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Plastic alternatives and substitutes in the packaging sector – A UK consumer perspective

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ABSTRACT

Alternative and substitute materials to conventional plastic packaging offer a range of potential opportunities to help reduce the environmental impacts of single-use plastic. Policymakers and industry stakeholders are currently debating measures to address the plastic pollution crisis globally, but successful implementation of new policies or packaging technologies will require understanding of consumer perspectives and consumer acceptability. The present study aimed to examine consumer perceptions around plastic alternatives and substitutes by employing a life cycle approach. The Kano model of consumer satisfaction was used to investigate how UK consumers ($n = 1177$) responded to a variety of environmentally relevant attributes and end-of-life scenarios for different types of packaging (conventional plastic, biodegradable plastic, and glass). These responses were further grouped based on sociodemographic characteristics of the consumers including age, gender and level of education, as well as psycho-environmental variables such as nature connectedness. We show that consumers valued recyclability or compostability of packaging as preferable end-of-life attributes, and that overall consumers considered the release of plastic packaging into the natural environment an unacceptable end-of-life scenario. Concerningly, this was not the case for packaging made of biodegradable plastic or glass, highlighting the potential for alternatives and substitutes to increase the proportion of mismanaged waste. All four consumer groups had distinct profiles of responses to packaging sustainability attributes and end-of-life scenarios: '*Educated environmentalists*', consisting mostly of female consumers, considered all of the attributes of interest to be important, whereas '*Older, less educated coastal dwellers*' showed similar responses but rated four out of seven sustainability attributes of biodegradable plastic packaging as irrelevant. '*Non-environmentalists*' perceived all attributes as irrelevant, as did '*Nature-connected egocentrists*', with the exception of glass being made of recycled material. Overall, our findings indicate that consumers are not sufficiently informed about the environmental impacts and opportunities around packaging, highlighting the need for appropriate consumer education to support policy and industry in implementing the UN Plastics Treaty.

1. Introduction

Packaging can contribute positively to environmental sustainability of fast-moving consumer goods for example by enabling longer shelf life, reducing food wastage and reducing damage during transport (Verghese et al., 2015). Packaging also helps consumers distinguish between products and brands, and may thus influence product choice. However, single-use packaging, especially that made of plastic, places a significant burden on the environment, waste management systems and the economy (Bassi et al., 2020; Beaumont et al., 2019; Gall and Thompson, 2015). From the production of greenhouse gasses in the extraction of raw materials and the manufacturing process (Landrigan et al., 2023) to the pollution engendered by insufficient and unsustainable end-of-life management (Hopewell et al., 2009; Jambeck et al., 2015), adverse environmental impacts are rendered throughout the packaging life cycle. A key strategy for achieving packaging sustainability is a transition from a linear take-make-dispose model towards a circular economy, where in addition to material reduction the circular use of natural resources is practised and maximised throughout the packaging life cycle (Geissdoerfer et al., 2017; Ghisellini et al., 2016). In the context of plastic packaging, the transition to reducing plastic production and increasing circularity may involve the development, promotion and

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wider application of alternatives and substitutes to plastic (Herrmann et al., 2022; Sid et al., 2021), objectives which are highly relevant to the UN global Plastic Pollution Treaty (United Nations Environment Programme (UNEP), 2023a, 2023b). While there is a clear need to ensure any such materials have better environmental outcomes than conventional plastics (Napper and Thompson, 2019), it will also be key to understand what consumers make of this transition as this will inevitably influence their buying behaviour and waste management decisions; making consumer acceptance and perceptions a vital consideration in measures to reduce plastic pollution.

Consumer demand for packaging sustainability is at an all-time high (Boz et al., 2020; Schnurr et al., 2018), but it is likely that consumers use varying criteria and metrics to infer sustainability of packaging materials. A person's perception of packaging sustainability stems from their subjective understanding and prioritisation of sustainability at various stages of the packaging life cycle (Otto et al., 2021): Some may be chiefly concerned about the carbon footprint of packaging, whereas others worry about the accumulation of waste. For example, when it comes to plastic packaging, carbon footprint considerations may be trumped by concerns about its accumulation in the marine environment as litter. In fact, consumers are increasingly concerned about packaging leaking into the natural environment, whereas manufacturers may focus their efforts on trying to reduce carbon emissions and promoting circularity of packaging materials (Hahladakis and Iacovidou, 2018). Consequently, although these concerns are not mutually exclusive, such potential trade-offs can inversely impact consumer acceptance and behaviour, despite consumers generally having pro-environmental intentions (Boz et al., 2020). Acquiring a holistic view of how consumers respond to and evaluate packaging sustainability encompasses uncovering their perceptions from pre-purchase to post-consumption (Camacho-Otero et al., 2018), and can as such help reduce the environmental burden of single-use packaging.

2. Literature review

The following sections provide a review of literature relevant to the present research focus and empirical method. Firstly, literature around consumer response to packaging sustainability, including perceptions of plastic alternatives and substitutes, are reviewed. The latter sections provide a background for the methodology used to capture consumer responses, namely the Kano model of consumer satisfaction and consumer segmentation.

2.1. Consumer perceptions of packaging sustainability across the packaging life cycle

Consumers are increasingly conscious of the environmental impact of packaging, and packaging sustainability can have a substantial impact on consumer purchasing decisions (Rokka and Uusitalo, 2008; Thøgersen, 1999; Van Birgelen et al., 2009). In a cross-national study by Popovic et al. (2020), using survey data from eleven countries, the majority of consumers (73 %) reported being willing to pay more for packaging that is environmentally friendly. As discussed above, consumers may vary in their interpretations of 'environmentally friendly' or 'sustainable'. According to a review by Otto et al. (2021), European consumers judge packaging sustainability on the basis of its contribution to the circular economy (i.e. recyclability) and by the 'natural' appearance of the material and design. Magnier and Crié (2015) defined the consumer perspective of sustainable (or environmentally friendly) packaging design as "a design that evokes explicitly or implicitly the eco-friendliness of the packaging" (Magnier and Crié, 2015, p. 361). As premised by the cue utilisation theory (Olson, 1978), consumers rely on a collection of cues that indicate particular product attributes, such as sustainability, before they arrive at an evaluation of product quality and ultimately at a purchasing decision. Sustainability cues on packaging include structural (e.g. material or recyclability), graphical (e.g. colours, images, or logos), and informational cues (e.g. sustainability claims; Magnier and Crié, 2015). Herbes et al. (2020) found that packaging labelling, such as a 'recyclable' label, is the primary cue that signals sustainability to consumers in Germany, France and the USA. Furthermore, Lindh et al. (2016) concluded that the packaging material was the key attribute on which consumers based their sustainability judgments. The emphasis that today's consumers place on packaging materials is likely to be influenced by the global issue of plastic pollution attracting concern in both public and scientific discourse (e.g. Dunn et al., 2020; Haward, 2018). With some observers going as far as calling this 'plastic bashing' (e.g. Otto et al., 2021), it may have shifted consumers' perceptions and caused them to view plastic as less sustainable in comparison to other material types.

As discussed above, consumers tend to focus on the post-use phase of the packaging life cycle (e.g. recyclability) when evaluating packaging sustainability. Similarly, existing research on consumer perceptions has primarily addressed the end-of-life attributes of packaging, with less research attention paid to the beginning-of-life aspects, involving the extraction of raw materials and carbon footprint of manufacture (Herbes et al., 2020; Otto et al., 2021). An exception is a cross-cultural study by Herbes et al. (2018) that studied German, French and American consumers' perceptions of environmentally relevant attributes of packaging – as well as their relative importance – across the packaging life cycle. They concluded that, in general, consumers placed emphasis mainly on packaging reusability, recyclability and biodegradability when determining how sustainable packaging is, while German consumers specifically indicated some concern for its beginning-of-life attributes (e.g. use of renewable materials). As noted by Herbes et al. (2018), consumers generally showing less interest and concern for the beginning-of-life phase of packaging is at odds with what packaging life cycle assessments often conclude: The production stage of the packaging life cycle generally outweighs the post-use phase in terms of its environmental impact (Kang et al., 2017; Maga et al., 2019), although exact comparisons are impeded by the complexities of the packaging circular economy and the high heterogeneity observed in life cycle assessment studies. After all, the total environmental cost of the post-use phase of packaging depends on the type of packaging material (e.g. plastic or glass), method of waste collection (e.g. kerbside collection or deposit return), and, naturally, the means of waste management (e.g. recycling, landfill or incineration; Simon et al., 2016).

From the consumer viewpoint, this focus on end-of-life is not surprising. After all, consumers mostly participate in the end-of-life stage of packaging with their disposal decisions. Although consumers generally value an eco-friendly packaging manufacturing process, as shown in previous research (Nguyen et al., 2020; Scott and Vigar-Ellis, 2014), the typical consumer does not have sufficient knowledge about the packaging production process, and their perceptions are easily influenced by the media (Clark et al., 2020). Furthermore, due to recent technological advancements in the industry, packaging of fast-moving consumer goods and solutions for sustainability therein have evolved rapidly over the past decades (e.g. Mohanty et al., 2018; Rai et al., 2021). It is therefore evident and not unexpected that consumers struggle to keep up with the evolving packaging landscape and may lack understanding of novel packaging solutions, substitutes and alternatives (Ketelsen et al., 2020). As an example, the term 'bioplastic' is frequently used in packaging communications but the term itself is confusing because it can mean either a bio-based plastic or a plastic that is biodegradable, or both (Dilkes-Hoffman et al., 2019).

2.2. Consumer perceptions of novel packaging: bio-based and biodegradable plastic packaging

Bio-based plastics are plastics that are at least partly derived from biological resources; including for example starch and cellulose polymers, polylactic acid and poly-β-hydroxybutyrate (Pan et al., 2016). They are considered to hold an advantage over conventional fossil-based

plastics because bio-based plastics use renewable material as the primary carbon source (Rosenboom et al., 2022). Such comparisons are more equivocal for other metrics of environmental impact: Growing the feedstock used in the production of bio-based plastic requires arable land, which somewhat compromises the benefits associated with bio-based alternatives to plastics, including reduction in carbon dioxide emissions (Van den Oever et al., 2017). In addition, the carbon source itself (bio vs. fossil carbon) has no direct bearing on the end-of-life fate of the packaging, for example its propensity to become litter. Furthermore, the wider use and development of bio-based plastics is presently hampered by limited technological feasibility and thus relatively high price of raw material (Shen et al., 2020). At the global scale, the production of bio-based plastics is expected to increase from 2.11 million tonnes in 2019 to approximately 2.43 million tonnes in 2024 (Halonen et al., 2020). These materials are increasingly being used in single-use packaging solutions, which has mobilised research on consumer perceptions around bio-based plastics. Onwezen et al. (2017) found that consumers had ambivalent (i.e. mixed) feelings about bio-based beverage packaging, which decreased their buying intention. However, in two international studies by Reinders et al. (2017), consumers consistently viewed the use of bio-based materials as a positive quality, with increased content of bio-based materials in packaging resulting in higher intentions to purchase. Yet, in Mehta et al. (2021), Irish consumers were reluctant to pay extra for bio-based plastics and showed scepticism towards the bio-based plastics industry, expressing concerns about certain types of organic waste (e.g. animal waste) being used as packaging raw material. The authors concluded with implications for informational strategies, suggesting that the industry could benefit from inserting transparency into consumer communications about the beginning-of-life processes and environmental impacts of bio-based plastic alternatives. Finally, Zwicker et al. (2020) found that a preference for bio-based plastic packaging (over conventional fossil-based plastic) involves moral considerations, as this preference was best predicted by feelings of guilt.

Some but not all bio-based plastics have been designed to biodegrade in either home or industrial composters, and some are intended to degrade in the natural environment. Biodegradable plastics can be produced from fossil or bio-based raw materials (Hann et al., 2020) and are intended to biodegrade in soil, water or compost under certain conditions (e.g. favourable temperature and presence of oxygen, nutrients and micro-organisms) in varying timeframes (SAPEA, 2020; Van den Oever et al., 2017). Only 0.6 % of plastic end products in the European market were biodegradable in 2016 (Hann et al., 2020). Use of biodegradable plastic as raw material for single-use packaging extends the range of possible end-of-life outcomes for packaging beyond recycling, incineration and disposal in landfill (Davis and Song, 2006). As noted by Hottle et al. (2013), any environmental benefits of biodegradable plastic largely depend on the availability of a dedicated pathway to end-of-life management, the realisation of which is limited by insufficient infrastructure. However, as discussed earlier, consumers value biodegradability of packaging highly: In a survey by Herbes et al. (2018), the majority of consumers chose biodegradability as a key 'green' (i.e. environmentally friendly) packaging attribute. Moreover, in an online choice experiment by Wensing et al. (2020), German consumers were willing to pay a price premium of 34.0 % for packaging that is compostable, while premiums for recyclable and bio-based packaging were 30.2 % and 22.8 %, respectively. Yet, various barriers to buying and using biodegradable products have been identified: An online survey of consumers from 42 countries (Filho et al., 2022) reports that the main barriers to using biodegradable products are limited availability, relatively high cost, concerns about material quality, and lack of awareness about the properties and benefits of biodegradability. Furthermore, according to Allison et al. (2021), British consumers report high levels of scepticism over packaging biodegradability claims and may not fully understand what the terms 'biodegradable' and 'compostable' on packaging labels actually mean.

In addition to the lack of infrastructure, this ambiguity around terminology likely contributes to biodegradable packaging failing to realise a desirable end-of-life scenario: Consumers tend to dispose of biodegradable (compostable) packaging incorrectly (Taufik et al., 2020). Furthermore, concerns have been expressed about the unintended consequences of packaging biodegradability. Some may believe that the norms around littering or its negative environmental impacts do not apply to biodegradable items, and therefore discarding these items into the environment may be seen as acceptable (Haider et al., 2019). Similarly, advertising of packaging as biodegradable or compostable might undermine consumers' perceived responsibility over its appropriate disposal. However, according to a review by Hann et al. (2020), there is no sufficient empirical evidence to show that biodegradability correlates with increased tendency to litter. Yet, the increased availability of novel biodegradable packaging paired with limited consumer knowledge and understanding might contribute to techno-optimism (Barry, 2012), potentially shifting end users' perceptions and disposal behaviours.

2.3. Consumer perceptions of end-of-life scenarios for packaging

Consumer perceptions towards the end-of-life properties of packaging (e.g. disposability and recyclability) have been studied extensively (Heiniö et al., 2017; Löfgren et al., 2011; Rokka and Uusitalo, 2008), but research on consumer responses to packaging end-of-life scenarios and disposal strategies is lacking (but see Taufik et al., 2020). A central consideration in the circular production of products and services, including packaging solutions, is thorough design for end-of-life (Marconi and Germani, 2017). Such designs can only work if the producers' objectives align with consumers' perceptions and behaviour at the end-of-life stage. For instance, designing packaging for maximal value recovery is not wholly desirable if end users do not prioritise value recovery, or if they do not know what actions (e.g. which disposal strategies) are required of them to reach maximal value recovery. If the producers' and consumers' motivations do not align, packaging may arrive at an undesirable end-of-life scenario, such as end up in landfill or in the natural environment, thus bypassing value recovery altogether. Similarly, the benefits of implementing advanced recovery infrastructures (e.g. deposit return schemes) cannot be realised fully if consumers are content with currently available methods for value recovery. Therefore, mapping consumers' perceptions of packaging end-of-life scenarios and disposal strategies can guide the design and communications around packaging circularity and relevant infrastructures.

It should be noted that the environmentally relevant attributes of packaging are essentially credence attributes (Herbes et al., 2020). For example, consumers cannot verify the manufacturer's claims regarding packaging raw material content and recyclability, but they must trust these claims. Similarly, the ultimate end-of-life course of packaging, such as it ending up in recycling or in landfill, is often not within the consumers' control: Once the end user has appropriately disposed of the packaging, they can only trust that waste managers handle their packaging waste in an appropriate manner. Previously, UK consumers have attributed their occasional failure to recycle packaging waste to mistrust in the local waste management (WRAP, 2017). As demonstrated by Rompf (2014), recycling behaviour is associated with high system trust. Therefore, trust in the waste management system is a factor that likely shapes consumers' perceptions around end-of-life scenarios for packaging.

2.4. Assessing consumer perception: the kano model of consumer satisfaction

Various approaches exist for mapping consumers' perceptions around products, services and their key properties of interest. The Kano model of consumer satisfaction (Kano, 1984) enables the assessment of the importance that consumers place on product features, such as

sustainability attributes, both qualitatively and quantitatively. Therefore, when consumer acceptance and satisfaction are of interest, the Kano model lends itself to capturing a more nuanced understanding of consumer response, when compared to traditional methods in consumer research, including rating-based questionnaires, choice tasks and willingness-to-pay paradigms. The Kano model builds on the theory of attractive quality (Kano, 1984) with the premise that product quality attributes that cause satisfaction in consumers may be different from those that cause dissatisfaction. As such, the Kano model proposes a methodology for determining, for example, which features are indispensable, which features delight consumers but are not required per se, and which are simply irrelevant to consumers. More specifically, five categories of features that affect consumer satisfaction differently are specified: must-be features, one-dimensional features, attractive features, indifferent features, and reverse features.

2.4.1. *Must-be features*

These are fundamental features that are taken for granted but cause dissatisfaction when not fulfilled in a product. That is, consumers would not specifically request these features, but simply expect them to be present. For single-use packaging, the ability to provide protection, for example, could be classified as a must-be feature (Löfgren et al., 2011).

2.4.2. *One-dimensional features*

These features have a linear relationship with consumer satisfaction: Their fulfilment results in satisfaction, and consumers are dissatisfied when they are not present. User-friendliness could be considered a one-dimensional feature of packaging, with increased user-friendliness causing higher consumer satisfaction (Löfgren et al., 2011).

2.4.3. *Attractive features*

These features are positive surprise attributes which are not expected, nor does excluding them cause dissatisfaction, but their fulfilment results in consumer satisfaction. Attractive features are thought of as the most important 'delight' attributes for consumer satisfaction (Sauerwein et al., 1996). Packaging resealability, for example, could be classified as an attractive feature (Löfgren et al., 2011).

2.4.4. *Indifferent features*

These features do not result in either satisfaction of dissatisfaction. That is, consumers do not place value on these features or care whether they are fulfilled or not. For packaging, attractiveness of the label print could be an indifferent feature that causes no meaningful consumer satisfaction (Löfgren et al., 2011).

2.4.5. *Reverse or questionable features*

These features result in consumer dissatisfaction when fulfilled and satisfaction when absent. Alternatively, a feature can be categorised as questionable if there is a lot of variability in consumer responses to said feature, which may indicate ambivalence in responses or that the respondents have misunderstood the question. For example, bio-based plastic packaging being produced from animal waste can induce both positive and negative appraisals in consumers (i.e. ambivalence; Mehta et al., 2021) and could thus be classified as a questionable feature.

The association between feature fulfilment (i.e. functionality) and consumer satisfaction for must-be, one-dimensional and attractive features is displayed in Fig. 1.

The Kano model lends itself to the assessment of consumer responses to various environmentally relevant features of single-use packaging. Löfgren and Witell (2005) and Williams et al. (2008) applied the Kano method to investigate consumer satisfaction with various ergonomic, technical and communicative attributes of packaging. More recently, Kovačević and Bota (2021) used the Kano approach to assess consumer perceptions of fourteen packaging attributes, including its recyclability and disposability. All these previous studies classified packaging recyclability as an attractive feature, indicating that consumers appreciate packaging being recyclable but do not expect it. Furthermore, the Kano model is also suitable for examining not only product features, but

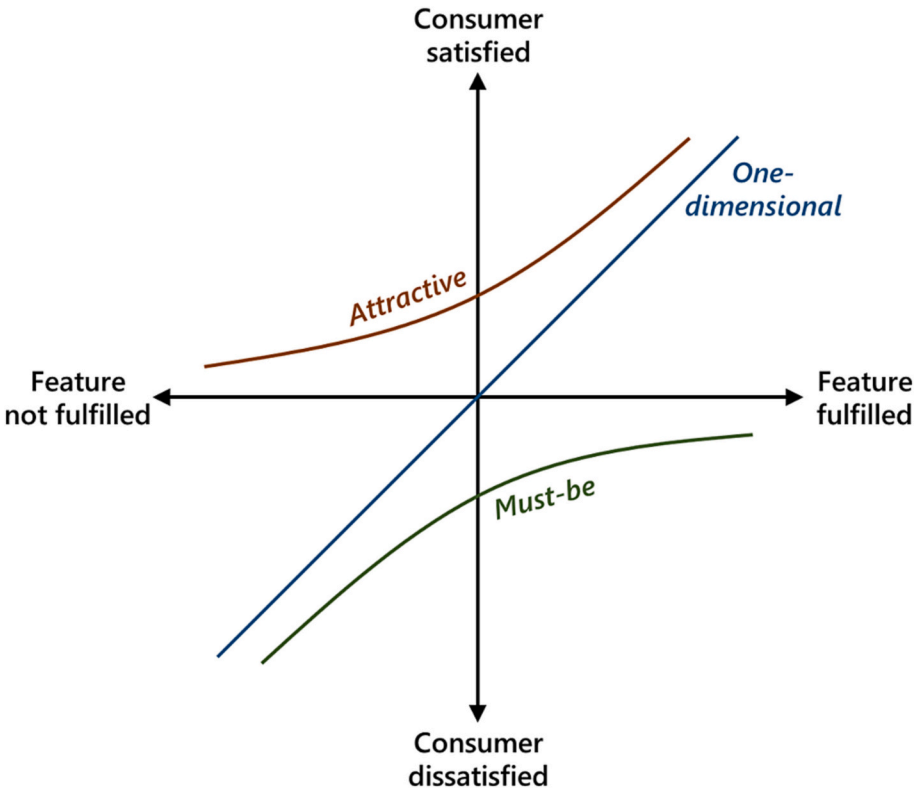

Fig. 1. Relationship between feature fulfilment and consumer satisfaction (Kano, 1984).

virtually any aspect of product functionality, such as its end-of-life course: Atlason et al. (2017) used a Kano survey to study how end users perceived different disposal strategies (collection from home and delivery to shop) and end-of-life scenarios (reuse, recycling and remanufacturing) for household electronic products. They report that, overall, consumers considered reuse as the most desirable end-of-life scenario for these products. In addition, their inspections of different consumer groups showed that women perceived all three end-of-life scenarios more favourably than men, providing evidence that differences across user segments should be acknowledged in consumer research around sustainability, as well as in the design of product circularity.

2.5. Segmentation

Segmentation is a social marketing approach where individuals are grouped into clusters (segments) based on a selection of criteria variables such as sociodemographic factors, attitudes and motivations (Lee and Kotler, 2015). Segmentation on the basis of environmentally relevant attitudes and motivations, or, 'green segmentation', can inform the design of tailored communication approaches, which can help promote behaviour change and ultimately aid in the attainment of sustainability objectives (e.g. Do Paco and Raposo, 2009; Martel-Morin and Lachapelle, 2022). Existing green segmentation models can be roughly divided into general, problem-specific and domain-specific approaches. General approaches are intended for a wide applicability across different pro-environmental behaviours and aim to address a variety of sustainability policy areas (Verplanken, 2018; Yilmazsoy et al., 2015). An example of a general approach is the sustainability segmentation model of the Welsh population by Poortinga and Darnton (2016): Based on a collection of psychological variables (personal values, perceptions around sustainability, attitudes towards climate change, and place attachment), members of the general public were segmented into six sustainability clusters ranging from 'enthusiasts' to 'self-reliant'. The extracted segments had unique profiles in terms of sociodemographic characteristics and levels of self-reported pro-environmental behaviour, such as use of energy and transportation, waste and recycling behaviours, and water use. Problem-specific segmentation approaches, on the other hand, address particular environmental issues such as climate change (Detenber et al., 2016; Maibach et al., 2011; Martel-Morin and Lachapelle, 2022) or, more recently, plastic pollution (Adam et al., 2021; Borg et al., 2021); whereas domain-specific approaches aim to discover population segments in regard to specific behaviours, such as energy use (Gordon et al., 2015; Sütterlin et al., 2011), tourism and travel behaviours (Anable, 2005; dos Reis et al., 2022; Kastenholz et al., 2018) or environmentally relevant consumption (Golob and Kronegger, 2019; Lee and Haley, 2022; Su et al., 2019).

A number of segmentation models have been developed recently that focus on sustainable packaging (e.g. Beacom et al., 2021; Chirilli et al., 2022; McCarthy and Wang, 2022). As the public's interaction with packaging covers multiple behavioural domains (product purchase, use and disposal), segmentation for sustainable packaging could be most accurately described as its own context-specific segmentation approach. An understanding of consumer dynamics in the sustainable packaging context can aid the development of marketing strategies and policy action that cater to distinct consumer groups with different characteristics and values. This objective has become increasingly central to the packaging industry that has transformed in recent decades due to emerging packaging alternatives and solutions (Boz et al., 2020). Marketers as well as policy makers operating within the industry may therefore benefit from context-specific guidance on effective communications and interventions. As an example of segmentation for sustainable packaging, Chirilli et al. (2022) used survey data on packaging-related sustainability behaviours to identify four consumer segments ('More sustainable – packaging-role-oriented', 'More sustainable – packaging minimisers', 'Less sustainable' and 'Medium sustainable'). These segments differed from one another in terms of consumers' perceptions of what makes packaging sustainable and which sustainability elements should be included on packaging labels. For example, when compared to the other segments, the 'Less sustainable' group regarded packaging material as a less important attribute at the point of purchase, and agreed to a lesser degree that packaging is sustainable if it is made of recycled materials. Furthermore, this group placed little importance on sustainability-relevant information on packaging labels, including instructions for disposal and cues about carbon footprint. Therefore, this consumer segment may not be persuaded or nudged by traditional means of communicating about packaging sustainability, such as messages and information on packaging labels. Moreover, the four segments identified by Chirilli et al. (2022) were also different from one another in terms of sociodemographic characteristics, with the 'More sustainable' segments having a higher percentage of females, and the 'Less sustainable' group including a higher proportion of young people. However, the four segments did not differ from each other with respect to educational level.

A key preliminary step in the segmentation process is the selection of variables used to assign consumers to different segments. The segmentation criteria for green segmentation models usually include generally accepted determinants of pro-environmental behaviour, such as sociodemographic factors (e.g. age, gender, level of education) and pro-environmental attitudes and values (Mackay and Schmitt, 2019; Poortinga et al., 2004; Van der Werff et al., 2013). As demonstrated by Sargisson et al. (2020), sociodemographic variables, although easy to measure and apply as part of the segmentation process (Jain and Kaur, 2006), are not a sufficient criterion for green segmentation, and should therefore be accompanied by psycho-environmental variables such as value orientations in the segmentation model. In addition, inclusion of behavioural variables in the segmentation criteria ensures that profiling of the target population reflects the nuances of the respective context and can thus provide a more solid requisite for behaviour change (Yankelovich and Meer, 2006). In the packaging context, segmentation should therefore acknowledge and assess the behavioural elements in consumer-packaging interactions, such as waste management behaviours of consumers (e.g. Chirilli et al., 2022). In summary, segmentation for sustainable packaging should encompass a collection of variables that bear relevance to how consumers interact with packaging throughout its life cycle.

2.6. Research questions and paradigm

The present study aimed to uncover consumer perceptions and preferences regarding the sustainability of plastic packaging as well as its alternatives and substitutes, from the extraction of raw materials to their end-of-life outcome. To this end, the following research questions were assessed:

RQ1. : Which environmentally relevant features and end-of-life scenarios of single-use packaging matter to the consumer (if any)?

RQ2. : How important are these features, both quantitatively and qualitatively?

RQ3. : Does the importance of these features differ across packaging material types, including conventional plastic and its alternatives (biodegradable plastic) and substitutes (glass)?

RQ4. : Does the importance of these features vary across consumer segments, and how?

We used the Kano model for consumer satisfaction (Kano, 1984) to gauge the (relative) importance of various environmentally relevant features of packaging from the end user's perspective. Features relevant to circular packaging design, disposal and carbon cost of production were examined, as well as a range of end-of-life scenarios for packaging. These features were inspected across three packaging material types:

conventional (fossil-based) plastic, biodegradable plastic (plastic alternative), and glass (plastic substitute). Furthermore, sociodemographic variables and environmental orientations previously associated with packaging perceptions and pro-environmental outcomes (e.g. nature and ocean connectedness, marine litter concern, value orientations and recycling behaviour) were assessed. These variables were used as criteria in the identification of consumer segments, permitting comparisons of the Kano findings across consumer profiles.

3. Methods

This study was implemented as an online survey comprising a Kano survey as well as measures for psycho-environmental and sociodemographic variables. More detail on the research design and participants, assessment instruments and data analysis are provided in the following sections.

3.1. Research design and participants

Before data collection commenced, the study procedure and materials were reviewed and approved by the University of Plymouth Faculty of Science and Engineering Human Ethics Committee. In the absence of guidelines regarding sample size requirements for a Kano analysis, the aim was to collect 400 responses from each country in Great Britain with a total aimed sample size of 1200. Altogether 1347 survey responses were obtained via an online survey panel platform, from adults (aged 18–65; quota sampled for age and gender) who regularly participate in grocery and household goods shopping. The responses were screened for incomplete responses and 'one-liners', resulting in a final sample size of 1177 consumers with a mean age of 40.62 ($SD = 13.15$), of which 597 were female, 575 male, and five were in the gender category 'other'. The sample is representative of the UK adult population in terms of age and gender distribution (see Table 1). In respect to level of education, the current sample is more highly educated (50 % holding an undergraduate degree or higher) than the UK population (33.8 % holding an undergraduate degree or higher; data for England and Wales from the Office for National Statistics, 2023a). The majority of participants were nationals of England ($n = 417$), followed by Scotland ($n = 381$) and Wales ($n = 376$). Each participant received a financial compensation for participation, amounting to approximately 2 GBP.

3.2. Measures

The following description follows the order in which the survey questions were presented to the participants (see full survey in SI). Variables described in Sections 3.2.3–3.2.9 were used as a basis for consumer segmentation.

Table 1
Characteristics of the obtained survey sample contrasted with UK population data.

	Survey sample ($N = 1177$) %	Population of the United Kingdom aged 18–65 (2021) %
Age		
18–29	25	23
30–49	46	44
50–65	29	33
Missing data	<1	–
Gender		
Female	51	51
Male	49	49
Other	<1	< 1
Missing data	<1	–

Note: UK population data retrieved from Statista (2023) and 2021 Census data (Office for National Statistics, 2023b).

3.2.1. Willingness to buy single-use packaging

In order to assess consumption habits, three questions "*How likely would you be to buy a drink bottle made of conventional plastic / glass / biodegradable plastic?*" were asked at the very beginning of the survey. These questions were answered on a 7-point Likert scale from "not at all likely" to "extremely likely".

3.2.2. Kano survey

A Kano survey was created and administered to capture consumers' responses to seven environmentally relevant packaging features of interest, including end-of-life scenarios, across the three material types (see Table 2). The seven packaging features were chosen because they either reflect the attributes of packaging that consumers consider when making judgments about its sustainability (e.g. Herbes et al., 2018; Herbes et al., 2020) and/or the typical end-of-life scenarios for single-use packaging (Vitale et al., 2018). In addition, it was of interest to assess how motivated consumers are to ensure correct disposal of packaging, and thus the importance of clear disposal instructions was inquired. Finally, as the Kano methodology is particularly suitable for mapping consumer views on functionalities that are not yet implemented (Kano, 1984), a question regarding the desirability of deposit return schemes for packaging value recovery was included. Following a traditional Kano approach (Kano, 1984), two questions were asked for each of the seven features: "*If feature X is present in the product, how do you feel?*" (i.e. the 'functional' question) and "*If feature X is not present in the product, how do you feel?*" (i.e. the 'dysfunctional question'). The features and end-of-life scenarios as well as the exact question pairs used are presented in Table 2. Participants answered each question by choosing one of the following response options: 1) *I like it*, 2) *I expect it,* 3) *I'm neutral*, 4) *I can tolerate it*, and 5) *I dislike it* (wordings adapted from Dace et al., 2020 for brevity and clarity). After the question pairs, following previous recommendations (e.g. Berger et al., 1993; Löfgren and Witell, 2005), a stated importance question "*How important is it to you that feature X is present in the product?*" was asked for each of the seven features (including end-of-life scenarios) of interest, for all three material types, in order to obtain a quantitative measure of importance. These questions were answered on a 7-point scale from "not at all important" to "extremely important".

3.2.3. Recycling habits

A question about recycling habits was included in the survey as a measure of pro-environmental behaviour, enabling consumer segmentation accordingly (like in Atlason et al., 2017). The question "*How often do you recycle the following materials at home?*" was asked, with five types of materials commonly recycled in the UK listed (paper or cardboard; plastic; glass; metal, aluminium or tin; and clothing or textiles). Answers were given on a 5-point scale from "never" to "always", and the mean of the five answers was computed in order to obtain a recycling score for each respondent (McDonald's omega reliability of the scale was 0.83).

3.2.4. Nature connectedness

Nature connectedness, defined as a sense of belonging to the natural world (Mayer and Frantz, 2004), has been previously associated with how consumers respond to packaging sustainability (Jaiswal and Bihari, 2020; Kautish et al., 2021). The connectedness to nature scale (CNS; Mayer and Frantz, 2004) was thus administered for segmentation purposes. The scale consists of 14 statements (e.g. "*I often feel a sense of oneness with the natural world around me.*"). In the current survey, the statements were answered on 7-point Likert-scale with a range from "strongly disagree" to "strongly agree", and the mean of the 14 answers was computed in order to obtain a total nature connectedness score for each respondent. The CNS has favourable psychometric properties (Mayer and Frantz, 2004), and reliability of the scale was high in the current sample (McDonald's omega 0.88).

Table 2
Environmentally relevant packaging features and end-of-life scenarios, and the relevant question pairs included in the Kano survey.

Packaging feature or end-of-life scenario	Functional question	Dysfunctional question
Made of recycled (or bio-based) material[a]	If a [MATERIAL TYPE] bottle is made of recycled material, how do you feel?	If a [MATERIAL TYPE] bottle is not made of recycled material, how do you feel?
Produced at low carbon cost	If a [MATERIAL TYPE] bottle has been manufactured at a low environmental cost / carbon footprint, how do you feel?	If a [MATERIAL TYPE] bottle has been manufactured at a high environmental cost / carbon footprint, how do you feel?
Recyclable (or compostable) material[b]	If the material in a [MATERIAL TYPE] bottle can be fully recycled after you have discarded it (i.e. it doesn't end up landfill), how do you feel?	If the material in a [MATERIAL TYPE] bottle cannot be recycled after you have discarded it (i.e. it ends up in landfill instead), how do you feel?
Value recovery in other ways[c]	If the material in a [MATERIAL TYPE] bottle ends up being incinerated in a waste-to-energy centre after you have discarded it (instead of it ending up in landfill), how do you feel?	If the material in a [MATERIAL TYPE] bottle does not end up being incinerated in a waste-to-energy centre after you have discarded it (and it ends up in landfill instead), how do you feel?
Clear instructions for disposal	If a [MATERIAL TYPE] bottle displays clear instructions on how to dispose of it (such as which bin to put it in), how do you feel?	If a [MATERIAL TYPE] bottle does not display clear instructions on how to dispose of it (such as which bin to put it in), how do you feel?
Captured in the waste management system	If a [MATERIAL TYPE] bottle stays within the waste management system after you have discarded it (rather than escapes into the natural environment), how do you feel?	If a [MATERIAL TYPE] bottle escapes into the natural environment after you have discarded it (rather than stays within the waste management system), how do you feel?
Deposit return scheme in place	If a [MATERIAL TYPE] bottle can be taken to a bottle return point for a refund after use (i.e. there is a deposit return scheme in place), how do you feel?	If a [MATERIAL TYPE] bottle cannot be taken to a bottle return point for a refund after use (i.e. there is no deposit return scheme in place), how do you feel?

Note: Material types included conventional plastic, glass and biodegradable plastic.

[a] This feature reflects circularity in the beginning-of-life phase of packaging. For biodegradable plastic, the following question pair was used: "*If a biodegradable plastic bottle is made from bio-based materials (such as plants) instead of fossil fuels, how do you feel?*" and "*If a biodegradable plastic bottle is made from fossil fuels, how do you feel?*"

[b] This feature reflects the preferred circular scenario for value recovery of packaging. For glass, the following question pair was used: "*If a glass bottle can be recycled into a new bottle after you have discarded it (*i.e. *it doesn't end up in landfill), how do you feel?"* and *"If a glass bottle cannot be recycled into a new bottle after you have discarded it (*i.e. *it ends up in landfill instead), how do you feel?"*. For biodegradable plastic, the following question pair was used: "*If the material in a biodegradable plastic bottle can be fully recovered by composting after you have discarded it (*i.e. *it doesn't end up in landfill), how do you feel?*" and "*If the material in a biodegradable plastic bottle cannot be recovered by composting after you have discarded it (*i.e. *it ends up in landfill instead), how do you feel?"*

[c] This feature reflects alternative value recovery when optimal circular value recovery cannot be realised. For glass, the following question pair was used: *"If the material in a glass bottle can be fully recycled into some other product after you have discarded it (*i.e. *it doesn't end up in landfill), how do you feel?"* and "*If the material in a glass bottle cannot be recycled into any other product after you have discarded it (*i.e. *it ends up in landfill instead), how do you feel?"*

3.2.5. Ocean connectedness

Following the premise of nature connectedness, ocean connectedness refers to the perceived sense of connectedness with the natural marine environment, and it was recently associated with consumer responses to environmentally relevant qualities of packaging (i.e. its recyclability and material type; Nuojua et al., 2022). The 6-item ocean connectedness scale is an adaptation of the CNS (Mayer and Frantz, 2004), with wordings of the items changed to reflect marine environments (e.g. "*I often feel a sense of oneness with the natural world around me.*" changed to "*I often feel a sense of oneness with the ocean around me.*"; Nuojua et al., 2022). Each item is answered on 7-point Likert-scale with a range from "strongly disagree" to "strongly agree", with the mean of the six answers reflecting a total ocean connectedness score (McDonald's omega 0.74).

3.2.6. Marine litter concern

Environmental concern was conceptualised in the present study as marine litter concern, which recently correlated with consumer responses to packaging sustainability features (Nuojua et al., 2022). Nine items adopted from the MARLISCO Perceptions about Marine Litter survey (Hartley et al., 2018) were used to measure awareness of and concern over marine litter in the present survey. Each statement (e.g. "*I am very concerned about the impacts of marine litter.*") was answered on a 7-point Likert-scale with a range from "strongly disagree" to "strongly agree". The mean of the nine answers was computed in order to obtain a marine litter concern score for each respondent (McDonald's omega 0.90).

3.2.7. Trust in the waste management system

As trust in the waste management system is likely to shape how consumers respond to packaging end-of-life scenarios, this variable was included in the current survey and segmentation approach. Based on Rompf (2014), three statements assessing perceptions around system trust, operationalised as system reliability ("*I can rely on the council to recycle the materials I put out for recycling.*"), effectiveness ("*I think that the council is effective in how it deals with my recyclable waste.*") and norm-enforcement (*"I think that my council enforces recycling."*) were included and answered on a 7-point Likert-scale with a range from "strongly disagree" to "strongly agree". The mean of the three answers was computed in order to obtain a trust score for each respondent (McDonald's omega 0.82).

3.2.8. Value orientations

Value orientations predict a number of pro-environmental outcomes, such as participation in waste recycling (Barr, 2003) and pro-environmental intentions in general (De Groot and Steg, 2008), and are therefore expected to shape consumer perceptions of packaging, too. Value orientations were assessed in the current study following the approach recommended by De Groot and Steg (2008): Altogether twelve core values were presented to the participants, and participants were instructed to rate the importance of each value on a 7-point Likert-scale from "not at all important" to "extremely important". Three primary value orientations were assessed: Egoistic (including value items social power, wealth, authority and influence), altruistic (equality, world peace, social justice and helping) and biospheric (preventing pollution, respecting the Earth, unity with nature and protecting the environment). Mean scores for each value orientation were computed, and scale reliabilities for all three were high (McDonald's omegas 0.82; 0.88; and 0.91, respectively).

3.2.9. Sociodemographic questions

Sociodemographic variables assessed and used in the consumer segmentation included age, gender, and level of education. In addition, estimated distance of home from the coast (in miles) was included as an exploratory variable in the segmentation model due to the study being part of a larger project focusing on human-ocean relations and perceptions around packaging.

3.3. Data analysis

3.3.1. Kano modelling

Kano modelling was conducted within the R environment (R Core Team, 2021), following the procedure outlined by Atlason and Giacalone (2018). As a first step, the survey respondents' answers to the functional and dysfunctional questions for each feature of interest (see Table 2) were collected into a classification table, presented in Table 3. Based on the mode of answers to each question pair from the surveyed sample, the product features of interest (here: packaging features and end-of-life scenarios) were classified into the Kano categories (must-be features, one-dimensional features, attractive features, indifferent features, and reverse/questionable features). In addition, two numerical values were calculated for each feature: consumer satisfaction score (*CS;* range from 0 to 1) and dissatisfaction score (*DS;* range from 0 to −1). These values denote user satisfaction when the feature is fully realised, and dissatisfaction when the feature is fully excluded, respectively. Equations for calculating these scores are outlined in Atlason and Giacalone (2018).

Kano categories, as well as *CS* and *DS* values, were determined for the seven packaging features and end-of-life scenarios of interest, separately for each material type (conventional plastic, glass and biodegradable plastic), to enable qualitative comparisons across materials. Kano modelling was firstly done on the survey sample as a whole, and then for each of the extracted consumer segments separately.

3.3.2. Consumer segmentation

The survey sample were clustered into segments on the basis of sociodemographic variables (gender, age, level of education and distance from coast) and environmental orientations (recycling behaviour, nature connectedness, ocean connectedness, marine litter concern, trust in the waste management system, egoistic value orientation, altruistic value orientation and biospheric value orientation). Clustering permitted grouping of survey data (i.e. participants and their characteristics) into clusters, such that the participants within the same cluster are as similar to each other as possible, yet as different as possible from those in other clusters. Clustering was conducted using a k-prototype algorithm (Huang, 1998) which is an extension to traditional k-means clustering methods and can be applied to data containing both continuous and factor variables. K-prototype clustering was done in the '*clustMixType*' package in R (Szepannek, 2018). The algorithm computes cluster prototypes as cluster means for continuous variables and modes for factor variables. The optimal number of clusters to be extracted was determined by inspecting the within sums of squares for each cluster solution, as well as their visual representation (also known as the elbow criterion; Syakur et al., 2018).

4. Results

In the following sections, results from the Kano survey are firstly reviewed for the whole survey sample. Next, the outcomes of the consumer segmentation process (i.e. the identified segments and their characterisation) are presented, followed by an overview of the segment-wise responses in the Kano survey.

Table 3
Kano classifications based on answers to functional and dysfunctional questions.

Functional	Dysfunctional				
	1. I like it	2. I expect it	3. I'm neutral	4. I can tolerate it	5. I dislike it
1. I like it	Q	A	A	A	O
2. I expect it	R	I	I	I	M
3. I'm neutral	R	I	I	I	M
4. I can tolerate it	R	I	I	I	M
5. I dislike it	R	R	R	R	Q

Note: A = Attractive; O = One-dimensional; M = Must-be; I = Indifferent; R = Reverse; Q = Questionable.

4.1. Kano results: whole survey sample (n = 1177)

Results from the Kano survey on the whole sample of participants are shown in Table 4 (see SI for demographic and psycho-environmental characteristics of the sample, including a frequency table of responses). Two features, namely '*clear instructions for disposal'* and '*deposit scheme in place',* were classified as indifferent for all material types, meaning that even if these features facilitate appropriate disposal, the presence (or absence) of these features does not cause satisfaction (or dissatisfaction) in consumers.

The only feature classified as a must-be feature was '*captured in the waste management system*', and only for conventional plastic packaging. This means that conventional plastic packaging (but not glass or biodegradable packaging) ending up in the natural environment caused great discontent in consumers. In addition, the only attractive quality was glass packaging being '*made of recycled materials'*, indicating that consumers value glass packaging that is made of recycled materials but do not expect it per se. Furthermore, '*recyclability*' (or compostability) was classified as a one-dimensional feature for all material types, meaning that recyclability had a positive linear relationship with user satisfaction. Similarly, feature '*produced at low carbon cost*' was a one-dimensional feature, but only for glass and biodegradable packaging. Finally, '*value recovery in other ways'* was classified as a one-dimensional feature for glass, indicating that consumers valued glass packaging being recycled to other products. Meanwhile, consumers were indifferent about conventional and biodegradable plastic packaging undergoing value recovery in other ways than via recycling (i.e. via incineration). **(RQ1, RQ2, RQ3).**

4.2. Consumer segmentation

Due to cases of missing data, consumer segmentation (and the following Kano models) used responses from 1123 participants. Application of the k-prototype clustering procedure, based on sociodemographic and environmental orientation variables, resulted in the identification of four consumer clusters, hereinafter referred to as segments. Descriptive results for these variables across the four segments are presented in Table 5. Upon inspection of the within-segment characteristics and relative differences across segments, the four segments were described as "*Educated environmentalists*" (segment 1), "*Older, less educated coastal dwellers*" (segment 2), "*Non-environmentalists*" (segment 3) and "*Nature-connected egocentrists*" (segment 4).

4.2.1. Kano results across consumer segments

Results from the Kano modelling (Kano classifications) for each consumer segment are presented in Table 6 (see SI for *CS* and *DS* scores and stated importance scores for each segment). As can be seen in Table 6, all packaging features and end-of-life scenarios bring satisfaction to '*Educated environmentalists'*. Notably, several features, including clear disposal instructions, were classified as must-be attributes for conventional plastic packaging. In addition, use of recycled (or bio-based) materials, as well as recyclability (or compostability) were perceived as one-dimensional features. That is, the more these features are present in packaging, the more satisfied the consumers in this segment were. Furthermore, this segment perceived deposit return scheme as an attractive feature, regardless of packaging material type. That is, having a deposit return scheme in place would bring this segment satisfaction, but its presence is not expected.

The results for '*Older, less educated coastal dwellers'* were largely similar. Like '*Educated environmentalists'*, '*Older, less educated coastal dwellers'* perceived deposit return schemes as attractive, although this feature was not valued for biodegradable plastic packaging. In contrast to '*Educated environmentalists', 'Older, less educated coastal dwellers'*

Table 4
Kano classifications, CS scores, DS scores and mean stated importance scores for packaging features and end-of-life scenarios, across three material types.

	Packaging material type[a]										
	Conventional plastic				Glass				Biodegradable plastic			
Packaging feature or end-of-life scenario	Kano class.	*CS*	*DS*	Mean stated imp. (*SD*)	Kano class.	*CS*	*DS*	Mean stated imp. (*SD*)	Kano class.	*CS*	*DS*	Mean stated imp. (*SD*)
Made of recycled (or bio-based) material	Indif.	–	–	5.64 (1.52)	**Attr.**	0.60	−0.37	5.67 (1.47)	Indif.	–	–	5.59 (1.48)
Produced at low carbon cost	Indif.	–	–	5.51 (1.52)	**One-dim.**	0.46	−0.53	5.64 (1.45)	**One-dim.**	0.49	−0.53	5.65 (1.46)
Recyclable (or compostable) material	**One-dim.**	0.54	−0.65	5.88 (1.44)	**One-dim.**	0.58	−0.61	5.82 (1.40)	**One-dim.**	0.58	−0.52	5.70 (1.42)
Value recovery in other ways	Indif.	–	–	4.96 (1.49)	**One-dim.**	0.60	−0.63	5.81 (1.38)	Indif.	–	–	5.18 (1.48)
Clear instructions for disposal	Indif.	–	–	5.42 (1.55)	Indif.	–	–	5.39 (1.53)	Indif.	–	–	5.54 (1.49)
Captured in the waste management system	**Must-be**	0.23	−0.59	5.46 (1.47)	Indif.	–	–	5.53 (1.44)	Indif.	–	–	5.45 (1.45)
Deposit return scheme in place	Indif.	–	–	4.98 (1.60)	Indif.	–	–	5.14 (1.60)	Indif.	–	–	4.99 (1.66)

Note: CS = Consumer satisfaction score; *DS* = Consumer dissatisfaction score. *CS* and *DS* scores are not computed for features classified as indifferent. Stated importance was measured on a scale from 1 to 7. Standard deviations are in parentheses. Value attributes (must-be, attractive, and one-dimensional feature classifications) are written in bold.

[a] Mean willingness to buy scores, measured on a scale from 1 to 7, were 4.77 (*SD* = 1.69) for conventional plastic, 5.03 (*SD* = 1.64) for glass, and 5.70 (*SD* = 1.38) for biodegradable plastic.

Table 5
Consumer characteristics across four segments.

	Consumer segment			
	Educated environmentalists (*n* = 354; 31 % of sample)	Older, less educated coastal dwellers (*n* = 300; 27 % of sample)	Non-environmentalists (*n* = 234; 21 % of sample)	Nature-connected egocentrists (*n* = 235; 21 % of sample)
	%	%	%	%
Age				
18–29	17	8	37	44
30–49	47	42	49	46
50–65	36	50	14	10
Gender				
Female	58	60	35	38
Male	41	39	65	62
Other	< 1	< 1	–	–
Level of education				
No formal education	< 1	2	3	2
GCSE	17	42	21	16
A-level	24	24	23	20
Undergraduate	41	22	34	42
Postgraduate	16	8	14	14
Doctorate	1	2	5	5
Distance from the coast				
≤ 1 miles	18	12	11	6
> 1–5 miles	18	16	24	20
> 5–20 miles	19	40	22	31
> 20–50 miles	34	20	31	23
> 50 miles	12	12	13	20
Nature connectedness[a]	5.71 (0.57)	4.56 (0.65)	3.99 (0.66)	4.95 (0.52)
Ocean connectedness[a]	5.60 (0.76)	4.24 (0.75)	3.81 (0.72)	4.57 (0.60)
Marine litter concern[a]	6.48 (0.51)	5.84 (0.77)	4.47 (0.86)	4.28 (1.04)
Trust in the waste management system[a]	4.29 (1.46)	4.47 (1.28)	3.97 (0.99)	5.41 (0.95)
Egoistic value orientation[a]	3.15 (1.18)	3.29 (1.06)	3.86 (0.98)	5.25 (0.96)
Altruistic value orientation[a]	6.55 (0.62)	5.85 (0.84)	4.35 (1.03)	6.03 (0.75)
Biospheric value orientation[a]	6.65 (0.50)	5.67 (0.87)	4.21 (0.92)	5.94 (0.78)
Recycling behaviour[b]	4.56 (0.53)	4.52 (0.49)	3.32 (0.84)	3.99 (0.76)

Note: Numbers displayed for age, gender, education, and distance from the coast groups represent percentages within each segment. For environmental orientation variables group means are given with standard deviations in parentheses. The groups were significantly different from one another (*p*-values <.001) in terms of distribution of age, gender, level of education and distance from the coast (assessed with chi square tests), as well as in terms of environmental orientation variables (assessed with analyses of variance).

[a] Measured on a scale from 1 (low) to 7 (high).

[b] Measured on a scale from 1 (low) to 5 (high).

perceived the use of recycled materials in glass bottles and the use of bio-based materials in biodegradable plastic packaging as attractive features. Furthermore, consumers in this segment did not value clear disposal instructions, nor were they concerned about biodegradable plastic packaging ending up in the natural environment.

'*Non-environmentalists*' did not value any of the environmentally

Table 6
Kano classifications for packaging features and end-of-life scenarios, across three material types and four consumer segments.

	Consumer segment											
	Educated environmentalists[a] (n = 354)			Older, less educated coastal dwellers[b] (n = 300)			Non-environmentalists[c] (n = 234)			Nature-connected egocentrists[d] (n = 235)		
Packaging feature or end-of-life scenario	Plastic	Glass	Biodeg. plastic	Plastic	Glass	Biodeg. plastic	Plastic	Glass	Biodeg. plastic	Plastic	Glass	Biodeg. plsatic
Made of recycled (or bio-based) material	O	O	O	I	A	A	I	I	I	I	A	I
Produced at low carbon cost	M	O	O	M	O	O	I	I	I	I	I	I
Recyclable (or compostable) material	O	O	O	O	O	O	I	I	I	I	I	I
Value recovery in other ways	M	O	O	M	O	I	I	I	I	I	I	I
Clear instructions for disposal	M	O	O	I	I	I	I	I	I	I	I	I
Captured in the waste management system	M	M	O	M	M	I	I	I	I	I	I	I
Deposit return scheme in place	A	A	A	A	A	I	I	I	I	I	I	I

Note: A = Attractive; O = One-dimensional; M = Must-be; I = Indifferent.
[a] Mean willingness to buy scores were 4.21 (SD = 1.80) for conventional plastic, 5.25 (SD = 1.64) for glass, and 6.14 (SD = 1.37) for biodegradable plastic.
[b] Mean willingness to buy scores were 4.97 (SD = 1.52) for conventional plastic, 4.90 (SD = 1.70) for glass, and 5.77 (SD = 1.20) for biodegradable plastic.
[c] Mean willingness to buy scores were 4.99 (SD = 1.60) for conventional plastic, 4.61 (SD = 1.65) for glass, and 5.09 (SD = 1.44) for biodegradable plastic.
[d] Mean willingness to buy scores were 5.11 (SD = 1.62) for conventional plastic, 5.33 (SD = 1.49) for glass, and 5.61 (SD = 1.27) for biodegradable plastic.

relevant features or end-of-life scenarios for packaging, as these were all classified as indifferent regardless of the material type. Similar classifications were observed for the '*Nature-connected egocentrists'* segment, the only difference being that they valued glass packaging being produced from recycled materials. This feature was classified as an attractive feature, signifying that '*Nature-connected egocentrists'* were delighted about glass being made of recycled materials, yet they did not express dissatisfaction if no recycled materials were used. **(RQ4).**

A verbal summary of key segment-specific findings including sample characteristics and responses to packaging sustainability attributes is presented in Table 7.

5. Discussion

The present study sheds light on consumer perceptions and priorities in regard to alternatives and substitutes to conventional plastic packaging materials, spanning from the extraction of raw materials to their end-of-life outcome. The applied Kano methodology enabled the

Table 7
Summary of consumer characteristics and responses to packaging sustainability across segments.

	Consumer segment			
	Educated environmentalists (31 %)	Older, less educated coastal dwellers (27 %)	Non-environmentalists (21 %)	Nature-connected egocentrists (21 %)
Demographic profile	• Mostly female • Mostly aged 30–49 • Mostly educated to undergraduate level • Mostly live 20–50 miles from the coast	• Mostly female • Mostly aged 50+ • Mostly educated to GCSE level • Mostly live 5–20 miles from the coast	• Mostly male • Mostly aged 30–49 • Mostly educated to undergraduate level • Mostly live 20–50 miles from the coast	• Mostly male • Mostly aged 18–49 • Mostly educated to undergraduate level • Mostly live 5–20 miles from the coast
Environmental orientation and value profile	• High levels of environmental orientation and behaviour • High altruistic and biospheric value orientation • Low egoistic value orientation	• Moderate levels of environmental orientation and behaviour • High altruistic and biospheric value orientation • Low egoistic value orientation	• Low levels of environmental orientation and behaviour • Moderate altruistic and biospheric value orientation • Low egoistic value orientation	• Moderate levels of environmental orientation and behaviour • High altruistic, biospheric and egoistic value orientation
Responses to packaging sustainability attributes: Key findings from Kano survey	+ Value packaging made of recycled or bio-based materials + Value packaging made at low carbon cost + Value packaging recyclability or compostability + Value material recovery in other ways (e.g. incineration) + Value clear disposal instructions ++ Expect that packaging does not escape into the natural environment * Consider deposit return scheme an attractive option	* Consider packaging made of recycled or bio-based materials an attractive option (− but not for plastic) + Value packaging made at low carbon cost + Value packaging recyclability or compostability + Value material recovery in other ways (e.g. incineration; − but not for plastic) - Indifferent about clear disposal instructions ++ Expect that packaging does not escape into the natural environment (− but not for biodegradable plastic) * Consider deposit return scheme an attractive option (− but not for glass)	- Indifferent about all packaging sustainability features	* Consider glass packaging made of recycled materials an attractive option (− but not for plastic or biodegradable plastic) - Indifferent about all other packaging sustainability features

Note: WMS = waste management system; + = one-dimensional attribute; ++ = must-be attribute; * = attractive attribute; - = indifferent attribute. Percentages refer to percentages of consumers in each (quota-sampled) segment.

appraisal of consumer perceptions both quantitatively and qualitatively, rendering a comprehensive and easily interpretable account of consumer response. Furthermore, segmentation of respondents according to both sociodemographic and psychological variables permitted comparisons of responses across different consumer profiles. We found that packaging recyclability is, overall, highly valued by consumers. The Kano classification of recyclability as a one-dimensional attribute signifies that packaging recyclability is valued by consumers, and that they are dissatisfied if packaging is not recyclable. This finding differs from those obtained in previous studies: Recyclability has been traditionally classified as an attractive feature, a delight attribute which is not essential for consumer liking (Kovačević and Bota, 2021; Löfgren and Witell, 2005; Williams et al., 2008). This trend in consumer response suggests that consumer expectations regarding packaging recyclability may have changed over the last decade. Löfgren et al. (2011) described this phenomenon as the *'life cycle of quality attributes',* illustrating the dynamic nature of quality attributes over time. Furthermore, compostability of plastic packaging was similarly classified as a one-dimensional feature by consumers. That is, compostability is appreciated by consumers, and consumers are unhappy if biodegradable plastic packaging cannot be fully composted and ends up in landfill instead. This finding aligns with previous research demonstrating that consumers hold packaging biodegradability in high regard (Herbes et al., 2018; Wensing et al., 2020).

Secondly, consumers had the expectation that conventional fossil-based plastic packaging should stay within the waste management systems. Whereas consumers were indifferent about glass or biodegradable plastic packaging ending up in the natural environment, they showed dissatisfaction with conventional plastic packaging realising this end-of-life scenario. Concerns about plastic packaging leaking into the environment are perhaps not surprising in the current global plastic pollution crisis. Thus, consumers are likely highly motivated to ensure, through their decisions and behaviour, that plastic packaging does not end up polluting the environment. Meanwhile, it was found that consumers were indifferent about whether or not conventional plastic packaging was produced from recycled materials or at a low carbon cost, indicating that consumers, in general, lack concern for the environmental burden of the beginning-of-life stage of plastic packaging, as shown previously (Herbes et al., 2018). In contrast, consumers showed appreciation for environmentally sustainable production (as well as value recovery) of glass bottles. Although consumers have been shown to overestimate the environmental sustainability of glass as a packaging material in previous research (Boesen et al., 2019; Otto et al., 2021), the current findings indicate that they especially value glass bottles being produced using circular strategies.

The consumer segment *Educated environmentalists,* consisting mostly of female respondents, obtained utility from all the environmentally relevant packaging features and end-of-life scenarios of interest. Overall, this finding supports earlier research where women, in comparison to men, have reported higher levels of pro-environmental intentions, behaviours and preferences for sustainable packaging (e.g. Huddart Kennedy et al., 2015; Madigele et al., 2017). Similarly, previous studies have shown that those who are more highly educated report increased pro-environmental attitudes and consumer behaviour (Finisterra do Paço et al., 2009; Tanner and Wölfing Kast, 2003), and that level of education is associated with how consumers view and prioritise packaging sustainability features (Baruk and Iwanicka, 2016). Notably, for *Educated environmentalists,* four out of the seven attributes of interest (low carbon cost of production, value recovery via incineration, clear disposal instructions, and packaging remaining in the waste management system) were classified as must-be features for conventional plastic packaging. That is, for these highly environmentally oriented and educated consumers, low environmental impact and circularity were required for plastic packaging, whereas for the other two material types these attributes were simply valued but not expected. Furthermore, this group of consumers, as well as the segment *Older, less educated coastal dwellers,* found deposit return schemes an attractive opportunity. Such schemes do not yet exist in the UK but are predicted to be implemented in 2025 (Department for Environment, Food and Rural Affairs et al., 2023). A positive reception to a deposit return scheme is therefore expected from consumers who are highly or moderately environmentally oriented, over 30 years of age, and mostly women.

Responses in the consumer segment *Non-environmentalists* were somewhat as expected. This segment did not find any of the packaging attributes or end-of-life scenarios valuable, or at least these attributes were not found to determine consumer satisfaction. In agreement with previous literature (e.g. Jaiswal and Bihari, 2020; Prakash et al., 2019), consumers (mostly male) low in nature connectedness, altruistic values and biospheric value orientation did not receive utility from environmental sustainability and circular value recovery of single-use packaging. Meanwhile, findings on the segment *Nature-connected egocentrists* were rather surprising. This segment consisted of younger consumers (mostly male) with relatively high levels of nature and ocean connectedness, high trust in the waste management system, and an egoistic value orientation. The Kano results for this group were very similar to those for *Non-environmentalists,* except that *Nature-connected egocentrists* found recycled content in glass bottles an attractive delight attribute. Yet, the finding that almost all packaging sustainability features were classified as irrelevant for this group of consumers warrants discussion. Notably, this group showed higher levels of nature and ocean connectedness than *Older, less educated coastal dwellers,* and yet the latter received satisfaction from almost all of the sustainability features of interest. Previous research on the role of egoistic values in green purchasing behaviour has been mixed. For example, Prakash et al. (2019) found that both altruistic and egoistic values were associated with positive consumer evaluations of eco-friendly food packaging. Nonetheless, an egoistic value orientation may be a more powerful motivational basis for sustainable consumer behaviour that has more direct consequences to one's wellbeing or health, such as buying organic food (Magnusson et al., 2003; Yadav, 2016). In the present study, upon inspection of the consumer characteristics across the four segments, it appears that even relatively high levels of nature and ocean connectedness will only predict more positive appraisals of packaging sustainability in those consumers who do not hold egoistic values.

Overall, the present findings indicate that sustainability attributes of packaging, as well as environmentally desirable end-of-life scenarios for packaging, are mostly valued by female consumers who are connected with nature and the ocean, are highly concerned about marine litter, and who hold biospheric and altruistic values. Consumers with these characteristics are more likely to ensure that packaging enters favourable end-of-life scenarios, such as optimal value recovery. Therefore, communications and cues signalling packaging sustainability and appropriate disposal, such as information displayed on the packaging label, could help sway consumer perceptions and behaviour in this segment. For others, such as males with strong egoistic values, these communications may be insufficient. Alternative means of promoting uptake and appropriate disposal of sustainable packaging in this segment could involve highlighting the functional properties of packaging or using novel, even disruptive packaging designs (Steenis et al., 2017). In addition, the present results showed that recyclability is (increasingly) valued by consumers, signifying that today's consumers are likely to be dissatisfied with packaging that is not recyclable. Therefore, those operating in the packaging industry or retail sector may wish to invest in packaging communications that signal packaging recyclability clearly.

Furthermore, the present findings indicate that consumers may more readily accept biodegradable plastic packaging bypassing value recovery. Even in the moderately environmentally oriented segment (*Older, less educated coastal dwellers*), consumers were more relaxed about biodegradable packaging not reaching favourable end-of-life scenarios, in comparison to conventional plastic or glass. This finding supports previous suggestions that biodegradability may undermine consumer willingness to ensure appropriate disposal of packaging (Haider et al.,

2019). Therefore, it is desirable that the packaging sector and manufacturers accurately and clearly inform end users about the properties and appropriate disposal methods of plastic packaging alternatives, including biodegradable packaging, in order to prevent misunderstandings and unintended consequences such as littering (Hann et al., 2020). Similarly, as the less environmentally oriented segments were indifferent about deposit return schemes for packaging, there is a need to inform these consumers about the benefits of such schemes.

The reader should be mindful about the limitations of the methodology applied in the current study. Kano surveys have been previously critiqued for being burdensome to survey respondents, and the obtained responses are somewhat sensitive to how the survey questions are worded (Violante and Vezzetti, 2017). A Kano survey was used in the current work because it bears several advantages over alternative consumer research methodologies: It enables the assessment of consumer satisfaction with specific product attributes both quantitatively and qualitatively, and as such renders the research findings easily interpretable and communicable (Sauerwein et al., 1996). Several alternative techniques for assessing consumer perceptions, choices and behaviour in a more realistic setting can be suggested for future work. These include measuring willingness to pay, applying a choice-based conjoint analysis, or using a virtual supermarket setting (Demarque et al., 2015; Klaiman et al., 2016; Rokka and Uusitalo, 2008). Moreover, the limitations of the consumer segmentation approach should be recognised. As the consumer segments were formulated in an inductive approach on the basis of sociodemographic and environmental orientation variables that are thought to bear relevance to consumer interactions with packaging, the segmentation model has limited applicability in other behaviour domains. However, considering that the identified consumer segments had distinct profiles in terms of their responses to the packaging-themed Kano survey, the model was evidently successful in segmenting for packaging sustainability.

6. Conclusions

The present study examined consumer perceptions around packaging sustainability by employing a life cycle approach. Among the key conclusions to be drawn from the findings is that packaging recyclability is, overall, highly valued by consumers, to the extent that they are unhappy if packaging is not recyclable or compostable. Consumers were also found to expect that packaging made of fossil-based plastic does not end up littering the environment, but no such expectations were expressed for plastic alternatives or substitutes (i.e. packaging made of biodegradable plastic or glass), signifying that consumers have varying sustainability perceptions and expectations depending on the type of packaging material. Furthermore, the application of a segmentation approach revealed that consumer responses were contingent on a number of consumer characteristics, including sociodemographic factors and psycho-environmental variables. For example, highly educated and environmentally oriented consumers were shown to value all of the environmentally relevant packaging features and preferable end-of-life scenarios of interest, whereas none of these features determined consumer satisfaction in the *Non-environmentalists* consumer segment. These findings indicate a need to bolster consumer understanding around alternative and substitute materials to conventional plastic packaging. As such, they may prove useful to those working with innovative packaging solutions, relevant infrastructures and consumer communications, and they may be used to inform the development of policy, such as the UN Plastics Treaty.

Declarations of competing interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Appendix A. Supplementary data

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