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Changes towards more sustainable food packaging legislation and practices. A survey of policy makers and stakeholders in Europe

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ABSTRACT

The European Commission advocates for the implementation of more sustainable food systems. To accelerate the transition towards zero waste for the benefit of citizens, industry, public organizations, and to preserve biodiversity, it is necessary to re-design our relationship with the planet's resources. The European Commission proposal on the circular economy (2015) has set high targets in relation to reusing, upcycling, and recycling of plastic materials. In this context, it is imperative to re-evaluate how we protect foods with packaging. In this work, we report the results of one-on-one interviews with policy makers, citizens, and industry actors held over the spring/summer period of 2021 across European countries. The interviews (2 per group, 6 per country, for a total of 54 interviews) highlighted the need to advance and improve policies, thereby leading to better industrial and societal practices in the EU. Furthermore, harmonization of policies and practices is needed to achieve the set sustainability targets. Key regional differences across Switzerland, Austria, Germany, Norway, Estonia, Sweden, the Netherlands, Ireland, and Germany became apparent during the interviews, especially in relation to the infrastructure for collecting, sorting and using of packaging waste. The interviews also showed that policymakers and industrial stakeholders have common goals towards a more circular economy. However, such collaborations require a whole systems approach to achieve behavioral changes towards this goal. Using ideation tools, namely the Iceberg model and the Berkana two-loop model, the different food packaging challenges were identified, explored and evaluated in terms of their feasibility and impact on sustainability. Furthermore, the main solutions were categorized in an Impact-effort matrix. These tools, through an extensive analysis, demonstrated that the integration of sustainable food packaging solutions within Europe depends more on policies and stakeholders' mindsets than on technical aspects.

1. Introduction

EU policymakers aim to reduce the volume and impact of specific plastic products on the environment through the Single Use Plastics Directive (Directive (EU), 2019). Member states are committed to introducing greater regulatory measures between now and 2030 (Directive EU, 2019). Food packaging sustainability is a critical aspect of the shift to a greener plastic economy. Integrating sustainability into the management of plastic production and its uses involves systemically incorporating technological, socio-psychological, environmental, policy, and other dimensions, from the micro to the macro levels. The perspectives of the involved stakeholders, namely policymakers,

industry, and citizens on the mitigation strategies linked to reducing food packaging plastics will be critical to support and foster the development of novel strategies and map out innovative ideas on how to reduce plastic pollution.

The role of education, at all levels of the food packaging value chain, as well as the development of sustainable materials and new technological and organizational routes have all been identified as costefficient and green approaches to minimize plastic waste. However, it is not clear which one would be the most effective route to reach a swift and rapid transition to a circular, sustainable system. A variety of factors must be considered to significantly reduce the need for single use petroleum-based plastic products. Although the impact of plastic on

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climate change seems to be a common concern, a small fraction of industry actors, policy makers, and citizens are truly pro-actively engaged in concrete mitigation activities. This discrepancy between environmental view and real action has been recognized as a great challenge (Duchi, Lombardi, Pass, & Loyens, 2020). It is therefore important to provide a better understand of the status of the activities across Europe. Previous research has shown that it is possible for the mindset of producers and consumers to lead to habit changes with respect to plastic production and use (Price, Coulter, Strizhakova, & Schultz, 2017). Given the large body of research presented in the literature, Soliman and Wilson (Soliman & Wilson, 2017) expect people's mindsets, i.e., a human vision of the world to be one of the main factors impacting which course will be taken to resolve environmental challenges. Therefore, examining such mindsets will enhance our understanding of the psychological barriers hindering pro-environmental action, and evaluate the discrepancies in the general population between their informed view of the human-caused climate change and their lack of action in this regard (Fielding, Hornsey, & Swim, 2014; Koger, Leslie, & Hayes, 2011).

In the past, through literature surveys, ideation, and system process mapping, potential solutions to the plastic challenge have been identified (Giacovelli, 2018; Shin & Selke, 2014). However, the issue related more specifically to sustainable food packaging has yet to be fully studied. Similarly, previous research has focused on understanding the mindset of consumers and producers, while little is known on the impact of national and EU policymakers' mindset on the development of food packaging legislation (Fielding et al., 2014). The understanding of policymakers' mindset will improve communication amongst stakeholders within the value chain and avoid misunderstanding with respect to the definitions and use of the EU directives. The EU directive came into effect in July 2021 and introduced specific measures which are directed towards the reduction of the most frequently used single-use plastic products. In this context, food packaging takes center stage (Directorate-General for Environment European Commission, 2021). The recent EU single-use plastic directive led to numerous debates among consumers and the media, as a result of the broad definition of plastic. For example, one definition includes both synthetic polymers and chemically modified natural polymers which may lead to bio-based biodegradable and compostable materials being treated equally to fossil-fuel plastic products. Thus, it is critical to improve these definitions and communication among stakeholders on this topic, so as to assist in finding innovative approaches and methodologies to reduce the impact of food related plastic waste on the environment.

The current work was motivated by the societal need to update and rethink the traditional systems, and the challenge of reducing food packaging waste. This work collected information on human mindset, industrial practices, technological innovations, and policies in the EU countries through various stakeholder interviews and through an indepth analysis aims to drive to a better understanding of the "plastic for food" challenge from the perspective of various societal actors. It therefore acts as a guide to reach balanced solutions between consumer's needs, farming and industrial productivity, commercial interest, and the EU policies and regulations fostering a carbon neutral society.

2. Methodology

2.1. Interviews

The term 'sustainable packaging' is often misused in the literature (Meinslschmidt, Schleper, & Foerstl, 2018). There is no definition for the term 'sustainable food packaging'. To better understand the mindset of national and EU policymakers and industry stakeholders a survey was developed. The questions are summarized in Fig. 1. Stakeholders were interviewed in seven EU countries: Belgium, the Netherlands, Sweden, Estonia, Ireland, Austria, Germany, and two countries which are associate members of the Schengen Area, namely Switzerland and Norway. In addition, consumers were also interviewed, as they play a central role

1	. What is in your opinion 'sustainable packaging' ?
2	2. What is the most sustainable packaging in the EU country which you represent today?
0	8. Can you describe the future design of sustainable packaging in the EU?
4	b. Do you think we should always avoid packed products from an environmental perspective?
5	5. How informed are you about changes in the legislation related to food packaging?
e	b. Do you organize and attend any seminars or workshops which are related to foo packaging legislation?
7	7. Which topics surrounding 'sustainable packaging' would need clarification in order to avoid confusion in the general public?

Fig. 1. Interview questions which were asked to policymakers, consumers, and plastic producers.

in the food value chain, and more importantly their behaviors are pivotal to the food and packaging end of life.

Engagement of diverse stakeholders is recognized as the way to achieve economically competitive and feasible innovative solutions across Europe. In this work, consumers were asked questions 1–5. However, questions 6 and 7 were reformulated, to survey their potential interest in learning more about food packaging, i.e., by participating in sustainable food packaging workshops and seminars, and to assess if they had any recommendations on how to minimize the confusion around a sustainable food packaging definition.

To provide a full picture of the issues being discussed, as well as an analysis of the views of the interviewees, the data resulting from the interviews was evaluated within the context of the EU directive as well as of established literature. Two representatives from each stakeholder group, in each EU country, were interviewed. Interviews for this study were conducted between November 2020 and August 2021. The main limitation of the present work was related to challenges in arranging meetings with interviewees due to their busy schedules. At least twice more invitations were sent out than the number of actual interviewed subjects. The interviews were carried out on a first come-first serve basis without a particular order. In general, the list of interviewees was created through contacts of the COST action Circul-a-bility members of that country. Therefore, the interviewees chosen were somehow involved in sustainability and environmental issues. The interviews with policymakers always began with an introduction of policymakers' professional interest without referring to their political membership. The questions related to the professional interests included their level of education and the time engaged with policy. The above-mentioned seven questions were asked in relation to food, sustainability, and their general understanding of plastic and packaging.

The one-on-one interviews lasted about one hour. The consumers were randomly chosen, but all had no background in sciences and engineering. They were selected from the immediate environment of people involved with food packaging research projects, to ensure compliance with participation. Questions to stakeholders were used as a platform for the discussion and the ideas from the conversation were later analyzed using the Iceberg model, Berkana two-loop model, and Impact-effort matrix. The interviews were asked in one-on-one meetings using online communication platforms like windows TeamsTM and ZoomTM. To ensure open discussions, all interviewees were guaranteed anonymity. Therefore, their names, roles, and institutional affiliation are not disclosed, and their contributions and views have been anonymized. Furthermore, any information or answers that could disclose their identities have been omitted. The results of interviews are structured and organized according to their country. A summary of their interviews can be found in the supporting documentation.

Iceberg model, Berkana two-loop model, and Impact-effort matrix were employed as ideation process tools in the transition to identify problems, explore solutions, through design thinking, and brainstorming. These tools are unique because they provide options to consider not only technical issues, but combine all aspects of sustainable food packaging including socioeconomic, technical, and public mindset (Directive EU, 2019; International Trade Center, 2019; Kassel, Mitchell, & Rimanoczy, 2016; Kochanska, Lukasik, & Dzikuc, 2021). The Iceberg model was employed to understand the current EU situation with respect to food packaging. The Berkana two-loop model identified a roadmap of change from the initial challenge to the potential solution. The goal is to deliver a sustainable packaging system fully integrating policies and systems, technology, environment, mindset and behaviors, initiatives, and outliers. The Impact-effort matrix was used to analyze which changes and what economic potential the transformation of current food packaging system will have in short and long-time ranges.

2.2. Iceberg model

The main findings were compiled using the Iceberg model. This model illustrates the various level of abstraction to a situation or organization, from the observable events to underlying patterns that generate these, to the supporting structure, and ultimately the mental models used by an organization. An Iceberg is used as an analogy to represent the underlying structures generating perceived events and issues, as it is known to have only 10% of its total mass apparent, "above the water", while 90% of it is "underwater", hidden (Meinslschmidt et al., 2018). A fundamental system thinking concept behind the Iceberg model is that different people in the food packaging ecosystem will reflect similar behavior. Thus, the ecosystem itself drives 80-90% of the change. In our case, different people, notably policymakers, have a similar professional aim and thus, form a similar ecosystem in the Iceberg model. The emphasis is not so much on the personality of the policymakers, but more about the environment in which policymakers are placed (Kassel et al., 2016). To understand their behaviors, we must identify first and foremost, and then understand, the systemic structures and the underlying mental models that lead to their behaviors.

Understanding the systemic structures and the underlying mental models that cause them are the pre-requisite for the implementation and sustainability of change. This is also the case for the "food plastic packaging" problem. The Iceberg model supports the perception of a problem within the context of the whole system without the limitations linked to a single activity or event (Kassel et al., 2016). This concept states that in many cases only a very small amount (the 'tip') of information is available or known, whereas the 'real' information or bulk of data is either unavailable or hidden, as illustrated in Fig. 2.

The Iceberg model allows to look at deeper levels of abstraction within the system. Most importantly, this model mainly focuses on barriers of change and how these barriers can be managed, to ensure that change will take place without causing any problems (Kochanska et al., 2021).

In the Iceberg model, the piece of the structure that appears above the surface represents a single "event"; just below the surface, a deeper level of examination reveals patterns of events, "patterns/trends".



Fig. 2. Iceberg model concept using concepts from scientific work (Kassel et al., 2016; Kochanska et al., 2021) (author constructed).

Further submerged below the level of the patterns/trends is the "structure". This level is the foundation that supports and creates the behaviors higher up in the Iceberg pyramid. The next level down is the "mental models" that can also include the mental models of previous generations. These mental models affect the structures we put in place and the way we understand the top of the Iceberg. Therefore, each lower level of the Iceberg offers a deeper understanding of the whole system, through the stages of reaction, responses, design, and transformations, increasing the chance to create more sustained changes.

2.3. Berkana two-loop model

The Berkana two-loop model was established following The Two Loop Theory of Organizational Change suggested by Wheatley and Frieze (Guillard et al. 2018). This tool is known to be used in the mapping of complex systems, e.g., food packaging, and aims at describing a nonlinear transition from the old system to the new. This model highlights both the growth and the decay sides of a transformation life cycle. The template of the Berkana two-loop model was taken from the homepage of the Berkana's research institute and the notes from the interviews were placed in each segment of the Berkana's model template (Ecochallenge.org, 2019). The recommendations were made based on the processing and analysis of the collected data.

2.4. Impact-effort matrix

An Impact-Effort matrix was developed to map the ideas emerging from the interviews and determine their potential for implementation immediately or in the future (Wheatley & Frieze, 2009). High and low potential solutions emerged from the discussions with the interviewees. This exercise helped to think about the role of relevant stakeholders, the desirability, feasibility, and viability of the solutions proposed. An alternative methodology of Edward de Bono's Six Hats concept can be used to screen the potential "easy win" solutions in relation to the food packaging challenge (Berkana two-loop model template, 2022).

3. Results & Discussion

3.1. Interviews

The Single Use Plastics Directive (Directive (EU), 2019) is focused on re-evaluating and re-inventing the use of single plastic to integrate circularity principles and eliminate waste in Europe (Directive EU, 2019; Saba, Saba, & Azouri, 2016). The principles related to plastic packaging sustainability strongly depend on legislation and recommendations with respect to waste management practices, the promotion of increased recycling, and the re-use of recycled materials. The new EU directive defines all synthetic polymers and chemically modified natural polymers as plastics. All manufactured food packages containing these polymers fall in the scope of the directive with no exceptions or minimum thresholds. The broad definition of plastic packaging in the directive may currently hinder the ability to provide safe and long-lasting food products, as the directive does not consider the impact of food packaging on food quality.

Many of the current food packaging practices do not measure well in terms of circular and sustainable supply chains, as they were developed when safety, convenience, affordability, and security of food were the important paradigms. However, the change to new solutions is affected by systemic challenges, including, but not limited to ineffective communication among stakeholders, misconceptions, broad and confusing definitions, unbalanced plastic supply and demands, legislative impact, and top-down policies. There are environmental, societal, technical, and economic needs to revise the current use of packaging for food products, not only in retail, but also in other distribution chains, such as food service and e-commerce. In the interest of clarity, we only provide a table summarizing the drivers of change, challenges, mindset and environmental behavior of policymakers, industry, and consumers as shown in Table 1. A full summary of the responses can be found in the supplementary material of this manuscript. The data in Table 1 is analyzed in the present study using ideation tools (De Bono, 1985; Kochanska et al., 2021; Korhonen, Honkasalo, & Seppälä, 2018).

3.2. Iceberg model

The Iceberg model was used as a systems tool to understand and identify patterns and behavior in the *current* food packaging system. The model was designed using the results from the stakeholder interviews and was structured so as to illustrate on one side emotions, feelings, and creativity and on the other side technical and environmental challenges, which may hinder the implementation of more sustainable materials in our food system.

Fig. 3 illustrates the Iceberg model that suggests the change to a more circular and sustainable food packaging system. This can be characterized by structures and mental models which include all actors such as policymakers, consumers, and plastic producers. Hence, all these three main categories were selected to be interviewed in this work.

The context for the design of the Iceberg model included the following assumptions:

- 1. Stakeholders strive for a circular economy and for food and packaging which is harmonized across EU.
- 2. Current production of sustainable and bio-based plastic materials is not prominent in the EU.
- Currently price competitive fossil-based materials and nonrenewable energy are predominant.

Table 1

Summary of drivers of change, challenges, mindset, and environmental behavior which originated from the interviews performed with the different stakeholder groups. A summary of the responses to the questions asked can be found in the supplemental material.

Drivers of change	 Ongoing education for consumers and industry Training for actors and practitioners in the value chain, and continuous updating of new technologies and solutions becoming available Government subsidies Mindset of stopping climate change and protecting biodiversity from significant transformation Local circular economy challenges, e.g., absence of bins for packaging collection, underdeveloped recycling infrastructure relative to EU standard, importance of personal comfort and protection of health
Challenges	 Economics of bio-based and sustainable solutions Complex properties needed for food packaging hinders selection of novel alternatives Demonstrating the benefits of reducing, replacing, reusing, and recycling using life cycle analysis of whole supply chains EU differences in recycling and reusing technologies Speed of new policies vs appearance of environmental challenges, e.g., policies fail to include nanoplastic, although they are a similar challenge compared to microplastic
Mindset and	 No packaging is preferred option
environmental	"Sustainable material" and "environmentally-
behavior	 friendly" are used interchangeably Regional systematic differences hinder progress as
	well as cultural differences
	All actors play a central role in developing new solutions
	 Importance of clear communication, dialogs, and opportunities to exchange, e.g., seminars, workshops

Challenges / events	Sustainable food packaging
Patterns / trends	(1) Increased economic activity coupled with consumption (2) Pernicious effect of waste accumulation (3) Mindset - large scale reprogramming behavior (4) Increase in stricter packaging regulations (5) Food as commodity (6) Consumers are disconnected from food production (7) Food waste
Underlying structures	(1) Versatile properties of synthetic plastics (2) Absence of global policies & regulations (3) Challenges with separation, reuse, recycle & disposal of plastics (4) Economic driver underlying current plastic packaging (5) Lack of incentives for sustainable packaging materials (6) Global food prices pressure -> low food cost in EU leads to waste (7) Lack of clarity on labels (8) Industrial food production led to food abundance
Mental models	(1) Packaging isn't harmful to the environment (2) Packaging is cheap and easily disposed (3) Changing of mindset is too difficuit (4) Sustainable materials are too expensive and are not ready yet (5) Access to non seasonal foods all year around (6) Industrial food manufacturian over natural modulets is more sterile

Fig. 3. Iceberg model of packaging in the food and packaging sectors (author constructed).

- 4. Harmonization of reuse, disposal, and recycling systems require harmonization of technologies, practices, and organizational systems to achieve full circularity.
- 5. Food packaging is important, but more important is to eliminate food waste.
- 6. The discussions did not include the present COVID-19 crisis mindset.

New environmental consequences and the impact of new business models, especially related to supply chain and logistics, are all significant tools to decrease the plastic use in the food industry and agriculture based on the developed Iceberg model. Bridging of policymakers, consumers, and materials manufacturers through a dialog is critical to achieve long lasting solutions to the plastic challenge.

The mindset of all stakeholders, outward communication and a dialogue between stakeholders have a strong impact on the way we package, store, process, deliver, and consume food, including feelings and emotions from packaging design and visual interactions. For example, redesigning supermarket shelves to reduce plastic use could be a great opportunity to use less plastic, but it would have profound consequences on how retail models are currently organized and run. All three parties (policymakers, industry, consumers) need to be central to a sustainable food packaging solution based on circular economy principles.

3.3. Berkana two-loop model

The main points raised during the interviews were mapped graphically to illustrate the potential changes that are required to alter the current packaging system, using the Berkana two-loop model (see Fig. 4). The graphic illustrates the opinions of various stakeholders on different sticky notes categorized according to color and according to stewardship, hospitality, networking, changes in mindset and human behavior, and organized and placed along the model line that forms two loops. The color of a note represents a context type, e.g., policies and systems, technology, environment, mindset and behaviors, initiatives, and outliers. The Berkana loop is based on the assessment of the current situation around food packaging and this information is partially reflected in the *first loop* (purple marked), whereas the potential solutions and systematic thinking on how to overcome identified challenges are illustrated in the *second loop* (gray marked).

The *first loop* of the Berkana model, located on the left side shows that high carbon emissions and excessive package waste are attributed to an intensive consumption of food, as well as the tendency to overpackaging food products. Specific situations were related to outdated policies or the absence of policies, and this was a challenge commonly identified from interviews (Environmental Pillar, 2021; Fanzo et al., 2020). As an example, one policymaker mentioned the confusion around



Fig. 4. Berkana two-loop model depicting the shift from current to new, more sustainable packaging systems for the food and agricultural sectors. The context of each discussion (policies & systems, technology, environment, mindset & behaviors, initiatives & outliers) is shown by the different color on the left bar in the figure (author constructed).

the definition of the term nanoplastic, when potential hazardous properties of food packaging were discussed in the interview. The definition of nanoplastic is discussed in the scientific literature (Sorensen & Jovanovic, 2021). However, the current policies and legislations do not address this issue adequately.

This is reflected in the Berkana two-loop model. Consumers and industry initially became aware of the existence of nanoplastic pollution, typically by reading open access information or being exposed to any available stewardship projects in the "STEWARDSHIP" category. The awareness is then followed by their interest in networking to "CON-NECT" and later "NOURISH" from actions towards the minimization of nanoplastic pollution. Another important finding which derived from the use of the Berkana model was the representation of opinions using all five colors. The presence of the different colors led to the conclusion that different contexts are involved in finding solutions for the sustainable food packaging challenge: the large amount of nanoplastics can be reduced using not only socioeconomic skills, but also through improvements in the environmental mindset and technology advances.

The *second loop* shows the emergence, by exploring how change happens as new systems become the norm (Berkana Institute, 2021). A common thread through all the interviews emphasized that a new system, established by new communities of practice and first adopters will be driven by ongoing consumer's education, training for practitioners and actors in the value chain, and governmental subsidies. Such networks and coalitions will be the initiators of real societal change (Wheatley, 2011; Granovetter, 1973). Following the example of the nanoplastics, in the second loop that is located on the right side of Fig. 4, all stakeholders consider sustainable materials as a solution to avoid pollution. They mention that the reuse of packaging or its recycling can support the reduction of nanoplastic pollutions into water reservoirs or agricultural soil. At the end of the second loop, a dialogue allows

involved stakeholders to create "The powerful system of influence". This means that at this point, policies and legislations are updated or extended, and consumers and industry can follow the policies and are fully aware of all consequences of food packaging utilization that can potentially lead to the release of nanoplastics into the environment. Mapping out the first and second loops in the Berkana model identified potential positive and negative knock-on effects of various interventions, which would drive further change.

Some of the suggestions obtained from the positive feedback loops brought forth during the interviews are listed below:

- Workshops and seminars increase the knowledge base and stakeholder's awareness which facilitate transformation by inspiring change from current to more sustainable types of food packaging. In addition, the increased networking between game changing communities will boost the interest to establish more start-up and business ventures.
- A better understanding of potential technologies and sustainable materials at the local level, by local authorities, actors and practitioners can increase the interest of stakeholders to reduce the amount of plastic use and find accessible pathways to recycle or re-use plastic packaging.
- Stakeholders could support the establishment of a large platform for knowledge exchange which would eventually result in more circular solutions common to many EU countries. This includes sustainable solutions to improve properties and technologies of food packaging which have been not completely developed for the use on the EU market, e.g., laminates utilization, etc. Directive EU (2018).

The examples of the negative feedback loops highlight some of the common challenges to change:

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- The absence of price-competitive sustainable materials is too large to be bridged right now and often cannot be compensated by governmental incentives.
- No financial incentives exist for industrial stakeholders and/or farmers to participate in sustainable food packaging practices.

The Berkana model applied to the results of the interviews leads to the following suggestions:

- Connect the pioneers among stakeholders from industry, government, value chain actors and citizens, with a focus on driving positive change in the mindset of all actors towards a reduction of plastic use;
- Nourish stakeholders with the education and training necessary to increase their awareness of emerging technologies and sustainable materials in food packaging, and to keep all actors engaged with the continuous progress to be able to provide small solutions along the way;
- Illuminate the pioneering work of stakeholders through media channels, seminars, and workshops by engaging and inspiring the broad community. This also aims at finding new supporters for food packaging minimization and initiate discussions on the environmental mindsets within groups of different ages. Thereby, communities can bring everyone to the same level of awareness and drive to either 'zero use concept' *first* or 'sustainable' packaging, *second*.

3.4. Impact-effort matrix

The current situation in relation to the food packaging was analyzed using the Iceberg model. The Berkana two-loop model was established to identify a roadmap towards resolving the food packaging challenge. Fig. 5 shows the results of the analysis of the interviews using the Impact-effort matrix. This approach helps to identify and prioritize activities and evaluate those that the stakeholders should ignore to implement sustainable packaging solutions in the EU countries. The model includes the various efforts in change management, the level of innovation and their impact towards more sustainable food packaging system. Fig. 5 shows key *easy wins,* related to education, open sciences, communication, as well as those solutions which were mentioned during the interviews that may require more effort, but of high impact at the EU and global scale.

A balance between food quality, material flexibility of use, emerging technologies and organizational system were ranked as solutions of high potential. These included retail deposit refund systems, as well as a new environmental mindset in the EU which could lead to the establishment of a common, sustainable supply chains at the EU level. In addition, the possibility of a new categorization and labeling system was also ranked as high potential. The design of future packaging and bio-based solutions for packaging were identified as low impact. In addition, the global supply chain management and operation were emphasized as an important solution, but due to the high investment and long-term implementation, this solution was ranked as low priority. Stronger policy connections between different governmental policy levels, new frameworks developed to foster the adoption of sustainable materials and new, emerging technologies, novel responsibility schemes which would include behavioural change in consumers or urban and rural land redesigns, were categorized as long game solutions.

4. Conclusions

The interviews of policymakers, consumers, and plastic producers clearly showed that across the EU food packaging is to be significantly reduced in the next decade. However, the paths to reach this goal were less clear, and were characterized by significant regional differences. There was a general consensus that sustainable packaging's primary function will continue to be the protection of food from its surroundings, and that shelf life is critical to decrease food waste. These important functions will continue to be a fix point in future food packaging design as they significantly contribute to decreasing the environmental impact of the food and agricultural sectors. In addition, the interviews underlined that education and awareness campaigns are critical to fostering change and that the integration and harmonization of new technologies, materials, and processes across Europe will need to be fostered. Key examples of this were deposit-refund systems and the categorization of plastic materials aiming to narrow down their use to only a few types. Advancements will not occur without open collaboration,



Fig. 5. Impact-effort matrix for the handling of food packaging challenge using a classification of the interview data into easy wins (quick and less tendentious way to make a change), high potential options (achievement by making change over short or intermediate time period), low priority and "long game" (changes over long time period having strong potential to make a large change in the food packaging challenge) (author constructed).

communication, and consultations of policies at various levels. The minimization of packaging through 'zero use concept' was preferred by all interviewed groups over the implementation of sustainable materials or innovative technologies. Fostering a strong 'environmental mindset' of policymakers, consumers, and plastic producers is key to direct the future of 'zero use concepts' in Europe. The ideation analysis in the present study identified both short- and long-term solutions and its economic potential. The expansion of policies and stakeholders' mindset will play a key role in the successful integration of sustainable solutions through public campaign and upgrade of policies in the short-time period. The establishment of global policies and new frameworks including technical and socioeconomic aspects will be resumed over long-period of time, but its successful integration will have a strong impact on the global sustainable food packaging system.

CRediT authorship contribution statement

Anna Trubetskaya: Conceptualization, Methodology, Investigation, Writing – original draft, Writing – review & editing, Visualization. Philip Benjamin Vincent Scholten: Writing – review & editing, Resources. Milena Corredig: Conceptualization, Supervision, Project administration.

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Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at doi:10.1016/j.fpsl.2022.100856.

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