plastics Pact, 2020) to foster the circular economy of plastics. Despite these efforts, the usage of plastics is foreseen to increase. Lebreton and Andrady (2019) have estimated that the production of plastics will reach the level of 155–265 Mt by 2060 at current growth rates. Furthermore, critical voices claim that the reduction of the usage of plastics in food packaging may lead to bigger environmental problems in the food chain, for example, in terms of food loss (Barlow and Morgan, 2013).

The plastic issue has become politicised during recent years in multiple ways (see, e.g. Nielsen et al., 2019). It is a typical example of a complex sustainability governance issue, characterised by contested and ambiguous knowledge, interests and values (see, e.g. Lange et al., 2019). As Nielsen et al. (2019) have found out in their comprehensive review of plastic politics, there is no one plastic problem but many plastic problems. The possible interpretations of what the plastic problem is about range from the mismanagement of waste to health issues and the shift towards bioeconomy. The different interpretations of what is at stake when aiming to solve the problems of plastic food packaging complicate the communication between various societal stakeholders concerning the possible solutions. Furthermore, because food packaging is a key element in enabling the functioning of the food system, the problems caused by plastic food packaging cannot be solved by mere regulation or through activities taken by a single actor.

In this article, we explore the reasons behind the difficulties of finding comprehensive governance measures that would render food packaging more sustainable by shedding light on the internal tensions between various sustainability issues related to plastic food packaging. We do this through an integrated literature review and analyse how studies in different disciplinary fields, ranging from material sciences to social sciences, define the essence of the sustainability issues related to plastic food packaging and the dynamics behind them. This kind of integrative, multidisciplinary approach is needed in order to bring up the contested views on the sustainability impacts of the usage of plastic in food packaging and to understand the impact of these contestations on the attempts to solve the sustainability problems caused by plastic food packaging. We particularly focus our analysis of the internal tensions between different sustainability governance aims on circular economy (CE) policies because this is a policy field where plastic food packaging has recently been gaining attention.

The European Union (EU) has addressed the problem of plastic food packages in its plastic strategy and Circular Economy Action Plan (European Commission, 2015). It offers transition towards a circular economy as an overarching solution for the plastic crisis. Integrating plastic food packages in the new circular plastic economy requires multi-actor collaboration and the engagement of various societal actors – including companies from different industrial fields, citizen consumers, authorities, policymakers and NGOs – in order to co-create novel modes of producing packaging materials and delivering food in a sustainable way. Furthermore, comprehensive transformative environmental governance (Jacob and Ekins, 2020) is needed in order to support the transition. The design of governance measures for such a systemic shift is not possible without a holistic understanding of the different roles of plastic packaging in the food chain and the achievement of various, sometimes even conflicting, sustainability goals. Furthermore, in-depth knowledge of the systemic impacts of the different policy measures designed to boost the circular economy transition in food packaging is also of major importance in order to avoid unintended negative sustainability impacts elsewhere when tackling the plastic problem.

To get a comprehensive picture of the various and often controversial sustainability issues related to plastic food packaging, this article provides a review of research papers discussing the sustainability of plastic in different parts of the food packaging life cycle. According to Nielsen et al. (2019), the focus of the plastics debate and research has so far been on relatively easily governed objects, such as plastic bags, whereas more complex objects, such as plastic food packaging, have gained less attention. Here, we define plastic food packaging broadly as primary packaging – such as cups, containers, bottles, and films – that is fully or partly made of plastics. This type of packaging is used for containing and/or protecting food and is in direct contact with food. It has been claimed that environmental policies are often fragmented and tackle narrow, specific problems. Following from that, they are not effective in enhancing the broader socio-technical transformations that are needed to achieve structural changes, such as the circular economy transition (Jacob and Ekins, 2020).

With an integrative review, collecting and analysing studies from different disciplinary fields, we take the need for a holistic approach seriously and investigate the sustainability of plastic food packaging as a systemic problem instead of focusing merely on single packaging items or particular environmental impacts. We are interested in plastic food packages as objects that flow through different societal regimes (see, e.g. Geels, 2002) and systems of production, and the need to meet the standards and expectations of different societal realms. Following from that, we not only focus on the sustainability impacts of the usage of plastic in food packaging but also pay attention to the processes that maintain the status of plastic as an easy, reliable and cost-effective material for food packaging. With the chosen approach we want to increase the understanding of the types of tensions that need to be solved when designing policies to advance the circular plastic economy within the food system. To do that, we systematically analyse how the sustainability of plastic food packaging is addressed in academic literature over the time period of 2000–2019 and through which circular economy policy measures these sustainability challenges are governed.

This paper is structured as follows: Section 2, 'Methodology', describes the research approach and methods of the literature review. Section 3 introduces the multiple societal sustainability concerns over plastic food packaging. Section 4 discusses a circular economy as a solution in governing plastic food packaging. In Section 5, internal controversies in the governance of plastic food packaging for the circular economy are presented. Section 6 synthesises and concludes the findings, focusing on the implications of different governance targets and the means of achieving those targets throughout the life cycle of food packaging, and discusses future research needs.

2. Methodology

Our analytical approach builds on the systematic literature review methodology (Tranfield et al., 2003) and the integrative literature review methodology (Torraco, 2016). The review protocol and, in particular, data gathering were conducted based on the systematic literature review methodology whereas the integrative analysis and synthesis were done according to the principles of an integrative literature review. We chose the integrative approach because it fits well with dynamic topics, such as the relatively recently emerged and rapidly changing plastic food packaging issue, which are experiencing rapid growth in the literature and generating 'a growing body of literature that may include contradictions or a discrepancy between the literature and observations about the issue, which are not addressed in the literature', as suggested by Torraco (2016). This methodological choice is suitable in cases where the aim is not to review and compare methods and concepts or analyse research gaps within a clearly defined field of research but instead to reach a comprehensive, multidisciplinary picture of an evolving, complex and controversial societal issue from different perspectives.

The review protocol had three stages: (1) the planning stage with the formulation of a research question that defines the boundaries of the literature to be reviewed, (2) the conducting stage, involving data extraction and coding, followed by data analysis and synthesis, and (3) the reporting stage, focusing on answering the research questions.

In the first stage, a list of potential key words that highlight the research question was formulated in order to draw boundaries for the literature search and to find the relevant search topics, enabling collecting a corpus of articles shedding light on food packaging as a governance issue from the perspective of different research fields. The relevance of the chosen key words was tested by using preliminary search strings of potential keywords in the Scopus database and exploring whether they hit articles relevant to the research aim. The preliminary search was limited to the article title, keywords and abstract. Based on this trial-and-error method, five main categories were identified: (1) packaging, (2) waste and safety, (3) the packaging life cycle, (4) governance and (5) zero-packaging. The keywords for the literature search are presented in Table 1.

Due to the multidisciplinary nature of the topic, two databases, Scopus and Web of Science, were used in the main stage of the literature search. The search was limited to peer-reviewed academic journal articles and reviews published in English during 2000–2019. We focused on peer-reviewed articles in order to get an understanding of how governance challenges and strategies are presented in the scientific literature, yet acknowledge that original sources for governance approaches are mainly grey papers. The database searches were carried out during October and November 2019.

The main body of literature derived from five search strings using different combinations of search terms (see Appendix 1). The searches resulted in 595 hits before the removal of duplicates. After the removal of duplicates, the titles and abstracts of these articles were read through to see the relevance to the study. If the article appeared relevant, then the entire text was read and compared to the research boundaries. The articles were analysed using the following inclusion criteria: relevance to (1) plastic food packaging and (2) sustainability governance. Articles were excluded if they focused (1) only on, for example, natural or material sciences without a relevant connection to governance and (2) on packaging labelling that is related to food consumption and health. Reading the abstracts resulted an initial selection of 137 articles, of which 80 were included in the content analysis. During the analysis phase, additional articles were identified from the references of the retrieved articles and recommended articles via the snowballing method. The research field is developing fast, therefore an additional article, published in 2020, was included in the review. This resulted in identifying a further 47 articles in total.

The analysis of data followed an inductive approach and qualitative content analysis was applied (Hsieh and Shannon, 2005). The analysis was conducted in four stages. Because we were particularly interested in the role of contested sustainability goals in the governance of food packaging, the main coding categories at the first stage related to contestations and various systemic roles of food packaging. The categories were (1) sustainability governance failures, (2) the role of food packaging in causing or solving sustainability issues, (3) governance measures and instruments and (4) tensions and conflicting issues. The initial coding was carried out using the actual words used in the articles (in vivo codes), followed by summarising the findings into subthemes (constructed codes).

At the second stage of analysis, we identified which substance topics were frequently brought up under each of the categories of the first coding stage and analysed how these topics related to different phases of the life cycle of food packaging. We chose the life cycle of food packaging as a guiding principle for organising the research results because it made it possible in the third stage of analysis to identify how circular economy policies address different sustainability goals at different phases of the food packaging value chain. In the fourth stage, we conducted a synthesis on the controversies of the governance of sustainability of food packaging within the framework of circular economy policies.

The initial coding was carried out by the corresponding author. In the case of differing interpretations, the coding categories and codes were deliberated and agreed upon by two researchers. The coding and the data analysis was carried out by using the NVIVO qualitative data analysis software.

3. Societal concerns over plastic food packaging throughout its life cycle

3.1. The environmental concerns related to the production of plastics for packaging

Plastic is perceived as a durable, moldable, light and inexpensive material (Geyer et al., 2017), which makes it ideal for packaging

Table 1
The keywords for the literature search.

Category	Search terms
Packaging	pack*, "food pack*", "food container", "plastic object", single-use, "plastic pack*", plastic
Governance	governance, govern*, collabor*, "hybrid arrangement", network, collective, stakeholder, participatory, "triple helix", partner*, politics, policy, "transition management", engagement
The packaging life cycle	eco-design, innovation, production, consumption, use, recycling, re-use, circular economy
Waste and safety	"plastic waste", waste, pollution, "food waste", "food loss", "food safety"
Zero packaging	"packag* free", package-free, zero-packag*

applications. Yet, plastics intended for food packaging comprise of a large family of different synthetic materials, including thermoplastics, bio-based plastics and bio-degradable plastics. The production and use of plastics have been increasing over the decades (Geyer et al., 2017). Several scientific papers that we reviewed rely on production figures provided by associations of plastics producers (see, e.g. Geyer et al., 2017). According to Plastics Europe, the production of plastics reached the level of 359 Mt in 2018 (Plastics Europe, 2019). This means that the plastic industry utilises about 8% of global oil and gas production, including the feedstocks (4%) and energy (3–4%) required for the production (Hopewell et al., 2009). Following from that, the increasing production of plastics has been claimed to accelerate global warming through the greenhouse gas (GHG) emissions produced during the extraction and usage of fossil-based oil. The environmental burden is further multiplied by the fact that a significant amount of plastic is used for disposable applications, such as single-use packaging (Hopewell et al., 2009). It was estimated that in 2015, approximately 42% of the produced non-fibre plastics – mainly composed of polypropylene (PP), polyethylene (PE) and polyethylene terephthalate (PET) – are used for manufacturing packaging (Geyer et al., 2017).

The increasing global consumption of commodities has raised concern about the depletion of crude oil in the scientific literature of the early 2010s. It has resulted in the extraction of oil and gas from increasingly challenging and environmentally sensitive areas, thus causing increased negative environmental impacts from the production of plastics as well. While the production of plastics is only a minor cause for the depletion of crude oil, it has triggered the development of biobased alternatives (Hottle et al., 2013). During the last decade, the production of biobased plastics has increased and is currently estimated to be 2 Mt per annum, which is less than 1% of global plastics annual production (European Bioplastics, 2019).

The majority of bioplastics are produced from crop-based agricultural feedstocks (Karan et al., 2019). While biobased plastics are proposed as environmentally benign alternatives to fossil-based plastics due to the renewable origin and potential biodegradability (Álvarez-Chávez et al., 2012), the cultivation of agricultural biomass has also been claimed to cause negative environmental and societal impacts, including conflicts in land and fresh water use (Bastos Lima, 2018). Yeh et al. (2015) observed that, while the current area used for the cultivation of biomass for bioplastics is still rather small and may not cause threats at low production levels, the increasing production of bioplastics may cause conflicts between cultivation of crops for nutrition and for manufacturing bioplastics. Industrial agricultural production methods for crop-based biomass rely on the use of toxic pesticides, which can cause further negative impacts on the environment and the biodiversity of ecosystems (Álvarez-Chávez et al., 2012). To avoid conflicts with food production, the second generation of bioplastics from agroforestry biomass (e.g. lignocellulosics from agricultural residues and wood) or waste fats and oils have been developed (Brodin et al., 2017). However, Karan et al. (2019) have argued that the increasing demand for biomass from agriculture and forestry for the production of bioplastics may interfere with natural carbon cycles and soil fertility. However, whether or not the impact is significant remains to be seen.

To overcome the potential constraints of existing bioplastics, the third generation of bioplastics is currently under development In their recent review, Karan et al. (2019) have foreseen several advantages in the production of photosynthetically derived and genetically modified biomass for bioplastics; the production of biomass can be located on non-arable land, the processes can turn CO_2 into biomass and fresh water can be saved by using waste and salt water. However, the rise of genetically modified feedstocks for bioplastics has raised concerns, especially related to food packaging (Yeh et al., 2015). In their policy analysis, Yeh et al. (2015) identified the need for the traceability of the genetically modified crops used for the production of bioplastic packaging used for organic food products.

Besides using crop-based or agroforestry biomass, waste (Brodin et al., 2017) or CO_2 (Karan et al., 2019) as alternative feedstocks for plastics, the use of recycled material in plastics production (Van Eygen et al., 2018) has gained importance in scientific literature. The production and transportation of all food packaging plastics, regardless of the feedstock, is shown to have environmental impacts, such as contributing to climate change, resource depletion, acidification, eutrophication, air pollution, ecotoxicity and land use (Dilkes-Hoffman et al., 2018; Toniolo et al., 2013), yet these impacts are lower than those of food production (Silvenius et al., 2014).

3.2. Packaging: the necessary mediator in the modern food system

Although the production of both fossil- and biobased plastics has many harmful environmental impacts, the benefits of plastics in enabling the modern food system make them difficult to replace. Through different functions – such as containment, protection, convenience and communication (Marsh and Bugusu, 2007) – packaging has a significant role in governing the life of food (Hawkins, 2018) and the prevention of food loss and waste (Williams and Wikström, 2011). In modern, global commerce, packaging also has a significant role in enabling and ensuring the safe delivery of products through supply chains to the end consumer (Lindh et al., 2016).

Innovation in material sciences and the development of plastic materials for food packaging have been suggested as key factors behind the transformation of the food markets since the 1960s (Yeh et al., 2015). As pointed out by Hawkins (2018), together with other factors, such as an increase in the amount of supermarkets and changing food purchasing and consumption habits, plastic packaging is one of the key mediators that is necessary for the functioning of the system. Depending on the point of view, food packaging can be seen as a market device that enables the development of new products, services and ways of consumption (Hawkins, 2018) or as a device that evolves in response to changing consumption patterns and lifestyles (Risch, 2009). Regardless of the viewpoint, the literature shows that the consumption of plastic packaging in the food system has been increasing and that modern commerce is highly dependent on it.

While in the majority of food applications, plastic packaging is still just a passive container for food, plastic packaging can have a more active role in protecting food (e.g. from oxygen, moisture and flavours) and in contributing to food quality (e.g. by removing oxygen or inhibiting the growth of microbes) (Risch, 2009). While recent innovations in packaging science target food preservation, the use of novel food contact materials, such as nanomaterials have raised novel health concerns in regard to potential ecotoxicity, migration and accumulation in humans and in the environment (Sharma et al., 2017). Chemical additives, like plasticiser, are needed to improve the properties of plastics. However, concerns about the potential health impacts of the migration of additives, including plasticisers, into foodstuffs from food-contact materials is an increasingly studied subject in literature (Hahladakis et al., 2018).

3.3. Debates over food waste and loss prevention versus overpackaging

As mentioned earlier, a dominating environmental concern related to food packaging literature has been the use of plastics and its negative effects. Plastics have, however, also been claimed to have an important role in diminishing the climate burden of the food system in terms of reducing food losses. During the last decade, an increasing body of literature has been published on the indirect environmental impacts of food packaging, thus linking the role of packaging with food loss and waste. It is well accepted that the uptake of food packaging innovations can reduce food losses significantly (Verghese et al., 2015). As reviewed by Lindh et al. (2016), food packaging contributes most to sustainable development through the protective function of preserving food, extending food's shelf-life and thus reducing food waste. The properties of plastics make it particularly suitable for protecting food and reducing food waste (Barlow and Morgan, 2013).

Verghese et al. (2015) studied the role of packaging within the food supply chain. They concluded that packaging can minimise food loss and waste trough different functions: distribution packaging can reduce damage in the logistics chain, retail-ready packaging helps the handling of food and improves the stock rotation in store, and primary packaging can reduce the food waste in households (Verghese et al., 2015). Smart packaging design can accommodate several consumer needs while acknowledging the interdependences between food waste, packaging design and circular economy principles (Halloran et al., 2014). However, concerns about overpackaging and underpackaging, and consequences in terms of the loss of food and accumulation of waste, still remain.

While packaging design has an important role in minimising food loss, several consumer studies indicate that poor design can contribute negatively to sustainability and increase food waste (see, e.g. Urrutia et al., 2019; Williams et al., 2012; Williams and Wikström, 2011). A Swedish consumer study showed that poor packaging design (e.g. packaging that is difficult to empty or too large) contributed to 20–25% of food waste (Williams et al., 2012). Only through a proper packaging design, which meets the key functions (protection, convenience and communication), packaging can decrease the food waste at the household level (Williams and Wikström, 2011).

3.4. Food packages and the dilemma of single-use culture

While several life cycle assessment (LCA) studies have shown that the direct environmental impacts of food packaging are considerably lower compared to the food it contains (see, e.g. Silvenius et al., 2014; Wikström et al., 2016; Williams and Wikström, 2011), consumer studies have revealed that consumers perceive food packaging, plastic packaging in particular (Boesen et al., 2019), as having a larger environmental impact (see, e.g. Hoek et al., 2017; Lindh et al., 2016; Williams et al., 2012). A recent Australian survey supported this, concluding that despite the convenience that plastic food packaging brings, consumers view the use of plastic food packaging negatively due to environmental issues connected to the use and disposal of plastics (Dilkes-Hoffman et al., 2019). Despite increasing attention being paid to the plastic problem in scientific literature, published literature on public opinion on plastic food packaging is still limited.

Packaging design can also contribute to food buying, consumption behaviour and eating habits (Girju and Ratchford, 2019). Furthermore, plastics in packaging have paved the way to new consumption practices (Hawkins, 2012) – like convenience food with easy-opening and re-closable packaging, ovenable packaged meals and single-portion packs (Sonneveld, 2000) and take-away food and fast food – through the introduction of single-use packages (Mikhailovich and Fitzgerald, 2014). The increasing demand for catered and take-away food and drinks have resulted in a significant increase in packaging waste (Maye et al., 2019). In today's society, disposable coffee cups are seen to symbolise the throw-away culture (Poortinga and Whitaker, 2018). Hage and Söderholm (2007) have gone so far as to state that, in the current society, packaging has become a symbol of unsustainable consumption. Much of the critique on plastic packages revolves around its short lifetime. The consumption phase of plastics is shortest in packaging applications and most of the plastic packages end up as waste within a year from their production (Geyer et al., 2017).

A variety of factors have been reported in the literature that can contribute to the increasing consumption of single-use plastics packaging. These factors comprise, for example, the good performance and low price of plastics (Geyer et al., 2017), issues related to food safety and hygiene that make it difficult to replace single-use plastic packaging in the food chain (Iacovidou et al., 2019), protective functions enabling the reduction of food waste (Barlow and Morgan, 2013), changes in household income and size (Thanh et al., 2011), changing consumer habits and the desire for convenience (Hawkins, 2018) and the lack of information on the environmental impacts of packaging at the point of purchase (Lindh et al., 2016). The controversial role of food packaging consumption in sustainability is well acknowledged in the literature. On the one hand, plastic food packaging is seen to contribute positively to sustainability by protecting food from being lost or wasted and by ensuring food safety and delivery. On the other hand, it is seen to enable and contribute to unsustainable consumption cultures, like the increased consumption of fast food and take-away food, and it is seen as a source of obesity and as a significant source of single-use plastic waste.

3.5. The end-of-life of plastic packaging

3.5.1. Packaging waste mismanagement: A source of plastic pollution

In public discussion, the plastic problem is most often framed as a pollution crisis. Also, in scientific literature, waste management and plastic pollution are dominant topics. A rapidly increasing body of scientific literature addresses both terrestrial and especially marine plastic pollution, their origins and their implications (see, e.g. Jambeck et al., 2015; Li et al., 2016; Miller et al., 2018; Thompson et al., 2009; Vince and Stoett, 2018). Several reasons make plastics problematic if they enter into the natural environment: firstly, plastics are perceived as persistent pollutants as they are durable and resistant to environmental degradation (Thompson et al., 2009). However, with exposure to sunlight, seawater and waves, plastic packaging can degrade into smaller debris and further into secondary micro-plastics, which can easily be ingested by animals and enter the food chain (Thompson et al., 2009). Furthermore, plastics can contain additives that are potentially harmful when they leak into the environment and bioaccumulate in organisms (Hahladakis et al., 2018). At the ecosystem level, the entanglement of animals by plastics has been widely reported (Li et al., 2016). Plastic litter and debris in the oceans has been reported to damage the fishing industry, as well as to cause aesthetic concerns, especially concerns regarding tourism (Moore, 2008).

Several studies indicate that plastic food and drinks packaging is a significant source of plastic litter found in aquatic and terrestrial environments. A study on riverine litter in Germany showed that the litter mainly consisted of plastics (30.5%), of which 44% were items related to food packaging (Kiessling et al., 2019). A longitudinal study on marine debris trends on the mainland beaches of California also indicated that the majority of debris is composed of small plastic fragments and single-use plastic items, including food containers, bottles and drink containers (Miller et al., 2018). The anthropogenic litter of plastic packaging mainly originates from land-based sources and enters the ocean through coastal areas and rivers (Jambeck et al., 2015).

While mismanagement of plastic waste takes place everywhere, regional differences in amounts of mismanaged plastic waste are notable. Jambeck et al. (2015) calculated that in 2010, 275 Mt of plastic waste was generated in 192 coastal countries, of which 1.7–4.6% was estimated to enter the ocean. In the highest-polluting coastal areas, the amount of mismanaged plastic waste was calculated to be up to 27.7% (in China) and 10.1% (in Indonesia) of all plastic mismanaged plastics waste generated globally (Jambeck et al., 2015). Furthermore, Asia is estimated to present 65% of the global mismanaged plastic waste generation (52 Mt), followed by Africa (17 Mt), Latin America and Caribbean (7.9 Mt), Europe (3.3 Mt) and Northern America (0.3 Mt) in 2015 (Lebreton and Andrady, 2019).

3.5.2. The failures and bottlenecks of recycling plastic packages

The role of plastic incineration and recycling was insignificant before 1980, and it was estimated that 60% of all plastics ever produced were discarded at the end of their lifetime and built up in landfills or in the natural environment (Geyer et al., 2017). Only a fraction (9%) of all plastics have been recycled, and only 10% of recycled plastics have been recycled again (Geyer et al., 2017). Accoring to Hahladakis and Iacovidou (2018), only approximately 5% of the material value of plastic packaging is recovered after a one-use cycle. Several reasons for low recycling rates have been reported in literature. Packaging design often includes the use of multi-materials that may not allow recycling with the existing waste management system (Maye et al., 2019). The multitude of different plastic material grades available on the market makes household plastic packaging waste heterogeneous, thus limiting the potential for closed-loop recycling (Eriksen et al., 2019). The contamination and degradation of recyclate feedstock may hinder recycling (Eriksen et al., 2019), and the quality of plastics is reported to degrade due to repeated reprocessing (Hahladakis and Iacovidou, 2018). The availability of certain new plastic materials for recycling, like biodegradable plastics, is still low and limits the development of the recycling systems, as is the case for polylactic acid (PLA) plastics (Hahladakis and Iacovidou, 2018).

The plastic litter problem is also connected to changes in the practices of food consumption. A high amount of single-use packaging made entirely or partly of plastics is used in the fast food industry. Furthermore, littering is a problem in this sector, which is shown to have a negative impact on brand image (Roper and Parker, 2013). A study by Aarnio and Hämäläinen (2008) showed that even though the theoretical recovery rate of packaging waste in the fast food industry is high (93%), the actual recovery rates are low (29%), partly because of the unavailability of proper waste sorting systems which does not allow consumers to sort their packaging waste. While certain sorting instructions and recycling labels exist for plastic food packaging, the lack of informative sorting and recycling labels or familiarity with existing eco-labels is seen to hinder consumers in sorting their food packaging waste appropriately, even if they would like to do so (Boesen et al., 2019). Wikström et al. (2016) suggested that packaging design attributes can also influence the recycling behaviour of consumers; for example, food packaging that cannot be fully emptied is likely end up in mixed waste. The lack of a recycling culture can have an impact on recycling rates (Hage and Söderholm, 2007). Market-related issues – such as low demand for recycled plastics, fragmentation of the value chain and a lack of coordination – have also been identified to hinder the recycling of plastics (Milios et al., 2018).

Despite increasing incineration and recycling activities, the amount of plastic waste produced and discarded is projected to increase in the future (Lebreton and Andrady, 2019). The increasing consumption of plastics has put pressure on solid waste management systems, especially in countries with rapid economic development and population growth (Brooks et al., 2018). While the collection and recycling of plastics is perceived as a solution to the plastics problem, it may, in fact, have contributed to the build-up of the problem, especially due to global waste trade from high-income countries to lower-income countries. The plastic waste trade is seen to contribute to the mismanagement of plastic waste in lower-income countries (Lebreton and Andrady, 2019). Brooks et al. (2018) have studied the global trade of plastic waste intended for recycling and reported that annual imports and exports have increased rapidly since 1999, by as much as 723 and 817% respectively in 2016. The authors suggest that plastic waste trade has been active between high-income OECD countries (accounting for 64% of all exports since 1988) and the lower-income countries of East Asia and the Pacific (accounting for 75% of all imports since 1988). China was the main import country until the import of nonindustrial plastic waste was banned in 2017 (Brooks et al., 2018). Furthermore, historically 89% of waste export belongs to the polymers used in single-use plastic food packaging (Brooks et al., 2018).

A functioning waste management system is necessary in order to combat the plastics crises on land and sea. Yet, all the waste treatment options, including landfill, incineration, energy recovery and recycling, also have socio-environmental impacts. For example, biodegradable packaging is a source of methane gas when disposed of in a landfill (Dilkes-Hoffman et al., 2018). Then again, waste incineration can cause environmental and health impacts which depend largely on incineration and emission control technologies and operations (Geyer et al., 2017). While the recycling of plastic packaging waste is shown to be favoured over incineration due to environmental reasons (Larsen et al., 2010), the reverse logistics and plastics recycling also consumes energy and contributes to GHG emissions (Kuczenski and Geyer, 2013). Health impacts have been reported, such as the exposure of workers to bioaerosols, such a fungi, bacteria or endotoxins, at recovery facilities (Schlosser et al., 2015). A recent Brazilian study addressed the social aspects of plastics recycling by linking the recyclability of plastic packaging to the economic survival of the low-income workers who are sorting the urban dry residues (Palombini et al., 2017). The key positive and negative aspects of plastic food packaging are summarised and presented in Fig. 1.

4. The circular economy as a suggested solution to governing plastic food packaging

As described in the previous sections, our review shows that plastic packages connect to multiple sustainability concerns such as GHG emissions, land use conflicts, health risks, marine pollution and food loss, to name but a few. The role of plastic food packages in these sustainability dilemmas varies considerably, which indicates that to solve the plastic crisis, there needs to be a coherent mix of policy instruments which both address the particular single problems and together guide the development of food packaging in a direction that is considered as societally favourable. Due to the complexity of the topic, this is not an easy task. Our review indicates that, in terms of governance, the solutions for the problems caused by plastic food packages are searched for from waste management and the circularity of plastic material. Hence, the dominant governance approach is material oriented and puts hopes on the transition towards a circular economy. If the sustainability dilemma of plastic food packages has many faces, so has the definition and interpretation of the circular economy (Kirchherr et al., 2017). As an open-ended concept, it can cover mutually controversial expectations (see, e.g. Lazarevic and Valve, 2017) and normative choices (Fitch-Roy et al., 2020), and be realised through very different socio-technical arrangements (Humalisto et al., 2020).

One of the guiding principles behind various circular economy strategies – including, for example, the EU plastics strategy – is the waste hierarchy principle. This principle emphasises the prevention of waste over reuse, recycling and recovery as energy, while waste disposal via landfill has the lowest priority. The principle can be interpreted in many ways and turned in to different policy implications. In the following, we draw together our findings on how the waste hierarchy and the principles of the circular economy shape the governance solutions and the kind of policy measures found in the reviewed literature that are suggested in order to solve the sustainability problems of plastic food packaging.

4.1. Reduce and replace

The main measures to reduce the use of plastics for food packaging present in the scientific literature are top-down regulation-driven measures, including regulatory and financial measures and measures to improve the eco-design of packaging. An increasing amount of voluntary, bottom-up initiatives also exist, such as brand owners promoting the use of recycled plastics (Foschi and Bonoli, 2019), grocery stores renouncing the use of disposable plastic packaging (Beitzen-Heineke et al., 2017) and retail chains committing to voluntary agreements to reduce packaging waste (Roper and Parker, 2013). Several transnational, voluntary, collaborative initiatives have emerged in recent years, including the New Plastics Economy Global Commitment of the Ellen MacArthur Foundation and the Global Plastic Action Partnership and the Global Plastics Platform led by the World Economy Forum, which both aim at reducing plastics use and pollution (Nielsen et al., 2019).

Literature on the environmental regulation of production and consumption of packaging is extensive, especially in context of the EU's packaging and packaging waste directive. For example, Cela and Kaneko (2013) have studied the effectiveness of a weight-based packaging product charge that aims to reduce the demand for virgin packaging material. The authors emphasised that caution is needed when designing taxation, and alternative environmental taxation, such as a material levy policy, could improve the uptake of technologies that would improve material efficiency and down-gauging, especially in countries where packages are extensively produced (Cela and Kaneko, 2013). Several countries have adopted extended producer responsibility (EPR) schemes for packaging waste management and reduction. In EPR schemes, a producer's responsibility covers not only the production and use stages but also the post-consumer stage (Leal Filho et al., 2019). The effectives of existing extended producer responsibility schemes might not be optimal for packaging waste reduction (Van Sluisveld and Worrell, 2013), nor may they incentivise producer eco-innovations (Røine and Lee, 2008). EPR also covers deposit refund schemes for PET plastic bottles. Hopewell et al. (2009) argued that outside Europe, deposit refund schemes are not perceived as a scalable strategy for reducing plastic waste. Recent studies contradict this view and indicate that the adoption of deposit refund schemes can be an efficient economic instrument to reduce littering (Schuyler et al., 2018).

Recently, the environmental regulation of single-use plastics through banning or taxation has gained increasing attention, especially in the frame of marine protection (see, e.g. Foschi and Bonoli, 2019; Nielsen et al., 2019; Prata et al., 2019; Schnurr et al., 2018). The literature is increasing on policy measures and initiatives that focus on banning certain single-use items, especially

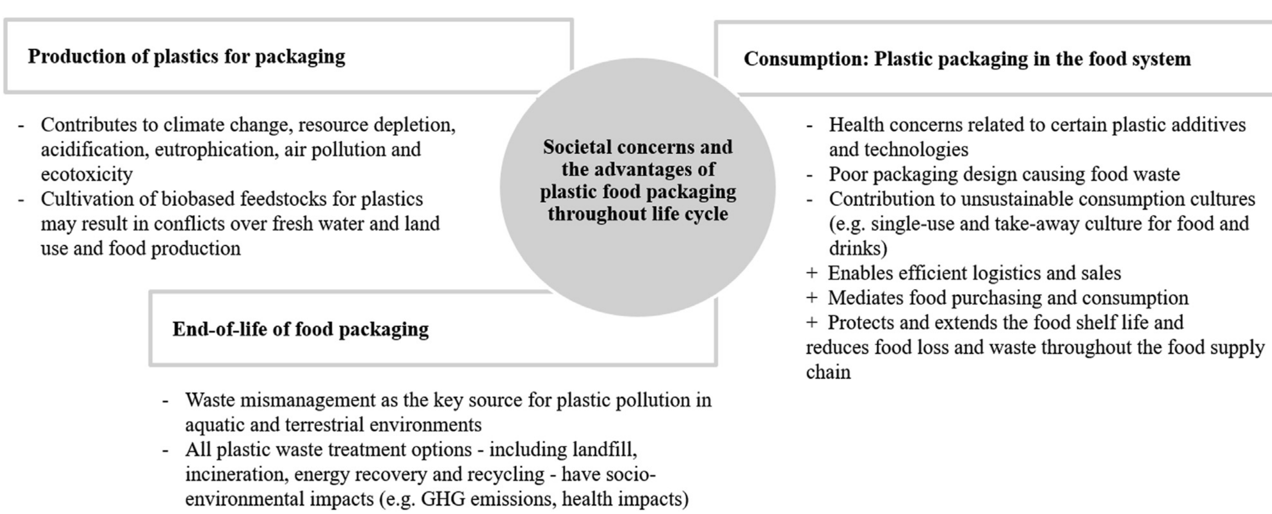

Fig. 1. An overview of the positive (+) and negative (−) aspects of plastic food packaging throughout its life cycle.

plastic bags and single-use plastic bottles (Schnurr et al., 2018). In their consumer study, Thomas et al. (2019) suggested that banning plastic carrier bags may lead to policy spillovers and improve the acceptance of other environmental policies aiming at reducing or eliminating single-use plastics, including those used in packaging. In fact, following the regulation for plastic bags, further bans on plastic products have been implemented globally. However, scientific papers on regulatory initiatives that focus on banning single-use plastic packaging for food and drinks are still limited. Schnurr et al. (2018) have reported on cases of national and sub-national bans on polystyrene food containers and cups implemented in Northern and Central America. Further initiatives towards reducing the use of single-use food packaging or cups by banning or taxation have also been reported (Schnurr et al., 2018), including the EU's recent directive on single-use plastics (Foschi and Bonoli, 2019). Furthermore, Maye et al. (2019) reported on the 'latte levy' suggested in Britain for disposable coffee cups.

Cases of bottom-up initiatives have been reported in the scientific literature, including charging for use, renouncing the use of take-away cups at points of sale (Maye et al., 2019) and bans on the sales of bottled water (Mikhailovich and Fitzgerald, 2014). While many of the presented cases focus on reducing take-away food and drinks packaging waste, the emergence of plastic-free supermarket aisles and package- or plastic-free shopping widens the scope to cover other food packaging items. Disposable package—free grocery shops are designed to meet the consumer demands for the removal of excess packaging, which is perceived as unsustainable (Fuentes et al., 2019). However, Prata et al. (2019) have suggested that banning single-use plastic packaging for perishable foodstuff should be avoided due to potential impacts on public health. The focus should, instead, be on improving the packaging design. Suggested eco-design improvements that aim to lower the environmental impact of packaging include material source reduction (lightweighting/downgauging, avoiding excessive packaging, reducing package void space, packaging in bulk/family packages) (Van Sluisveld and Worrell, 2013), using biodegradable or biobased plastics (Karan et al., 2019), especially from forest biomass and agricultural residues (Brodin et al., 2017), designing for reuse (Van Sluisveld and Worrell, 2013) and improving the recyclability of packaging (Toniolo et al., 2013).

4.2. Reuse

Direct or closed-loop reuse schemes, including take back and refilling, are not yet common for food packaging targeted to consumers. In contrast, deposit refund schemes for multiple use (reusable) PET bottles and single-use (disposable) PET bottles exist as part of EPR (Xevgenos et al., 2015). Refillable plastics packaging is often heavier than disposable packaging (Clark, 2018), and over the years, disposable PET bottles have outperformed reusable bottles in many of these refund schemes, as pointed out by Xevgenos et al. (2015) in their review. However, reusable PET bottles, as part of a deposit refund system, are shown to reduce GHG emissions compared to disposable, recycled bottles (Simon et al., 2016).

The sustainability of reusable plastic packaging for food has also been studied. LCA studies suggest, that the adaptation of reusable plastic containers in fresh fruits and vegetables supply chains can provide economic and environmental benefits, such as significantly reducing GHG emissions and solid waste (see, e.g. Levi et al., 2011; Singh et al., 2006). However, the economic and environmental impacts are highly case sensitive and depend on several parameters, such as the reusable plastic container's lifespan, the washing rate, the waste disposal system and (reverse) supply chain geography, as pointed out by Accorsi et al. (2014). Recent LCA studies on takeaway food containers show that material choices and recycling rates affect the environmental impact of reusable food containers (Gallego-Schmid et al., 2018) The digitalisation of food packaging has been suggested as a tool for the management of reusable food packages and for the quantification of the environmental and economic impacts within the food supply chain (Vanderroost et al., 2017).

The reduction and banning of disposable, single-use packaging has driven further market-based initiatives, such as TerraCycle (Mahmoudi and Parviziomran, 2020) and reCIRCLE (Dorn and Stöckli, 2018), on reusable packaging alternatives for food and drink. Based on an existing market-based initiative, Dorn and Stöckli (2018) carried out a behavioural change intervention on reusable plastic food containers at a takeaway restaurant. They concluded that the use of reusable food containers can be fostered by social influence. However, the uptake of reusable plastic takeaway containers remained low as less than 7% of the customers chose this type of container. The authors suggest that the high costs of reusable plastic container deposit, being charged for acting sustainably and lower convenience could contribute to the low uptake (Dorn and Stöckli, 2018). Geueke et al. (2018) have proposed that deposit schemes for reusable food packaging could be promoted by using standardised containers that could be returned and refilled at different points of sale.

Contrary to market-based deposit schemes for food packaging, reusable coffee cup schemes are based on bans and financial incentives, such as charges for disposable cups designed to promote the use of reusable cups (Maye et al., 2019). Poortinga and Whitaker (2018) studied the use of reusable coffee cups at university and business coffee sites and concluded that a combination of measures, including normative messaging, the provision of reusable alternatives and financial incentives, such as placing a charge on disposable cups, resulted the greatest behavioural change. Until recent times, the studies on the effectiveness of reusable food and drink container schemes had still been limited.

4.3. Recycle and recover

Plastic recycling and recovery are perceived as the main waste management options for packaging waste (Hopewell et al., 2009). In a recent review of the literature, Prata et al. (2019) noted the socio-economic and environmental benefits of plastics recycling — such as the reduced need for landfills, resource and energy savings, lower emissions compared to primary production and the creation of jobs — may outweigh the economic disadvantages. The impacts of plastics recycling depend on the types of polymer as well as on what packaging applications the material is used for. For example, the polymer properties of PET make it suitable for closed-loop recycling (Welle, 2011). In closed-loop recycling, which is also known as direct or primary recycling, the collected post-consumer plastic is mechanically reprocessed and reused in a similar type of application to the case of bottle-to-bottle recycling (Vanderroost et al., 2017). While the individual polymer grades of PE and PP can be easily recycled (Leal Filho et al., 2019), the material heterogeneity of food-packaging plastic waste and polymer degradation during the recycling process have been shown to especially limit the closed-loop recycling of PP plastic waste (Eriksen et al., 2019). Furthermore, the manufacture of food packaging from recycled plastics is highly regulated in Europe and the United States in order to ensure food safety (Welle, 2011). In their recent study, Foschi and Bonoli (2019) reviewed the EU policy mix for food packaging, concluding that the stringent regulation on plastics recycling for food packaging has, in fact, stimulated innovation, investments and partnering in biomaterial development and recycling processes. With the exception of PET bottles, the examples of the closed-loop recycling of plastic food packaging are still rare in scientific literature. In open-loop recycling, also known as secondary recycling, the plastic food packaging is recycled as material to be used for applications other than food or drink packaging (Vanderroost et al., 2017). Tertiary recycling covers both chemical recovery/recycling and the composting of biodegradable plastics while energy recovery (incineration) is categorised as quaternary recycling (Hopewell et al., 2009).

Well-performing collection and sorting are prerequisites for efficient recycling and the circular economy of plastics (Van Eygen et al., 2018). Environmental policies have been established to incentivise the collection and recycling of plastics, including legislative, financial and voluntary measures. EPR is seen as one of the key instruments in the circular economy of plastics (Leal Filho et al., 2019) and waste hierarchy (Milios et al., 2018). Globally, deposit refund schemes have been shown to improve the collection and recycling of PET bottles (Schuyler et al., 2018), yet the benefits of deposit refund schemes are case sensitive and needs to be assessed for each region and each plastic material used (Prata et al., 2019). In Europe, the circular economy of plastics is high on the political agenda, with an emphasis on plastics recycling (Foschi et al., 2019). EPR schemes have been established to implement the EU Directive on Packaging and Packaging Waste and to support the sorting and collection of used plastic packaging material. The existing EPR policies are designed to comply with recycling targets, but schemes have been criticised for not supporting innovation and stimulating sustainability transformation, as reported in the case of packaging-related EPR in Norway (Røine and Lee, 2008). In the EU context, the implementation of EPR for post-consumer plastic packaging has shown to be challenging due to the lack of harmonisation and transparency (Leal Filho et al., 2019). However, Leal Filho et al. (2019) argued that, despite the current challenges, more ambitious EPR for plastics could provide economic incentives for favouring circular business models and initiatives, including further reuse and deposit schemes. Furthermore, tightening regulations and higher plastic recycling rates in the EU are foreseen to force changes not only in packaging design and recycling infrastructure but also in the entire packaging value chain, as pointed out by Pauer et al. (2019). Some indication of such progress exists as 30 organisations along the plastics value chain formed the Circular Plastic Alliance in 2019, committing to provide 10 million tonnes of recycled plastic to the EU by 2025 (Nielsen et al., 2019).

Despite positive progress in plastics recycling, the closed-loop recycling of plastic food packaging still faces several challenges, as described earlier. Eriksen et al. (2019) suggested that, to overcome the challenges with heterogeneity in household plastic waste, improved tracer-based sorting and regulatory harmonisation related to packaging design or even chemical recycling are needed. To increase plastic waste recycling, policy interventions to create market demand are also called for, including preferential taxation (Milios et al., 2018), the mandatory use of secondary materials (Prata et al., 2019), better packaging sorting and recycling labelling (Boesen et al., 2019), improved public procurement and the introduction of international quality standards, as well as interventions in value chain coordination and integration, innovation and capacity building (Milios et al., 2018). Examples of the measures and initiatives targeting plastic food packaging are summarised in Table 2.

5. Controversies in the governance of plastic food packaging for the circular economy

5.1. Contradicting sustainability targets and rebound effects

As indicated by our review, sustainability targets and priorities addressing plastic food packaging can be contradictory in many ways (e.g. the reduction of plastic waste, the reduction of [marine] littering, decreasing the use of single-use plastics, increasing demand for biobased packaging or recycled plastics, the reduction of GHG emissions, reducing food waste and loss, ensuring food safety, the reduction of obesity etc.). Policies that are suggested to prevent food waste and loss, like packaging improvements to extend shelf life or to protect the products better (Thyberg and Tonjes, 2016), may require increasing the environmental impact of packaging (Williams and Wikström, 2011), that is to say, the impact is increased due to the use of more plastic packaging material or materials that are difficult to recycle (Verghese et al., 2015). Yet, the environmental impacts of increased packaging are justified if it prevents food waste (Williams and Wikström, 2011), which causes higher impacts than the plastic packaging (Silvenius et al., 2014). However, sometimes packaging improvements intended to extend shelf life may in fact lead to food waste at the household level if the packages are difficult to empty (Wikström et al., 2016). Pro-environmental initiatives, such as banning certain disposable plastics that are used in single-portion food and drinks, may lead to unhealthy dietary choices, as suggested in an Australian study on PET bottles (Mikhailovich and Fitzgerald, 2014). On the other hand, more-demanding recycling targets may force replacing non-recyclable, lightweight plastic films with heavier materials that can be easily recycled but that have a higher direct environmental burden from, for example, production or transport (Wikström et al., 2016).

In the light of the reviewed literature, sustainability policies focus strongly on governing the direct environmental impacts of post-consumer plastics, such as littering and waste, while the indirect environmental impacts, such as food loss and waste and related GHG emissions during the production and consumption phases, seem to have lower priority. Furthermore, the different functions of plastic food packaging, like containing take-away food versus protecting perishable food products, are not yet acknowledged in the environmental policies. The exponential growth of the plastic littering problem, especially in marine ecosystems, has drawn attention to the environmental problems. Furthermore, direct environmental impacts appear easier to comprehend than indirect impacts. As mentioned earlier, disposable food packaging is seen as a symbol of unsustainable consumption, and packaging waste is perceived by consumers to have a higher environmental impact than food waste (Lindh et al., 2016). Against this backdrop, it is understandable why plastic packaging is at the centre of public and political attention.

Another reason for the emphasis on packaging litter and waste could be that assessing the sustainability of food packaging options is still challenging. LCA is a widely applied method for evaluating the environmental impacts of packaging, and it has become an important decision-supporting tool in packaging development and design (Pauer et al., 2019). It is, however, important to note that the method has its limitations. Due to many modelling approaches and a multitude of factors that affect the environmental impacts of different food or drink packaging systems, the results of different LCA studies are difficult to generalise and compare (Pauer et al., 2019). Many packaging material LCA studies do not take into account the indirect impacts of packaging on the food supply chain, like food loss and waste (Molina-Besch et al., 2019), or recyclability (Pauer et al., 2019), nor do they take into account packaging design characteristics that impact on consumer behaviour related to household sorting (Wikström et al., 2016) or littering (Dilkes-Hoffman et al., 2018). Increasing demands have been raised by academia to study food and its packaging as a complete system in order to optimise sustainability (see, e.g., Molina-Besch et al., 2019; Wikström et al., 2019). It is, however, difficult to quantitatively compare food waste reduction with packaging waste reduction as

Table 2
Examples of measures and initiatives that address waste management and the circular economy of plastic food packaging.

Measures and initiatives/primary targets	Waste reduction	Promote reuse	Promote recycling	Reduce littering
Regulatory				
Packaging waste legislation and recycling targets	x		x	x
Bans on single-use products (e.g. coffee cups and bottles, food packaging)	x	x		x
EPR schemes for post-consumer plastic packaging (in the EU)	x		x	
Food contact legislation on the manufacture of recycled plastics			x	
Financial				
Deposit-refund schemes for PET bottles	x	x	x	x
Material or packaging levies, taxation and weight-based material charges	x	x	x	
Market-based/voluntary				
Deposit schemes for reusable food containers	x	x		x
The use of recycled plastics	x		x	
Renouncing plastic's use (plastic-free grocery shops, coffee shops)	x	x		x
Eco-design improvements	x	x	x	x
Investments in plastics recycling	x		x	
Voluntary agreements and pledges (e.g. the Courtauld Commitment)	x	x	x	x
Communicative				
Behavioural change interventions, awareness raising, capacity building, labelling	x	x	x	x

the comparison inevitably involves some judgement of how to prioritize between different sustainability goals. The literature shows that the current role of plastic food packaging is highly contested. The optimisation of plastic food packaging needs to entail its entire life cycle, but it involves several trade-offs (Barlow and Morgan, 2013).

5.2. Failing responsibilities

Other important characteristics that hamper the collaboration towards more sustainable food packaging are the unclear responsibilities and tendency to externalise the problems. Retailers are claimed to externalise the problems caused by the disposal of packaging waste to consumers, for example. While several environmental laws and regulations, like EPR schemes for waste packaging, are implemented in order to force producers to take care of post-consumer packaging waste, the polluter pays principle does not always materialise. For example, in the case of single-use coffee cup recycling in England, 90% of packaging waste disposal is paid by the taxpayer and only 10% by business, as pointed out by Maye et al. (2019). Financial instruments, like EPR schemes, have encouraged global waste trade from high-income countries to developing economies and this has contributed to the marine litter problem (Brooks et al., 2018). In addition, in the food packaging value chain the responsibility is distributed along the value chain and does not incentivise material reduction (Beitzen-Heineke et al., 2017), and unclear responsibilities are seen to fuel negative externalities from disposable, single-use plastics consumption, such as littering (Roper and Parker, 2013). Sometimes there is a fine line between the responsibilities of producers, consumers and the public sector. Consumers may assume that the recycling labels provided by packaging producers denote that the packaging is recycled if sorted into appropriate waste bins, yet the lack of bins or recycling infrastructure may hinder the actual recycling, as reported in the case of single-use coffee cups (Maye et al., 2019). While distributed responsibility has its challenges, it is suggested as a solution that could govern the problems (Maye et al., 2019).

While packaging-free groceries and supermarket aisles may remove certain negative externalities (i.e. disposable packaging waste) from consumers, they shift the responsibility of packaging choices to consumers by forcing consumers to purchase, clean and transport reusable food packaging. Regarding food waste reduction, economic incentives have been suggested for business actors to optimise packaging solutions (Thyberg and Tonjes, 2016). Yet, delineating producer, consumer and public sector responsibilities in food consumption and post-consumption stages is challenging from the perspective of plastic packaging.

5.3. Separate circular economies for plastics and food systems

Although a circular economy is proposed as a solution for the plastics problem and as a means to improve sustainability (Ellen MacArthur Foundation, 2020), several scholars have argued that increasing the circularity may not be an environmentally sound option and may result in new sustainability challenges (see, e.g. Nielsen et al., 2019; Pauer et al., 2019). As argued by Nielsen et al. (2019), the industry may simply comply with the minimum recycling targets and market these efforts as systemic change. Furthermore, recycling does not encourage reducing the production of unsustainable products (Roper and Parker, 2013). Evidence from existing packaging waste EPR supports this argument. Kalmykova et al. (2018) have observed that, in general, an emphasis on the circular economy is still on the material recovery, recycling, consumption and use stages while manufacturing, for example, is less featured. Systemic change or transformation is still rare in the implementation of a circular economy (Kalmykova et al., 2018).

The reviewed literature indicates that plastic food packaging is discussed in the context of the circular economy of plastics, especially from the perspective of material recycling, recovery and reducing the consumption of disposable packaging. From the perspective of food systems, the emphasis is on the role of packaging in preventing food waste and loss. While in the circular economy of food systems, plastic packaging is seen as a solution in reducing food wastage, in the circular economy of plastics it is perceived as a recycling and waste problem that needs to be solved. Currently, these two circular economies mainly intersect in relation to the recyclability of food plastic material and the material safety of recycled plastics. Setting system boundaries is a necessity in research but there is a risk that in policymaking and business choices, too tight boundaries may result in sub-optimisation and distort the overall sustainability.

6. Concluding remarks

At first sight, an ordinary food package appears to be a simple object to be governed. Our results, however, reveal its complexity. Food packages as material objects and food packaging as a practice are intertwined with the key societal functions of materials provisioning and nutrition, for example. Following from that, the current governance measures for plastic food packages, similar to the governance measures suggested by research literature, are numerous, depending on the sustainability targets addressed (e.g. marine protection, climate mitigation, resource efficiency, health and safety). The main emphasis seems to be on the mitigation of the direct environmental impacts of plastic waste and littering. By contrast, the indirect environmental impacts including food loss and waste, which have the highest impact on GHG emissions, have gained less attention.

The solutions for the environmental harms caused by plastic food packages are mainly searched for from the waste management and circularity of plastic material. Thus, the dominant governance approach is material oriented and puts high expectations on the ability of the circular economy transition to tackle the plastic crisis. Yet, our overview of policy measures that are either currently applied or suggested as potential tools to advance the reduction, reuse and recycling of plastic packages indicates that the goals of the circular plastic economy are inherently contradictory in many ways. For example, improving the mechanical recyclability of food packaging may lead to use of heavier monomaterials. Furthermore, different policy measures that promote mechanical recycling may create new path dependencies and lock-ins that hinder the adaptation of other sustainable practices, like biological recycling of biodegradable packaging, as has been the case in certain EPR schemes.

In addition to the different goals of the circular economy being mutually contradictory, the material emphasis of the circular plastic economy approach has also led to downplaying one important aspect of food packaging, that of providing services at the interfaces between different industries and consumers. In addition, the current environmental policies seem to fail to differentiate between the containment and protective functions of food packaging. While the circular economy covers the entire life cycle of a food package, so far, the beginning and the end of the life cycle have gained the most attention in the governance. Thus far, only a limited number of policy measures focus on the consumption phase, targeting the functional aspects and behavioural practices related to plastic food packaging. Thus, the different functions of plastic food packaging need to be acknowledged better in environmental policy design.

Following from the tendency of solving particular problems caused by food packages or enhancing particular goals under the umbrella of circular economy policies, the governance of the sustainability of plastic food packaging is fragmented, as is often the case with environmental policies dealing with systemic transformations. Our review shows that there is a lack of critical evaluation of systemic sustainability impacts of different circular economy policy measures in relation to different sustainability goals. There is clearly a need to increase this kind of knowledge base to support the designing of comprehensive policy mixes that could simultaneously tackle the environmental problems and address the need to use innovation to regenerate those practices of food packaging which are dependent on plastic at the moment. In addition, to avoid unanticipated systemic impacts from particular policy measures on other parts of the food packaging system, systematic tools for the use of anticipatory, future-oriented policy impact assessment in policy design should be developed.

CRediT author statement

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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

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