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Packaging Waste Statistics, Producer Motivations and Consumer Behaviour

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[2] For long Acknowledgments Section, please place on the next page on its own

DISCLAIMER

This report is based on research carried out/data from September 2019 – December 2021 More recent data may have become available since the research was completed.

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Executive Summary

Packaging waste comprises 35% of municipal solid waste, of which over 19% is plastic packaging (Eurostat, 2022). The 2018 European Plastic Strategy and the Single Use Plastic Directive of 2019 (EU 2019/904) underpin the objectives of a circular economy by aiming to significantly reduce the amount of plastic packaging intended for single use. However, the volume of packaging waste has continued to increase across the EU, reaching a record of 177 kg per capita in 2019. The amount of plastic waste generated has increased even more sharply to 15.2 million tonnes, corresponding to 33 kg per capita on average. At nearly one fifth of packaging waste, plastic is the next most common packaging waste material after paper and cardboard.

The revised EU Packaging Waste Directive (EU 2018/852) requires that 65% of packaging waste, and 50% of plastic packaging waste, be recycled by 2025, with these proportions rising to 55% and 75% by 2030. Ireland has so far performed well in meeting its targets. Over 62% of packaging waste is already recycled, exceeding the current EU target of 55%, while plastic packaging recycling, at 25%, is also above the target of 22.5% (EPA, 2021). However, recycling rates are falling with more material being directed to incineration/energy recovery. Moreover, in terms of the official data, Ireland would appear to have performed poorly in terms of the levels of plastic packaging. Plastic packaging use was 65 kg per capital, a figure that is nearly four times higher that of the Member State with the lowest reported use (Eurostat, 2022).

This report finds that a probable reason for Ireland's elevated levels of packaging and plastic packaging waste is the methodology adopted by Ireland to calculate its figures. The EU recognises two alternative approaches to measure packaging volumes, that which is Placed-on-the-Market, and that which ends up as waste (Waste Analysis). Many EU Member States use a mixture of methods but, Ireland, as a relatively small country which imports many consumer products, relies largely on the Waste Analysis method. This method requires regular and thorough sampling that can provide accurate measures of moisture and contamination found in waste packaging. Many other countries use the Placed-on-the-Market approach in which the volume of packaging is reported by producers, either voluntarily or through producer responsibility schemes. However, this material is clean and dry relative to its state once it becomes waste. There are various incentives to under-reporting and risks of incomplete data due to cross-border trade, free-riders and exclusion of smaller companies from reporting requirements. It appears possible that Ireland may use more plastic packaging than some other countries, but its position as an outlier can be contested. Accurate waste statistics are essential for determining national recycling rates, managing waste performance and setting achievable packaging targets.

Aside from the statistics, there is still much to do to change both producer and consumer behaviour regarding packaging. Plastic is an inexpensive, but versatile commodity with positive characteristics in terms of resource use, lightness, strength, air and moisture barrier properties. Without it, energy and transportation costs would be higher and food waste even more of a problem. However, its versatility depends on different polymers which can be challenging to recycle, especially when combined. Producers have pushed technological boundaries to their limits to deliver packaging which protects the product, prolongs freshness and is identifiable by brand.

This report presents the result of a survey which found that producers are experimenting with more recyclable packaging, but, while conscious of the prospect of stricter future policy, have more often done so in response to pressures from major retailers. In parallel, a survey of consumers found a widespread awareness of food packaging issues and a willingness to purchase recyclable packaging if the price premium is modest. It found that recyclability is preferred, or more familiar, than compostability, but that preference, or awareness, of the re-use of plastics in packaging is low. The consumer survey revealed a poor understanding of recycling or sustainability labelling.

For both consumers and producers, there would seem to be a desire for more targeted information and more persuasive measures to induce change in motives or behaviour.

1. Introduction

1.1 Objectives

The ReWrapped project set out to examine the production, consumption, management and reporting of packaging waste, specifically plastic packaging. Its objectives were to:

- Critically compare alternative methodologies used across the EU for the compilation of packaging waste statistics, including their reliability and comparability.
- Undertake an integrated analysis of packaging from production, through the distribution chain to the consumer.
- Investigate the factors influencing the behaviour of both producers and consumers, and the role of different forms of plastic packaging, including different polymers and recycling opportunities.

1.2 European waste and packaging waste policy

European policy on waste goes back over forty years, but recent years have seen increased attention being given to packaging, as a major component of household and commercial waste, and particularly to plastics and plastic packaging given the abundance of plastics, their limited capacity to degrade in the environment, and the impact they have on litter and marine ecosystems. The original Waste Framework Directive (WFD) dates back to 1975, but it is WFD 2008/98/EC and subsequent which provide much of the overall legislative base for current European waste policy and which established the relevant concepts and criteria, including the definition of waste, waste reduction, recycling and recovery. The Directive stipulates the measures to be taken by Member States for all stages of waste management. At the heart of the Directive is a 5-tier 'waste hierarchy' to encourage waste minimisation successively through 1) prevention/reductions in use, 2) re-use, 3) recycling or reprocessing of constituent materials, 4) recovery of the embedded energy, and 5) appropriate disposal as the final option.

A guiding principle of European waste policy is the Polluter Pays Principle (PPP) which seeks to ensure that those who produce waste also carry responsibility for the cost of its management. In this respect, Article 8 and 8a of the WFD outlines the role of Extended Producer Responsibility (EPR) schemes whereby packaging producers are made aware of the downstream costs associated with product disposal and encouraged to fund collection and recycling operations.

The European Union (EU) has since committed itself further to creating a more circular and resource efficient economy that decouples waste generation from economic growth and moves instead towards materials recovery. The first objective of this new strategy is to retain the value of products, materials and resources within the economy as it is argued that this will provide for competitive advantage by protecting European industry against future resource scarcity and the price volatility associated with raw materials. The second objective is to provide a direct public good by minimising waste generation, reducing water and marine pollution, and moving towards the more sustainable use of materials and energy.

Plastics have been a particular focus of this approach given that fossil fuels are the raw material and the challenge of worsening environmental pollution. The European Strategy for Plastic in a Circular Economy (2018) outlined ambitious targets to further reduce the use of plastics and to increase the uptake of recycled materials, including that 55% of plastic packaging be either reusable or capable of being recycled cost-effectively by 2030 (see Table 1.1). By its nature, almost all packaging becomes waste and includes throwaway items such as single-use carrier bags, food packaging, wrappers and drinks containers. This packaging is specifically addressed by the EU Packaging and Packaging Waste Directive (94/62/EC) which requires Member States to introduce harmonised systems for the reduction of packaging waste and for its increased collection and segregation. The Directive sets 'Essential Requirements' in relation to the manufacturing and composition of packaging, including its potential for reuse or recovery.

Table 1.1 – Current and future EU Packaging targets

Packaging waste targets	***Current***	***2025***	***2030***
Packaging waste recovered or incinerated with energy recovery	**60%**	-	-
Packaging waste recycled	**55%**	65%	70%
Glass recycled	**60%**	70%	75%
Paper and cardboard recycled	**60%**	75%	85%
Metal recycled	**50%**	70%	80%
Aluminium recycled	**-**	50%	60%
Wood recycled	**15%**	25%	30%
Plastic recycled	**22.5%**	50%	55%

The revision of the Directive in 2018 (2018/852) included new targets for packaging waste and recyclability and provided a mandate for the European Commission (EC) to require improvements in the design of packaging to encourage reuse or recycling (European Union, 2018). The relevance of the Essential Requirements has been questioned by the EC itself (EC, 2020) given the lack of discrimination between the end-of-life costs and environmental impacts of different packaging together with the problems presented by the range of packaging types and of materials often used in the same packaging. The abstract nature of the Essential Requirements is also identified as having undermined enforcement, noting also producers' readiness to demand clarification of the use of particular packaging designs. The recommendations include those listed below and will be addressed in a further revision of the Packaging Directive which is expected in 2022.

- A reflection of the waste hierarchy in packaging design
- Clarity on packaging design and its identification
- More strictly defined requirements and fewer derogations
- Alignment on the role of compostable packaging to reflect its use and value
- Support for the supply and demand of high-quality material
- Well-defined enforcement to replace a presumption of compliance.

A priority has been to address the issue of unrecyclable packaging and the use of labelling to raise consumer awareness. A second priority has been to design for recycling, ensuring that the recyclability of packaging is maximised the first time it is placed on the market.

1.3 Plastic packaging

Plastic has increasingly become a major component of packaging and is second only to paper and cardboard in its contribution to packaging waste (EPA, 2021). Plastic has many desirable properties. It is low-cost, strong, durable, light-weight, easily mouldable, water resistant (hydrophobic) and bio-inert. It has also made a remarkable contribution to reducing food waste by extending the lifetime of products, although this does also cause households to often dispose of products that are still contained in their packaging once the sell-by date has been exceeded. The major problem, though, is the negative impact that plastic has on the environment when it is not, or cannot, be recycled or disposed of properly. In particular, plastic pollution in the oceans has become one of the greatest environmental challenges of our time (Nielsen et al., 2019). This negative impact is compounded by plastic's abundance. The use of plastic in packaging has accelerated due to its versatility, along with a

shift from cardboard or metal containers to convenient single-use plastic (SUP) products. As of 2015, it was believed that 6,300 million tonnes (MT) of virgin plastic had been manufactured since the material first became available. Of this total amount, only around 9% is thought to have been recycled, 12% has been incinerated and 79% has accumulated in landfills or in the natural environment as litter (Geyer et al., 2017). At least, 150 MT has accumulated in the oceans (Ocean Conservancy & Environment, 2015; World Economic Forum et al., 2016).

Plastic is therefore precisely the type of material that must be addressed by EU waste and recycling policy. In contrast to its adverse environmental impact, it has potential value given the embedded energy left from its manufacture. The EU Circular Economy Action Plan (2020) contains specific actions on plastics, including the need to address potentially hazardous additives and the practicalities of biodegradability. The plan aims to further EPR further by ensuring greater harmonisation and reliability, including a clearer definition of responsibilities and common definitions of what constitutes packaging and recyclability. It will extend responsibility to the costs of clean-up, including of litter, and apply differentiated costs to the production of packaging depending on its recyclability. The European Plastics Strategy, adopted in January 2018, proposes that plastic material should be more recyclable, and that demand for this recycled plastic be increased.

However, trends in plastic use have remained on an upward course. There has, for example, been a 4.2% annual global increase in food and drink packaging placed on the market since 2010 (Ketelsen et al, 2020). In Europe, packaging waste reached a record of 177 kg per capita in 2019 (Eurostat, 2022). At 19.4%, plastic is the next most common packaging waste material after paper and cardboard (40.6%). The volume of plastic waste generated in the EU-27 increased by 9.6% between 2008 and 2019, to 15.2 MT, corresponding to 33 kg per capita on average. The same trends have been seen internationally.

The SUP Directive and the new 2020 updated Circular Economy Action Plan (CEAP) (forming part of the EU Green Deal) can therefore be seen as a response to these negative trends. In the first instance, the strategy foresees 90% of plastic bottles being recycled by 2025 supported by producer responsibility schemes and that plastic bottles up to 3 litres will be required to have a minimum 30% recycled plastic. By 2030, the CEAP foresees that all packaging will be capable of being recycled.

1.1.1 Plastic packaging levels in Ireland

In Ireland, policy has implemented the Directive and the strategy of the waste hierarchy of prioritising prevention and reuse ahead of recycling and energy recovery, with landfill to be considered as a last resort. This accords with the principles of the WFD by focusing on resource efficiency and fostering a more coordinated approach to waste management. A National Waste Strategy is set out in 'A Waste

Action Plan for a Circular Economy', published in September 2020 and followed by a Circular Economy Strategy a year later (DECC, 2021). The plan included proposals for the establishment of a Deposit and Return Scheme for plastic bottles and aluminium cans along with proposals that certain single-use plastic (SUP) items accounting for more than 70% of marine litter will be banned in line with the SUP Directive 2019/904. Small items, such as sachets, bottle tops and collars, are especially evident in marine litter. Small format items represent 10% of the packaging market, but are vulnerable to leakage into the environment These products include plastic cotton bud sticks, cutlery and polystyrene cups, amongst other items. Oxo-degradable products were also included in the ban due to concerns that they might not be fully degradable in an outdoor environment and could still add to litter and microplastic pollution. Other targets for SUPs, including attachment of lids and recycled plastic content for PET bottles are set for 2024 and 2025. Under the Plan, companies who produce or use packaging, either primary packaging where there is direct contact with the product, or secondary and tertiary packaging for distribution between companies or producer to retailer, will be required to join Repak which represents the producer responsibility organization (PRO) for EPR in Ireland. Formerly, companies had the option of self-declaring their amounts of packaging. Repak charges fees to members to cover the cost of collection and recovery. Eco-modulation has been introduced to account for the end-of-life management options including the costs of recycling different types of materials.[6] Repak member fees were raised in 2021 from €175 per tonne for both recycled and non-recycled plastics to €175 for the latter to accommodate a higher subsidy to cover the treatment costs (collection, sorting and recycling) faced by waste processors. Fees are due to be increased in 2002 to €214 per tonne and to €271 per tonne in 2023 to cover the total estimated costs of processing non-recyclable plastic packaging.

However, the most recent figures available for Ireland mirror wider international trends by revealing that the level of packaging waste continues to increase, having risen from 1.012 million tonnes in 2018 to 1.125 million tonnes in 2019 (EPA, 2021). Table 1.2 shows that over 62% of packaging waste was recycled, exceeding the current EU target of 55%. However, the rate of recycling has been declining in recent years at a time when the targets of the Packaging and Packing Waste Directive are due to be raised to 65% in 2025 and 70% in 2030. Furthermore, of total packaging waste, only 16% is recycled in Ireland with the remainder sent abroad for recycling. As with EU statistics, plastic is the second most common packaging waste generated. However, of the 319,082 tonnes produced, only 28% was recycled. While this again exceeds the current EU target of 22.5%, new targets of respectively 50% and 55% will apply by 2025 and 2030. Moreover, two-and-a-half times more plastic packaging waste was sent for energy recovery through incineration than was recycled with the share

[6] Article 8a(4)(c) of the Waste Framework Directive (WFD)

having risen to 69% in 2019 compared with 44% in 2017. The level of recycling for plastic is far below that achieved for other materials despite its much higher environmental impact. As recycling rates are higher for glass (84%), paper & cardboard (79%), wood (79%) and metal (69%) (EPA, 2021), this demonstrates that there are in comparison fundamental difficulties with the recycling of plastics.

Interviews undertaken with waste collection/processing companies as part of the project confirm high levels of contamination in residual waste of 22%-28%. Of the recyclables fraction, aluminium and steel are the most valuable materials, but paper was also realizing €130-€140 per tonne on the open market in 2020 due to a shortage (usual prices are between €50-€100). Plastic prices are linked to that of oil as the raw material alternative, but clear plastic was fetching €80-€120 per tonne. EPA studies reveal that brown bins also contain a lot of plastic waste, mostly food packaging, all of which is presuming to be non-recoverable, and only 50% of which is incapable of degrading in the industrial composting process.

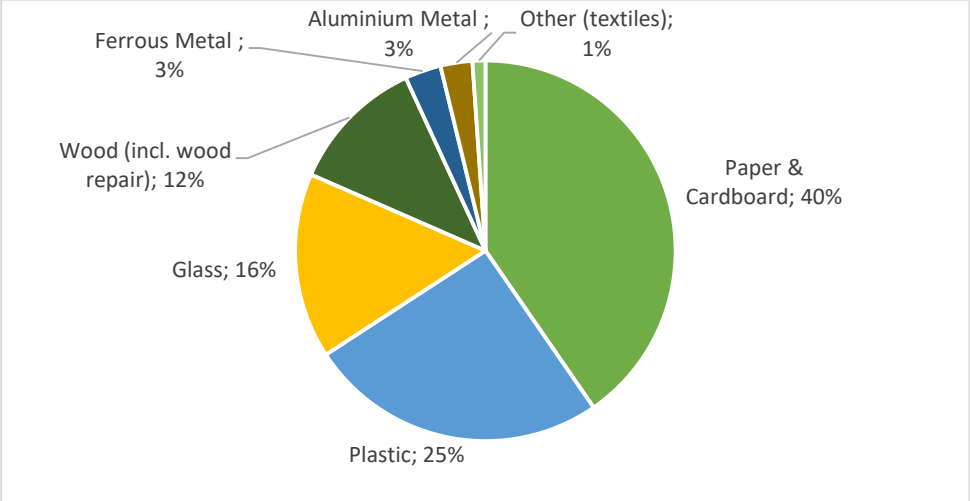

Figure 1.1 - percentage of materials in packaging waste stream (EPA, 2020)

Table 1.2 - Key packaging statistics 2019

	Packaging tonnes	*Packaging per capita kg.*	*Recycling rate 2019*	*Current target*	*Packaging Directive Target 2020*
All packaging	1,124,917	229	62%	55%	70%
Plastic packaging	319,082	65	28%	60%	55%
Paper & board	473,459	96	79%	60%	85%
Ferrous metals	40,432	8	78%	n/a	80%
Aluminium	25,328	5	54%	n/a	60%
Glass	161,114	33	84%	60%	75%
Wood	92,763	19	79%	15%	30%

2. Packaging waste statistics

For Europe's policy ambitions to be realised there needs to be a clear understanding of the amounts and type of waste generated, including packaging and plastic packaging. This requires a framework that permits analysis and comparison of different streams and types of packaging, particularly the complexity of plastic packaging (Matthews et al., 2021), including the contribution made by different polymers, flexible/rigid plastic containers, mixed plastics, composite plastic/cardboard/foil packaging. Reliable and comprehensive waste data assists with the setting of future targets and is vital to implement the SUP Directive (Sahimaa et al., 2015). These data are also essential for the subsequent monitoring of performance against national and EU targets for waste management, including waste collection, reuse, recycling, recovery and landfilling (Brunner and Rechberger, 2016, Yu and MacLaren, 1995).

Under the Packaging Directive, Member States are obligated to report their packaging waste data, including figures on generation and treatment. New guidance on reporting has recently been prepared by Eurostat, the statistical unit of the European Commission (Eurostat, 2021). Information on the different types of packaging, i.e. plastic, glass, paper and cardboard, the total sum of metal, wood and other types of materials, is required, along with now mandatory cross-checking between the two main placed-on-the-market and waste analysis methods used for packaging waste reporting. National authorities are responsible for submitting this data to Eurostat electronically no later than 18 months after the end of the reference year.

However, recent studies by Robaina et al. (2020) and Cimpan et al. (2021) highlight the complexity of plastic waste data analysis. There are issues with the consistency of the methods used to collect and compare this data between Member States. Official data for Ireland indicate that total packaging waste per capita amounted to 228 kg in 2019 and that Ireland also reported the largest amount of plastic packaging waste generated, at 65 kg, a figure that is 97% greater than the EU average (Eurostat, 2022). This figure also compares with a reported 25 kg per capita in Germany in 2017 (Picuna et al., 2021). Furthermore, the amount of plastic bottles and plastic packaging reported by Repak members as a proportion of total packaging waste is also lower, at 24% in 2019, than national figures would suggest at 28.4%

Across the EI, the lowest amount for 2018 was reported by Croatia at 16.8 kg per capita. Although there is a sizable difference in the level of economic development, and therefore personal consumption, between countries, the highest level of plastic packaging generation in the EU is almost four times that of Greece, Bulgaria and Croatia.

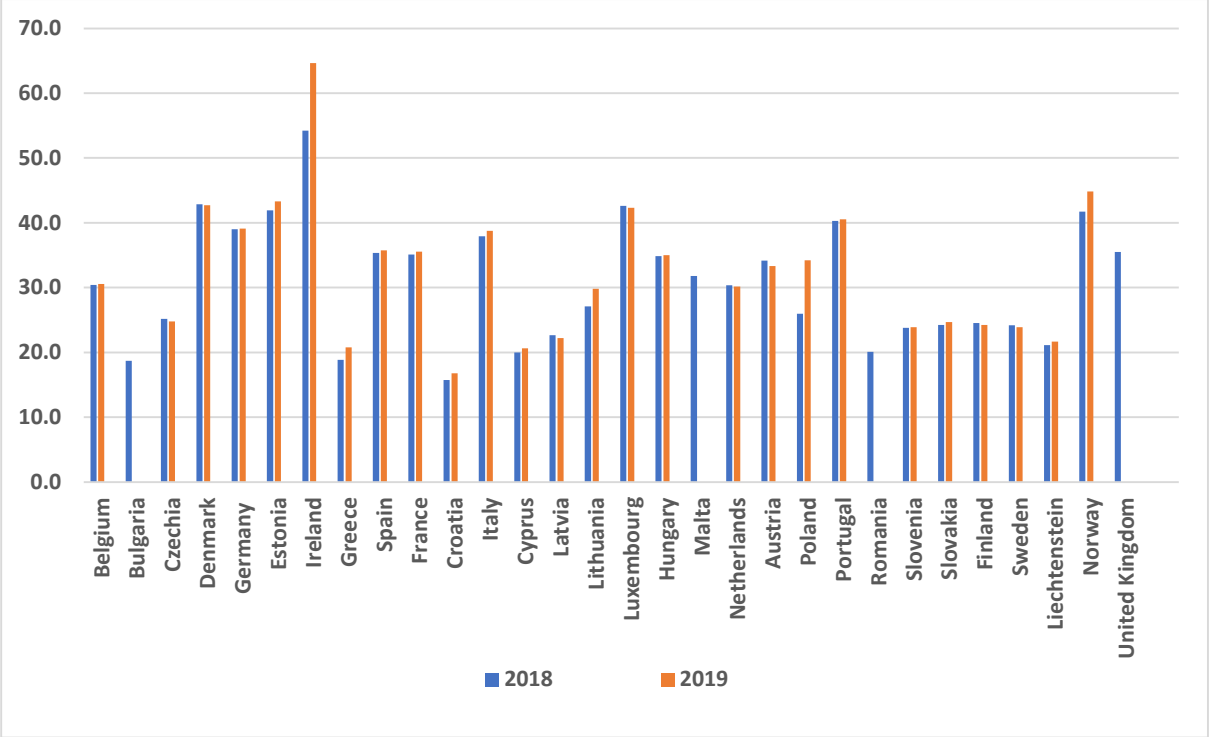

Figure 2.1 - plastic packaging waste generation across the EU (kg per capita)

Under Article 2(2) of the EC Decision (2 March 2005) relating to Directive 94/62/EC, 'Packaging waste generated in a Member State may be deemed to be *equal to* the amount of packaging placed on the market in the same year within the Member State'.[7] This statement signals acceptance by the EU of the two main aforementioned methodologies, 'placed on the market' (PoM) and 'waste analysis' (WA) approach (Table 2.1), to estimate the quantity of packaging waste generated.

The reliability of both methods is dependent on the quality of the data collected or the sampling undertaken. Eurostat guidelines (2021) propose that PoM data be collected directly from producers, or as submitted to national or regional authorities, independent consulting companies or PROs who represent manufacturers and retailers and are responsible for EPR. Meanwhile, WA should involve numerous samples of equal weight or volume, broken down into different waste categories, across different times of year, bearing in mind factors such as settlement structure, household characteristics, socio-economic factors, and the waste services or charging schemes in operation. The merits and disadvantages of these two approaches are summarised in Table 2.1.

[7] Commission Decision (22 March 2005) Establishing the Formats Relating to the Database System Pursuant to Directive 94/62/EC of the European Parliament and of the Council on packaging and Packaging Waste (Document Number C(2005) 854) (2005/270/EC).

Table 2.1 - Overview of applications, advantages, disadvantages and relative costs of waste analysis and placed on the market approaches (Brunner and Ernst, 1986).

	Waste analysis	**Placed on the Market**
Applications	Determination of waste composition. Spatial, temporal, socio-econ variations. Evaluation of waste management system Assessment of recycling potential.	Assessment of a single materials. Assessment of relative importance of different sources
Advantages	Reliable information. Detects spatial, seasonal and other variations.	Inexpensive. No field sampling and analyses. Relative low effort.
Disadvantages	Labour and time intensive. Unidentified fraction.	Estimations necessary to define fractions in MSW. Complete dependence on data supplied by 'economic actors' - incentive for underreporting.
Relative costs	High	Low

In practice, it is challenging to obtain information on the precise implementation of the particular methodology Member States use. Although, they are now obliged to submit 'quality reports' to Eurostat on a yearly basis to describe how data are collected and estimates calculated, no specifications were provided on the degree of detail needed within the report. Consequently, there is lack of transparency. Different Member States use different methodologies, typically based on historical approaches, including also estimates based on trade statistics, waste management statistics and/or a combination of both.

2.1 Alternative methodological approaches – Placed-on-the-market approach

2.1.1 Placed-on-the-Market approach

The PoM approach is the more prevalent across the EU. Data is primarily collected by PROs operating EPR schemes on behalf of their members. POM assumes that packaging is used within a short time-frame. Various adjustments are then applied to account for imports, exports and cross border sales (Brunner and Ernst, 1986, Brunner and Rechberger, 2016). Data collection varies among the Member States depending on the extent of their relative dependence on EPR, statistical offices estimation of production and trade statistics, and industry declarations.

a) Data from producers

Twenty five of the 27 Member States have EPR in place (IEEP, 2017) in which manufacturers and retailers report how much packaging they are producing or selling. EPR can be looked upon as the main source of data supported by the other three sources listed below in Section 2.1.1.1. Currently, only a few schemes have more advanced eco-modulation of fees where no fee is applied to reusable packaging, while higher fees are applied for non-sortable, non-recyclable or composite packaging. EPR schemes need to be more harmonised and transparent to improve data quality (Leal Filho et al., 2019).

b) Production and trade statistics

These data are used by at least 5 Member States to estimate the amount of associated packaging placed on the market based on standard coefficients for different product types. Calculations are based on a range of assumptions regarding the composition and packaging for many different product groups. For example, the Danish system relies on assumptions regarding the composition and amount of packaging used for almost 9,000 different products. Although the frameworks can be sophisticated, there is inevitable uncertainty when assumptions are associated with many different products.

c) Industry declarations

Self-declarations are used by around 13 Member States while questionnaires or other means of verification are used by at least another 13 Member States. Information may also be based on studies by consulting companies or regional authorities. In Ireland, self-declaring companies account for an estimated 36% of packaging waste reported. By comparison, the plastic packaging placed on the market by Repak members amounts to 132,000 tonnes (Repak, 2018) of the total of 319,000 tonnes of plastic packaging waste estimated by WA (EPA, 2021).

2.1.1.1 Limitations of Placed on the Market approach

In practice, hybrid systems are often used which rely on a range of source, but these vary by Member State. The variety of methodologies, data sources and level of validation for PoM is problematic. Inaccuracies arise from at least the following sources:

- Irregular or incomplete reporting, for example where there is a reliance on occasional data collection;
- Double-counting due to uncertainty over who in the production chain is responsible for reporting;
- Incomplete industry data, for example where sample sizes are not representative, or when incorrect calculation has been applied;

- Declaration of the predominant packaging material to the exclusion of others packaging components such a plastic lids or bottle tops;
- Lack of comprehensive import and export data, including that by third parties. Reliance on self-declarations by traders, although their accuracy is uncertain as declarations are rarely verified.

Extended Producer Responsibility

EPR implementation lacks harmonisation and transparency across the EU and there is no common approach to the collection of data (OECD, 2014, Zero Waste Europe, 2015). The characteristics of PROs vary considerably. Member States have chosen to adopt either collective or individual (company) producer responsibility reporting. Different schemes can apply to different types of waste and some countries' schemes focus on household and commercial waste, but exclude industrial packaging.

Some PROs assume simple financial responsibility for the management of packaging, while others have adopted partial direct or full responsibility for the management of this waste. For example, in the Netherlands, the Afvalfonds Verpakkingen PRO exercises responsibility through reimbursement contracts with municipalities and sorting plants. The nature of the financing, including its monitoring or oversight, inevitably affects the figures which are reported to the EC on the amounts managed.

As of 2020, twelve countries (41%) had one EPR scheme, whereas nine others (33%), such as Portugal, have competing schemes. In addition, there is currently no clear information on what different Member States define as packaging waste or how this waste is related to its source.

In all schemes, there is an inherent incentive for companies to report lower quantities of packaging to minimise the fees they are obliged to pay. This incentive is exacerbated by the commercial status of some PROs, including where PROs are competing with one another. In fact, all players, including local authorities, waste management companies and EPR schemes, have an incentive to report the lowest possible plastic packaging waste generation and as high as possible a recycling rate.

Self-declarations are subject to inaccuracies. Free riders are at the extreme of the spectrum as they place plastic packaging on the market, but often do not report data or take responsibility for the costs of collection and treatment. A recent study by the OECD (2018) identified online sale platforms as a major contributor to free riding of EPR schemes. Packaging placed on the market by these producers could amount to between 3% and 9% of all electrical EEE sales in the EU. E-commerce generally has been growing at over 5% year-on-year and over-packaging by these companies has been identified as a distinct issue (EC, 2020). In addition, cross border trade exacerbates freeriding as some packaged items are purchased in one country, but their packaging is disposed of in another (Eunomia, 2018).

De-minimis thresholds

De-minimis applies to smaller producers who are not obligated to provide data. National reporting authorities estimate the quantities below the threshold, but with varying accuracy. Moreover, the threshold itself varies across Member States. In Ireland, many smaller companies are members of Repak, but the de-minimis threshold means that they are only requested to report turnover (although turnover tends to be a more accurate figure than the weight of packaging). The new Eurostat guidelines (EC, 2020) will require waste reporting even for small producers who fall below the *de-minimise* for EPR schemes.

Table 2.2 - Examples of countries applying different de minimis for the obligatory declaration of plastic packaging placed on the market (Eunomia, 2019).

Country	Plastic packaging (kg)	Turnover
Latvia	300 (total)	NA
Germany	30,000	NA
Austria	100	€ 730,000
Czechia	300	4,500,000 CZK
The Netherlands	50,000 (total)	NA
The UK	50,000 (total)	£2m
Portugal	Not in place	Not in place
Ireland	10,000	€ 1,000,000

2.1.2 Waste analysis

WA is used primarily by small countries in which many products are imported from abroad, including Ireland, Estonia, Luxembourg and Austria, but partly also as a secondary check by Portugal and Hungary. WA provides information about the amounts and types of materials in the waste stream and involves samples at point-of-generation (i.e. household, business or drop-off centres) or at a waste processing facility. In principle, WA should provide the more accurate measure of packaging waste generated as it captures data that might not be reported by PoM, including the packaging generated by companies below the *de-minimis*, on-line sales and that of free-riders, as discussed above. In Ireland, data for WA is collected from waste collectors and recycling plants and checked against data from the National Waste Collection Permit Office (NWCPO), the National Transfrontier Shipment Office (for waste exports and imports) and from Repak compliance reports. A characterisation of waste material composition is undertaken and typically consists of four phases: (i) planning and design

of analyses, (ii) sampling of the waste, (iii) sorting into component categories (e.g. paper, plastic, organics, combustibles, etc.) and (iv) evaluation and interpretation of the data.

2.1.2.1 Limitations of Waste Analysis

Sampling

The sampling procedure used for WA has a profound effect on estimates of the proportion and type of packaging. To ensure accurate compositional sampling, it is necessary to take frequent and consistent samples of adequate size (Sahimaa et al., 2015). Moreover, to capture all packaging waste in Municipal Solid Waste (MSW) requires an analysis of separately collected recyclates and of other packaging that ends up as litter, in drop-off facilities, street bins, private disposal and as large bulky refuse (Expra, 2015).

There are different views on sample size in the literature (Nordtest, 1995). As a rule of thumb, a minimum number of samples for characterization is 10 if the sample size is 100 kg or larger (Dahlen and Lagerkvist, 2008). The most crucial choices are then stratification (i.e. the choice of a relevant number of waste sources and types), sampling procedure, sample size, and the type and number of waste component categories. An essential stratification is between household and other waste, but other important strata include urban/rural, residential structure (e.g., single-family houses, apartment complexes), separation at source (e.g. number of bin types), season, socio-economic differences, or availability of recycling centres (EC, 2004, Sahimaa et al., 2015, Edjabou et al., 2015).

Furthermore, if a 20% random sampling error were present (as is quite possible given the difficulty of achieving a representative sample for waste) and assuming there to be an overestimate of the amounts generated, the estimate of per capita plastic packaging waste could be reduced to 46 kg/capita, marginally below the level of Estonia and Luxembourg. If a 35% sampling error is present, this would lower the amount to 38 kg per capita, around the same level as France, Austria and Spain.[8]

For these reasons, the Solid Waste Analysis-tool project delivered a European standard for the sampling of MSW.[9] However, there has been an absence of standardised rules for sampling and the collection of data. What guidelines there are, are complex and costly to apply. In practice, different methods continue to be used throughout Europe (Dahlen and Lagerkvist, 2008, Edjabou et al., 2015, Sahimaa et al., 2015).

[8] WRAP (2015) Guidance on the Methodology for Waste Composition Analysis for local authorities commissioning waste composition analysis of municipal waste, Report June 2015, https://www.zerowastescotland.org.uk/sites/default/files/WCAMethodology_Jun15.pdf

[9] https://cordis.europa.eu/project/id/EVK4-CT-2000-00030

Moreover, specific breakdowns of packaging by source or sector are few, including estimates of the proportion of food and beverage, and non-food packaging (estimated at 2:1 (TMR, 2018)). According to Plastics Europe (2018), 20.5 of the 51.2 mt of plastic manufactured is represented by packaging, of which 8.2 mt is food packaging and 12.3mt is *other*. One report (Schweitzer et al, 2018) notes that data on the amount of plastic packaging used for food is difficult to obtain, although is has been estimated by Muncke (2009) at 41% . This makes it more difficult to resolve issues of unsustainable packaging at source. Composite packaging is also becoming more common, in part due to the growing demand for SUP beverage cups that combine cardboard and plastic waterproofing. The use of composites has also followed producer efforts to reduce the amount of plastic with lighter packaging.[10] However, its constituent materials can be challenging to determine as they are often laminated together and so are difficult to recycle.

Contamination and moisture

Another issue arises from the degree of contamination or moisture. Packaging placed on the market is dry and free of extraneous material and contaminants. However, once this packaging becomes waste, moisture has generally added significantly to weight. Light materials such as paper or plastics can also be heavily contaminated by labels, glues, inks and food residue. The degree of use of these materials appears also to have increased (EC, 2020). Extrapolation for WA therefore requires a correction factor that accounts for this moisture, residue and contaminants.

However, the variation is considerable. A study by WRAP (2015), for example, estimated non-target materials as accounting for 10% by weight of MSW. It is therefore essential that correction factors are applied to account for differences in weight due to contamination, although the variation makes it difficult to arrive at reliable comparisons. Studies have reported up to 65% contamination depending on the material, including 39% for drinks cartons, 41% for plastic bags and films (CTC, 2018). Ireland applies various correction factors for household plastic waste (see Table 2.3). Eunomia (2018) recommend a correction factor of 25%, but actual correction factors vary between Member States.

Table 2.3 - Correction factors applied in Ireland to account for contamination of packaging (CTC, 2018)

Material	PET	PE	PP	Plastic bags & film
Correction factor	15.9%	19.8%	29.1%	32.7%

[10] Plastic bottles have become 53% lighter since 1970 (www.spadel.com, 2018)

2.2 Comparing data between Member States

Even allowing for variation in the statistics derived from both methods, it is unclear why estimates should vary even amongst those Member States which use the WA method. The extent of variation is apparent from Figure 2.2. There could be a multitude of reasons for this discrepancy which could only be determined through a like-by-like and detailed evaluation of the precise application used by other countries using WA rather than an evaluation of the method in principle or of reporting by Ireland alone. For example, until recently, Estonia did not account for moisture at all.

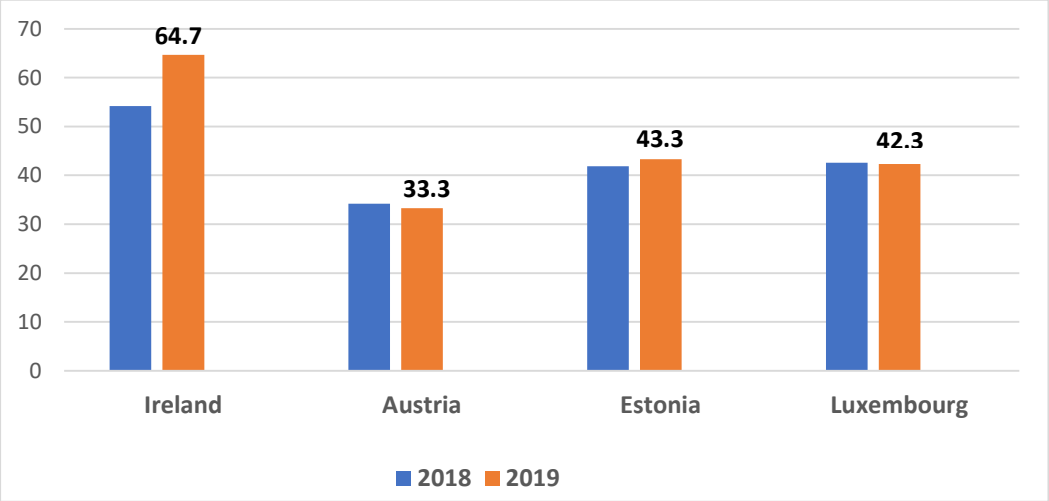

Figure 2.2 - Plastic Packaging waste in EU Member States who use the Waste Analysis method (kg per capita)

While data quality will increase with increased sample size, greater sampling frequency and the number of strata, so too will the cost and labour intensity of sampling. Data is challenging to compare over time and between regions in larger countries where consumer behaviour and waste management varies from region to region. In practice, the expense of thorough sampling means that Member States relying on WA are tempted to sample only infrequently. This can lead to discrepancies in annual estimates of the amounts of plastic packaging waste generation between Member States.

While Member States are encouraged to use either WA or PoM, no country applies both methods equally. In addition, several Member States use a combination of approaches, largely for the purpose of verification. In Germany, for example, the Association of Packaging Market Research - GVM (Gesellschaft für Verpackungsmarktforschung mbH) uses data from trade statistics, industrial declarations and numerous individual studies or samples, together with data on household sales and packaging composition databases.

As a check on the approximate validity of the two methods, we can compare the packaging and plastic packaging waste generated as a proportion of Municipal Solid Waste (MSW) in Table 2.4 and

also MSW per capita as shown in Figure 2.3. A ratio of MSW generated to the packaging waste estimates from WA involves a comparison of related waste streams and is likely to be more accurate than a comparison with PoM.

Table 2.4 shows that Ireland's packaging and plastic packaging as a proportion of MSW is indeed high relative to other Member States. MSW tends to represent mostly household waste. Ireland total packaging is at a similar level to the UK which mostly relies on PoM. However, for plastic packaging, Ireland's level is second (only) to Estonia, while Austria and Luxembourg have much lower levels.

Table 2.4 - Packaging and plastic packaging a proportion of MSW 2019 (* Data for 2018)

Country	***Packaging***	***Plastic packaging***
Estonia	58.9%	11.7%
Poland	49.3%	10.2%
Hungary	43.3%	9.0%
Ireland*	38.1%	10.8%
UK*	36.7%	7.7%
Spain	36.2%	7.5%
Belgium	35.3%	7.4%
Portugal	35.0%	7.9%
Italy	34.2%	7.7%
Slovakia	31.9%	5.9%
France	31.2%	6.5%
Norway	29.3%	5.8%
Germany	29.2%	6.4%
Lithuania	29.0%	6.3%
Romania*	28.7%	7.2%
Sweden	28.0%	5.3%
Netherlands	27.9%	5.9%
Austria	27.5%	5.7%
Czech Rep	26.9%	5.0%
Denmark	25.5%	5.1%
Latvia	23.9%	5.1%
Luxembourg	23.7%	5.3%
Slovenia	23.3%	4.7%
Finland	23.2%	4.3%
Malta	22.7%	4.6%
Bulgaria*	18.2%	4.6%
Greece	17.6%	4.0%
Croatia	15.9%	3.8%
Cyprus	12.6%	3.2%

Figure 2.3 further indicates that Ireland ranks high on the table for MSW generation, although, on this occasion, its levels are below those of some countries which are not represented highly in the previous table

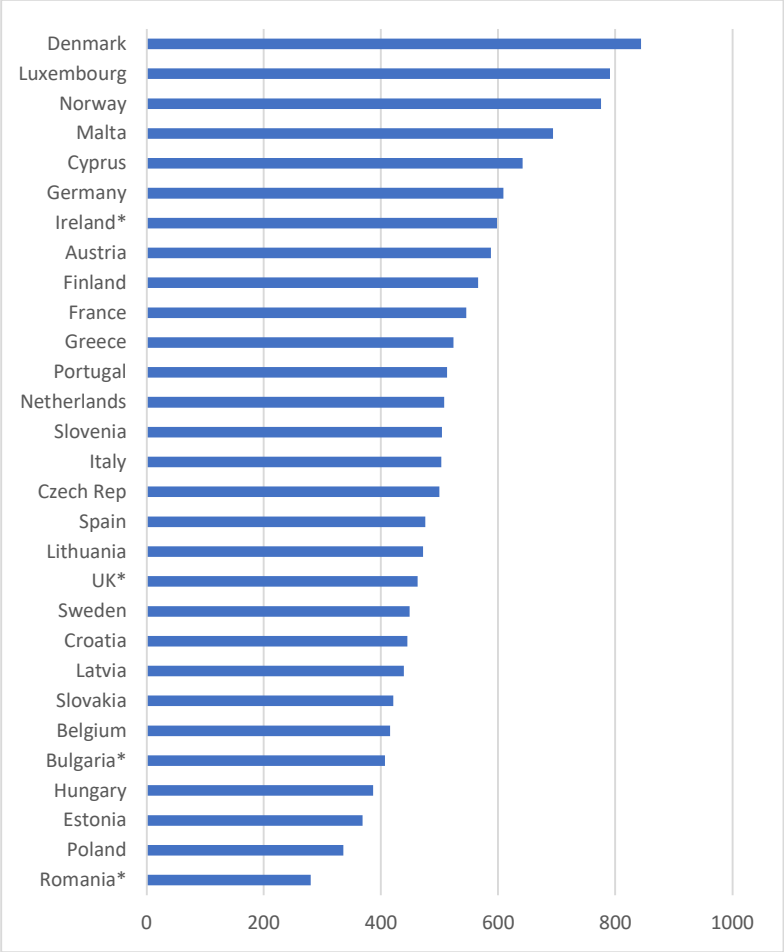

Figure 2.3 - Municipal Solid Waste Generated, kg per capita, 2019
*Source: Eurostat (MS using WA (Estonia, Luxembourg, Austria, Portugal and Hungary). * Data for 2018*

These data show that Ireland's waste generation is 7th in the rankings, but less than Luxembourg and similar to countries such as Austria and France, while not being too far from the EU-27 average. Luxembourg and Austria also rely largely on the WA approach. Typically, there is a partial positive correlation between household income and waste production. Ireland, Luxembourg and Austria have similar levels of GDP per capita, although on the basis of Eurostat statistics of adjusted gross disposable household income per capita (2019), Luxembourg's level (€35,102), and that of Austria (€28,098), are much higher than Ireland's household income (€21,877), which in turn, is higher than of Estonia (€17,513), which also relies on the WA approach and has a level of waste generation which is significantly less).

A possible reason for the difference between Luxembourg and Ireland, is that the former applies a higher correction factor of 35% for contamination to mixed waste. Without doubt, contamination does vary considerably by packaging product type and can be up to 35%. Street litter, for example, typically has a high level of moisture and food waste contamination. As noted previously, waste processors in Ireland report typical levels of 22%-28%, while the EPA applies estimates that may be more specific than Luxembourg as discussed in Section 2.1. It could therefore be the case that Ireland may be reporting a higher level of plastic packaging than Luxembourg, although this would still be insufficient to make up the difference in the reporting of plastic packaging.

The evidence by which to draw conclusions on the accuracy of waste analysis is therefore mixed. Allowing for the difference in methodologies, it does seem possible that countries using the WA approach could be overestimating the amount of plastic packaging waste generated. It is just as likely that some other Member States using PoM which are reporting low levels of plastic packaging waste generation could be underestimating, particularly due to free-riding. However, it is less clear why Ireland would appear to be producing a much higher level of plastic packaging waste than Luxembourg or Austria.

Aside from packaging data, market research on retail sales does indicate a high usage of some plastic packaging in Ireland.[11] For example, pouches account for 34% of sales and are commonly used for soups, breakfast cereal and pet food. Ireland also consumes most HDPE bottles, equal to 7% of sales, and has the second highest use of plastic film for primary packaging at 13%. However, our consumption of plastic trays and PET bottles is relatively low compared with other Member States. Milk sales would explain the high levels of use of HDPE bottles as people in Ireland are amongst the world's highest consumers of milk at 138 litres per year. Continental European countries also tend to package milk in tetrapacks. HDPE is highly recyclable compared with other plastics aside from PET. If high volumes of these bottles were being recycled, it would matter less if there is greater use of plastic milk bottles in Ireland. However, as of 2016, only 20% of PET bottles, 12% of HDPE bottles and 6% of pots, tubs and trays were being recycled (EPA, 2018).

2.3 Summary

The transition to a circular economy presents challenges in terms of policy and planning which requires reliable, comprehensive and comparable data on waste generation and composition. A first step is to ensure quality data on packaging waste generation and to harmonise the measurement of packaging waste generation and recovery.

[11] GlobalData, https://www.globaldata.com/

The predominant PoM approach commonly *under-estimates* packaging waste generation. Some of the less developed EU Member States declare levels of packaging that are low as a proportion of the amount of MSW they produce. However, the high level of inconsistency extends to all Member States that rely on EPR, even though Eurostat has recently provided clearer guidelines on how data should be collected. There is also high likelihood of free-riding by online sales companies and of variations in *de minimis* reporting.

By comparison, the WA approach includes used material that has a higher moisture content and is often contaminated by food waste or other residues. The WA approach also demands thorough and frequent sampling, but this is typically deterred by high costs such that formal composition analysis is only undertaken in occasional years.

In conclusion, the study highlights a lack of harmonisation in the methods adopted for reporting. It indicates that the apparent high level of packaging waste in Ireland is likely to be an output of the statistical method used, even though there are reasons to think that Ireland may be in the upper end of the scale due to its high dependence on imported products. Achieving shared circular economy goals cannot be achieved without first understanding the magnitude of the challenge and addressing this with stricter guidance.

Very lightweight plastic bags

As part of its terms of reference, a survey was undertaken on the use of very lightweight plastic bag (<15 microns thickness). One tonne of plastic would be sufficient to produce 260,000 vest-type carrier bags or many more smaller bags of the type routinely provided by greengrocers, butchers or some other small shops such as discount retailers and newsagents. The lightness of these bags means they do contribute to litter, even though soft plastics generally are now permitted for recycling. Contamination is an issue where the bags have been used for meat. At present, Directive 94/62/EC aims for a reduction in the consumption of lightweight plastic bags. Very lightweight plastic bags (VLWPBs) are currently excluded from this requirement, but Member States are asked by the Commission to report on the numbers or weight of these bags.

The best way to collect data on the amount of very lightweight plastic bags placed on the market would be by receiving data direct from the manufacturers or importers. However, while assistance was received from three suppliers (whose help we gratefully acknowledge), other companies, including three large suppliers chose not to respond. On the basis of figures received, we estimate that Ireland's seven main supermarket chains are responsible for providing 145 million units per year to customers. This figure would be equivalent to 2.3 VLWPGs per household per week, but is likely to be a considerable underestimate given the prevalence of such bags amongst independent greengrocers, butchers and smaller retailers.

3. Producer behaviour

Ireland's own National Waste Policy 2020-2030 underpins Ireland's commitment to the EU Waste Action Plan and the European Green Deal (EC, 2019). Its goals include moving to carbon neutrality by 2050 and decoupling economic growth from single use resource dependence. The Circular Economy Action Plan (CEAP) for Europe, identifies seven key value chains, one of which is packaging.

Ireland's own Waste Action Plan for a Circular Economy contains the key objectives "to shift the focus back up the product life cycle, to remove or design out harmful waste, to extend the life of the products and goods we use, and to prevent waste arising in the first place – consistent with the concept of a zero-waste future" (DCCAE, 2020). These objectives place an onus on producers to contribute to the realisation of a circular economy. Key measures will include the:

- Introduction of targets for specific packaging formats, e.g beverage and food packaging;
- Mandatory EPR before 2024, including eco-modulation of fees based on packaging type;
- Ensuring that all packaging is reusable or recyclable in an economically viable way by 2030;
- Proposals for mandatory recycled content in packaging materials, including the introduction of a virgin plastic levy;
- Producers to be responsible for a minimum of 80% of the costs associated with the management of the packaging they place on the market;
- Reduce the complexity of packaging, including the number of materials and polymers used;
- Collaboration with the Food Safety Authority of Ireland (FSAI) on food contact packaging in terms of re-use while conforming to health and safety requirements;
- Continued development of mywaste.ie as a principal communication tool;
- Introduction of a deposit and return scheme for plastic bottles and aluminium cans.

There are numerous challenges to be overcome in realising these objectives. Producers' adherence to the use of plastic in packaging arises from the primary attention given by producers to containment, protection, convenience and communication. Inadequate containment or protection will cause the product to be leak, be damaged, contaminated or degraded. Convenience allows the product to be more easily handled for transport and presentation, and for use by the customer. Communication is a tool for brand marketing, but also for providing information on use, cooking, nutritional content or disposal (Marsh & Bugusu, 2007; Robertson, 2012). Plastic packaging fulfils each of these needs depending on the nature of the product, and has the added advantage of being inexpensive. Furthermore, highly recyclable alternatives are not free of environmental costs. The production of paper and cardboard, for example, requires large volumes of water, metal cans require

much energy in production as does glass which also has high transportation costs (ING, 2019). The benefit of plastic's positive characteristics, especially the enhanced preservation of food, has also to be offset against the costs of its negative environmental impact. Where packaging is used simply for single use convenience, marketing, for multi-packs, to permit remote sourcing or simply to "sell air", then the balance of its beneficial properties can be questioned.[12] There has been few Life Cycle Assessment (LCA studies) of plastic packaging and insufficient analysis of consumer behaviour with regard to their storage of packaged foods. Plastic may be good for preserving food products, but much of the content of green and brown bins consists of food still in its packaging (Gali and Brunori, 2013).

Repak's Plastic Packaging Recycling Strategy (2018) sets out strategies for the better design of packaging for increased re-use and recycling, and to encourage sustainability consumption. The PRO has been instrumental in attempting to direct producers towards the choice of more sustainable packaging. Its guidance document *Packaging and Design for the Circular Economy (Version 2)* (Repak, 2021) acknowledges the need to reduce the material complexity of packaging and provides producers with a range of recommendations that can be used to increase the potential for re-use of recyclability. For plastic packaging, it recommends avoiding the use of materials with different densities or at least to make them easily separable. For paper packaging, it recommends reducing use of plastic laminates to 5% of less, avoiding PVC, or coating on one side and making plastic windows easily peelable or removable. Numerous proposals are presented with regard to films, non-PE layers, additives, colours and labelling. In response, many companies have signed a Repak Member's Plastic Pledge (Repak, 2019) to prevent waste, support the Circular Economy, simplify polymers, use recycled materials and avoid food waste wherever possible. This may have involved terminating single-use product lines, increasing the recyclability of packaging, reducing plastics through redesign, moving away from composite materials to mono-materials, or reducing the use of polymers for laminating board.

Eco-modulation has recently been introduced by Repak whereby EPR fees are set according to the recyclability of the packaging. It is hoped that this will incentivise businesses to move towards improved packaging design (eco-design). It is acknowledged, though, that the lack of information currently available on the actual level of recyclability by polymer type means that it is challenging to refine eco-modulation to reflect the precise costs of recycling (Repak, 2018).

[12] For example, Heinz manufactures 11 billion single-serve sachets of ketchup each year (Gustarfson, 2014)

Decisions to reduce packaging, to improve the recyclability of packaging or to include more recycled content, must first address producer needs. However, for food producers, there is the added constraint of food safety regulations. For example, EC Regulation No 1935/2004 sets out the general principles of safety and inertness for all Food Contact Materials (FCMs). This restricts the use of recycled plastics unless the recycling process has been assessed for safety by the European Food Safety Authority (EFSA) and authorised by the EC. As recycled plastic contains a mix of plastics whose origin cannot be verified, its quality cannot be guaranteed for food packaging. To be recycled into food packaging, there is an onus to demonstrate that 95% of the material was previously used for food packaging. At present, this can only be achieved by recycled PET, which therefore has a high price and is consequently collected separately (ING, 2019).

Plastic packaging comes in various forms with associated levels of recyclability. Plastic can be categorised as rigid, flexible or semi-flexible. Its chemical composition is defined by its Resin Identification Code (RIC) as in Table 3.1 which is also recognised by the EC under directive 94/62/EC (EC, 1997).

Table 3.1: The seven RICs, materials and the plastic demand distribution across all industries in 2019 (source: American Chemistry Council, 2016; Plastic Packaging Facts, 2021; PlasticsEurope, 2020)

RIC	Application	Demand
1-PET polyethylene	Plastic bottles for soft drinks, water, juice, sports drinks, beer, condiments Food jars for peanut butter, jelly, jam, and pickles Oven tolerant film Microwavable food trays	7.9%
2-HDPE high density polyethylene	Milk bottles Grocery bags Cereal box liners	12.4%
3-PVC polyvinyl chloride	Blister packs shrink wrap for deli and meat wrapping	10%
4-LDPE low-density polyethylene	Bags for bread, frozen foods and fresh produce Food packaging film Shrink wrap and stretch film Coatings for paper milk cartons and hot and cold beverage cups Container lids	17.4%
5-PP polypropylene	Containers for yogurt, margarine, takeout meals, and deli foods	19.4%

	Sweet and snack wrappers Bottle caps and closures Bottles for condiments and syrup	
6-PS polystyrene	Food service items, cups, plates, bowls, cutlery, hinged takeout containers Meat, fish and poultry trays Rigid food containers	6.2%
7-Other	Not frequently used for food packaging	25.4%

The relative use of these polymers has remained rather constant over time, but for small reductions in the amount of PVC and HDPE, and an increase in LDPE. However, this reduction in use does not necessarily equate to a reduction in the number of items given parallel efforts by producers to reduce the thickness or weight of packaging. On a unit basis, the weight of items fell by 32% between 1990 and 2015 (EC, 2020).

it is important also to distinguish between different kinds of packaging. There are various levels of packaging (Robertson, 2012):

- Primary packaging is that which is in direct contact with the product. It works as the initial and often the primary protective barrier. Examples include metal cans, paperboard cartons, glass bottles and plastic pouches. It is usually the primary packaging that the consumer sees.
- Secondary packaging often contains multiple primary packages. It is the physical distribution carrier and is often designed for use by retailers, including shelf-ready secondary packaging, e.g. corrugated cases and boxes.
- Tertiary packaging is used for distribution of secondary packages from producer to retailer. These are often stretch plastic wrapped pallets of corrugated cases.
- Quaternary packaging is used for the transport of tertiary packages. These are more used in global trade. They are generally metal containers, and in certain cases can have their internal environment regulated (humidity, temperature and gas atmosphere).

3.1 Producer study

Various businesses are represented in the supply chain from materials suppliers, packaging producers, fillers and co-packers, retailers and waste processers. The five dominant supermarkets are Dunnes Stores, Supervalu, Tesco, Aldi, and Lidl, which together are responsible for 89.4% of grocery business in Ireland (Coppola, 2020) compared with closer to 50% in continental Europe.

Retailers rely heavily on marketing (including this role for packaging) and have a high interaction with consumers (Schweitzer and et al, 2018). Most, though, do not disclose their waste flow data (SumOfUs, 2016).

Repak membership fee data gives a reasonable estimate of the packaging placed on the market in Ireland. Except for a lower proportion of plastics, Repak's estimated volumes by material are comparable to the national packaging waste figures issued by the EPA, allowing for the volumes produced by self-declaring companies and others placing plastic on the market (See Figure 3.1). Over one third of fees, or 35%, are received from retailers and 32.1% from food/drink/tobacco sector. When related categories are summed, retailers are responsible for 85% of the final packaging placed on the market, followed by grocery wholesalers at 11.2%. The data shows the food/drink/tobacco products account for 70% of packaging, followed by pharmaceuticals and healthcare with 9%, and chemical producers with 8.2%.

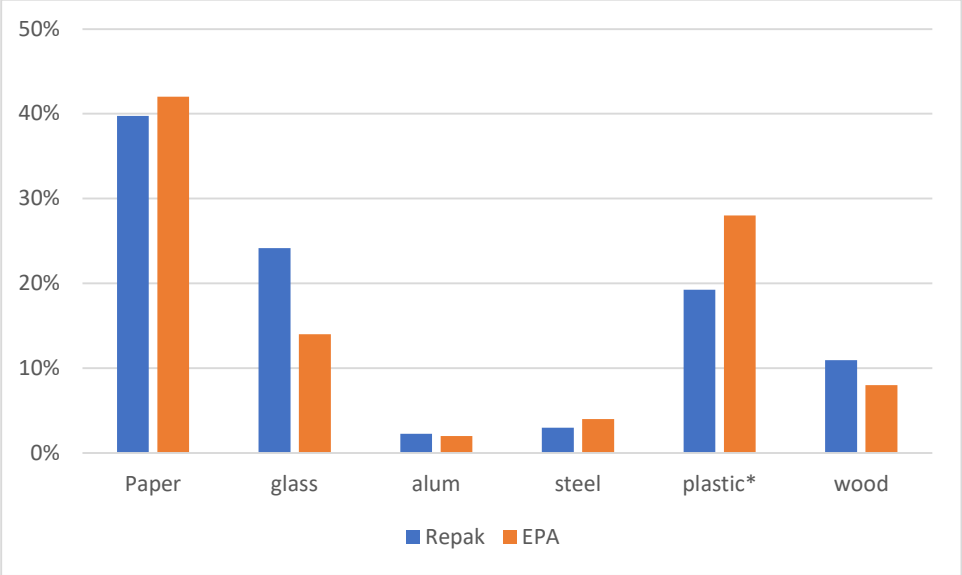

Figure 3.1 - Proportional volumes of Repak members' packaging PoM and national EPA packaging waste data
** Repak plastic (bottles = 6%)*

3.1.1 Methodology

To examine producer decision making in relation to packaging and to examine the factors that influence this, ReWrapped undertook a series of semi-structured interviews with stakeholders in the winter of 2020/21. These were followed by a survey of food producers and retailers in the summer of 2021. Food and beverage packaging represents two thirds of the market value of European packaging (Eunomia & Cowi, 2020; European Environment Agency, 2018). More details on the approach and results are available in the ReWrapped research report *The Irish Packaging Life-Cycle and Factors Influencing Non-consumer Stakeholders.*

Key issues to be explored in both the interviews and survey were producers' priorities for packaging, the use of packaging types, especially plastic, the decision making process, the influence of external organisations, overseas head offices and consumers, the role of policy, producer moves towards sustainability, barriers and producer perceptions of solutions.

3.1.1.1 Stakeholder interviews

Interviews were held with food producers, retailers, packaging companies and waste handlers and processors. The composition of the food producers is given in Table 3.2:

Table 3.2 - Food producers interviewed

Interviewee number	**Industry**	**Main products**	**Brand**	**Main packaging materials**
1.	Beverage non-alcoholic	Soft drinks Water	Own Brand Other Brand	PET Bottles, Aluminium Cans Glass bottles.
2.	Meat	Fresh Meat Frozen Meat Processed Meat	Own Brand Retailer Brand	PET trays, Plastic film, Cardboard Card sleeves, Film packaging
3.	Dairy	Butter Cheese Milk powder	Own Brand Retailer Brand	Aluminium foil, HDPE tubs Plastic packaging, Cans
4.	Fruit and Vegetables	A large variety of fruits and vegetables	Retailer Brand	PET trays, Cardboard trays Film, Bags, PP Labels Water soluble glue
5.	Snacks	Confectionery	Own Brand Retailer	Wax paper, Cans, Shrink plastic Cardboard, OPP plastic
9.	Meat	Fresh meat	Retailer Brand	Vacuum packs, Vacuum pack trays, MAP pack (modified atmosphere)
10.	Meat Catering	Fresh Meat Cold cuts	Own Brand Retailer	PET PE tray with top film, Paper
11.	Beverage alcoholic	Spirits Wine	Own Brand Other Brand	Paper, Cardboard, Glass Bottles labels, Carton Dividers
12.	Snacks, dry goods, Canned/Jars		Own brand	Cardboard, Metal, Glass, Plastic

The semi-structured interview was based around 28 questions which can be viewed Re-Wrapped Producer Report. Questions were divided into five sections, namely an introduction, the role of packaging producers, the role of packaging producers' clients, the role of policy, and the role of sustainability. Data were analysed using NVivo 12 software using the 16 nodes listed in Table 3.3.

Table 3.3 - Nodes used to identify semi-structured interviews

Node:	Definition:
Attributes	Main industry and brand relationship
Packaging Materials	Main packaging materials they used
Packaging System	The infrastructure they used to produce their packaging
Packaging design	Design processes for new packaging or revising existing packaging and factors taken into account
Secondary packaging	Their secondary packaging system
Argumentation for choice of material	The reasons for using current materials packaging
Communication with recycling facilities	What collaboration do they have with recycling facilities and waste processors
Communication with retailers	What collaboration do they have with retailers
Communication with Consumers	What interactions do they have with consumers
Sustainable solutions	Approaches taken to minimise their packaging and sustainable development of packaging
Challenges for Sustainability and Circularity	Barriers preventing packaging from being more sustainable and circular
Recycling of packaging	The recyclability of their packaging, and barriers and incentives for designing recyclable packaging.
Reuse of packaging	The reusability of their packaging, and barriers and incentives for designing reusable packaging
Deposit-Return Scheme	Advantages and challenge for setting up Deposit-Return Scheme in Ireland
Adaption to policy	What actions have they taken to adapt to policies, and what polices are they preparing to adapt to
Repak	Comments related to Repak's role and impact

3.1.1.2 Key findings from the interviews

A total of 15 interviews were held with stakeholders, of which 9 were from the food sector, 2 were retailers, 1 was a packaging solutions company and 3 were waste processors. Many of the findings

from the analysis of the interviews with stakeholders have been combined under the relevant headings from the larger producer survey. However, the following findings are discussed below

Producer choice of materials

Packaging solution companies are responsible for many of the key proposals on materials and format, with the input of the producer as the client. Recommendations on the materials to be used for packaging appear to be made by a technical team quite early in the process of introducing a new product, although other benchmarks must be achieved before the packaging is approved, including considerations such as cost and sustainability. The materials and packaging will also be subjected to rigorous stress testing. Protection of the product is the key consideration and products will need to withstand transportation and changes in ambient conditions, including for export, even with the additional protection of secondary or tertiary packaging. Materials, and material combinations, will have been selected for these properties. This includes the different types of polymers listed in Table 3.1. Producers interviewed argued that more recyclable materials, including the wider use of mono-materials, may not always be able to withstand the same stress tests.

Retailer influence

Retailer approval is vital and was argued to have been behind much of producers' recent efforts to ensure packaging was sustainable. Decisions and pledges on recyclability have been made at corporate level by many of the larger retailers, but these can place large demands on producers, especially where products are of lower unit value. Factors, such as shelf-life are of considerable importance to retailers too and can take precedence. However, there have been requests that producers shift from PVDC films to ethylene vinyl alcohol (eVOH) films which are less impermeable to moisture and extend shelf-life. Retailers may also seek exclusivity on new or innovative products or packaging. These arrangements may restrict the options and incentives of producers to sell to alternative outlets. They may also want to trial the new packaging with their brands, reinforcing exclusive relationships. Consumer acceptability is paramount. However, the point was made that better sustainability or recyclability does not necessarily result in higher sales, and could, indeed, compromise these. Replacement of black meat trays with transparent ones has not been welcomed by consumers who have become accustomed to associated black trays with higher quality. There have been reversals on the use of some more sustainable packaging, as with bacon products, because consumers did not like the packaging or associated higher quality with the use of plastic packaging (Cochoy and Grandclement-Chaffy, 2005)

Recyclability

A widespread comment was the need for a coordinated across-the-table drive to recyclability led by Government. Producers argued that little active advice had come from Government, although they acknowledged an awareness of prospective changes in policy. It was stated that efforts were needed to encourage greater recyclability in product design, but that these needed to be mirrored by support for the re-use of recycled materials. Consumer awareness and waste processing were also seen as part of this process. Markets exist for all recyclable materials, even for low value composites. PET is acknowledged to be amongst the most valuable of recycled material. However, even in an undeveloped marketplace, demand often exceeds supply due to the difficulty of minimising contamination. Even for recycled PET (rPET), food safety rules prevent use for many products. Nevertheless, rPET is much in demand for items such as fruit or vegetable trays and prices of rPET have increased from €600 mt in 2009 to €900mt in 2019, largely because food grade materials are needed at a purity rate of 95%. An absence of colour contaminants is also essential for bottled water given the need for purity and transparency. Contaminants, such as the addition of colour dyes, can cause bottles to fracture, but can be tolerated to a degree with the bottling of soft drinks.

Re-use

The re-use of packaging presents its own problems. It was argued to often be limited to office water coolers and glass bottles from the bar trade. Producers also commented that re-usable plastic packaging needs to be sturdy to sustain multiple use and so is often thicker, requiring more plastic, and therefore more resources. This, though, does not contradict the benefits of re-use where this can be achieved. The proposed deposit-return scheme (DRS) would provide for re-use and be capable of delivering a purer flow of materials, although potential fraud and imports from Northern Ireland were mentioned as issues to be overcome. It has been argued though that for waste processors a DRS would divert profitable recyclates like PET from the waste stream and reduce the value of the materials that remain.

Waste processing

Waste processors interviewed argued that there was minimal communication between themselves and producers on packaging material choices. Slightly more communication had occurred with retailers. The argument was made that producers fail to communicate with them over what is, and is not, recyclable. On occasions, it was said, producers label materials as recyclable - possibly naively, when they are either not recyclable - or poorly recyclable. Aluminium foils have been one example, least prior to the recent change in policy to permit their inclusion in the green bin. Foil seals for butter, or plastic seals which give the appearance of being foil, may still present a problem.

In particular, processors faced challenges recycling composite materials due to their low value. They argue that the recylability of packaging has fallen overall in recent years, rather than having improved. In contrast to commitments by many producers to improve the recyclability of their packaging, It was suggested that the value of recycled plastic had been reduced overall as a result of producer packaging design decisions. While some of these designs were regarded as defensible by the processors, others such as the use of coloured plastic re argued to be avoidable. Homogeneity of material is the key factor permitting recyclability, although a market does exist for coloured "jazz flake" plastic which permits more options for recyclability than higher value transparent plastics that consist of purer materials. Tertiary packaging such as commercial plastic wrap was identified as being amongst the most recyclable material due to its uniformity. Most of the plastic waste generated in Ireland is exported for recycling, largely to the UK. Landfill was argued to account for just 7% of the packaging waste handled by one processor, but much low-recyclable plastic currently finds its way to cement kilns or for incineration. The level of incineration has been increasing as observed earlier in this report.

As with aluminium foil, soft plastics have been included among the materials accepted for recycling. However, although recyclable in principle, soft plastics generally have poor value due to the different colours used and high levels of contamination. Indeed, soft plastic can contaminate other recyclable materials, such as paper, due to the difficulty of separating materials which are of similar density.

Consumer awareness

There was overall agreement that consumer awareness was low and acted as a major constraint on the amount of materials that becomes available for recycling, particularly due to contamination following use. The variety of bin colours used by local authorities was identified as unhelpful factor in this respect. However, inconsistent labelling and a lack of public education by government were also identified as major factors.

3.1.2 The producer survey

The producer survey was designed around the issues which emerged from the interviews. The survey was prepared on the SmartSurvey platform. Repak provided the team with an anonymised membership list. Other participants were recruited through LinkedIn or emails to companies. All participants worked for a company providing food products to the Irish market. The survey was then distributed to food producers in June 2021 following contact by telephone. The questionnaire was designed around 6 topics; Introductory Questions, Packaging Decision Making, Recycling, Barriers to Adopting New Packaging, Communication with Other stakeholders and Sustainable Packaging

Solutions. Participants were assured of anonymity to secure a higher sample size and minimise the risk of false data in terms of inflated sustainability efforts, a risk identified for example by Bonini and Swartz (2014) .

A total of 76 responses were received from 14 different industries (with some overlap) and 4 from "other" categories. As shown in Figure 3.2, the four main sectors were meat (16%), bakery (15%), alcoholic beverages (12%) and dairy (12%). Of companies replying, 50% were small-sized businesses (less than 50 employees), 35% were medium-sized (50-250 employees), and 15% were large businesses (greater than 250 employees).

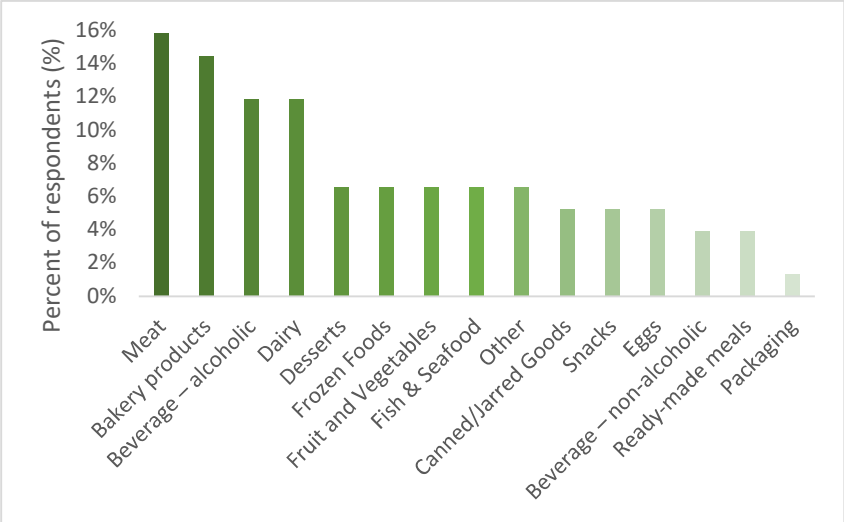

Figure 3.2 - Distribution of industries by percentage of total respondents

Reasons for packaging

Results from the producer survey confirmed findings from the interviews that protection of the product and cost are the first and second most important priorities for packaging. These priorities are quickly followed by information, marketing, convenience, retailer specifications, extension of shelf life and portioning. Nearly 60% of responses agreed that protection is critical given that products can be subjected to numerous extreme conditions. Packaging is likely to be air-tight, most especially for dairy and meat products. This may be done by gas flushing, vacuum packing or shrink wrapping. In a competitive market, especially for low priced products, cost and the minimisation of packaging failure rates, are very important.

Involvement in the packaging decision process

Figure 3.3 shows that the company departments who are most invested in packaging decisions are Marketing and Operations, closely followed by Purchasing. Transport and Logistics are lower down

the scale, while involvement of an overseas parent company ranged from 'not applicable' to 'sometimes involved'. Packaging design companies 'almost always' have an influence, but so too do in-house design teams.

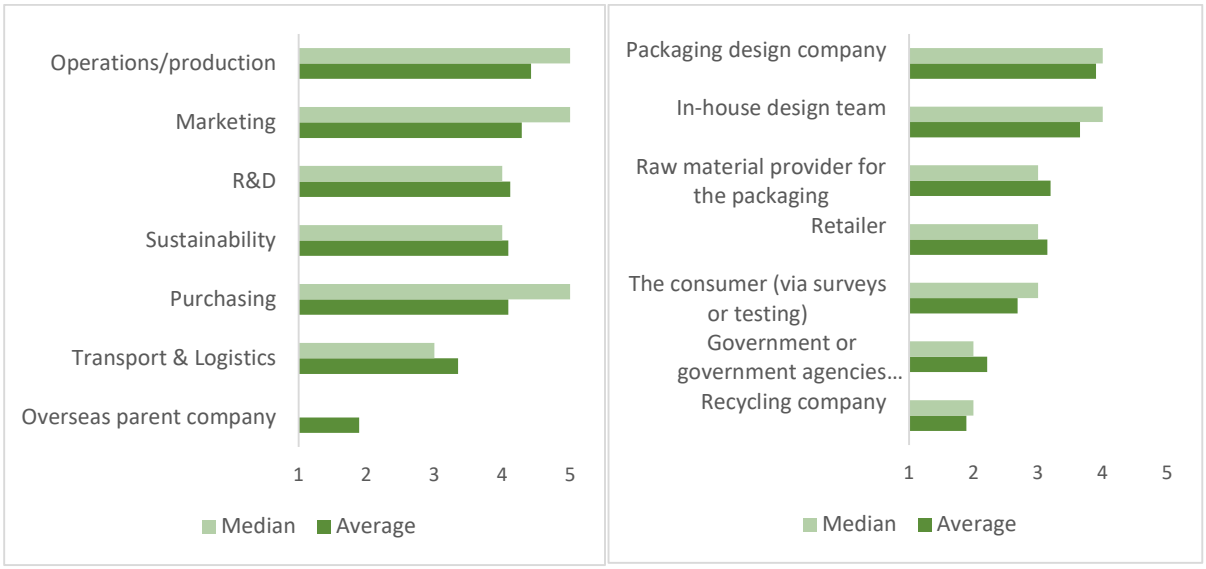

Figure 3.3 - Involvement of (a) internal departments or (b) external bodies on packaging decision-making

Left: 1:Never, 2:Rarely, 3:Sometimes, 4:Almost always, and 5:Always. **Right:** How often do external stakeholders departments influence the packaging, on a scale from 1-5, where 1:Never, 2:Rarely, 3:Sometimes, 4:Almost always, and 5:Always.

The influence of different departments within an organisation varies by the stage of product development, but conception and early *product development* is often led by the marketing team or influenced by a retailer or packaging design company. Larger companies may have a dedicated technical team. None of the companies surveyed said that they had changed packaging in response to policy, although they did admit to monitoring EU and national policy. *Cost* emerges as an important consideration in the next stage of *feasibility* in which the company compares its existing process to that which is necessary for the new packaging. Food producers often sign long-term contracts with packaging companies to ensure that their existing packaging machinery remains appropriate. Marketing and conformance with retailer guidelines will also be considered at this stage along with sustainability. The third stage of *capability* tests the packaging under different conditions to determine its failure rate, shelf life, how many products can be packaged per hour, and whether new investment is needed. *Rollout* is the final stage to see how consumers and retailers respond to the new packaging.

External to the survey, Garcia-Arca et al (2017) report that packaging design is primarily the responsibility of marketing and R&D, but that production and purchasing departments also have an input. They argue that the range of requirements for packaging, requires coordinated action within

companies and externally in the supply chain through a proposed "sustainable packaging logistics" approach that bring together design requirements within a holistic organisational structure, facilitating also innovation to improve the packaging's sustainability.

Sourcing of packaging

Most companies surveyed, i.e. 93%, source their packaging from packaging companies, while only 7% manufacture the packaging themselves. Meat trays and plastic bottles are, however, commonly moulded in-house. The range of packaging formats depends on the product, noting that many respondents produce several different types of product. Paper/cardboard and plastic are most common materials at over 91%. Boxes, bags and pots/tubs/trays are the most popular formats (see Figure 3.4). Cardboard boxes are used by 86% of food producers with 43% using this for shelf-ready packaging, while 31% of producers use reusable crates for business to business movement. More than half (51%) of producers use plastic wrap for tertiary packaging.

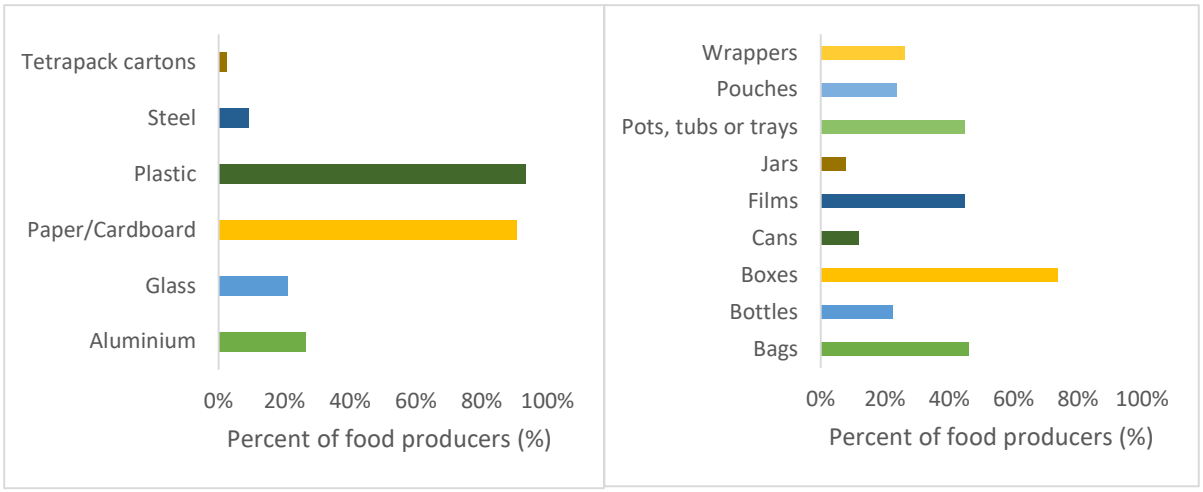

Figure 3.4 - - (a) Producers' use of materials and (b) Producers' use of formats

Sustainability

Larger global companies want their brand to be sustainable and have a positive brand image in this respect. Their focus on sustainability is mainly internal. For food companies supplying only in Ireland and the UK, the push for sustainability appears rather to have come mainly from the retailers. Reducing packaging and introducing recyclable materials are considered to be the main solutions, while use of recycled materials appears to be at an early stage. Reducing packaging may involve the removal of unnecessary packaging such as sleeves or the use of thinner packaging subject to stress tests. For food contact materials, the options are more limited due to food safety regulations. To be acceptable under this legislation, new packaging needs to be of consistent material from the same

source, and this has been one argument used in favour of deposit return schemes. The present low recycling rate for plastic means is a factor that has caused supplies to be inadequate and inconsistent.

At present, most producers have opted to investigate recyclability (Figures 3.5 and 3.6), with 62% using 'partially recyclable packaging'. Only 25% of producers are using 'fully recyclable packaging'. Just 11% are producing 'reusable packaging', although it is not always clear if this means reusable packaging or just repurposing. Many of these efforts have occurred in the last five years, with 60% of producers having moved to produce partially recyclable packaging in this time, indicating that there is still potential for further innovation. The figures do, though apply, to all types of packaging, and not specifically plastics. At the time of the survey, soft plastic was not recyclable in Ireland, but 73% of respondents said their packaging would be more recyclable if it were.

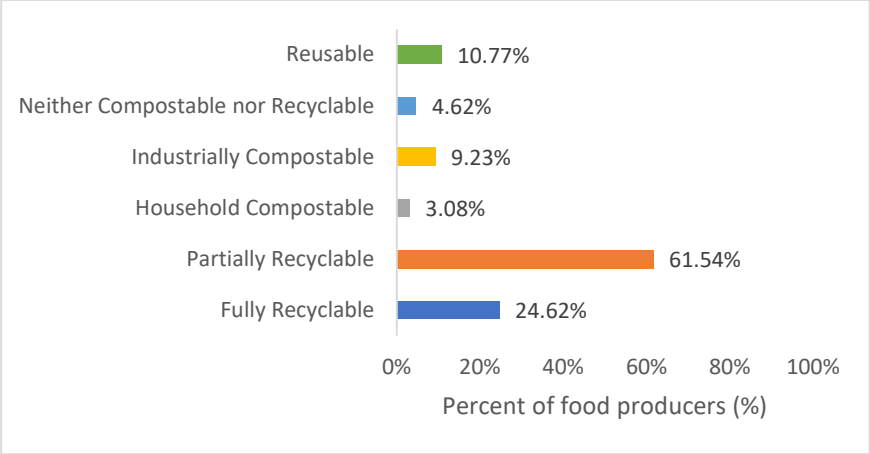

Figure 3.5 - End-of-life primary packaging for food producers

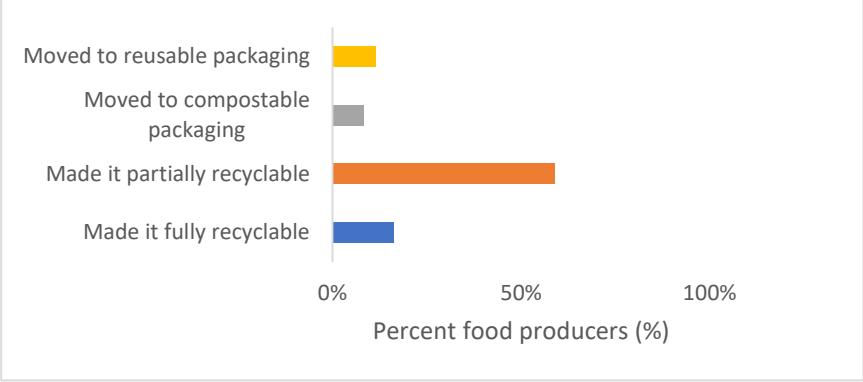

Figure 3.6 - Changes made by food producers to their packaging in the last five years

Figure 3.7 shows the main specific action proposed for the future is to reduce the amount of packaging (21.0%) followed by fully recyclable packaging (19.0%) and the incorporation of more recycled materials (17.9%). There was a lower, but still reasonable, proportion of companies who

intended to reduce the types of plastics they use (11.8%) or to reduce the packaging materials (11.3%) used in a single product.

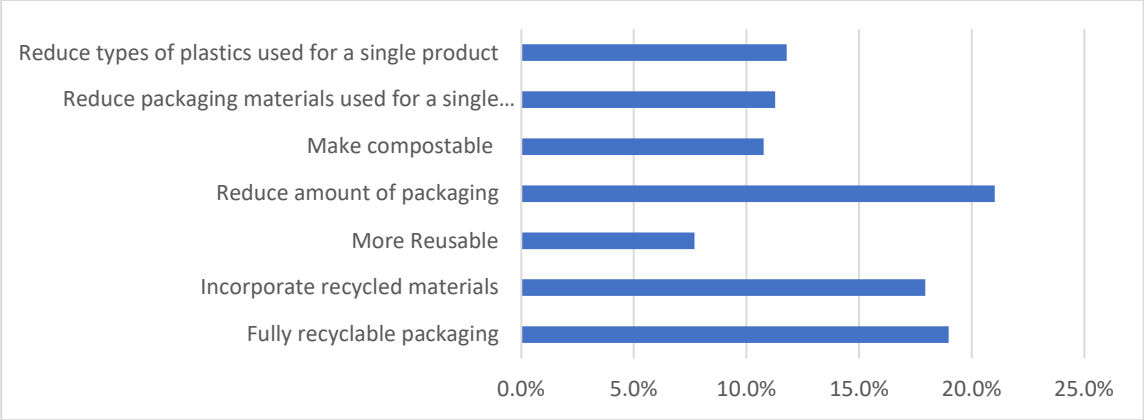

Figure 3.7 - Plans for packaging in the next five years

Figure 3.8 reveals the polymers used for packaging by those businesses who use plastic. PET, PP and HDPE are used by respectively 23.9%, 20.9% and 13.4% of producers, and are commonly recyclable. However, the options for some producers could be more limited. LDPE is used by 16.4% of the producers in the survey, but is less valuable as a recyclate and difficult to segregate. PVdC is an additional polymer which provides both heat sealing and good barrier properties and which is commonly used in the meat and dairy industries, but can contaminate waste streams (McKinlay & Morrish, 2016). Composites of plastic and aluminium foil are not recyclable, but are used by 11.2% of producers. By comparison, mono-materials used in the beverage sector are highly recyclable. As current low supply levels are a restriction, these companies would benefit potentially from a deposit return scheme in which more consistent quality could be assured. At present, reusability is more common between businesses than between businesses and consumers.

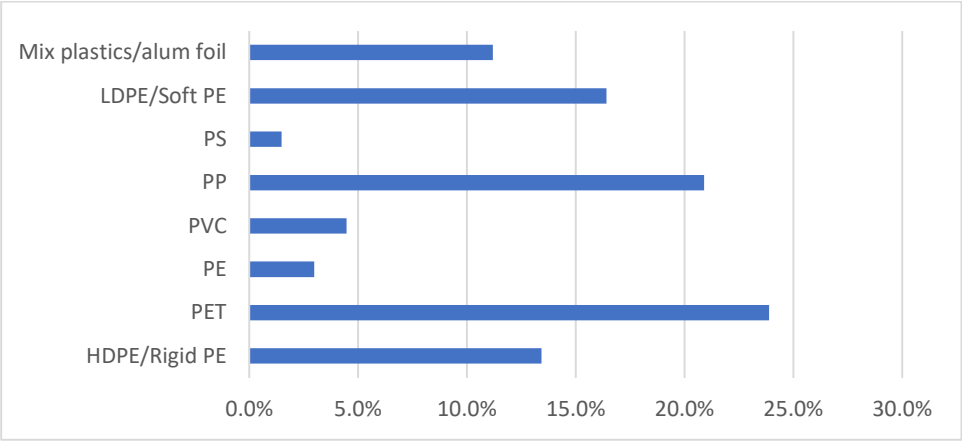

Figure 3.8 - Polymers used by producers using plastic packaging

Communication between stakeholders

The survey indicates that most of the communication occurs between producers and retailers. Smaller companies are especially dependent on retailers with whose packaging guidelines they need to conform. Retailers have often been at the front end of reducing the use of some plastic materials, such as the cessation in the use of PVC packaging by Tesco. The retailers realise the positive marketing that sustainable packaging provides. There has been engagement with producers, with retailers setting incentives that can include providing producers with favourable shelf space, in-store promotions and continuous sales data. The varying demands of different retailers are, however, a cause of confusion and, while they have promoted sustainability in recent years, retailers have a shared interest in marketability, long shelf-life, low cost and convenience.

Communication also occurs with packaging solution companies, especially when it come to new products or innovations for which these companies specialise in finding solutions that meet marketing and manufacturing needs . When it comes to consumers, most communication has been indirect through the retailer, although periodic focus groups are arranged by some companies to provide feedback. The importance that consumers attach to sustainability is described overall by producers as a 'moderate' influence. Consumers have other objectives such as low cost and appearance and are argued by producers to be swayed more by product appearance than sustainability. For instance, producers argued that it was typically necessary to add transparent plastic windows that allow the packaged product to be seen, conscious that this reduces the sustainability of cardboard packaging.

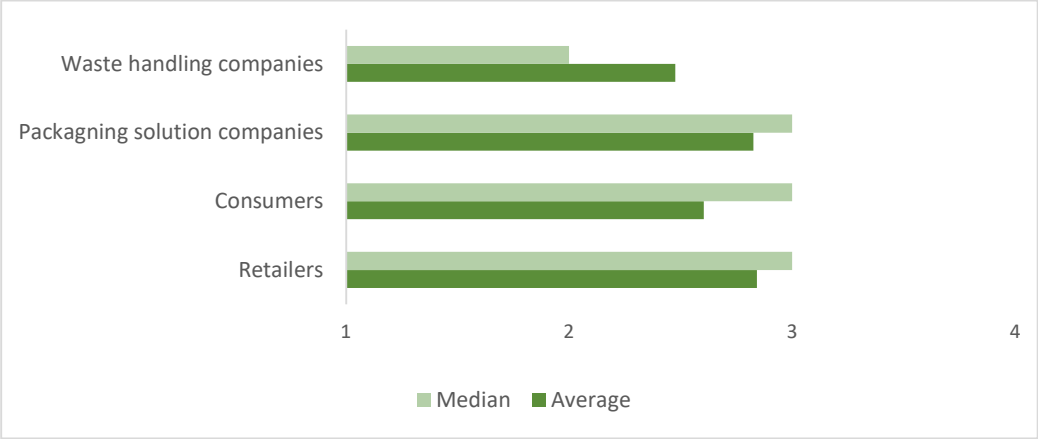

Figure 3.9 - The impact different stakeholders have according to food producers (Scale from 1-4, 1: Not at all, 2: Slightly, 3: Moderately, and 4: A significant amount)

Both the interviews and survey confirmed that minimal communication occurs with waste processers, despite the latter's responsibility for disposal and recycling. The survey indicated that producers consider waste processors to be the stakeholders least likely to push the sustainability

agenda. However, the waste processors counter that they are often the stakeholder least likely to be consulted on packaging design and packaging measures, a criticism acknowledged also by the EC (2020).

Government and EPR organisations are not directly involved in packaging decision-making. Repak was considered to be a good source of information and a bridge between producers, waste processors and other stakeholders, although its influence on decision-making was regarded as 'slight'. There has been criticism of Repak's previous fee structure which has been based on an index that prices plastic at only a slightly higher value per tonne as other materials, despite its much lower weight. For example, while a half-litre glass bottle weighs 292 g, an equivalent plastic bottle weighs 9.9 g, making the plastic bottle 2.5 times cheaper in terms of member fees. Eco-modulation has, however, been introduced recently to the fee structure . The fee of non-recyclable plastics and composites increased to €175 per tonne in July 2021 with further increments due to come into effect to achieve the 80% cost estimation of €271 by 2023. Respondents asked that more industry specific advice be provided from both Repak and the Irish Government. They reported that government advice to date had been vague and that retailers had been were far more influential in pushing the sustainability agenda. Some companies replied that they favoured more legislation, arguing that this would give those who had adopted new standards a competitive advantage. They were less keen to see revisions to legislation that restricts the use of recycled plastics in the packaging of food for reasons of health and safety. Beverage companies, in particular, favour a deposit return scheme as they believe this will lead to more supply and consistency in the materials available for reuse.

Barriers to a circular economy

The most significant barrier to a circular economy is argued to be the large variety of materials currently used for packaging. Even so-called sustainable materials can cause confusion among consumers. Different paths have emerged, one pushing for biodegradability, or compostability, and another for recyclability. However, there is no merger between these paths. Unless thoughtfully segregated at point of disposal to the brown and green bins respectively, the different products lead to contamination downstream once the waste reaches the processor. Many Irish households, particularly in rural areas, also continue to have no brown bin to allow this. Oxy-degradable materials are being banned by the EU directives for this same reason.

Added to this is the problem of the use of additives such as adhesives for labelling of composite materials which cannot be separated, such as plastics, films and foil in meat trays or crisp packets. Prioritisation is given to the protection of the product. Tight margins require packaging to constitute no more than a few cents of the price, causing respondents to argue that long lead times are needed

to replace machinery and switch to more sustainable packaging. At the time of the survey, respondents were calling for soft plastics and aluminium foil to be made recyclable given their importance to the food industry. This packaging can now be placed in the recycling bin, although it remains unclear just how many of these materials are recycled given their light item-to-weight volumes and frequent contamination by food residue. Food safety regulations and the limited supply of clean plastics and aluminium restrict producers' ability to use recycled materials.

Figures 3.10 and 3.11 show, that overall, producers consider cost as the principal internal barriers to a circular economy followed by a limited supply of recycled materials, while also indicating that sustainable packaging could have drawbacks in terms of its ability to protect the product or endure varying conditions. Among external factors were insufficient guidance, an absence of recycling facilities for some packaging, and the difficulty of meeting food standards.

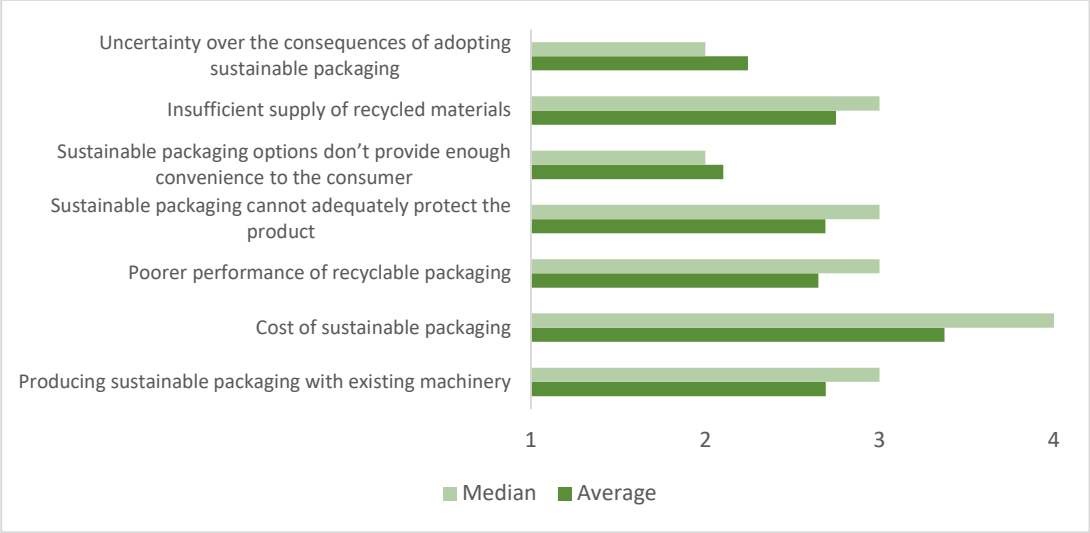

Figure 3.10 - Significance of internal barriers for food producers to transition to a circular economy (Scale from 1-4, 1: Not a barrier, 2: Slight Barrier, 3: Modest Barrier, and 4: Major Barrier)

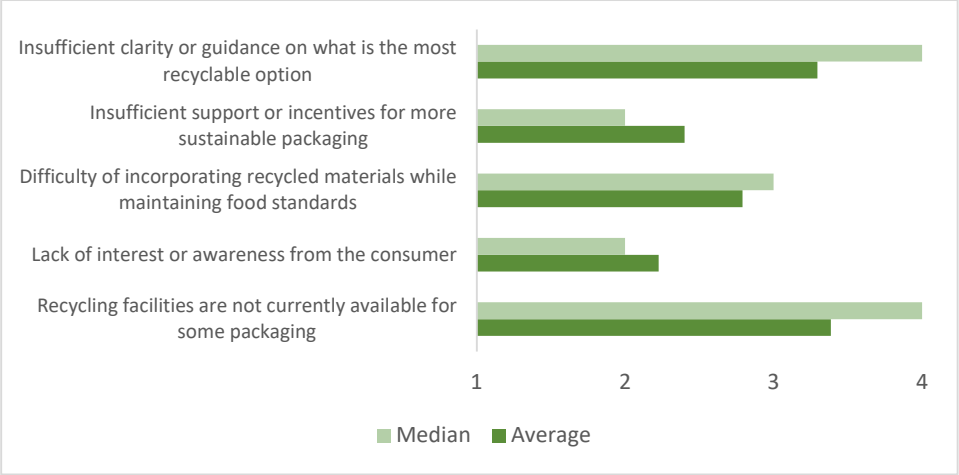

Figure 3.11 - Significance of external barriers for food producers to transition to a circular economy (scale from 1-4, 1: Not a barrier, 2: Slight Barrier, 3: Modest Barrier, and 4: Major Barrier)

3.1.3 Solutions

When asked for potential solutions, producers favour the incorporation of more recycled materials and the use of fully recyclable packaging. However, producers acknowledge that a variety of solutions may be needed Figure 3.12 shows that only a few food producers consider reusable packaging to be the future of their packaging. It is clear from the semi-structured interviews and the producer survey that there is not just one solution, but multiple solutions and a need for a process that continuously works towards the circular economy.

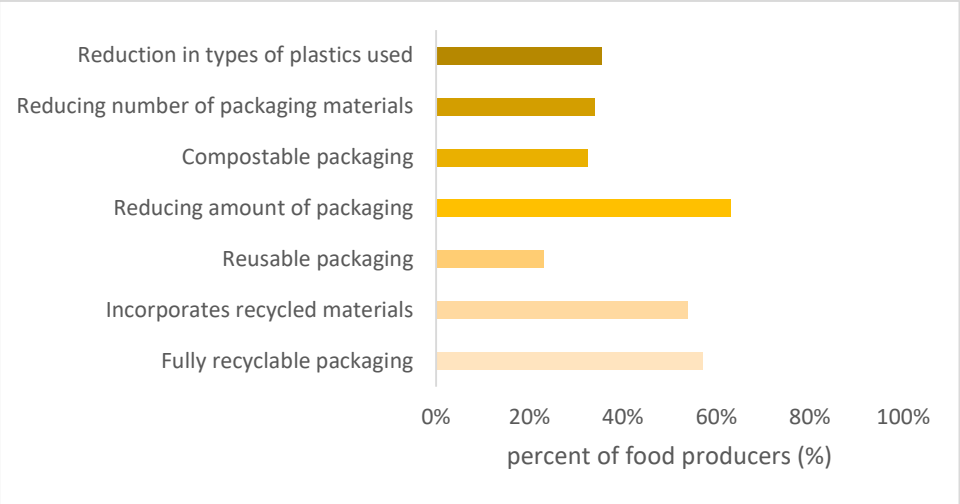

Figure 3.12 - What do food producers see as their future packaging

Figures 3.12 and 3.13 show how much respondents to the producer survey supported various prospective solutions. The most favoured solutions were government support for companies to commit to more sustainable packaging, media campaigns to increase consumer awareness of sorting, and an expansion of recycling infrastructure.

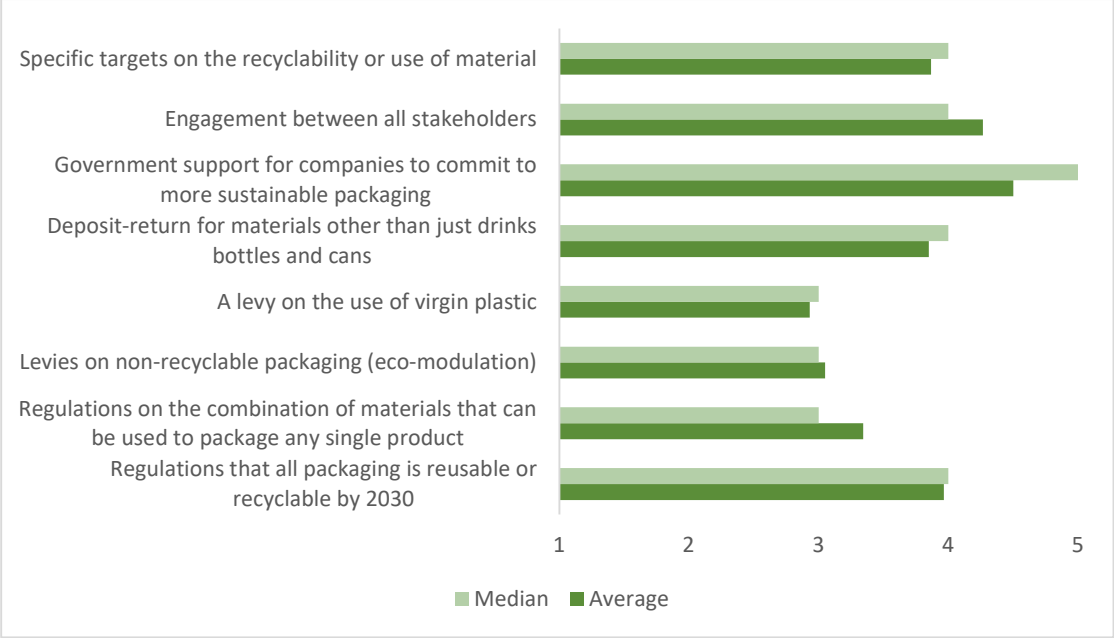

Figure 3.13 - Support of solutions involving food producers
(Scale from 1-5, 1: Would strongly not support, 2: Would not support, 3: Neutral, 4: Would support, and 5: Would strongly support)

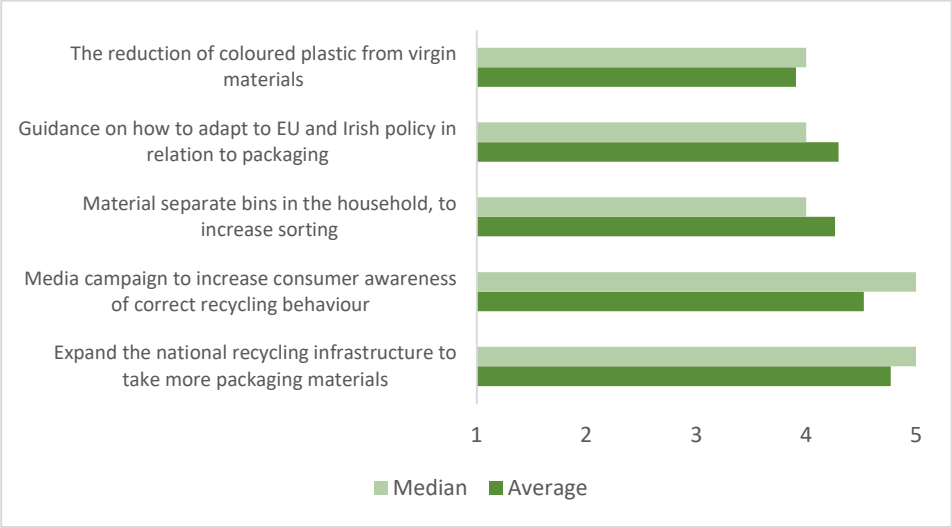

Figure 3.14 - Solutions proposed by food producers to increase the sustainability of packaging.
(Scale from 1-4, 1: Not a barrier, 2: Slight Barrier, 3: Modest Barrier, and 4: Major Barrier).

4. Consumer behaviour

While producers have a direct influence on the packaging which is placed on the market, consumers have a significant indirect influence too in terms of what they choose to buy and a more direct influence on what constitutes waste in terms of what they choose to do with the packaging after the product has been used.

4.1 Consumer survey

An on-line survey of 500 consumers was undertaken with the questionnaire consisting of six sections:

1. Questions on socio-demographics and general sustainable behaviour;
2. Questions on purchasing habits;
3. A discrete choice experiment on packaging choices;
4. Questions on waste and recycling behaviour;
5. An experiment on respondents' understanding of packaging labels;
6. The respondents' understanding and position on reusables and bioplastics.

The online survey was programmed on the platform Qualtrics. The questionnaire can be seen in the Deliverable Report. The survey was distributed through the on-line survey company Dynata in two rounds, firstly using a pilot of 50 persons, followed by distribution to 450 people.

4.1.1 Results from behavioural questions

One of the most common problems with surveys that ask people about sustainable behaviour is self - selection bias, particularly with internet-based surveys. The consumer survey that was distributed drew on a random or stratified sample from a much larger sample of the public to ensure that representative views can be obtained. The benefit of this approach is apparent in the responses to the first survey question on environmental behaviour which enquired about people's interest in the environment based on the frequency with which they watch environmental programmes on TV, their reading of environmental articles, donations to environmental organisations, membership of environmental organisations and contributions of time to Tidy Towns or neighbourhood clean-ups.

Table 4.1 - Environmental score results of respondents to survey in percentage. The score dependant on how often the respondent did the activity, with Never equalling 0, sometimes 1 and often 2.

Activities	***0: Never***	***1: Sometimes***	***2: Often***
Watch environmental programmes on TV	7.4%	73.4%	19.2%
Regularly read environmental articles in newspapers or magazines	20.8%	60.6%	18.6%
Donate to environmental organisations	49.8%	41.8%	8.4%
Belong to an environmental organisation	77.2%	16%	6.8%
Contribute time or work for local Tidy Towns or residents group clean-ups	49.4%	38.8%	11.8%

The results in Table 4.1 show an average score of 3.61 out of a possible 10, with respondents indicating a rather low level of engagement for most of these activities with the average score lifted somewhat by the relatively frequent activity of watching environmental programmes on TV scoring 1.05 where 0 equals never, 1 sometimes, and 2 often. Regularly reading environmental articles in newspapers and magazines equalled 1.00, but contributing time to clean-ups (0.75), donating to environmental organisations (0.55) and belonging to an environmental organisation (0.25) were all less than one.

However, while the survey respondents were not much engaged in environmental activities, they did express reasonably sustainable behaviour when it came to purchasing products and packaging.

Figure 4.1 shows for instance that, on average, respondents almost always reuse their shopping bags, although of course the plastic bag levy has been an incentive in this regard. The choice of not buying products which have packaging that is difficult to recycle is less incentivised, as is also the case for purchases of loose fruit and vegetables.

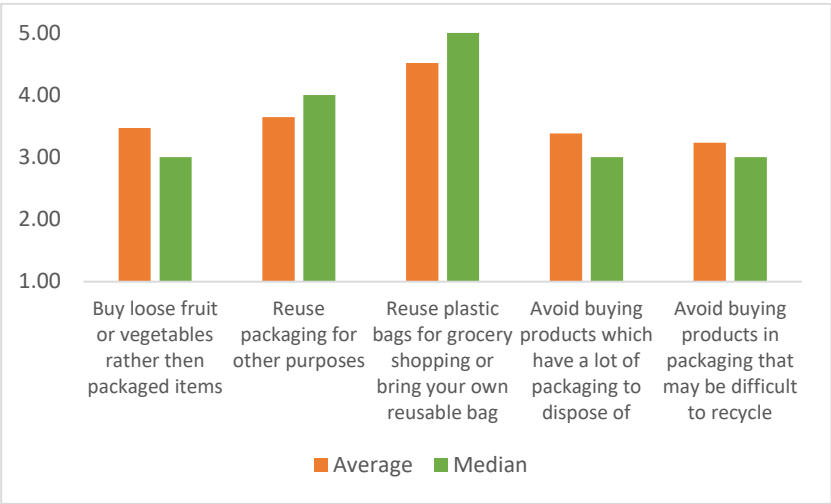

Figure 4.1 - Frequency of respondents purchasing behaviour
(Scale of 105, never = 1, rarely 2, sometimes 3, usually 4 and always 5).

Respondents were also asked about their response to the properties of packaging. Figure 4.2 shows that a preference for packaging made of cardboard rather than plastic, for recyclable packaging and convenience to store.

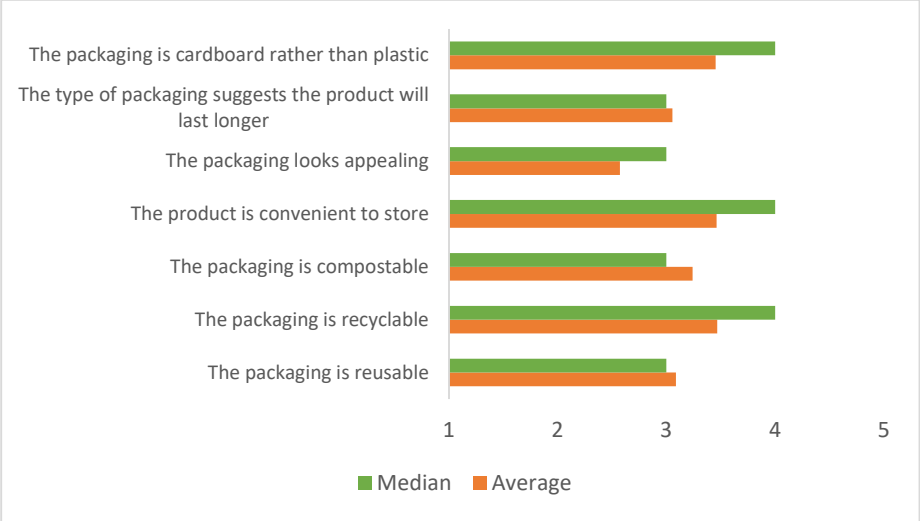

Figure 4.2 - -Value of different packaging properties, average and median
(Scale 1-5: 'not at all important' equalling = 1, slightly important 2, moderately important 3, very important 4 and extremely important 5).

4.1.2 The discrete choice experiment

A discrete choice experiment (DCE) was used to examine the effect of packaging properties on the food purchasing behaviour of consumers. The experiment also explored whether different products influence consumers' purchasing decisions with respect to the packaging used. Two products were presented, namely beef burgers and yoghurt. As, in Ireland, up to 8% of the population is vegetarian (Bord Bia, 2020), a question was added on whether the respondents ate meat. If the response was "no", the product was instead presented as a vegetarian meat substitute (or "veggie burger").

Although the respondent sample indicated that people were randomly selected and not especially environmentally-minded, there is still a risk that some could choose to express answers that imply more pro-sustainable behaviour than might actually be the case. The DCE helps to minimise this risk as it is less obvious what a "desirable response" could be. A DCE breaks down the description of a good into its key characteristics (or "attributes") and the "levels" at which these are realised (these can be continuous variables such as price or weight, or categorical variables such as quality). Three key influential attributes were identified from previous project findings, i.e. the material used for the packaging, the disposal of the packaging and the price of the product. The levels presented for the packaging material were set as virgin plastic and recycled plastic. For the disposal of packaging, three levels were used, i.e. that the packaging goes to general waste, is compostable, or is recyclable. The

last attribute was the price of the product which was presented as a continuous variable, i.e. the usual price paid by the consumer, 5% more than the usual price, 10% more, and 20% more. Price was presented as percentages rather than euros so that it would be comparable between the two product options given that one is more expensive per unit than the other. The attributes and levels are set out Table 4.2. Choice experiments can be quite complex, but at some risk of respondent comprehension. In this case, the experiment was kept deliberately simple to address key questions and increase the prospect of rational responses.

Table 4.2 - Levels and attributes of discrete choice experiment

Attributes	***Levels***
Packaging material	Virgin plastic/Recycled plastic used in product
Packaging disposal	General waste/Compostable/Recyclable
Price	Usual price/5% more than usual price/10% more than usual price/20% more than usual price

Although rather straightforward as an experiment, all combinations of the attributes and levels would cause a full factorial design to require $(2x4x3)^2 = 576$ different choice questions. However, the design can be reduced with some prior knowledge of the variability of the data. To provide this, the DCE was first run using the pilot of 50 people. The results from the pilot were analysed in *NLogit* to obtain initial coefficients which were then entered into *Ngene* to obtain an optimal discrete choice design. This design included 24 choice questions which were then divided into six blocks of 4 questions. Each respondent was presented with eight choice questions, with an example for yoghurt presented in Figure 4.3.

Figure 4.3 - Example of a discrete choice experiment question

Full details of the experimental design are included in the project deliverable on consumer behaviour. The results were analysed in *NLogit* in accordance with random utility theory (McFadden 1978) in which the utility of a choice can be expressed as what individual *n* derives from alternative *j* at choice occasion *t* using the following equation:

$$U_{njt} = V_{njt} + \varepsilon_{njt}$$

where V_{njt} is the systematic component of the utility function, and ε_{njt} is a random component that accounts for the effects on preferences of unobserved attributes of the alternative and individual (https://mpra.ub.uni-muenchen.de/53026/1/MPRA_paper_53026.pdf). This was used to establish the function for the experiment:

$$U_{njt} = ASC + \alpha PRICE_{njt} + \beta_{REC,n} REC_{njt} + \beta_{COM,n} COM_{njt} + \beta_{RECL,n} RECL_{njt} + \varepsilon_{njt}$$

In which ASC is an alternate-specific constant for the *no buy* option. $PRICE_{njt}$ is the price level of the product in percentage of the usual price. REC_{njt} is effects coded with the value 1 if the choice is made of recycled material and -1 if the choice is virgin material, and 0 for the *no buy* option. COM_{njt} and $RECL_{njt}$ are both effects-coded, COM_{njt} having the value 1 is the choice is compostable, -1 if the product is recyclable or goes in general waste, and 0 for the *no buy* option. RECEnt is similar to COM_{njt}, but it has the value 1 is the choice is recyclable, -1 if the product is compostable or goes in general waste, and 0 for the *no buy* option.

For the analysis, the data were sorted into 'all products which included the DCE for all three products together, and separate results for Yogurt options, the Meat burger and Vegetarian burger.

4.1.2.1 Results from the DCE

Good results were obtained for the "all products" sample, with each attribute level coefficient being significant at 1%, see Table 4.3. A positive coefficient indicates that a change in the level of any attribute increases the odds of its choice, demonstrating that each attribute adds utility for the consumer. *ALT 3* is the axis level for the product option, with the positive value meaning simply that there is a preference for buying the product. Only a single level for the *packaging material* attribute is shown and two of the three levels for the *packaging disposal* attribute. This is because the command must provide for data variability with the baseline attributes of 'virgin plastic', 'disposal in general waste' and 'usual price' omitted from the analysis. However, as the coefficients for each attribute sum to one, indicating the probability of choice and sum to one, the value and sign of the missing baseline levels can be determined. Hence, for *packaging material*, virgin plastic has a

negative value equal to that of the positive value of recycled plastic. For packaging disposal, both recyclable and compostable has a similar coefficient level, although recyclable is slightly higher. Disposal in general waste would have a strong coefficient value of -0.663. *Price* is the only negative coefficient, indicating a preference for the less expensive alternative.

Table 4.3 - Discrete choice experiment results

Coefficient	*value*	*Error*	*Prob. Z*	*|z|>Z**	*95% Interval negative*	*95% Interval positive*
ALT 3	4.819***	0.214	22.530	0.000	4.400	5.238
Recycled plastic	0.145***	0.022	6.680	0.000	0.102	0.187
Compostable	0.301***	0.032	9.410	0.000	0.238	0.364
Recyclable	0.362***	0.032	11.170	0.000	0.299	0.426
Price All_levels	-0.083***	0.004	-21.17	0.000	-0.090	-0.075

Statistics

Log likelihood function	-3527
N	3592

Taking the ratio of the physical attribute level coefficient to that of *price* indicates that people have a positive willingness-to-pay (WTP). In this case *price* is represented in percentage terms rather than an absolute amount. The material from which the packaging was made and the sustainable disposal options each have a positive WTP. Recycled plastic is preferred over virgin plastic, and compostable or recyclable packaging is preferred over packaging that can only go to general waste. An observation is that the Irish consumer gains more utility from sustainable disposal options than from the selection of material from which the packaging is made. The coefficients reflect current preferences. It can be inferred that consumers understand the concept of recycling more than the benefits of the product being made of recycled plastic. This preference could change now that producers are being active in advertising their packaging as being made of recycled plastic, although it could be the case that consumers are wary of buying products made of recycled plastic for fear of contamination. Indeed, current food standards would require guarantees of purity and not permit meat to be sold in recycled plastic. People do also prefer recyclable over compostable packaging, but only by less than one percentage point. In both these cases, there is likely to be an influence for awareness, e.g. of greater awareness of recyclability over use of recyclates, and perhaps a lower awareness of the practical limits to compostability once these materials are combined with

recyclable products in the waste stream as is currently the case where compostable material is disposed of in the green bin along with non-compostables.

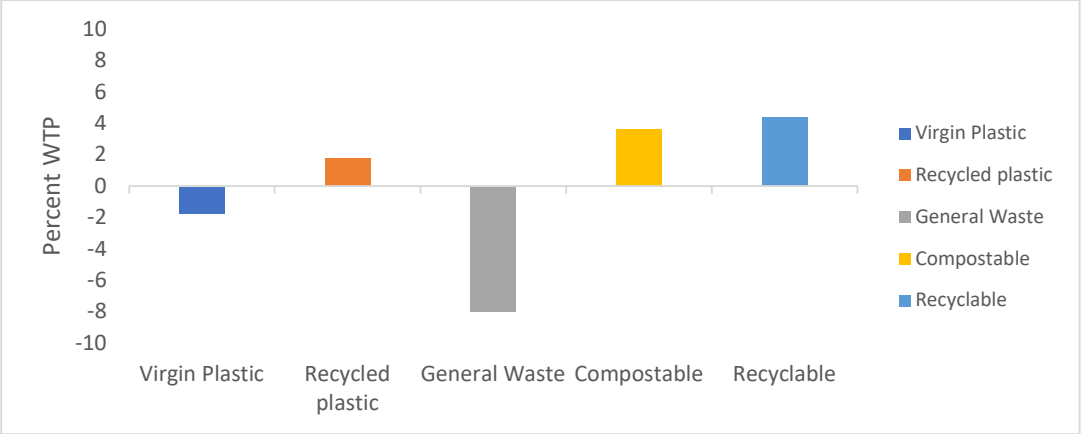

Figure 4.4 - Willingness-to-pay of consumers for different properties of packaging

If *price* is treated as a categorical variable using the individual percentage levels, than there is a predictable declining trend in values for the sustainable attributes where associated with higher prices, but most especially for the level of a 20% higher price among all population subsets. This is a threshold above which the choice experiment indicated most people are not inclined to pay for greater sustainability.

The alternative product options were examined to see if there were any significant differences in consumer behaviour. A difference was observed for attitudes towards packaging for the yoghurt choices in that coefficient values were higher for use of recycled plastic (0.170), compostability (0.310) and recyclability (0.398) compared with the equivalent levels for the meat/vegetarian burger choices (0.120, 0.294, 0.325), especially in the case of the preference for recycled plastic over virgin plastic and the preference for recyclability over compostability. All values were significant at 5%.

Of population subsets, vegetarians accounted for 7.8% of respondents. The coefficient values for vegetarians revealed the same pattern as for meat eaters, although with all attributes the sustainable levels were valued slightly more for recycled packaging (0.215), for compostables (0.360) and recyclability (0.518) compared with (0.111, 0.290, 0.309). All values were again significant at 5%. These higher values could relate to more sustainable choices by vegetarians given that one motivation for vegetarianism would be a preference for food that is more environmentally sustainable. However, it could also reflect non-represented factors such as income if vegetarians were to be assumed to have higher incomes (a question on income was not included). *Age* demonstrated no significant difference, but for a possibly lower interest in sustainable attributes

among older subsets. *Education* too reveals no significant difference, but perhaps for a higher value being placed on recyclable plastic by subsets having a progressively higher education level with graduates recording 0.401 and those with junior certificates 0.185. Families recorded a higher value on recyclability, but this was not explained by housing context as house occupiers valued compostability and recyclability only slightly higher than apartment dwellers, but at relative values for each level that were similar to the entire sample.

4.1.3 Waste sorting habits

Respondents' waste sorting habits are shown Table 4.4. This shows that 13.4% of consumers don't have either brown bins or home composting and so compostable options were not available to this group. Although high proportions usually or always use the brown bin, home composting generally of fruit and vegetables is less prevalent than other sorting options, being more likely for those with garden space. 'Sorting recyclable packaging from other waste' is habitual for a slight majority of respondents, scoring highest at 3.4. A small number of respondents, 3.2%, claim to have no access to recycling facilities, and 2.2% said they do not have a recycling bin.

Table 4.4 - Results of consumers' waste sorting habits in percentages.

ACTIVITIES	**Have no facilities**	**1: Never**	**2: Rarely**	**3: Usually**	**4: Always**
Sort recyclable packaging from other waste	3.2%	2.2%	10.8%	28.2%	55.6%
Put compostable packaging in the compostable or brown bin	13.4%	4.2%	13.4%	27.6%	41.4%
Put fruit/veg aside for home composting	13.4%	16%	15.4%	22.2%	33.0%
Wash packaging before putting in the recycling bin.	2.2%	6.8%	14.2%	34%	42.8%

Respondents were also asked if they use a single-purpose bin for all waste. A majority of 61.8% said that they never used a single-purpose bin. However, a significant percentage of consumers, 22.8%, admitted to using a single-purpose bin for waste, usually or always. Apartment dwellers would often have less convenient options in this respect and possibly no brown bin at present (although this is due to change with new proposals). People were also asked what materials they put in their recyclable bin (see Figure 4.5). This revealed a large variation in behaviour with levels varying from 34.2% to 86.4%. The two materials most people put in the recyclable bin were cardboard and paper with 86.4% and 85.6%, respectively. Nearly 60% recycle their rigid plastic and large proportions also

recycle soft plastic and aluminium foil even though the option to recycle these only officially became available in September 2021 at the time the survey was undertaken.

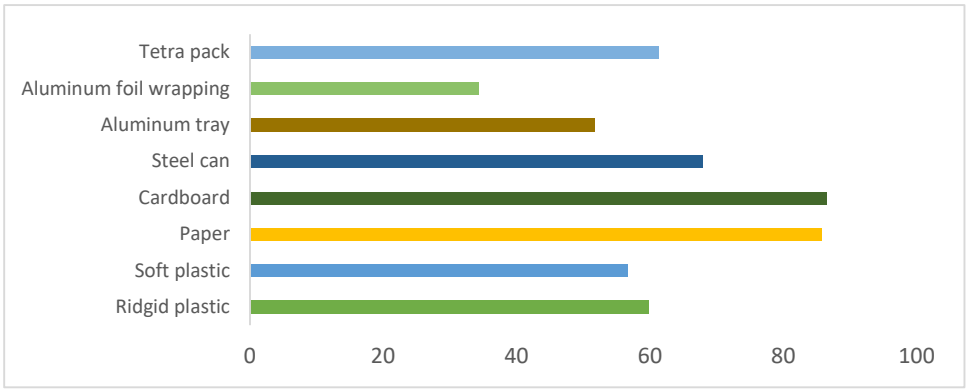

Figure 4.5 - Materials consumers put in their recycling bin

4.1.4 Label experiment

Another objective of the survey was to find out the level of familiarity and knowledge that people have about packaging waste disposal. There was a huge variation in responses to these questions as revealed by Figure 4.6.

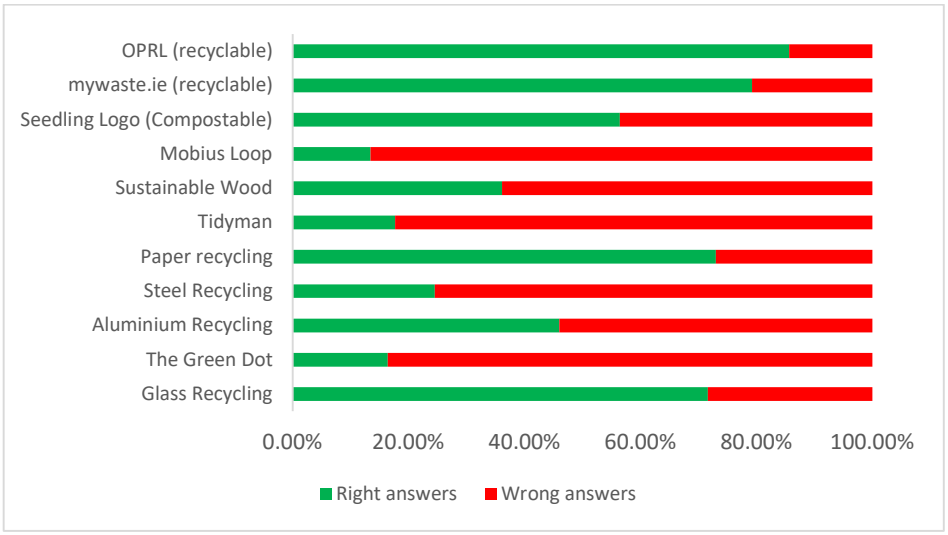

Figure 4.6 - Consumers placing packaging in their bins according to the packaging label

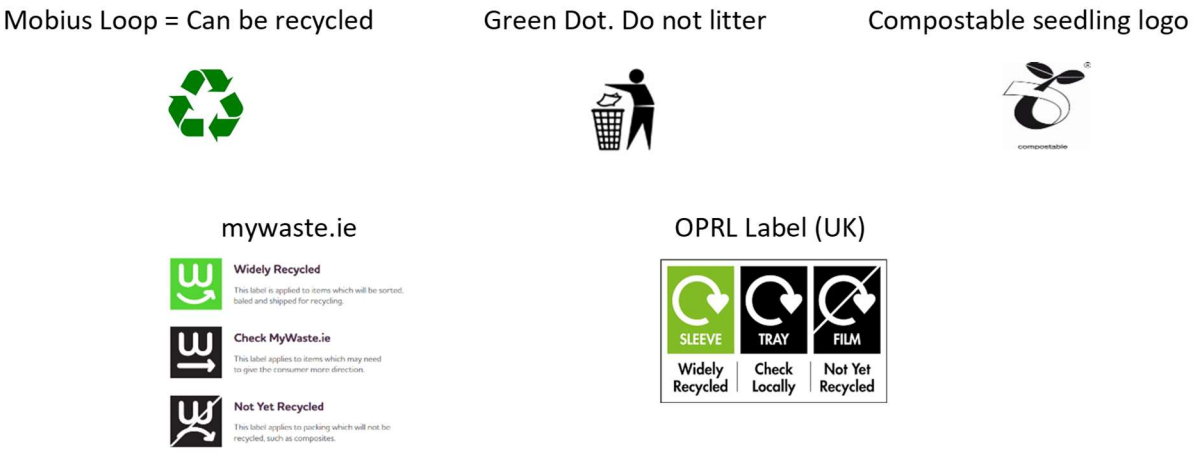

Figure 4.7 - Some examples of sustainability logos

4.1.5 Attitudes to future strategies for sustainable packaging

On average, respondents got 47% of the labels correct. Only 13% of respondents properly understood the Mobius Loop label at 13%, while the label that was most understood was the OPRL label with 86%. The mywaste.ie label was correctly described by 79% of respondents. The last results from the consumer survey concerned attitudes towards future packaging policy implementations that could affect consumers. The first question asked about measures to implement reusable packaging. Overall, the positive response to such measures was quite low with the highest being 'return the packaging to the supermarket to get deposit back' at 55%, followed by an 'extra bin for reusable packaging' at 43%, and lastly pay a deposit for the packaging at just 18%.

A final questions asked about bioplastics, for which 43.4% of consumers stated that these were either 'very important' or 'extremely important' to resolving the situation with packaging waste; a result which would be somewhat at odds with the ability of recycling infrastructure to accept this packaging and EU policy on the current constituents of much biodegradable packaging.

4.1.6 Comparisons with previous and international findings

The consumer is the last person on the plastic consumption lifespan, while also being the first person on the packaging waste lifespan (Clapp, 2002). In our survey, respectively, 42.2%, 29.4% and 13.2% of respondents to the survey said that they sometimes, usually or always avoid buying products which have a lot of packaging, with the average value being 3.1 (sometimes). By comparison, a survey for "Which?" in the UK reported that 54% of people tried to avoid products which are over-packaged and 23% said that excess packaging was a reason to avoid buying a product (Which?, 2011). It is less clear whether these results indicate a willingness to behave sustainability or to avoid

the inconvenience or extra cost of disposal. The EPA funded VOICE project found much use of SUPs such as drinks bottles, crisp and biscuit packets and clingfilm in school lunch boxes (O'Callaghan-Platt and O'Brien, 2021), for which individual packaged portions are often marketed by companies, but where alternatives are nevertheless available to parents.

The survey was focused on food packaging. The relatively low cost of food means that producers have limited options when upgrading from the cheapest forms of packaging and that consumers have been assumed to be disinclined to spend much more on packaging or to avoid packaging altogether. In Ireland, only 9.6% of income is spent on food (FAO, 2011). However, the survey results do indicate that consumers are prepared to pay 5% or 10% more for products that have sustainable packaging. Although this willingness fall away rapidly once the premium reaches 20%, the 5%-10% bounds do appear to allow producers more options than some had presumed in the producer survey.

The results reported for labelling are not restricted to Ireland alone, but have been observed internationally too. Numerous researchers have argued that consumers have difficulty understanding ecolabels (Ketelsen et al., 2020, Thorgersen, 2005). This could be exacerbated by a lack of awareness as to their meaning or consequences of packaging waste. (Kumar et al., 2012, Thorgersen, 2005, Ballard, 2005). It is not helped by the variety of eco-friendly behaviour presented by the labelling itself, which includes advice on avoidance of littering, recycling, use of biodegradable packaging or purchase of goods from companies who have contributed to sustainable waste schemes. The last of these groups could be argued to be any company that has joined Repak. If there is a weak understanding of waste management, as assumed by producers in the survey, and is poor labelling does not help matters, then there is limited opportunity for consumers to use their purchasing power. As discussed earlier in this report, packaging can be used to promote a sense of food quality associated with freshness (Barber et al., 2014). It may also confer a perception of easy handling and convenience (Lindh et al., 2012, Cochoy and Grandclement-Chaffy, 2005). These perceptions can, of course, be at variance with its sustainability. Rhein and Schmid (2020) report that 70% of consumers are not influenced by eco-labelling on products. It has been argued that consumers are, in any case, inattentive to ecolabels when actually engaged in shopping (Andors and Fels, 2018), rather than being asked about these labels in surveys. Although there is limited literature on the extent to which this is true and evidence is anecdotal. For example, in the UK, an experiment by the Waitrose supermarket chain to encourage shoppers to purchase loose fruit and vegetables and packaging free products failed despite the goods being cheaper than the packaged alternatives (Kumamaneni et al., 2019).

There is no guarantee that knowledge equates to changes in behaviour (Clapp, 2002) or even that opinions will change behaviour (Zsoka et al., 2013). According to the behavioural theory put forward by Stern et al (1999), willingness to change behaviour, including towards the environment, is promoted by a conjunction between values, beliefs and norms that cause people to adopt social norms that are not necessarily tied to self-interest. This, they argue, depends on an acceptance of the consequences (in this case of the environmental impacts of plastic use) and a belief that individual actions can make a difference in promoting these same values.

However, while awareness of recycling may have reached a certain threshold, it is not clear as to whether people feel sufficient peer pressure to proactively avoid unsustainably packaged goods in practice. Changes in behaviour involve a personal investment in understanding packaging and its environmental impact. Each individual will have personal barriers to raising their understanding when packaging guidance must compete with other advice on fair trade, nutrition, animal welfare or climate change. Barriers include time, money, knowledge, limited attention span and (often overlooked) the ability to read small lettering (Thorgersen, 2005). Consumers will not automatically respond to eco-labels even if they choose to look at them. There has to a level of commitment and/or social pressure present, before people will contemplate change, particularly if this means replacing a habitually selected good with another. In this respect, campaigns such as Repak's Team Green (https://repak.ie/team-green/) can begin to make a difference by identifying influencers and champions for recycling to encourage an overall societal change towards sustainability and recycling.

5. Conclusions

Consumers have an impact on the characterisation and recyclability of packaging waste through their purchasing choices and waste sorting behaviour. The poor level of sorting of recyclable by Irish households has been widely cited (O'Doherty, 2018). In the absence of direct incentives, there will be always be a proportion of consumers who are not inclined to spend much time sorting their waste, be this through nature, a lack of facilities or the absence of a green or brown bin. The consumer survey found that only 55.6% of respondents always sort their recyclable packaging waste from other waste, and that just 41% always put compostable waste in the correct bin. The situation is not improved by low public awareness of what is recyclable. The survey showed a low level of comprehension of sustainability labels on products, a position that is not helped by the voluntary nature of labelling by producers and an absence of awareness campaigns. In addition, the survey found that 21% of consumers rarely or never washed packaging that is placed in the green bin, an observation reflected in waste characterisation surveys which have found high levels of

contamination by food residues which renders much packaging as waste, even if the raw materials can be recycled. Given the increasingly stringent controls being introduced by third countries for the acceptability of plastic waste imports for recycling, much of this material is instead being directed to recovery in Ireland.

In the survey, consumers reported that they are discriminatory when it comes to the choice of products. However, only 13.2% '*always*' avoid products which have a lot of packaging, while 12.4% '*always*' avoid buying products in packaging that might be difficult to recycle. At 53.8%, a high proportion of consumers '*usually*' or '*always*' seek to re-use packaging for other purposes, or re-use their plastic bags (86.8%), although this is a habit that is incentivised through the plastic bag levy. It is therefore fair to observe that reasonably high proportions do 'usually' or 'sometimes' avoid buying excess packaging, avoid non-recyclable packaging, re-use packaging, or buy loose fruit or vegetables. These habits are not encouraged after all by financial incentives or social pressures and shopping decisions must focus on a limited range of competing products, are subject to heuristics, are made easily and rapidly. Respondents to the producer survey were less convinced, arguing that they do not believe that consumers are strongly motivated by sustainability relative to other product characteristics and that much of the incentive to improve the sustainability of packaging appears to come from major retailers who wish to promote a sustainable image which, in practice, is realised at corporate level more than through individual products.

The discrete choice experiment found reasonable awareness of food packaging issues and a willingness to purchase recyclable and compostable packaging so long as the price premium is modest. It did find that recyclability is preferred, or is more familiar, than compostability. The preference (or awareness) of the use of recycled plastics in packaging is positive but relatively low. This is perhaps not too surprising given that producers, such as those of soft drinks, cosmetics or detergents, have only recently began actively advertising the use of recycled materials in their product packaging. Therefore, there is the potential for upward movement when it comes to influencing consumer purchase decision making and the sorting of waste, given that there is something of an open door in terms of awareness of the merits of recycling and a willingness to do the right thing, even at a modest cost in terms of product prices.

Producers

Producers do seem to be conscious of the need to make their packaging more sustainable. A high proportion (61.5%) use packaging that is partially recyclable, and nearly a quarter more use packaging which is fully recyclable. Around 60% of producers have moved to make their packaging more recyclable in the last five years, and a further 16.7% have made their packaging fully recyclable

in this time. In the next five years, over one fifth of producers are looking to reduce their amount of packaging, while just under one fifth plan to use only fully recyclable packaging, while others propose to use recycled materials. Twelve percent propose to reduce the range of plastic polymers they use. There are opportunities here as the larger proportion of producers using plastics, use higher value or highly recyclable polymers such as PET, PP and HDPE, while 17% use lower value polymers and eleven percent use mixes of plastic and aluminium foil.

However, the limited opportunity for producers to use recycled plastics for food packaging (i.e. food contact material) is a constraint directing recyclable plastics towards drink or non-food uses rather than for meat or dairy products. Producers remarked that consumer behaviour has a slight to moderate influence on their packaging decisions, but that the greater influence comes from retailers and the packaging solution companies who design the packaging. Retailers have a shared interest in ensuring good product sales and so their influence is not singularly in the direction of sustainability. Likewise, packaging solution companies, while conscious of stakeholder concerns with sustainability, have an interest in designing practical, yet unique and marketable packaging for their clients. Therefore, within companies, operations and marketing divisions have strong, if sometimes conflicting views, on packaging design. Operations is keen to ensure low cost and protection of the product, with minimal risk of investing in the production of products that could fail to sell well due to unappealing packaging.

The influence of Government on producers to date would appear to have been muted. Producers acknowledge an awareness that policy is changing in the direction of a circular economy, but that sales and retailer acceptability remain the current priority. At EC level, Circular Economy Guidance has been agreed, including stricter limitations on single use products, recyclability and composite materials, extended producer responsibility, and eco-modulation of packaging fees. However, anticipation of change has not been sufficient to have had a pressing influence on producer motivations, but is rather as something to work towards on a more strategic timescale.

Producers refer to the barriers to the introduction of more recyclable materials, or uptake of recyclates, as being unit cost, followed by supply constraints, existing machinery, performance (protection of the product) and uncertainty (in this order). More strategic barriers include an absence of guidance of sufficient clarity, an absence of recycling facilities, difficulty of incorporating recycled materials, insufficient support or incentives and a lack of interest or awareness by the consumer. This contradicts arguments by Repak that relevant information is provided. The survey responses indicate that producers are looking for specific guidance for their operations and resent paying producer responsibility fees. The current fee structure, although higher for plastic, has

shortcoming in that is does not penalise plastic packaging sufficiently given it relative lightness. It is likely, though, that fees will rise over time as required by the Packaging Waste Directive and the Single Use Plastics Directive, and that eco-modulation will soon account for recyclability and the overall environmental impact of packaging.

Furthermore, while producers complained about a lack of recycling facilities for certain materials, some of the reasoning behind this response may have been removed by the recent decision to permit soft plastics and aluminium foil to be placed in the green bin. Although it is somewhat uncertain just how recyclable these materials currently are, it was apparent from the consumer survey that many people had been assuming that this packaging was recyclable already. Furthermore, while producers did express a wish for waste processors to provide a better recycling service, there would appear to have been rather little engagement between producers and the waste processing sector, as argued by the processors themselves in interviews undertaken by the project prior to the survey.

Packaging statistics

The benefit of Government and Repak actions to encourage greater levels of recycling and packaging recyclability, could be undermined by statistics which appear to show that Ireland has a higher level of packaging and plastic packaging waste relative to other EU Member States. Accurate packaging statistics are essential to estimate the level of recycling and for the design and adoption of appropriate policies, levies and incentives. However, these statistical results are due to conflicting methods of estimating packaging waste. Most European states apply a mixture of methods, but rely heavily on the Placed-on-the-Market (PoM) method. Ireland, by comparison uses the Waste Analysis (WA) method which involves more direct estimation. Although there are limitations in the frequency and statistical accuracy of waste characterisation surveys that are undertaken for WA, it does seem that much of the problem attaches to the PoM method which has a tendency to underestimate packaging waste. In truth, Eurostat are aware of these issues and have recently responded by requiring more detailed ‘quality reports’ on the application of methods by Member States and by publishing new guidelines on producer responsibility and reporting by smaller companies. However, the increasing volume of online sales by multinational companies compounds the problem. Neither has it been possible to retrospectively adjust recently published figures and ranking of performance by Member States to account for evident shortcomings in the application of the methodologies applied.

Summary

It does seem that issues of reporting have been impacted by a governance approach that has only gradually coaxed EU Member States towards more sustainable solutions for packaging, beginning with the setting of ambitious targets, but only subsequently backing this with firm implementation measures. Sustainability improvements to packaging design and eco-modulation of packaging waste fees are urgently needed, but do not appear to be a priority for producers surveyed by the ReWrapped project. Improvements have been achieved, but it is rather frustrating that at the same time producers have moved towards the use of more complex packaging, including mixed polymers and materials, that have low recyclability. Consumer awareness of the packaging issue could also be better, and social or economic incentives for adherence to waste management could be implemented. Meanwhile, the level of recycling, particularly of plastics has stalled with more material being directed to the inferior options of energy recovery through incineration. Litter remains a scourge in our urban spaces and rural roadsides, and marine litter, together with its ecological implications, continues to be a major global environment issue.

Recommendations

1) Use a hybrid model for generating waste statistics by applying a placed-on-the-market method to estimate Irish packaging volumes in line with Eurostat guidelines while continuing with the use of Waste Analysis which additionally provides important information to inform the implementation of policy through waste characterisation surveys and evidence of the extent of sorting of materials by households and businesses.

2) Improve public awareness and the design of sustainability labelling to communicate the degree of recyclability or compostability of products, including if possible mandatory use of the My-Waste logo by products produced in Ireland or imported from third countries (now including the UK).

3) Re-invigorate efforts to raise public awareness of the benefits of recycling, composting and the proper sorting of household waste.

4) Raise public awareness of the societal and environmental benefits of recycling and the use of recycled materials in new products. Investigate the role of social norms and behavioural nudging to encourage people to select more recyclable options.

5) Improve guidance for producers and more targeted information from Repak or Government on how to produce more recyclable products.

6) Advance legislation to improve sustainability and recyclability in product packaging design.

7) Advance legislation to extend producer responsibility to cover the environmental costs of packaging waste.

8) Government, EPA or Repak to provide for more communication between stakeholders via such fora as webinars, conferences and roundtable workshops for policy-makers, packaging solution companies, producers, retailers and the waste processing sector.

9) Investigate the role of education of third level education and availability of course aimed at future packaging designers, producers, retailers and other key stakeholders

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