Barriers to recycling plastics from the perspectives of industry stakeholders

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Title: Barriers to recycling plastics from the perspectives of industry stakeholders: qualitative study

Abstract

Previous research exploring the psychological, social, and environmental barriers to recycling has predominantly focused on consumer attitude and behaviour. However, the plastics system involves a chain of stakeholders with a role in decision-making and actions in relation to plastic production and management post-use, affirming the need to explore the barriers to recycle across various other stakeholders implicated in the lifecycle of plastic product and packaging. To expand this evidence-base, N=12 in-depth qualitative semi-structured interviews explored the perspectives of some of the stakeholders responsible for various aspects of the plastic life cycle (fast moving consumer goods industry, retailers, and waste management professionals). Using a semi-directed content analysis approach via NVivo, three overarching themes were extracted from the data: 1) Disempowerment and lost opportunities 2) Solutions and opportunities reside with use of legislation 3) The circular economy stakeholders need motivation, and to be more knowledgeable. The themes suggest that stakeholders implicated in the plastics lifecycle lack the drive and perceived personal and organisational efficacy to generate meaningful change in the plastics system. These barriers are exacerbated by a lack of collegial partnerships between stakeholders to facilitate knowledge transfer and collective action. This study recommends greater collaboration and communication between stakeholders implicated in the end-to-end plastic 'chain', and makes a renewed call for further legislation, having shed light on important socio-political and pragmatic barriers to reducing plastic waste.

Key words

Plastic waste, Circular economy, Recycling Behaviour, Qualitative research, Knowledge Exchange

1. Introduction

It is estimated that annually, eight million tonnes of plastic waste find their way into our oceans across the globe (Ellen MacArthur Foundation, 2017). Despite recognition of the harmful impact of plastic waste, strategies to address this challenge are often circumscribed by idiosyncratic policy, which lack generalisability (Dhanshyam & Srivastava, 2021). It has been estimated that G20 countries cause 66 per cent of plastic waste globally, but a review of their policy initiatives was found to be insufficient in scope (Fadeeva, & Van Berkel, 2021), with little attention paid to reduction of waste, something necessary to achieve a circular economy i.e., no waste (Jaeger & Upahhyay, 2020). A circular plastic economy is posited by G20 countries (Fadeeva, & Van Berkel, 2021). Such an economy aims to: Reduce, Redesign, Remove, Reuse, Recycle and Recover plastic waste (UNEP, 2016). If we look to the end of the plastic life cycle, processing will be dependent on the degree to which plastic materials have been separated from other waste correctly (by consumers and organisations/industries), and the extent to which the plastic materials made can be recycled, both in terms of the materials used in products/packaging, and the infrastructure available to recycle i.e., recycling plants and processors. There is a view held by some economists such as Siderious and Zink (2022) that a circular economy cannot succeed, because it continues to try to adhere to a *free market system,* the goals and principles of which are directly opposed to the ideals of the circular economy, and its pro-environmental goals. This is exacerbated by the existence of further obstacles, such as the Circular Economy Business Model (CEBM) being more multi-faceted compared to a linear business model LBM); a lack of confidence in the finances; consumer leanings; a lack of suitable regulatory restrictions and infrastructure; and organisations not having suitably knowledgeable and skilled managers to execute a CEBM (Hina, Chauhan, Kaur, Kraus, & Dhir, 2022). The problem is therefore complex and may also require a shift in political thinking at the high levels in governments. Government decision-making has huge implications on the extent to which Extended Producer Responsibility (EPR) can be effectively implemented. Such decisions are tied up with other competing socio-political circumstances and therefore governments need also to be incentivised to endorse change at the level of the supplier and industries. Future research studies would benefit from focusing on government perspectives towards the barriers to implementing EPR systems.

In the United Kingdom (UK) a plastic circular economy is less visible, despite growing concern about the escalating environmental and economic costs of excessive plastic waste. However, UK government is resolved to tackle this issue, with ambitions to obliterate disposable (i.e., non-recyclable plastic) packaging by 2042 (Defra, 2018). A Plastics Packaging Tax (Hirsh,

2019) is also in operation in the UK. The European Commission (2019) is working to operationalize its Single Use Plastics Directive, initially tabled in May 2018. In the UK, while campaigns such as the plastic bag tax resulted in large scale behaviour change at the level of the consumer (DAERA, 2021), maintenance of the use of re-usable plastic bags has gradually receded, and other streams of plastic pollution remain (Siderius & Zink 2022).

In Northern Ireland, the current producer responsibility scheme for packaging has existed for 25 years. The full cost of disposing of packaging waste has historically been the responsibility of local taxpayers and local councils. Current overall recycling rates sit at around 50%. However, plastic waste rates are much lower. The Government department in Northern Ireland who has overall responsibility for legislation in this matter is Department of Agriculture, Environment and Rural Affairs (DAERA). They are currently developing an EPR Strategy, but implementation is not due until 2024. The goal is to shift the costs of packaging throughout their lifecycle to companies who produce the packaging, referred to as the "polluter pays" principle. Also less sustainable materials will become more expensive to obtain, and new challenging recycling targets will be set for plastic.

It is acknowledged that the plastics system involves a chain of stakeholders with a role in decision-making and actions in relation to plastic production and management post-use. Previous research, primarily with manufacturers, identified the behaviour of consumers and the inadequate policies and incentives of government as the main barriers to implementing a circular economy (Kumar et al., 2019). Many stakeholders believe that they are already playing their part in attempting to deliver the circular economy and consequently they are identifying the other areas where change is required. Stakeholders often deflect responsibility from one cohort to another (to include policymakers, manufacturers, retailers, recyclers, consumers), when in fact the responsibility is cross-cutting and requires behavioural and procedural change across these diverse groups (Heidbreder Bablok, Drews, & Menzel, 2019). The introduction of EPR to Northern Ireland will begin to help in this regard.

Research by McNicholas and Cotton (2019) used qualitative interviews to explore professional and consumer stakeholder perceptions of the perpetuating factors and prospective solutions toward marine plastic waste. The overarching message was that it is crucial to engage various stakeholders such as policy makers and legislators, as well as supporting consumers as they navigate a plastic-abundant environment (McNicholas & Cotton, 2019). Similar conclusions

were drawn in Nepal in relation to the need for better communications among stakeholders producing plastics (Bharadwaj & Rai, 2021). In addition, Heidbreder and colleagues (2019) explored different intervention strategies to mitigate waste from beverage bottles and plastic bags, and the take-home message once again, emphasised the importance of collaboration across stakeholder groups to ensure interventions are effective. Beyond this research, less attention has been placed on understanding the occupational and organisational barriers that confront key stakeholders and therefore a gap in our understanding of this remains.

Much of the previous psychological and social scientific evidence has focused on the psychological, social, and environmental factors influencing recycling behaviour in consumers (e.g., Hage, Söderholm, & Berglund, 2008) and explored behaviour change interventions at the level of the consumer (e.g., Heidbreder, et al., 2019). Recent relevant insights come from exploratory research with consumers, which implicates a number of barriers created by stakeholders to improve plastic collection rates , such as the abundance and variety of plastic packaging generated, which results in choice fatigue (e.g. Roy et al., 2021). Consumers' believe that stakeholders involved in decision-making around the manufacturing of plastic packaging should pioneer the change needed in our relationships with plastics (Roy et al., 2021).

To expand the current evidence base beyond the consumer, it is necessary to further explore and understand how systems perpetuate the production and waste of plastic products. If the focus continues to be on one part of the plastic value chain, or circular economy, the latter end of the stakeholder chain will continue to be overlooked, where professionals are involved collecting and processing any discarded or recycled plastic materials from householders and businesses. This is a significant part of the chain, because, if plastic waste mis-managed, or sent to landfill, the opportunity to recycle is lost. Thus, consulting with representative stakeholders involved in decision-making related to production and handling of plastic products is an important subsequent step in this research area, so that we can understand different stakeholder perspectives, and obstacles faced; perceived or real. The development of a deeper understanding of the challenges perceived and experienced by professional stakeholders is a useful starting point in the development of more cohesive and achievable, sustainable plastic waste reduction strategies. In turn, this understanding can support consumers as they navigate a plastic-abundant environment by informing organisational decision-making and influencing consumer purchasing environments (Bharadwaj & Rai, 2021).

This study aims to build on previous stakeholder research (e.g. McNicholas & Cotton, 2019) and recent relevant consumer-centred research (Roy et al., 2021), by exploring in-depth, the perceived barriers and facilitators to addressing plastic waste from the perspective of various stakeholder representatives (manufacturers, retailers, waste management specialists and local government). By doing so, we will provide a more holistic overview of the psychosocial, environmental, and structural factors influencing the end-to-end plastic waste management system.

3. Materials and methods

3.1. Design

This qualitative study adopted a semi-structured interview design which was deemed most appropriate to address the complex research question. Ethics approval was obtained through the authors' institution prior to recruitment (Queen's University, Faculty of Engineering and Physical Sciences; EPS 19_318). This study is written in line with the Consolidated Criteria for Reporting Qualitative research (COREQ) guidelines to support the sound reporting of methods and findings (Tong, Sainsbury, & Craig, 2007). This report has been pre-registered as a pre-print on Open Science Framework [insert identifier].

3.2. Participants

Recruitment took place during Autumn 2019, using convenience sampling. The researchers invited several important stakeholders in the plastic's circular economy within a single region of the UK to participate. The 12 participants represented manufacturers of plastics, retailers, waste managers, a large University, recycling companies and local and central government.

The interviews took place at a mutually acceptable venue, either on University premises or at the participant's place of work. Before the interviews began, the participants were given the information sheet and offered the chance to ask questions. The participants were also advised that they could stop at any time during the interview. If they still wished to proceed, they completed the consent form. Age and sex and role of participants are displayed in Table 1.

[INSERT TABLE 1 HERE]

3.3. Data Collection

All the researchers involved in the coding and analysis (DR, MD, EB, KO) were experienced in the use of qualitative methods, and adopted a phenomenological approach (Smith, 1996). Semi-structured questions and the interview schedule were designed to gain an understanding of existing plastic consumption and plastic waste disposal services, and any challenges and opportunities being experienced by each stakeholder.

3.4. Conceptual Framework

The interview schedule was set within the context of a broad behavioural theoretical framework that encapsulates the multiple factors involved in plastic waste production and disposal; the Capability, Opportunity and Motivation (COM-B) model of behaviour (Michie, Hyder, Walia &West, 2011; Michie, van Stralen, & West, 2011). Given the inter-disciplinary and multi-dimensional nature of the plastic materials economy, part of the discussion is set in the context of the Ecological Systems Theory developed by Bronfenbrenner (1974). The semi-structured interview schedule included example scenarios to elicit current beliefs, attitudes, and feelings towards policy implementation (see supplementary file 1 (S1) for interview schedule). DR conducted the interviews and is an experienced qualitative researcher with a phenomenological orientation, but who also integrates this naturalistic enquiry with a realist stance (Pistrang, & Barker, 2012). This is because of her experience and knowledge of applying socio-cognitive models to explain sustainable behaviour and attitudes towards the environment. Biased interpretation was mitigated, by other members of the research team reading the transcripts to check for consistency in the emerging codes, and continued reviews of the analysis (Korstjens & Moser, 2018). The interviews lasted 45 minutes on average, and these were audio recorded. The participants were unknown to DR before the interviews took place. The core research team (DR, MD, EB) held coding meetings regularly, and concluded, after 12 interviews, that no new themes of note were emerging and consequently were satisfied that saturation point had been reached (Namey, Guest, McKenna & Chen, 2016).

3.5. Data analysis

The analysis was based on a semi-directed content analysis approach (Hsieh & Shannon, 2005) along with a search for emerging themes. The researchers therefore allowed for the possibility of novel patterns to emerge while also considering the findings within the context of the COM-B framework, and other relevant theoretical frameworks. This also preserved the flexibility to

offer interpretations of all the data, and to allow themes to be derived from the data. DR initially familiarised herself with the data and used NVivo 12 software to assist with coding by category and consistency, and then looked for any patterns that presented. This was an iterative process. A reflexive record was kept of the decision-making of the researcher as she coded and searched for patterns in the data. A subset of the transcripts was initially coded by other members of the team (MD and EB) to ensure reliability and to ensure that findings were trustworthy and practically sound. Overarching themes were finally identified and checked by the whole research team to confirm they provided a good representation of the findings (Braun & Clarke, 2006). This process ensured that reflexivity was maintained throughout the analysis to support credibility and confirmability, particularly with recognition of the potential influence of researcher bias (Korstjens & Moser, 2017).

4. Results

Three overarching themes were extracted from the interview data: 1) Disempowerment and lost opportunities; 2) Solutions and opportunities reside with use of legislation; 3) The circular economy stakeholders need motivation, and to be more knowledgeable.

4.1. Sense of disempowerment and lost opportunities

There is a sense of disempowerment, that opportunities are being lost, due in part to a perceived lack of investment in the core infrastructure to increase recycling rates and appropriate facilities that could help to maximise the repurposing of the varieties of plastics in the marketplace. This is felt particularly among those responsible for developing recycling capacity and service and within both local institutions and local authorities.

> *"[Our region] has got an infrastructure deficit of about 30 years behind the rest of the UK and further behind Europe. We just do not have the facilities to dispose of materials and so much of our waste is being offshored; its being sent to Europe for incineration". (Local Authority leads)*

There are considerable financial benefits to be made by local authorities if recycling rates could be improved and it is seen a lost opportunity, only adding to sense of frustration.

> *"If everybody did everything today, we could save £2million using the existing architecture that is in [name of City] right how… "If we look at some of the most recent studies there is easily £50 million gross value to be added to the [name of region] economy through better recycling, and*

that is from one particular recycling agent, who is prepared to put their head about the parapet and say it" (Local Authority lead)

The use of social media was also a subject of debate, as using this medium for educating the public only reaches those who are able, and comfortable, with using social media. It was felt that the medium for dissemination of knowledge needs to be capable of reaching all age groups.

"There's an awful lot - the default at the minute is social media, just stick it on social media, and we've done our bit, but there's a hell of a lot of people out there that do not care, there's people my age group who don't have Facebook or Twitter because they don't like it and there's my mum and dad who never have, and never will, and it's a lot of the older generations as well really..they don't realize how it's going to hit wee Mrs. Jones's, who is 70 years old and doesn't have Wi-Fi" [Local Authority lead].

An enhanced level of knowledge among producers of plastic packaging about what happens at the end of the cycle is essential, as it appear that gaps still exist, and producing food retailers are prioritizing the use of attractive packing for marketing purposes, over the needs to protect the environment.

"And we have companies, that say they are going to minimize packaging and [Name of company] did they, where they are minimizing packaging? They go on and put it in a purple box, then in a film bag thing. and then - how is that recyclable?" [University Sustainability Representative]

Those responsible for providing recycling services also took the view that profits have a higher priority than the environment among manufacturers, and this was part of the problem, creating feelings of pessimism about how much can be achieved.

"The only way that it's going to change for them [manufacturers], is if they're told that they have to … there's other companies that feel, we need to make so many millions this year and so, to hell with the environment!" (Recycling Company Representative).

4.2. Solutions and opportunities reside with use of legislation

There was an acknowledgement that nations are placing a greater value on environmental issues, albeit sometimes from economic necessity, but some policy changes have now been introduced aimed at reducing plastic exports:

"The politicians would never have had environmental stuff at the front of their manifestos. But if you look at the manifestos both labour and conservative have said, we are going to ban plastic exports, and you know that is quite a radical thing to do, because the infrastructure … and the technology isn't here for us to deal with it". (Government Representative).

Some stakeholders acknowledged that it would make their job easier if augmented pro conservation legislation was in place, as there is an imbalance between what they could potentially do, compared to what is manageable, determined by availability of resources. And conversely, politicians are reluctant to introduce changes that would be unpopular with voters, thus negatively impacting on any motivation they may have to enforce the very policies that could increase recycling rates.

One principle that is being adopted by the UK Government across all its nations in a few years, is the 'polluter pays' principle and so producer responsibility schemes are being enhanced (Dawson, 2019).

"A *Circular Economy Waste Package, again from the EU, and at moment that's to be introduced next year, so that's already in the pipeline, I think July next year it's to be introduced by so that's on the cards" (Government lead).*

Despite these initiatives and enabling new legislation, there are still many people who have a role to play in the circular economy who are not cooperating with each other.

"So there is a barrier between manufacturers and retailers. There are barriers is all over the place when you speak to them, the whole way up the value chain" (Government Lead).

4.3. The circular economy stakeholders need motivation and improved knowledge

Production of virgin plastic is not slowing down, as oil companies are looking to the plastic market for their future survival, given the car industry is moving to using more sustainable sources of fuel.

"Shell is investing.., 18 billion dollars in terms of new plastic production because they are looking to the future, they are going to have to retain market value". (Local Authority Representative)

Without some sort of incentive for plastics industry to reduce production of virgin plastic, not all plastic can be repurposed and recycled. This is because the existence of open loop recycling

internationally means a lack of an effective circular economy, and plastic packages not yet being designed-for-recycling to ensure plastic materials will be processed downstream. Consequently, this is keeping recycling rates drastically below what they should be.

> *"The real failing in our existing system, in recycling and manufacturing systems, is we have open-source recycling. So there is not a clear-cut home for all the materials we are placing into the marketplace, and they can leak from the system. 91% is leaking into the system… so it means it is going for a large part, somewhere else" (Local Authority Lead).*

Large corporations have a narrow scope, and their efforts comprise of working with environmental charities, primarily to change behaviour around littering and recycling.

> *"We have partnerships with [environmental organisations]. So, we really work with them quite closely to understand how we can change behaviour in relation to littering, recycling" (Large Corporation)*

It is very possible that food packaging manufacturers may have good intentions to create less food packaging, but these fail by add-ons of attractive marketing covers, on top of the plastic tubs etc.

> *"And we have companies, that say they are going to minimize packaging [Name of company] did they, where they are minimizing packaging? They go on and put it in a purple box, then in a film bag thing.. and then how is that recyclable?" (University Sustainability Representative).*

Improved understanding among manufacturers is needed, in terms of the type of collection arrangements that are provided by relevant local authorities, and also the types of bins that are given to householders to sort plastics and other waste and, importantly, which plastics, recycling companies can re-purpose. The perceived disconnect between consumers' behavior, and its wider environmental impact may also come from a poor understanding among individual consumers about how their unwillingness to separate plastics at point of disposal affects the environment directly or indirectly.

> *"I think there needs to be some kind of mechanism to make people make the link between their own consumption and the potential effect that it has on the environment". (Government Representative).*

Also, the effortful nature of recycling, coupled with a lack of clarity and confusion around how to recycle properly was recognized as a challenge. The most confusion lay with the recycling of plastics.

"It's plastics…it's the clarity of what can and can't be…what we find is that if you get too specific, it overwhelms people" Recycling Company)

It is not all bad news; there has been an increase in the amount of plastic waste that is separated by householders for collection over the last few years, and the recycling company suggested that this may be a result of consciousness driven by, for example, the impact of the 'Blue Planet Effect' seen first-hand.

"If we tracked our material sales of plastic, to indicate what came into us, when that program was first shown, what it, about one and a half or two years ago? That's where you'll see a spike because people went, shit, really, is that what happens to that poor wee bird with all the plastics in it, that really has had a massive effect… It's trendy now to be environmentally aware". (Recycling Company)

5. Discussion

This exploratory research sought to investigate the beliefs and attitudes of a range of stakeholders (manufacturers, retailers, waste management specialists and local government) on the challenges and opportunities related to the management of plastic waste. Using the COM-B model of behaviour (Michie, et al., 2011) as scaffolding for an interview topic guide facilitated an in-depth exploration of the extent to which stakeholders feel *capable* of contributing to the change needed for a circular plastics system, perceive that there is *opportunity* and resource available to influence organisational change, and the extent to which they feel *motivated* and empowered to take action.

It is understandable that those charged with collecting and recycling the nation's waste feel disempowered. One reason for this is simply the absence of an EPR scheme in Northern Ireland, making its absence fairly unique in the wider European context. The Local Authority waste management services cited years of underinvestment in both household collection services, and recycling facilities, as one of the main obstacles to increasing recycling to optimal levels. This speaks to existence of barriers to CE highlighted by Hina et al., (2022) at the beginning of this paper. This is a sticking point, because it is less expensive to export plastic waste to other countries, and it is cheaper to make new virgin plastic rather than try and repurpose discarded plastics (Border, 2018). In smaller regions of the UK, the challenge, even with investment, will be harmonising what are now, conflicted political agendas. Adding to this sense of disempowerment is the perception among professionals involved in collecting and

recycling plastics, that large retailers lack insight into the extent to which their marketing activities exacerbate the problem, not least in their use of colour in packaging. Among many of the stakeholders interviewed, consumers are perceived to be at the crux the plastic waste problem through lack of appropriate plastic waste sorting behaviour, which is a further barrier posited by Hina et al., (2022). There is no doubt that consumers' (in general) lack sufficient knowledge and lack motivation to seek information about the types of plastics that can be repurposed and sorted, so that recycling companies can collect them and convert to valuable recycled plastics.. But arguably there is reluctance and lack of perceived incentives among manufacturers and retailers to reduce plastic production and simplify the materials being used by large food retailers. The findings by Roy et al (2021) suggest that the disorganised abundance of plastic materials that have to be sorted for recycling is but one important reason (out of many) as to why many consumers find recycling a challenge. This implies the need for change at the level of plastic packaging design (to include a strong multi-national legal framework on use of complex, coloured, and mixed material packaging) as well as increasing the opportunity to recycle by means of environmental restructuring (more consistent bin availability and visual cues to help consumers navigate the recycling system). This echoes Hina et al's (2022) assertion that a lack of suitable regulatory is a barrier to a CE, and also Jaeger and Upahhyay's (2020) findings that manufacturers need to move away from current norms and engage in more innovative product design to contribute to the development of a circular economy. Di Foggia, Giacomo; Beccarello, & Massimo (2022) suggest that a way to support this change is to adopt a waste sector manager or systems operator (SO) with an overarching co-ordination responsibility, but will rely upon an EPR being put in place. Creating such posts will ensure environmental goals are the focus across the waste management sector. This multi-level regulator could provide information, report plans, monitor and report goals and results, support and co-ordinate local councils activities, and engage local residents (DiFoggia et al, 2022).

Other research has reinforced the notion that improved packaging can be achieved through innovation, and collaboration with the supply chains, and use of pilots to test different collection processes that could handle the various types of plastics (Gong, Putnam, You & Zhao, 2020). If however the CE continues to work within a free market system, a continued lack of overarching administrative or government control, will mean efforts to collaborate more, but also efforts to bring changes to plastic packaging design, will fail (Siderious & Zink (2022).

But assuming an EPR will soon be in place in NI, knowledge transfer and training among leaders in each sector will be of value as a risk averse company culture is one of the main barriers to the implementation of a circular economy (Hina et al., 2022; Kirchherr et al., 2018). When managers in an organisation have an internal rather than an external locus of control, they are more likely to display perseverance, applying new efficient procedures in making decisions, within technical limits (Kerdlap, Low & Ramakrishna, 2019), organizing their own work and that of their subordinates (Dumitriu et al., 2014).

However, consumer-facing companies can empower themselves to be more circular, and Bocken and Konietzko (2022) suggest one way is to this is to adjust their business models by developing strong visions of sustainability, and building their understanding of how customer behaviour impacts upon the environment. All of which can be achieved by these companies collaborating more with each other (Hull, Millette & Williams, 2021). Such consortia of like-minded individuals could be the environment where creative solutions, and consequently feelings of empowerment may then emerge, underpinned with legislative support (Langendahla, Mark-Herbert, & Cook (2022).

The responsibility is cross-cutting and requires behavioural and procedural change across these diverse sectors (Heidbreder et al., 2019). Discussions about the circular economy within an organisation need to reach more influential departments such as operations or finance (Kirchherr, et al., 2018). One suggestion could be to develop an accessible education program. Help could be sought from an organisation such as the UK Waste and Resources Action Program (WRAP) which already works alongside industries involved in the manufacturing and retail of plastics and already, 1.5 billion un-recyclable black plastic ready-meal trays have been replaced with recyclable alternatives by supermarkets since 2018 (Clear on plastics, 2021). The use of the modified Ecological Systems Theory (EST) developed by Bronfenbrenner (1974) (see Figure 1) could be visualised in an accessible education program or interdisciplinary workshop; given how it explains the impact context and its interaction with individual behaviour. It could be used to highlight the importance of communication and collaboration between the different systems and supply chain stakeholders to understand how their actions impact upon each other i.e. the 'ripple-effect'. Figure 1 contextualises stakeholders interviewed to EST and frames them within the wider supply chain and product lifecycle, drawing upon key findings elicited from the interviews. This modified EST visualises the respective roles of stakeholders and highlights the need to co-create solutions to any implementation problems. See Gasde et al. (2021) for a more comprehensive example of how these stakeholders fit within

a product life cycle. Crucially, industries involved in plastic manufacturing should learn how waste is collected, sorted and recycled. But equally recycling companies would also benefit from gaining a greater understanding of challenges and trade-offs that fast moving consumer goods industries have to negotiate. Each section of the model can thus be used as scaffolding to explore the internal idiosyncrasies related to plastic waste and recycling within systems as well as exploring their intersectionality across different contexts and cultures.

[INSERT FIGURE 1 HERE]

5.1 Conclusion

This qualitative research captures the challenges perceived and experienced by professional stakeholders including manufacturers, retailers, waste management specialists and government. The perceived and experienced barriers discussed provides a sense of the psychological, systemic, and pragmatic limitations experienced by stakeholders. It is important to consider that some strong opinions overall could be the result of 75% of the sample being female as previous research for example, Dilkes-Hoffman, Pratt, Laycock, Ashworth, and Lant (2019).found that males view the issues of plastic waste pollution to be less serious than females, something to be considered when developing education progammes. Also, it is apparent that no stakeholder cohort bears, or should bear, sole responsibility for the plastics dilemma. But a strong multi-sector legal and knowledge framework is essential, along with significant investment to develop the infrastructure enabling the processing and repurposing of a broader range of plastics, including low grade plastics. Adopting an interdisciplinary approach to addressing complex societal challenges is certainly not a new concept; but it is often overlooked, which can lead to any attempts to findings a solution to plastic waste exacerbating the waste problem. There is a reason to have some optimism, as further legal frameworks stem the tide of non-recyclable plastic entering the plastic supply chain, but this must be accompanied by investment in infrastructure and collaborative education programs/projects utilising helpful socio-ecological models (as discussed above). Engaging in these interdisciplinary activities to inform decision-making, organisational processes, and environmental change (e.g. architecture of purchasing environments) in relation to plastic manufacturing, retail, and waste management, can support consumers as they navigate a plastic-abundant environment.

Furthermore, the scapegoating of consumers to account for the suboptimal levels of recycling is an example of responsibility deflection which should not be overlooked, particularly because this belief generates feelings of disempowerment. It is vital that stakeholders such as manufacturers and retailers (and the legislators involved in product development and sales) are supported and encouraged to explore their role in helping consumers make better decisions. As eluded to above, one example of where manufacturers, retailers, and waste management professionals' roles and capabilities can be galvanised more effectively include changes to plastic packaging design (which may necessitate legislation change on use of complex, coloured, and mixed materials if change is to be adopted on a national and international scale). Another example includes increasing the opportunity to recycle by means of environmental restructuring (e.g. making better use of visual cues to help consumers navigate the recycling system and ensuring comprehensive availability of recycling resources). Again, such innovations require interdisciplinary partnerships, collaboration, humility to recognise the responsibilities of their role, and through partnership working recognition that they can influence other systems implicated in the plastic lifecycle.

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Declaration of interest statement

This manuscript has not been previously published and is not currently under consideration elsewhere. The work is original and our own, and no copyright has been breached by the inclusion of any content drawn from another source. The submitted manuscript has been approved by all co-authors who have no conflicts of interest. The study followed strict ethical guidelines and was approved by the Ethics Committee of the Psychology Department at Queens University Belfast.

Data Accessibility Statement

The dataset is held in a secure repository at Queens University Belfast Psychology Department. Interested researchers wishing further data should initially contact [insert details – removed in anonymous version].

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References

Bharadwaj B., Rai R.K. (2021) Stakeholders Perception of Used Plastics. In: Baskar C., Ramakrishna S., Baskar S., Sharma R., Chinnappan A., Sehrawat R. (eds) *Handbook of Solid Waste Management*. Springer, Singapore. https://doi.org/10.1007/978-981-15-7525-9_54-1

Braun, V. & Clarke, V. (2006). Using thematic analysis in psychology. Qualitative Research in Psychology, 3, 77-101.

Bocken, N., & Konietzko, J. (2022). Circular business model innovation in consumer-facing corporations. *Technological Forecasting and Social Change*, 185, 122076.

Bronfenbrenner, U. (1974). Developmental research, public policy, and the ecology of childhood. Chil*d Development, 45*(1), 1-5.

Clear on Plastics (2021). Accessed 13 December 2021 https://clearonplastics.com/brands-retailers-and-plastic-producers-arent-doing-enough-only-paying-lip-service-to-the-problem/

Department of Agriculture, Environment and Rural Affairs (DAERA) (2021). Northern Ireland carrier bag levy statistics. Department of Agriculture, Environment and Rural Affairs, Northern Ireland. https://www.daera-ni.gov.uk/articles/northern-ireland-carrier-bag-levy-statistics

Dawson, L. (2019). Our Waste, our Resources; A Strategy for England'– Switching to a circular economy through the use of extended producer responsibility. *Environmental law Review, 21(3),* 210-218.

Department for Environment, Food and Rural Affairs (DEFRA) (2018). Our Waste, our resources: A strategy for England. Accessed 13.12.21 https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/765914/resources-waste-strategy-dec-2018.pdf

Di Foggia, Giacomo; Beccarello, Massimo (2022) : Introducing a system operator in the waste management industry by adapting lessons from the energy sector, Frontiers in Sustainability: Sec. Circular Economy, ISSN 2673-4524, Frontiers Media, Lausanne, Iss. (Article No.:) 984721, pp. 1-10,

Dilkes-Hoffman, L. S., Pratt, S., Laycock, B., Ashworth, P., & Lant, P. A. (2019). Public attitudes towards plastics. *Resources, Conservation and Recycling, 147*, 227-235. doi:10.1016/j.resconrec.2019.05.005

Dumitriu, C., Timofti, I.C., Nechita, E., & Dumitriu, G. (2014). The Influence of the Locus of Control and Decision-making Capacity upon the Leadership Style. *Procedia Social and Behavioral Sciences*, 141, 494-499.

Ellen MacArthur Foundation. (2017). The New Plastics Economy – Rethinking the Future of Plastics & Catalysing Actions https://emf.thirdlight.com/link/cap0qk3wwwk0-l3727v/@/#id=1. Accessed 7 December 2021.

Fadeeva, Z., & Van Berkel, R. (2021). Unlocking circular economy for prevention of marine plastic pollution: An exploration of G20 policy and initiatives *Journal of Environmental Management, 277,* Article 111457.

Gasde, J., Woidasky, J., Moesslein, J., & Lang-Koetz, C. (2020). Plastics recycling with tracer-based-sorting: Challenges of a potential radical technology. *Sustainability*, *13*(1), 258.

Hage, O., Söderholm, P., & Berglund, C. (2008). Norms and economic motivation in household recycling: Empirical evidence from Sweden. *Resource Conservation Recycling, 53,* 155–165.

Heidbreder, L. M., Bablok, I., Drews, S., & Menzel, C. (2019). Tackling the plastic problem: A review on perceptions, behaviors, and interventions. *Science of the Total Environment, 688*, 1077-1093.

Hina, M., Chauhan, C., Kaur, P., Kraus, S., & Dhir, A. (2022). Drivers and barriers of circular economy business models: Where we are now, and where we are heading. *Journal of Cleaner Production, 333*, 130049. doi:10.1016/j.jclepro.2021.130049

Hull, C. E., Millette, S., & Williams, E. (2021). Challenges and opportunities in building circular-economy incubators: Stakeholder perspectives in Trinidad and Tobago. *Journal of Cleaner Production, 296*, 126412.

Hsieh, H., & Shannon, S. E. (2005). Qualitative Health Research, 15, 1277-1288.

Jaeger, B., & Upadhyay, A.(2020). Understanding barriers to circular economy: cases from the manufacturing industry. *Journal of Enterprise Information Management*, 33, 729-745.https://doi.org/10.1108/JEIM-02-2019-0047

Kerdlap, P., Low, J.S.C., & Ramakrishna, S. (2019). Zero waste manufacturing: A framework and review of technology, research, and implementation barriers for enabling a circular economy transition in Singapore. *Resources, Conservation and Recycling, 151*, 104438. https://doi.org/10.1016/j.resconrec.2019.104438

Kirchherr, J., Piscicelli, L., Bour, R., Kostense-Smit, E., Muller, J., Huibrechtse-Truijens, A., & Hekkert, M. (2018). Barriers to the Circular Economy: Evidence from the European Union (EU). *Ecological Economics*, 150, 264-272. https://doi.org/10.1016/j.ecolecon.2018.04.028.

Korstjens, I., Moser, A. (2018). Series: Practical guidance to qualitative research. Part 4: Trustworthiness and publishing. *European Journal of General Practice, 24(1):*120–4. https://doi.org/10.1080/13814788.2017.1375092

Kumar, V., Sezersan, I., Garza-Reyes, J.A.,Gonzalez, E.D.R.S. & AL-Shboul, M.A.(2019). Circular economy in the manufacturing sector: benefits, opportunities and barriers. *Management Decision, 57(4),* 1067-1086.https://doi.org/10.1108/MD-09-2018-1070

Langendahl, P. A., Mark-Herbert, C., & Cook, M. (2022). Creating possibility spaces for the development of circular bioeconomy initiatives. *Journal of Integrative Environmental Sciences, 19(1),* 209-225.

McNicholas, G., & Cotton, M. (2019). Stakeholder perceptions of marine plastic waste management in the United Kingdom. *Ecological Economics, 163,* 77-87.

Michie, S., Hyder, N., Walia, A., West, R. (2011). Development of a taxonomy of behavior change techniques used in individual behavioral support for smoking cessation. *Addictive Behavior, 36(4),* 315-319.

Michie, S., van Stralen, M. M., & West, R. (2011). The behavior change wheel: A new method for characterising and designing behavior change interventions. *Implementation Science, 6*, 6-42.

Namey, E., Guest, G., McKenna, K., & Chen, M. (2016). Evaluating bang for the buck: A cost-effectiveness comparison between individual interviews and focus groups based on thematic saturation levels. *American Journal of Evaluation. 37(3),* 425-40.

Pistrang, N., & Barker, C. (2012). Varieties of qualitative research: A pragmatic approach to selecting methods. In H. Cooper, P. M. Camic, D. L. Long, A. T. Panter, D. Rindskopf, & K. J. Sher (Eds.), APA handbooks in psychology®. APA handbook of research methods in psychology, Vol. 2. Research designs: Quantitative, qualitative, neuropsychological, and biological (p. 5–18). American Psychological Association

Reijonen, S. (2011). Environmentally friendly consumer: From determinism to emergence. *International Journal of Consumer Studies, 35,* 403 - 409. 10.1111/j.1470-6431.2010.00956.x.

Resource. (2019). How to recycle biodegradable coffee cups. Accessed 7 December 2021. https://resource.co/article/how-recycle-biodegradable-coffee-cups-13020

Roy, D., Berry, E., & Dempster, M. (2021). “If it is not made easy for me, I will just not bother”: A Qualitative Exploration of the Barriers and Facilitators to Recycling Plastics. Manuscript submitted for publication. School of Psychology, Queens University Belfast. https://doi.org/10.31234/osf.io/bkpqw Scientist Action and Advocacy Network, (2019).

Siderius, T., & Zink, T. (2022). Markets and the Future of the Circular Economy. *Circular Economy and Sustainability, 24,* 1-27.

Tong, A., Sainsbury, P., & Craig, J. (2007). Consolidated criteria for reporting qualitative research (COREQ): A 32-item checklist for interviews and focus groups. *International Journal for Quality in Health Care, 19(6),* 349–57.

Unite Nations Environment Programme. (2016). Marine Plastic Debris and Microplastics: Global Lessons and Research to Inspire Action and Guide Policy Change, United Nations Environment Programme, Nairobi.

Waste and Resources Action Program (WRAP) Accessed on 13 December 2021 https://wrap.org.uk/

Appendix

Supplementary document 1 (S1): Interview Schedule for Stakeholders

The interview schedule will used to give some focus to the discussions and encourage reflections on current practices around beliefs, any barriers, any solutions, and consumer behaviour. A small number of structured scenarios may be used to prompt their understandings around **motivation, capabilit**y (knowledgeable, being in control), and **opportunity** of all stakeholders.

N.B. Not all questions will be relevant to each stakeholder, but we have included the full set of questions in the schedule. We will skip any questions that are not relevant to the respondent on the day.

Questions	**Prompts**
(1)Please tell us a little bit about your job.	*What is their role in their company - are they scientists, retailers, managers, etc.*
(2)When it comes to recycling, could we do more, what could we do?	*Governments, businesses, industry, retailers like Sainsbury's etc.* *Probe knowledge–do you think it is better to bury than burn it?*
(3)Who needs to take responsibility?	*Government, manufacturers, businesses retailers, consumers, industry etc.* *Is it a consumer responsibility or shared responsibility?*
(4)What are opportunities and best ways to encourage re-use and recycling more?	*Probe where do they think the opportunities lie.*

	Probe knowledge and understanding of plastics and best ways to reduce plastic waste.
(5)What do you understand about sustainable plastics should we use them more? ***(Glass bottles, cloth bags for shopping, food packaging made from sugar cane products, tapioca or paper etc.***	*Ask about the benefits and also any barriers to more widespread manufacturing and consumption of sustainable plastics.* *Think of food packaging, containers, or children's toys, or shoes, building houses, window frames, plastic containers for cleaning fluids etc.*
(6)If you haven't already, why have you not implemented new, more sustainable plastics (eg. bio-based plastics)?	*What are the barriers/facilitators to doing this? (for manufacturers)*
(7)What would make it easier to recycle the materials you collect? ***(Recycling businesses and collectors, e.g. Bryson, Council)***	*How they are separated, or the materials used, better advice and education for consumer etc?*

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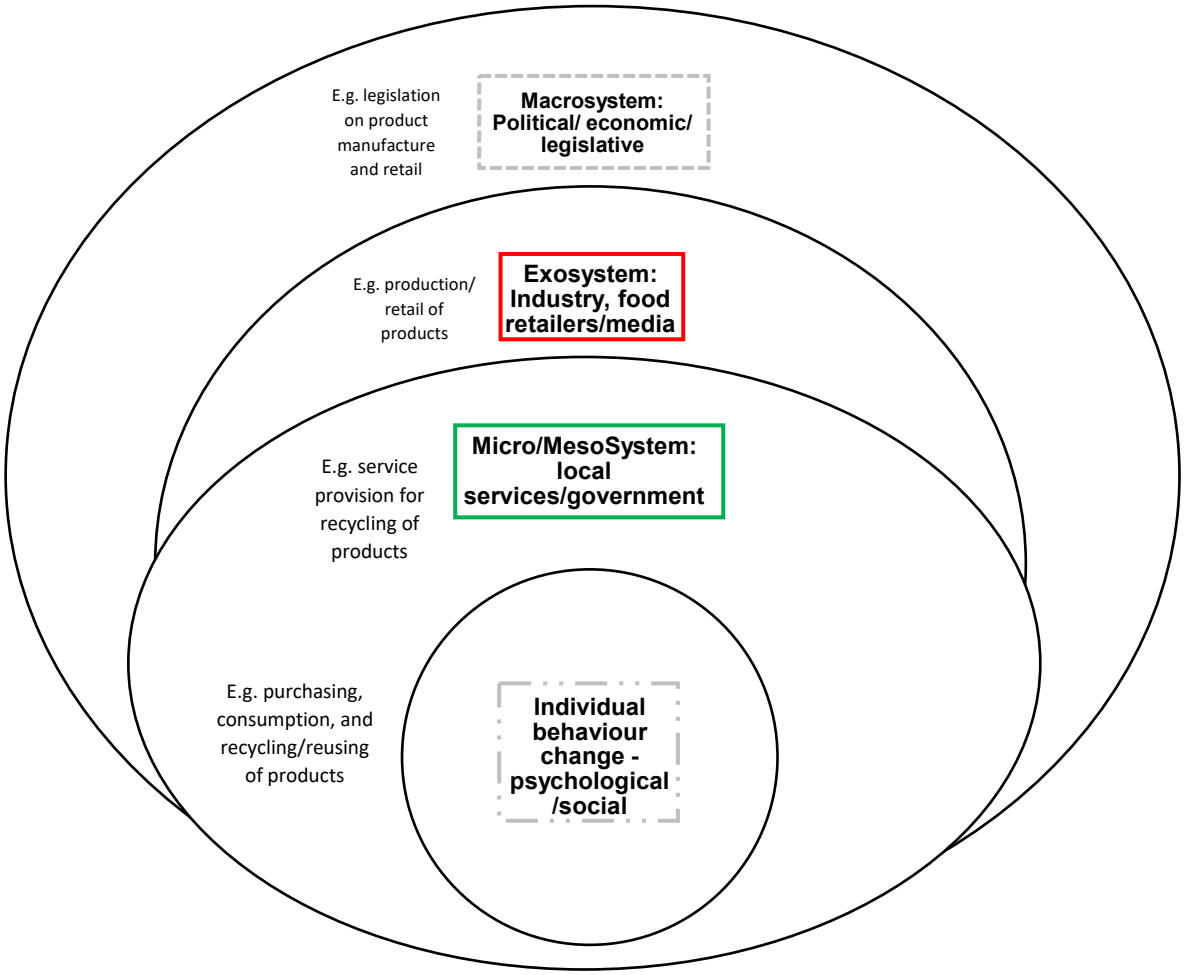
Questions	**Prompts**
(8) What could consumers do to make this easier? ***(Recycling businesses and collectors, e.g. Bryson, Council)***	*Do you think they need help to do this – who is best placed to help them?*
(9) Is there anything that other people could do to make your recycling business more viable? ***(Recycling businesses and collectors)***	*In addition to the consumer – what else could be done, by whom?*
(10) How flexible can your recycling business be – can it easily adapt to new products? ***(Recycling businesses and collectors)***	*What are the barriers / facilitators to this?*
(11) What level of communication do you have with manufacturers/retailers about new products and any adaptations you need to make? ***(Recycling businesses and collectors)***	*Any opportunities to meet, any associations you all are part of;* *Any tensions/ barriers to this happening?*
(12) Anything you would like to add that we haven't covered?	*Is anything you are currently doing to tackle the issue but we haven't touched on?*

	What are the biggest hurdles for yourstakeholder/company? *Something around the relevance and importance for that stakeholder/company – is it an important business objective (the need to recycle plastics/reduce plastic waste etc.) ?*

Table 1. Demographic Breakdown of Interviewees by Age and Sex

	SEX	
AGE	**Male**	**Female**
<30	0	1 (Sustainability management representative in a university)
30-40	0	2 (Representatives of a company that produces, bottles and distributes soft drinks). 1(Representative from large recycling services provider). 1(Environmental management representative in a university).
41-50	0	1 (Owner of company selling refills and eco-friendly products). 1 (Policy lead, Central Government). 1(Policy lead, Central Government).
51+	3 (x 1 Senior manager, x2 Policy leads in Local Authorities/Local Government.	1 (Policy lead, Central Government).



Legend:

Representative stakeholders interviewed: Policy lead Central Government, Senior Policy Manager (EST construct pertains most strongly to theme 4.2. i.e. legislative change needs).

Representative stakeholders interviewed: Refill/eco-friendly company owner, Representative plastics manufacturer (EST construct pertains most strongly to theme 4.3. i.e. motivational and educational support needs).

Representative stakeholders interviewed: Recycling services representative, Sustainability/environmental management representatives, Policy leads for Local Authorities/Government (EST construct pertains most strongly to theme 4.1. i.e. infrastructure and service developmental support needs).

Not interviewed but implicated in the supply chain and lifecycle of products (EST construct pertains most strongly to theme 4.3. i.e. motivational and educational support needs).

Figure 1. Bronfenbrenner's Ecological Systems Theory (EST) contextualised to the Circular Economy, with Supply Chain Stakeholders represented and framed in the data.