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# Understanding Consumer's Willingness to Engage with Digital Reuse Systems

**Meghann Matthews * and Thomas L. Webb**

Department of Psychology, University of Sheffield, Sheffield S1 4DP, UK; t.webb@sheffield.ac.uk
* Correspondence: m.r.matthews@sheffield.ac.uk

**Abstract:** Reusable packaging systems can help tackle the global problem of plastic waste by keeping material in circulation. Furthermore, technology now makes it possible to trace material as it moves through the reuse process, which potentially confers benefits across the supply chain. However, research into these digital reuse systems remains limited, particularly from the perspective of consumers who are asked to use such systems. The current work involved a series of online studies designed to identify (i) the barriers and enablers to engaging with digital reuse systems, (ii) which are most strongly endorsed and predict willingness to engage, and (iii) what information about digital reuse systems influences consumers' willingness to engage and their beliefs. Studies 1 (N = 40) and 2 (N = 300) found that, while people are typically willing to engage with digital reuse systems, some people have concerns over the tracking aspect of digital reuse systems, and this is associated with their willingness to engage. Study 3 (N = 690) found that providing consumers with different types of information about digital reuse systems (e.g., going into more vs. less detail) did not influence their willingness to engage with digital reuse systems or their beliefs about the systems. These findings have implications for how digital reuse systems should be implemented.

**Keywords:** plastic; packaging; reuse; barriers; enablers; consumer willingness



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## 1. Understanding Consumer's Willingness to Engage with Digital Reuse Systems

It is estimated that 390 million metric tons of plastic are generated each year, where one of the main applications is packaging [1]. Packaging is required to protect products, extend shelf-life to reduce food waste and ensure food hygiene and safety [2]. However, packaging can quickly change from something of use to an item of waste [3]. For example, in the UK, households are estimated to throw away 66 items of plastic packaging a week on average, equating to almost 100 billion items a year, with just 12% of the plastic packaging being recycled [4]. Consequently, a significant amount of plastic waste ends up in landfills, and it is estimated that almost a third of plastic packaging leaks into the natural environment, posing threats to the natural environment and human health [5]. Commitments to tackle plastic waste and move towards a more sustainable, circular economy are being made on both national and international levels (e.g., the Global Commitment led by the Ellen MacArthur Foundation). One way that this is being achieved is via bans on single-use plastics [6]. Subsequently, there will be an increased reliance on alternative options, such as reusable packaging systems. Reusable packaging is "packaging which has been conceived, designed and marketed to carry out multiple trips in its lifetime by being refilled or reused for the same purpose for which it was conceived" [7] and is more sustainable than single-use alternatives so long as it is reused as intended [8].

The Ellen MacArthur Foundation [9] divides reusable packaging schemes into four categories: (i) returnable packaging schemes, where the packaging is owned by a company and a consumer borrows and returns the packaging and (ii) refillable packaging schemes, where the consumer owns the container and (re)fills the container with the product from the company. Both returnable and refillable reuse models can operate either (i) from home or (ii) on the go. For example, returning containers from home involves the collection of

the containers by a delivery service, whereas returning containers on the go involves the consumer returning their packaging to a shop or drop-off point. Refill at home involves consumers refilling their reusable containers at home, such as with refills from a subscription service, whereas refill on the go involves consumers refilling their reusable containers away from home, such as getting a coffee from a coffee shop. The World Economic Forum [10] suggests that three primary groups of actors are required for systems change (e.g., to move from single use to reusable packaging systems), namely (i) consumers, (ii) businesses, and (iii) the public sector. For example, for the schemes to be implemented, businesses need to overcome challenges in terms of infrastructure, affordability, concerns regarding meeting health and safety standards, and brand reputation [10,11]. But even if businesses can tackle these challenges, the success of the scheme still depends on consumers' willingness to engage, including buying products in reusable packaging, potentially cleaning and storing used packaging, and then refilling or returning that packaging so that it can be used again.

There are already a number of reusable packaging schemes in place. For example, the Living Landscape of Reusable Packaging Solutions database [12] includes over 1000 reusable packaging solutions available worldwide. However, while research suggests that reusing and refilling containers can be more sustainable than single-use alternatives [8] and reusable packaging options are gaining popularity, the sustainability of reusable packaging systems cannot be taken for granted [13]. Manufacturing reusable containers typically requires more energy and resources than manufacturing single-use packaging [14]. Therefore, reusable containers must be used multiple times—even as often as 150 times [15]—to extract sufficient value from the raw materials for them to be considered to be more sustainable than their single-use counterparts. Thus, consumer engagement is integral to the success of reusable packaging schemes. Unfortunately, research suggests that although 85% of people want to buy products that come in reusable packaging, only 16% actually engage with reuse systems [16], suggesting that people may encounter (or believe that they will encounter) a number of barriers to engaging with reuse systems.

### *1.1. Factors That Influence Consumers' Engagement with Reusable Packaging*

Research has identified a range of factors that may hinder the acceptance of and use of reusable packaging by consumers. One factor that has been identified as a potential barrier to reuse is concerns about the cleanliness and hygiene of the reusable packaging (e.g., [17–19]). Individuals may have concerns about contamination from shared objects (e.g., [20]), particularly when they are used in close proximity to the body [21], leading them to reject the idea of using packaging that was used by someone else previously. People can also be influenced by signs of wear and tear to the containers, which serve to cue the potential for contamination (e.g., [22–24]). Additionally, the inconvenience associated with reusing containers may lead people to favour single use. For example, Jiang and colleagues [18] examined consumers' preferences regarding reusable takeaway containers and found that 70% of consumers took takeaway food because it is convenient and saves time, and 57% of consumers were not willing to spend the time and effort needed to reuse containers. Other factors relating to the perceived inconvenience and additional effort required to reuse containers include having to store and/or carry the containers until they can be returned and having to remember to return the containers (e.g., [17,19]). Furthermore, consumers may be concerned about additional costs or having to pay a deposit to use reusable containers (e.g., [17–19,25,26]). Taken together, accumulating evidence points to a number of barriers associated with reuse systems that may influence consumer adoption and, in turn, the success of these types of systems in reducing plastic waste.

### *1.2. Digital Reuse Systems*

Technology may help to address some of the challenges associated with reuse systems and help move towards a more circular economy. For example, embedding technology such as Radio Frequency Identification (RFID) tags into packaging makes it possible to trace the material as it moves through the reuse process. For example, Lampe and Strassner [27] found that RFID improves traceability, asset management, and maintenance of reusable kegs in the

alcohol industry. Incorporating technology into reuse systems can also help to meet health and safety standards via batch coding and providing evidence of cleaning [11]. This information could also be shared with consumers to provide reassurance about the quality and provenance of the packaging, although we note that research is needed to investigate the impact of such information. A recent review of how technology has been used within reuse systems for food and drink identified 62 reuse schemes that incorporate tracking technology [28]. Specifically, the schemes used four types of tracking technology (QR codes, RFID, barcodes, and near-field communication) to monitor 15 different types of information, including information about the point of manufacture, fill, purchase, and return of the packaging.

As governments introduce mandatory digital tracking of waste to help drive the circular economy (e.g., [29,30]), it is likely that technology will be increasingly used in reuse systems. However, including these tracking and traceability technologies within reuse systems may impact consumer engagement. For example, reuse systems incorporating digital technology may require consumers to download an app or use a website to engage with the system (e.g., to 'check out' the packaging, confirm a return, or pay a deposit). In addition to reducing convenience, some consumers may be anxious about technology, feeling nervous, fearful, and/or hesitant when using items that incorporate digital technology [31,32]. Anxiety has been identified as a barrier to consumers' acceptance of other technologies, including self-service technology and digital assistants (e.g., [33,34]). However, research regarding the inclusion of technology within reuse systems (i.e., digital reuse systems) and what may influence engagement with them is currently limited. Therefore, the current research aimed to examine consumers' beliefs and willingness to engage with digital reuse systems.

### *1.3. The Present Research*

Research identified a number of barriers and enablers to engaging with non-digital reuse systems. However, despite an increasing number of digital reuse systems being developed, little is known about how consumers think about and interact with such systems and the barriers and enablers to engagement. Therefore, the current research aimed to identify (i) the barriers and enablers that consumers associate with engaging with reuse systems supported by digital technology (Study 1), (ii) which barriers and enablers are most strongly endorsed and important for consumers and influence their willingness to engage with reuse systems (Study 2), and (iii) examine what information about digital reuse systems influences consumers' willingness to engage and their beliefs about the reuse systems (Study 3).

## 2. Study 1

Study 1 explored what barriers and enablers consumers associate with using reuse models supported by digital technology. In order to do so, a number of scenarios describing how different reuse models can work (e.g., reusable containers collected from home vs. returned to store) were created, and participants were asked to read these scenarios and then answer a series of open-ended questions regarding how they would find engaging in the behaviours described in the scenario.

### *2.1. Method*

#### 2.1.1. Participants

Forty participants were recruited via Prolific (M age = 41.63, range = 26–80, 50% female). Prolific is an online platform where studies can be advertised to help researchers recruit participants and has been found to produce high-quality data [35,36]. The study took, on average, 20 minutes to complete, and participants were remunerated £4 for their time.

#### 2.1.2. Materials

*Scenarios.* Three scenarios were created, each describing a context in which containers and packaging might be reused (dry goods delivered to homes, dry goods purchased in store, "grab-and-go" bottled drinks purchased in store) and different systems for reusing such containers (e.g., return to a delivery driver vs. return to store). Each of the scenarios

specified that the containers have a digital chip in them that allows them to be tracked to see where they are (i.e., whether the container is with a customer, in a washing facility, is ready to be refilled for the next customer, and so on). All materials and datasets for each of the studies can be found on Open Science Framework (https://osf.io/r5u4j).

*Open-ended questions.* Following each scenario, participants were asked five questions relating to how difficult/easy they would find engaging in the behaviours described in the scenario if they would have any concerns about using the reusable containers described in the scenario, and what advantages and disadvantages they associate with using reusable containers.

#### 2.1.3. Procedure

Figure 1 provides an overview of the procedure. Participants completed an online questionnaire on Qualtrics. After reading the information sheet and providing informed consent, each participant was presented with three scenarios in a random order. After each scenario, participants were then asked the open-ended questions outlined above. Finally, participants were asked to provide demographic information, including their age and the gender they identify as, and were fully debriefed. Each of the studies presented in this paper was approved by the Department of Psychology's ethics committee at the University of Sheffield (Ref. 049492, Ref. 051092, and Ref. 052816, respectively).

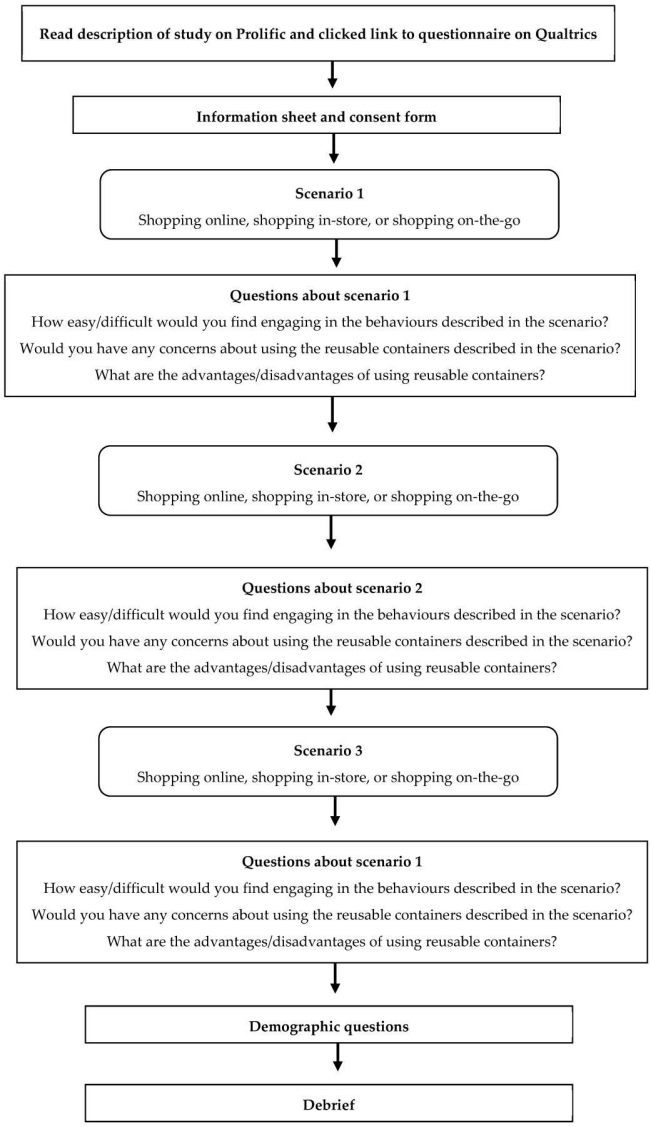


**Figure 1.** Overview of the procedure of Study 1.

### *2.2. Results*

Participants' responses to the open-ended questions were analysed using a bottom-up inductive approach, which involved identifying themes across the ~600 open-text responses. This involved initially coding the data by giving each response a label that described the response and then categorising them into themes. Thirty-seven themes were identified and organised as reflecting enablers or barriers to engaging with digital reuse systems. These are outlined in Table 1. In line with Allison et al. [37], a theme was categorised as reflecting an enabler if it seemingly promoted the behaviours involved with engaging with digital reuse systems and was categorised as a barrier if it seemingly deterred the same behaviours. It is, however, worth noting that the same theme could present both a potential barrier and an enabler to someone engaging with a digital reuse system, depending on how it is framed and/or manifested for the specific system and/or person. For example, the design of the container can present both a barrier (e.g., if it is not stackable and so easily once stored) or an enabler (e.g., if it is stackable). Similarly, anticipated emotions could present a barrier (e.g., if someone expected to feel embarrassed at having to return damaged containers) or an enabler (e.g., if someone expected to feel proud at having done something positive for the environment). Therefore, some themes appear in both lists.

**Table 1.** Enablers and barriers identified in Study 1 with illustrative quotes.

| Theme | Example Quotes |
| --- | --- |
| **Enablers** | |
| Environmental benefits | "Reusing containers is much more environmentally friendly and sustainable".<br>"There would be less going to landfill and less waste" |
| Domestic benefits | "Having reusable containers that would go back to the retailer would mean that my recycling bin at home would be less cluttered each week". |
| Reminders to return | "A list of the products I received that were using reusable containers so I would be able to return all the containers without fail".<br>"A reminder from the online delivery supermarket to get your containers ready for pick up". |
| Informed about how to use system | "Clear instructions on what to do".<br>"Information on what happens if they are broken or missing". |
| Ease of using systems | "The smart return point would have to be quick and efficient in this fast society". |
| Convenience | "Having them collected from your home is far easier than having to return them yourself".<br>"If it is a supermarket that you visit regularly then it's no hardship to take your containers back with you when you next go shopping" |
| Central locations for return points | "Having lots of drop off points not just at the supermarket for example amazon lockers etc so can drop off at a close location".<br>"Wide availability of return points, not linked to any one brand of shop".<br>"They would need to be able to be returned to any of numerous locations away from the purchase site. The whole thing about buying 'on the go' is that I'm quite possibly not going to be returning to that same location". |
| Incentives to use system | "If there was a reward system in place".<br>"Having an incentive to return them (price reduction, coupons)<br>"Customer needs an incentive to keep the bottle rather discard it. For example, a drink may be 20p more expensive but you get that 20p back when returning the bottle". |
| Anticipated emotions | "Feeling good about being environmentally friendly" |
| Already sort waste (e.g., for recycling) | "We are already in the habit of taking reusable bags into the store—adding containers for recycling to take back is just a minor adjustment in a routine".<br>"I already collect these items for recycling, so it would be easy for me to store them separately to send them back to the shop". |
| Design of reusable containers/packaging | "Ideally they would need to take up as little space as possible (i.e., be stackable)"<br>"If they were study enough to be used properly again".<br>"Containers are light so can be easily transported by bike/car". |
| Automation of process | "Returning to a machine would be easier than a person".<br>"An automatic financial incentive to return the bottle". |

**Table 1.** *Cont*.

| Theme | Example Quotes |
| --- | --- |
| **Barriers** | |
| Design of reusable containers/packaging | "Size of them might put people off keeping them until the next delivery"<br>"Having specific opening and closing mechanisms could make it difficult".<br>"If I've taken it back to the office for my lunch I don't want to be walking round with a huge bottle that needs taking back to the store" |
| Do not drive | "I also don't drive, so if I did a small to medium shop, which I sometimes do without the car I would have to carry them all into town. This is a disadvantage to those of us without cars".<br>"Getting to the location of certain retailers" |
| Feel unable to clean | "If the containers could not be cleaned easily."<br>"If they are difficult to clean" |
| Effort involved in using system | "More effort for the consumer"<br>"You have to think a bit more about your waste, and make sure you don't throw things away that need to be returned"<br>"It would be an additional job to do in returning the packaging" |
| Memory demands (e.g., forgetting to bring or return containers) | "To start it might be difficult to remember, as it was for reusable bags".<br>"Just forgetting to bring them".<br>"Having to return them in shop. This means I have to remember to pick up the container from home" |
| Complexity of system | "A complicated process with different types of containers".<br>"Scanning system in store that is complex and may require regular assistance from staff".<br>"It's more complicated than just being allowed to use your own containers". |
| Cleanliness | "The containers could be dirty, so you would need quality control in place".<br>"I would be concerned that the bottles had been cleaned thoroughly" |
| Hygiene | "The downside would be a potential poor hygiene situation. Spread of pathogens".<br>"My main concern is the hygiene standards of the business. Sanitary cleaning would be essential".<br>"Containers for pasta/rice is not such an issue as you aren't directly putting your mouth to the packaging, plus cooking the food before eating to get rid of bacteria. But with a drinks bottle that has more cause for concern". |
| Contamination of product | "I might be concerned about the containers degrading or containing harmful chemicals that could leach into food (e.g., BPA)".<br>"Food contamination is my main concern. Especially with fresh produce. I would much rather re-use my own containers than some containers whose whereabouts and sanitation procedures I am not sure of". |
| Concerns over tracking | "Digital chip again. I'm concerned about the location of my house being compromised and accessed by someone other than the retailer".<br>"The scheme above sounds a bit intrusive. I wouldn't want them to be able to track me or my products".<br>"Digital chip could possibly be hacked, and my location could be accessed by someone else" |
| Damage to containers | "Damaged containers not accepted back".<br>"The cost of replacement when they get damaged".<br>"Some may not be in good condition for return" |
| Erroneous beliefs about system | "Expected to clean them before return" |
| Penalties | "Would you be penalised for damaging the packaging?" |
| Environmental cost | "I question the cost (in CO2) of delivering the packaging to a cleaning centre, and back to the store".<br>"The materials used to create the containers and the energy consumption/environmental impact in their creation".<br>"Might be more environmentally damaging if people aren't returning them and throwing them away instead" |
| Confidence in return | "If the technology failed then this could cause a problem".<br>"That you may take the containers to a return point while on the way somewhere else, only to find that the return point was broken or not functioning" |
| Responsibility for containers | "I would want to wash the containers so it's very likely a digital chip would get damaged. If they were damaged would the shop charge for their replacement?"<br>"Containers being stolen from the front of the property. If left out someone may just come and take them". |

**Table 1.** *Cont.*

| Theme | Example Quotes |
| --- | --- |
| Attitudes towards plastic | "My main concern would be that wouldn't be solving the issue of getting rid of plastic. Companies would have to be making more plastic to make these containers. We need less plastic in the world. Not more".<br>"It doesn't really solve the plastic problem. You are replacing a problem with another problem". |
| Finite resources being used for digital reuse systems | "The raw materials in digital chips are running low, worldwide, and are increasingly hard to get hold of. Is this the best use of them or should priority be given to laptops and essential equipment?"<br>"Waste of microchips" |
| Anticipated emotions | ""People probably would be embarrassed bringing in dirty containers". |
| Storage at home/carrying containers | "Depending on the number of reusable containers that was received each week, the problem would be where to store them—if there was numerous containers the problem would be where to store them until the next weeks online shop arrived".<br>"I am dubious it would work for large families who have limited space to keep the containers"<br>"If you're on the go you might not be able to carry containers with you and just want to throw it in the bin instead" |
| Storage in store | "Concerns would be that stores could not cope with the returns in an adequate time, and queues would mount up. Shoppers might give up and discard them".<br>"Where would the supermarkets find the additional room?" |
| Accessibility/Availability | "If it's difficult to locate the return point".<br>"Availability of products, for example if you only had the brand name products who had signed up to this, it reduced options available".<br>"If only selected stores had the facilities". |
| Financial cost | "It would probably make things more expensive".<br>"The cleaning step could add more cost to the shopping".<br>"It would need to be a suitable cost". |
| Time to engage with system | "The time taken to scan them in and out"<br>"Making time to return my reusable containers"<br>"If it took time or there were queues for returning containers that would be a barrier to completing this". |
| Return window | "Having a limited amount of time to return it"<br>"If there was a time limit for returning them that didn't fit in with your schedule".<br>"If I needed to store these items in the container and they weren't empty by the time I had my next delivery" |
| Others not engaging | "It would be difficult if people threw them away instead of returning them".<br>"People not returning creating demand for more reusable items to be made as those not returned getting disposed and not used for its original purpose".<br>"I see people failing to return them or losing them. I also see people breaking them perhaps". |

### *2.3. Discussion*

Study 1 used an exploratory, bottom-up approach to identify potential barriers and enablers to digital reuse systems. By asking participants to imagine using reusable containers in three different scenarios (i.e., when shopping online, when shopping in-store, and when shopping on the go), we were able to identify 25 potential barriers and 12 potential enablers to consumers' engaging with digital reuse systems. Potential barriers included the accessibility and availability of systems and return points, storing and carrying the containers, concerns over hygiene and the cleanliness of the containers, the effort associated with returning the containers, forgetting to return the containers and concerns over the tracking aspect of digital systems. Potential enablers included the convenience of returning the containers, the accessibility and availability of reuse systems and return points, incentives for using reusable containers, the design of the containers and being informed about how to use the reuse systems. These findings both support and extend those from previous research that has investigated the barriers and enablers associated with using (non-digital) reuse systems (e.g., [17]). However, Study 1 also identified an additional barrier that is spe-

cific to digital reuse systems, namely concerns over tracking. Specifically, some participants felt that tracking is intrusive and raised concerns about how the technology could allow them and their products to be tracked and lead to their security being compromised. Thus, it is possible that some consumers may experience technology anxiety in relation to digital reuse systems, which in turn may influence how willing they are to engage with digital reuse systems (e.g., [34]).

## 3. Study 2

Study 2 aimed to use the findings from Study 1 to examine (i) the strength of participants' beliefs about potential barriers and enablers to engaging with digital reuse systems and (ii) whether participants' beliefs are associated with their willingness to engage with digital reuse systems. Willingness refers to how willing someone would be to perform the behaviour if given the opportunity to do so [38] and has been found to be a key predictor of behaviour (e.g., [39]). Willingness is also likely to be a more appropriate reflection of the likelihood that consumers will engage with a reuse system than, for example, intentions [40], which may be undermined by the (current) scarcity of such systems (i.e., people are unlikely to intend to do something that they have not yet had the opportunity to do, but yet may be willing to). In order to examine the extent to which participants endorsed the various beliefs associated with using digital reuse systems (identified in Study 1), we created a series of statements reflecting each of the potential barriers and enablers and asked participants to indicate the extent to which they agreed with each. We also measured how willing participants were to engage with the reuse system outlined in the scenario and potentially relevant individual differences—including disgust sensitivity (how unpleasant the experience of disgust is believed to be) and propensity (how easily they are disgusted) [41], pro-environmental identity [42] and concern [43], reuse behaviour, attitudes towards reusable products concerns over privacy [44] and technology anxiety [45]—to examine whether they were associated with willingness to engage with digital reuse systems.

### *3.1. Method*

#### 3.1.1. Participants

A nationally representative sample (UK) of 300 participants was recruited via Prolific (M age = 46.30, range = 19–80, 51.33% female). The sample size was determined via Prolific's guidelines for the minimum number of participants to recruit in order to provide a nationally representative sample (in terms of age, sex, and ethnicity). The study took approximately 15 minutes to complete, and participants were remunerated £3 for their time.

#### 3.1.2. Materials

*Scenarios.* Participants were presented with one of the three scenarios used in Study 1 in a between-participant design that was described as outlining how digital reuse systems might work in different contexts (i.e., shopping online, shopping in-store, shopping on-the-go). Alongside reading the scenario, participants also had the opportunity to watch a short whiteboard-style animation that illustrated how the digital reuse system would work.

*Beliefs about Reuse Systems.* Participants' beliefs about reuse systems were measured by asking them to indicate the extent to which they agreed with statements reflecting each of the barriers and enablers identified in Study 1. Example items included 'I would forget to return the containers', 'Reusing containers benefits the environment', 'Tracking containers is intrusive' and 'Reusable containers would be dirty'. Some categories of beliefs were measured with multiple statements. For example, concerns over tracking were measured with two items: (i) 'Tracking containers is intrusive', and (ii) 'My security would be compromised by tracking the containers'. Other beliefs were measured with a single statement. For example, beliefs about environmental costs were measured with one statement: (i) 'Reusing containers would do more harm to the environment than good'. The statements were based on key words identified from the open-ended responses of

participants in Study 1. Participants in Study 2 were asked to respond to each of the statements on a 5-point scale (1 = strongly disagree, 5 = strongly agree). Where beliefs were measured with multiple statements, responses were recoded (where relevant) so that higher scores indicate greater agreement with the statements, and then responses to each of the statements were averaged to provide a single measure of each belief. Not all of the beliefs were relevant to all 3 of the scenarios (e.g., central locations for return points were not relevant to shopping online), thus the number of belief statements presented to participants depended on the scenario that the participant was presented with.

*Willingness to Engage with Digital Reuse Systems.* To assess participants' willingness to engage with the digital reuse system, after reading the scenario, participants were presented with the statement "I would be willing to complete my food shopping in the way described in the scenario above". Participants responded on a 5-point scale (1 = strongly disagree, 5 = strongly agree), such that higher scores indicate greater willingness to engage with the digital reuse system outlined in the scenario.

*Disgust Sensitivity and Propensity.* Disgust sensitivity and disgust propensity were measured using the 16-item Disgust Propensity and Sensitivity Scale-Revised [41]. This scale includes items such as "I become disgusted more easily than other people", and participants responded on a 5-point scale (1 = never, 5 = always). The items proved internally reliable ($\alpha = 0.89$), and so the items were averaged to create a single measure where higher scores indicate greater propensity and sensitivity to feelings of disgust. In addition, participants were asked to complete the short version of the Food Disgust Scale [46]. This scale contains 8 scenarios (e.g., "Eating with dirty silverware in a restaurant" and "Finding a little snail in the salad I wanted to eat") in which participants rate how disgusting they find them on a 6-point scale (1 = not disgusting at all, 6 = extremely disgusting). The items proved internally reliable ($\alpha = 0.77$), and so the items were summed to create a single measure where higher scores indicate greater sensitivity to food-related disgust.

*Pro-Environmental Identity and Concern.* Pro-environmental identity was measured using 4 items from Whitmarsh and O'Neill's Green Identity Scale [42]. Examples of items are "I think of myself as an environmentally friendly consumer" and "I would be embarrassed to be seen as having an environmentally friendly lifestyle". The items were internally reliable ($\alpha = 0.75$), and so were combined into a single index. Pro-environmental concern was measured using 4 items developed by Ellen [43], such as "Compared to other things in my life, environmental problems are not that important to me". The items were internally reliable ($\alpha = 0.81$), and so were combined into a single index. Participants responded to all these items on a 5-point scale (1 = strongly disagree, 5 = strongly agree). Higher scores indicate greater pro-environmental identity and concern.

*Reuse Behaviour.* Reuse behaviour was measured using 9 items adapted from Ertz et al. [47], such as "I bring a reusable coffee cup every time that I buy a takeaway hot drink". Participants responded on a 6-point scale (1 = never, 6 = always), and the items were averaged to create a single scale where higher scores indicate greater use of reusable containers. To improve the reliability of the scale, one of the items was removed ("I purchase takeaway hot drinks in disposable cups"), resulting in a Cronbach's alpha of 0.60. The items were then combined into a single index.

*Attitudes Towards Reusable Products.* Attitudes towards reusable products were measured using the stem "For me, using reusable products (e.g., a reusable shopping bag) is. . ." followed by 5-point response scales anchored by foolish-wise, bad–good, harmful–beneficial, unenjoyable–enjoyable, unpleasant–pleasant, unfavourable–favourable, and negative–positive. This measure was derived from Ertz et al. [47], who adapted the items from Sparks and Shepherd [48]. The items were internally reliable ($\alpha = 0.91$) and were combined into a single index. Higher scores indicate more positive attitudes towards using reusable products.

*Concerns over Privacy.* The 10-item Perception of Being Observed scale [44] was used to measure concerns over privacy. This includes items such as "I have concerns that when I am using technological devices, I am being watched" and "In general, I think that everyone

is being watched while they are making purchases". Participants responded on a 7-point scale (1 = strongly disagree, 7 = strongly agree). The items were internally reliable ($\alpha$ = 0.90) and so were combined into a single index where higher scores indicate a greater perception of being observed.

*Technology Anxiety.* Anxiety relating to technology was measured using items adapted from the Tech Anxiety Rating Scale [45], which includes items such as "I worry that other people will see information that I don't want them to see" and "I worry that people I don't know (e.g., hackers) will steal my information or identity". Participants responded on a 5-point scale (1 = strongly agree, 5 = strongly disagree). The items proved internally reliable ($\alpha$ = 0.95) and so were combined into a single index. Higher scores indicate higher technology anxiety.

### 3.1.3. Procedure

Figure 2 provides an overview of the procedure. Participants were asked to complete an online questionnaire on Qualtrics. After reading an information sheet and providing informed consent, participants were presented with one of three scenarios depicting a context in which containers and packaging might be reused. After reading the scenario, participants were asked to rate their willingness to engage with the reuse system and the extent to which they agreed with the statements designed to reflect potential beliefs about the reuse system. As it is possible that responding to the statements reflecting potential beliefs about the reuse system might influence participants' willingness to engage, the order in which the measures of beliefs and willingness were presented to participants was counterbalanced across participants. To ensure that participants were paying attention, three statements were included, which asked participants to respond to the statement with a specific answer. For example, 'Just to check you are paying attention, please select 'strongly disagree". No participants failed the attention checks.

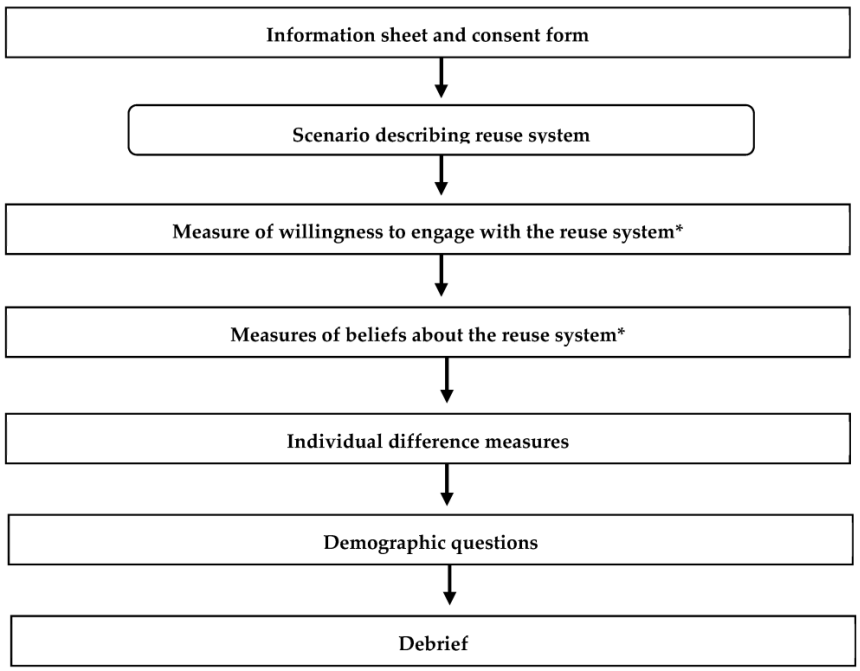


**Figure 2.** Overview of the procedure in Study 2 and 3. Note. The order in which the sections indicated with an asterisk were counterbalanced between participants.

Participants were then asked to complete measures of individual differences that may be associated with their beliefs about potential barriers and enablers to reuse (e.g., disgust sensitivity and propensity, environmental identity and concern, current reuse behaviour, attitudes towards reuse, concerns over privacy and technology anxiety). The order in

which these measures were completed was randomised. Participants were asked some questions about their demographics, including their age, the gender that they identify as, their ethnicity and their household income. They were also asked about their shopping habits (e.g., whether they shop online or in-store) and whether they buy bottled drinks when 'on the go'. Finally, participants were debriefed.

#### 3.1.4. Data Analysis

To examine which beliefs were most strongly endorsed by participants, the means and standard deviations of participants' responses to the measures of each of the beliefs were calculated, and then the beliefs were ranked from most strongly to least strongly endorsed. A t-test was conducted to see if there was a significant difference in willingness to engage with the reuse systems depending on whether participants rated their willingness to engage before or after reading and rating the belief statements. In order to examine which beliefs are associated with participants' willingness to engage with digital reuse systems, stepwise regression analyses were conducted. As some of the beliefs were specific to the contexts outlined in the scenarios (e.g., using reusable containers when shopping online, when shopping in-store and when shopping on-the-go), a separate regression analysis was conducted for each scenario. The analyses were hierarchical such that the first step included the measures of individual differences in reuse behaviour, pro-environmental identity, pro-environmental concern, the perception of being observed, technology anxiety, disgust propensity, disgust sensitivity and food disgust. The remaining variables were entered in the second step. The data met the assumptions for regression analyses. Specifically, for each regression analysis, the data evidenced (i) independence of observations as assessed using the Dubin–Watson statistic, (ii) linearity and (iii) homoscedasticity as assessed by visual inspection of scatterplots, (iv) no multicollinearity as assessed by VIF and Tolerance values, (v) no outliers as assessed by z-scores (defined as $|z| \geq 3.29$), and (vi) normal distribution of the residuals as assessed by visual inspection of the histogram.

### *3.2. Results*

#### 3.2.1. Willingness to Engage with Digital Reuse Systems

On average, participants were willing to engage with the digital reuse systems ($M = 3.75$, $SD = 1.19$), and there was no significant difference in willingness to engage with the three reuse systems described in the scenarios ($F(2, 297) = 1.54$, $p = 0.215$). Participants who rated willingness to engage before reading the belief statements were, however, significantly more willing to engage with the digital reuse systems ($M = 3.91$, $SD = 1.16$) than those who rated their willingness to engage after reading the belief statements ($M = 3.61$, $SD = 1.21$), $t(298) = 2.20$, $p = 0.029$.

#### 3.2.2. Beliefs about Digital Reuse Systems

Table 2 shows the descriptive statistics for each of the beliefs about digital reuse systems by scenario. In terms of enablers, participants strongly endorsed the beliefs relating to the benefits associated with and the practicalities of using digital reuse systems. For example, participants strongly endorsed beliefs about the environmental benefits of using reusable containers (e.g., that it reduces waste and would benefit the environment) and also the benefits for the individual engaging with the reuse system (e.g., domestic benefits such as having less waste at home, anticipated emotions such as feeling good for reusing containers and receiving incentives for engaging with the reuse systems). Other strongly endorsed beliefs included those related to the practicalities of engaging with the reuse system, such as being informed about how to use the systems and design features of the containers (e.g., being stackable and lightweight). Additionally, participants strongly endorsed other practicalities, such as whether the reuse systems are easy and convenient to use, that there should be multiple return points in central locations, and how this behaviour could be easily adopted if they already engaged in more sustainable behaviours such as sorting waste for recycling.

**Table 2.** Means and SDs reflecting the extent to which the categories of beliefs were endorsed in the different scenarios. Cronbach's alphas are reported where more than one item examined the category of belief.

| | Shopping Online | | | Shopping in Store | | | Shopping on the Go | | | Overall | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Belief** | ***M*** | ***SD*** | **α** | ***M*** | ***SD*** | **α** | ***M*** | ***SD*** | **α** | ***M*** | ***SD*** |
| **Enablers** | | | | | | | | | | | |
| Environmental benefits | 4.61 | 0.57 | 0.72 | 4.46 | 0.78 | 0.82 | 4.49 | 0.62 | 0.55 | 4.52 | 0.59 |
| Informed about how to use system | 4.50 | 0.62 | 0.72 | 4.40 | 0.60 | 0.50 | 4.37 | 0.58 | 0.68 | 4.43 | 0.60 |
| Design of reusable packaging/containers | 4.46 | 0.46 | 0.44 | 4.43 | 0.46 | 0.58 | 4.22 | 0.63 | 0.26 | 4.37 | 1.18 |
| Convenience | 4.40 | 0.84 | | 4.19 | 0.99 | | 4.20 | 0.96 | | 4.26 | 0.93 |
| Already sort waste (e.g., for recycling) | 4.37 | 0.84 | | 4.21 | 0.79 | | 4.14 | 0.92 | | 4.24 | 0.85 |
| Anticipated emotions | 4.24 | 0.67 | 0.54 | 4.03 | 0.69 | 0.54 | 4.01 | 0.78 | 0.58 | 4.09 | 0.72 |
| Ease of using systems | 4.02 | 0.92 | 0.78 | 3.80 | 0.77 | 0.73 | 3.91 | 0.71 | 0.55 | 3.91 | 1.17 |
| Domestic benefits | 4.04 | 0.64 | 0.46 | 3.90 | 0.56 | 0.09 | 3.75 | 0.56 | 0.09 | 3.9 | 0.60 |
| Central locations for return points | | | | 3.88 | 0.60 | 0.04 | 3.82 | 0.65 | 0.18 | 3.85 | 0.61 |
| Incentives to use system | 3.37 | 0.86 | 0.29 | 2.76 | 0.82 | −0.05 | 2.86 | 0.88 | 0.41 | 3.74 | 0.86 |
| Reminders to return | 4.14 | 0.92 | | 3.70 | 1.02 | | 3.36 | 1.23 | 0.46 | 3.74 | 1.10 |
| Automation of process | 4.29 | 0.71 | | 3.99 | 0.92 | 0.26 | 4.06 | 0.92 | 0.26 | 3.4 | 1.07 |
| **Barriers** | | | | | | | | | | | |
| Erroneous beliefs about system | 3.33 | 1.16 | | 3.58 | 1.09 | | 3.58 | 1.10 | | 3.50 | 1.18 |
| Penalties | 3.66 | 1.17 | | 3.61 | 1.15 | | 3.21 | 1.25 | | 3.50 | 1.20 |
| Attitudes towards plastic | 3.36 | 0.71 | 0.30 | 3.42 | 0.74 | 0.45 | 3.58 | 0.70 | 0.43 | 3.45 | 0.72 |
| Others not engaging | 3.20 | 0.75 | 0.65 | 3.38 | 0.65 | 0.58 | 3.50 | 0.71 | 0.59 | 3.36 | 0.71 |
| Concerns over tracking | 2.94 | 1.21 | 0.85 | 3.37 | 1.25 | 0.88 | 3.19 | 1.34 | 0.91 | 3.17 | 1.27 |
| Finite resources being used for digital reuse systems | 3.05 | 1.01 | | 2.97 | 0.95 | | 3.28 | 1.00 | | 3.10 | 0.99 |
| Damage | 2.93 | 0.63 | 0.20 | 3.07 | 0.78 | 0.58 | 3.08 | 0.84 | 0.62 | 3.03 | 0.75 |
| Responsibility for containers | 2.90 | 0.77 | 0.16 | 3.05 | 0.84 | 0.56 | 2.97 | 0.88 | | 2.97 | 0.83 |
| Memory demands (e.g., forgetting to bring or return containers) | 2.50 | 1.22 | | 2.83 | 1.17 | | 2.96 | 1.18 | | 2.76 | 1.20 |
| Storage at home/carrying containers | 2.72 | 1.34 | | 2.71 | 1.23 | | 2.69 | 1.30 | | 2.71 | 1.29 |
| Storage in store | | | | 2.6 | 1.06 | | 2.67 | 1.19 | | 2.64 | 1.13 |
| Return window | 2.85 | 1.05 | | 2.72 | 0.97 | | 2.06 | 0.98 | | 2.55 | 1.05 |
| Time to engage with system | 2.71 | 1.26 | | 2.26 | 1.10 | | 2.59 | 1.24 | | 2.52 | 1.21 |
| Do not drive | | | | 2.44 | 1.39 | | 2.59 | 1.41 | | 2.51 | 1.40 |
| Contamination of product | 2.24 | 0.97 | | 2.60 | 1.05 | | 2.65 | 1.08 | | 2.50 | 1.05 |
| Effort involved in using system | 1.94 | 1.07 | | 2.42 | 0.87 | 0.49 | 2.30 | 0.86 | 0.37 | 2.42 | 0.87 |
| Confidence in return | 2.25 | 1.11 | | 2.55 | 1.10 | | 2.32 | 0.98 | | 2.37 | 1.70 |
| Cleanliness | 2.10 | 0.78 | 0.68 | 2.35 | 0.78 | 0.68 | 2.32 | 0.88 | 0.72 | 2.25 | 0.82 |
| Accessibility/availability of system and items | 3.57 | 1.11 | | 3.32 | 0.49 | 0.45 | 3.21 | 0.80 | 0.59 | 2.21 | 1.11 |
| Complexity of system | 1.94 | 0.94 | | 2.21 | 1.06 | | 2.37 | 1.18 | | 2.18 | 1.09 |
| Unable to clean | 1.89 | 0.96 | | 2.15 | 1.13 | | 2.41 | 1.04 | | 2.15 | 1.06 |
| Financial cost | 1.88 | 0.99 | | 2.19 | 0.94 | | 2.23 | 1.02 | | 2.10 | 0.99 |
| Hygiene | 1.82 | 0.80 | 0.73 | 2.15 | 0.84 | 0.64 | 2.22 | 0.97 | 0.68 | 2.07 | 0.89 |
| Environmental cost | 1.73 | 0.75 | | 1.98 | 0.85 | | 1.87 | 0.93 | | 1.86 | 0.85 |

Note. Higher mean values reflect higher agreement with the beliefs. Predictors of willingness to reuse containers when shopping online.

In terms of barriers, participants strongly endorsed the beliefs that reflected concerns that they might have about using the system, such as believing that they would have to wash the containers twice, that the containers could be damaged, and that they would be penalised if this were to happen. Additionally, participants believed that other people may not engage with the system and may throw the containers away instead of returning them. Other barriers that were endorsed related to whether making digitally enabled reusable containers was the best use of resources and also concerns over the tracking aspect of digital reuse systems, such as it being intrusive and potentially compromising their security.

#### 3.2.3. Predictors of Willingness to Reuse Containers When Shopping Online

Table 3 shows the variables that contributed significantly to the prediction of willingness to use digital reuse systems when shopping online ($F(6, 92) = 22.34$, $p < 0.001$). Five variables accounted for 59% of the variance in willingness: Anticipated emotions, concerns over tracking, the complexity of the system, domestic benefits, and concerns over finite resources being used to support digital reuse systems. These findings suggest that participants who believed that they would experience positive emotions (e.g., would feel good if they used reusable containers), avoid negative emotions (e.g., would not feel guilty if they used reusable containers), who believed that the reusable containers provide domestic benefits such as reducing waste at home, would make more space in the general waste and/or recycling bins, and/or would serve another purpose at home were *more* willing to use digital reuse systems when shopping online. However, participants who believed that the tracking aspect of digital reuse systems was intrusive and/or would compromise their security, believed that it would be complex to return the containers, and/or believed that the resources required for the tracking technology would be wasted on reuse systems were *less* willing to use digital reuse systems when shopping online.

**Table 3.** Stepwise regression of willingness to reuse containers in different contexts on beliefs about reuse systems.

| | **Shopping Online** | | **Shopping In-Store** | | **Shopping On-the-Go** | |
|---|---|---|---|---|---|---|
| **Belief** | **Beta** | ***t*-Value** | **Beta** | ***t*-Value** | **Beta** | ***t*-Value** |
| Anticipated emotions | 0.36 | 3.89 ** | 0.29 | 2.89 * | | |
| Concerns over tracking | −0.23 | −3.18 * | | | −0.26 | −3.31 * |
| Complexity of system | −0.19 | −2.17 * | | | −0.21 | −2.19 * |
| Domestic benefits | 0.18 | 2.48 * | | | | |
| Finite resources being used for digital reuse systems | −0.16 | −2.10 * | | | | |
| Reminders to return | | | 0.27 | 3.06 * | | |
| Storage in store | | | −0.20 | −2.69 * | | |
| Reuse behaviour | | | | | 0.27 | 2.68 * |
| Ease of use | | | | | 0.23 | 3.80 ** |
| Confidence in return | | | | | −0.22 | −2.67 * |
| Responsibility for containers | | | | | 0.23 | 3.23 ** |
| $R^2$ | 0.59 | | 0.53 | | 0.58 | |
| Adjusted $R^2$ | 0.56 | | 0.50 | | 0.54 | |

Note. * $p < 0.05$, ** $p < 0.001$, Betas are standardised coefficients.

#### 3.2.4. Predictors of Willingness to Reuse Containers When Shopping in Store

Three variables contributed significantly to the prediction of willingness to use digital reuse systems when shopping in-store ($F(6, 94) = 17.33$, $p < 0.001$): Anticipated emotions, receiving reminders, and space in the store. These variables accounted for 52.5% of the variance in willingness. Two of the variables were positively associated with willingness (anticipated emotions and receiving reminders), suggesting that participants who believed that they would experience positive emotions and/or avoid negative emotions by engaging with the reuse system and/or that receiving a reminder would make it easier to return the containers were *more* willing to use digital reuse systems when shopping in-store. Beliefs about space in the store were negatively associated with willingness, suggesting that participants who believed that there would not be enough space in store for the return points were *less* willing to use digital reuse systems when shopping in-store.

#### 3.2.5. Predictors of Willingness to Reuse Containers When Shopping On-the-Go

Six variables contributed significantly to the prediction of willingness to use digital reuse systems when shopping on the go ($F(7, 91) = 17.70$, $p < 0.001$): Past reuse behaviour, beliefs about the complexity of the system, concerns over tracking, ease of use, confidence in return, and responsibility. These variables accounted for 57.7% of the variance in willingness. These findings suggest that participants who currently engage with reuse systems believed that the return points would be easy to use and that it would be quick and efficient to return the containers, and/or believed that they were responsible for taking care of the containers were *more* willing to use digital reuse systems when buying food or drink items on-the-go. On the other hand, participants who believed that it would be too complex to return the containers believed that the tracking aspect was intrusive and/or would compromise their security, and/or did not trust the smart return point were *less* willing to use digital reuse systems when buying food or drink items when on-the-go.

### *3.3. Discussion*

Study 2 aimed to examine the extent to which consumers endorse specific beliefs about digital reuse systems and whether these beliefs predict their willingness to engage with digital reuse systems. Participants tended to agree that digital reuse systems confer benefits for the environment and the individual, such as reducing waste at home and providing incentives, but that the systems need to be practical, easy and convenient to use (e.g., include clear guidance on how the system works, multiple central return points and reminders to return containers). In terms of barriers, participants believed that the containers would need washing twice, that the containers could be damaged and this might result in penalties for the user, that others would not engage with digital reuse systems, and had concerns about the use of digital chips for reusable packaging systems and the tracking aspect of the digital reuse system. Three of these beliefs predicted participants willingness to engage with at least two of the digital reuse systems: (i) anticipated emotions (e.g., feeling good knowing they were using reusable containers), (ii) concerns about tracking technology (e.g., that their security would be compromised), and (iii) how complex participants believe it would be to return the containers. Two of these beliefs reflect those identified in previous research—e.g., on anticipated emotions [49] and perceived complexity [50] as drivers of behaviour; and also pertain to both digital and non-digital reuse systems (although potentially to different degrees). However, the third belief—concerns about tracking—is specific to digital reuse systems, and although technology anxiety has been considered in other contexts (e.g., [33,34]), the findings from Study 2 suggest that it is also relevant to understanding whether consumers will engage with digital reuse systems and so warrants further examination.

## 4. Study 3

The findings of Study 2 suggested that some consumers are concerned that tracking reusable containers is intrusive and might compromise their security. Furthermore, the extent to which consumers endorsed these beliefs predicted how willing they were to engage with reuse systems involving digital technology, such that people were less willing to engage with digital reuse systems if they had concerns with respect to tracking. Therefore, Study 3 aimed to identify what information might be provided to consumers to reduce their concerns and increase engagement. In order to do so, Study 3 expanded the scenarios presented in Study 2 to investigate whether providing information to participants about aspects of the digital reuse system influences their beliefs about and willingness to engage with the reuse system. Three aspects of the information that people could be provided about digital reuse systems were considered.

1. Information making it clear (rather than ambiguous) that it is the movement of the containers in the supply chain that are monitored (not the movement of consumers) and that the RFID tags (referred to as digital chips in the scenarios) are not GPS enabled, and so their location is only registered when scanned.

2. Information about the technology being used and how it works.
3. Information emphasising the benefits of including this technology in reuse systems (i) for the system as a whole or (ii) for the consumer.

The design, hypotheses, and data analysis strategy for Study 3 were preregistered before data collection began (https://osf.io/r5u4j).

### *4.1. Method*

#### 4.1.1. Participants

An a priori power analysis was conducted using G*Power (version 3.1.9.6, [51]) to estimate the required sample size. With a significance criterion of $\alpha = 0.05$ and power = 0.95, the minimum sample size needed to detect a small-to-medium-sized effect (Cohen's F = 0.15) of the different types of information on participants' beliefs in a between-participants ANOVA was N = 690. Consequently, a nationally representative sample (UK) of 690 participants was recruited via Prolific (M age = 45.92, range = 18–88, 51.4% female). The study took approximately 10 minutes to complete, and participants were remunerated £2.25 for their time.

#### 4.1.2. Design

There were three independent variables, namely (i) emphasis on tracking the containers (ambiguous vs. specific language), (ii) information about how the technology works (information provided vs. information not provided), and (iii) information about the benefits of using technology in reuse systems (benefits for the system vs. benefits for the consumer vs. no information on benefits). There was also a group of participants who were presented with information about a reuse system that did not involve digital technology (i.e., a hanging control group). Consequently, participants were randomly allocated to 1 of 13 conditions in a $2 \times 2 \times 3 + 1$ design.

#### 4.1.3. Materials

*Scenarios.* Participants were asked to imagine that they had completed their food shop online and had bought a number of items in reusable containers. They were told that they would have to store the containers before they were collected by the delivery driver when they next had a food shop delivered. This study focused on the online scenario due to the growth of online shopping in the UK—which was suggested to have nearly doubled since 2016 [52]—combined with the potential for reuse systems that involve the collection of containers from the consumer by a delivery company [14] Other information presented in the scenario reflected the manipulations outlined below.

*Manipulation of information on what was tracked.* Participants were either presented with a paragraph that (i) specifically stated that the digital chip allowed the retailer to see where the containers were and used the term 'traceability' rather than 'tracked' or (ii) was more ambiguous as to whether it was the container or the individual being tracked.

*Manipulation of information on how technology works.* Participants were either presented with (i) technical information, which stated that the digital chip is an RFID tag and how this works (e.g., by providing a unique identification code that can be scanned using a specific reader that allows the retailer to 'check in' an item at a particular location) or (ii) no technical information.

*Manipulation of emphasis on who benefits from the digital tracking.* Participants were either presented with text that describes how digital tracking benefits (i) the system (e.g., the movement of the containers through the supply chain can be monitored to ensure that the retailers have a good return rate) or (ii) the customer (e.g., be automatically provided with a discount voucher for taking part in the scheme and returning the containers). A third group of participants were not provided with any additional text about the benefits of the technology.

*Willingness to Engage with the Reuse System.* How willing participants were to engage with digital reuse system outlined in the scenario was measured using 4 statements de-

signed to reflect the different behaviours involved in engaging with a reuse system: (i) I would be willing to buy food and drink in reusable containers, (ii) I would be willing to eat and drink products that come in a reusable container or bottle, (iii) I would be willing to store the reusable containers until the next delivery, and (iv) I would be willing to return the reusable containers to the delivery driver. Participants were asked to respond on a 5-point scale from 1 (strongly disagree) to 5 (strongly agree). The items were internally reliable ($\alpha = 0.88$) and so were combined and averaged to create a single scale score where a high score indicates a higher willingness to engage with the reuse system.

*Beliefs about the Reuse System*. Participants were presented with 25 statements designed to assess their beliefs about the reuse system. These were based on the findings from Study 2 regarding what beliefs were endorsed and predictive of willingness to engage. Participants were asked to respond to each statement on a 5-point scale (1 = strongly disagree, 5 = strongly agree).

Principal axis factoring with direct oblimin rotation was performed to identify the underlying structure of the statements used to measure beliefs. An examination of the Kaiser-Mayer Olkin measure of sampling adequacy (KMO = 0.915) and Bartlett's test of sphericity ($p < 0.001$) indicated that the data was likely factorable. To determine which items to include in the analysis, the communality values were inspected, and any items that had values < 0.2 were removed. Consequently, the items measuring whether participants believed that (i) it was appropriate to fine consumers for not returning the container, (ii) the container would have another purpose, and (iii) they already sorted waste for recycling were removed. The remaining 22 items were included in the factor analysis. Kaiser's criterion (eigenvalue > 1) suggested that a 6-factor solution might provide the best fit to the data. However, the factors were difficult to interpret, and it has been suggested that Kaiser's criterion is among the least accurate methods for choosing the number of factors to retain [53,54]. The scree plot suggested that three factors might provide a good fit, and so the analyses were re-run, extracting three factors. After rotation, the first factor accounted for 33.19% of the variance, the second factor accounted for 6.37% of the variance, and the third factor accounted for 4.59% of the variance. Table 4 displays the items and factor loadings for the rotated factors.

Factor 1 consisted of 9 items reflecting consumers' beliefs about the practicalities of engaging with a reuse system (e.g., 'it would be too expensive for me to reuse containers', 'returning containers would be too complex') and their concerns about the tracking aspect of the reusable containers (e.g., 'tracking containers is intrusive' and 'my security would be comprised by tracking the container'). This factor was labelled 'Beliefs about the practicalities and tracking aspect of using reusable containers'. Factor 2 consisted of 10 items reflecting consumers' beliefs about the benefits associated with engaging with the reuse system. These statements reflected receiving incentives for engaging with the system (e.g., 'Receiving an incentive (e.g., discounts, a points system) for returning the containers would encourage me to do so'), the ease and convenience of returning the containers (e.g., 'Returning the containers to the delivery driver would be easy') and the emotional benefits that consumers might anticipate feeling as a result of engaging with the system (e.g., 'I would feel good knowing that I was reusing containers'). This factor was labelled 'Benefits of engaging with reuse system'. Finally, Factor 3 consisted of 3 items reflecting consumers' concerns about the cleanliness and hygiene of the reusable containers (e.g., 'Reusable containers would be dirty'). As such, this factor was labelled 'Concerns about cleanliness'.

*Reuse Behaviour.* Alongside the 9 items used in Study 2 (adapted from [47]), an additional 2 items were included to reflect other ways that consumers might use reusable containers. These items were "I order takeaway in reusable containers" and "I buy the majority of my grocery shopping in reusable containers". Participants were asked to respond on a 6-point scale (1 = never, 6 = always). To improve the reliability of the scale, one of the items was removed ("I purchase takeaway hot drinks in disposable cups"), resulting in a Cronbach's alpha of 0.68. The items were then combined into a single index.

**Table 4.** Factor loadings, means, and standard deviations for each factor and each item reflect beliefs about reuse systems.

| Item | Loading | *M* | *SD* |
|---|---|---|---|
| **Factor 1: Concerns about tracking and practicalities of using the system ($\alpha$ = 0.86, Eigenvalue = 7.82)** | | **2.64** | **0.77** |
| Returning containers would be too complex | 0.64 | 2.02 | 1.05 |
| Tracking containers is intrusive | 0.58 | 2.86 | 1.29 |
| My security would be compromised by tracking the container | 0.58 | 2.68 | 1.26 |
| I am concerned that I would be penalised if I damaged or lost the containers | 0.53 | 3.60 | 1.06 |
| I would not trust the delivery driver to correctly scan and return all the containers | 0.62 | 2.35 | 1.06 |
| The materials used to make the digital chips are limited and would be wasted on reuse systems | 0.60 | 2.95 | 1.04 |
| I would not have space to store the containers before returning them | 0.57 | 2.61 | 1.27 |
| It would be too expensive for me to reuse containers | 0.54 | 2.14 | 0.98 |
| It would take too long for the delivery driver to scan the containers | 0.66 | 2.56 | 1.11 |
| **Factor 2: Benefits of using the system ($\alpha$ = 0.84, Eigenvalue = 2)** | | **4.08** | **0.49** |
| Receiving an incentive (e.g., discounts, a points system) for returning the containers would encourage me to do so | 0.59 | 4.50 | 0.75 |
| Reusing containers would reduce waste at home | 0.55 | 4.42 | 0.76 |
| Reusing containers would make more space in the waste and/or recycling bins | 0.47 | 4.30 | 0.83 |
| I would feel good knowing that I was reusing containers | 0.70 | 4.33 | 0.81 |
| I would feel guilty buying items in plastic packaging if they were not reusable | 0.47 | 3.45 | 1.13 |
| Having a delivery driver collect the reusable containers would be convenient | 0.51 | 4.37 | 0.83 |
| Receiving incentives should be automated | 0.43 | 4.25 | 0.83 |
| Returning the containers to the delivery driver would be easy | 0.44 | 4.26 | 0.86 |
| Returning the containers to the delivery driver would be quick and efficient | 0.41 | 4.00 | 0.92 |
| I would want all my products to come in reusable containers | 0.37 | 3.50 | 1.15 |
| **Factor 3: Concerns about cleanliness ($\alpha$ = 0.82, Eigenvalue = 1.42)** | | **2.13** | **0.87** |
| Reusable containers would be dirty | −0.65 | 2.26 | 1.03 |
| Reusable containers will have been thoroughly cleaned | 0.47 | 4.17 | 0.86 |
| Reusable containers would not be hygienic | −0.72 | 2.30 | 1.12 |

Note. The means and standard deviations presented in this table are based on the responses of the participants who experienced the manipulations (i.e., not including the responses of participants who read about the non-digital reuse condition).

*Past Experience with Digital Reuse Systems.* Participants were presented with four items, each of which reflected a different reuse model as outlined by the Ellen MacArthur Foundation (i.e., refill from home, refill on the go, return from home, return on the go). They were asked if they had engaged with a system similar to the one described (Yes/No) and to provide any details they could remember about using this system. For example, the item reflecting the 'return from home' reuse model stated: 'Some schemes allow you to borrow and return reusable containers from home. For example, ClubZero offers RFID-enabled reusable cups and food containers that can be used for takeaway food (e.g., for delivery via Just Eat or Deliveroo). Once the container is empty, a collection can be arranged for a small fee.'

*Interest in learning more about reuse systems for food and drink.* Participants were provided with the opportunity to view information about the Loop trial with Tesco. This included information and images from Loop's web pages that outlined how the trial worked and how the items were returned. Whether participants looked at this information and how long they spent looking at this information was recorded to provide a measure of interest in reuse systems.

*Concerns over privacy.* As in Study 2, concerns over privacy were measured using the 10-item Perception of Being Observed scale [44]. The items proved internally reliable ($\alpha$ = 0.90) and so were combined into a single index.

*Technology anxiety*. Technology anxiety was measured using items adapted from the Tech Anxiety Rating Scale [45]. The items proved internally reliable ($\alpha$ = 0.95) and so were combined into a single index.

#### 4.1.4. Procedure

Figure 2 provides an overview of the procedure. Participants completed an online questionnaire on Qualtrics. After reading an information sheet and providing informed consent, participants were presented with a scenario describing how containers and packaging might be reused when completing grocery shopping online. The scenarios varied in terms of what information was presented across the three independent variables of (i) emphasis on tracking the containers (ambiguous vs. specific language), (ii) information about how the technology works (information provided vs. information not provided), and (iii) information about the benefits of using technology in reuse systems (benefits for the system vs. benefits for the consumer vs. no information on benefits presented). There was also a group of participants who were presented with information about a non-digital reuse system.

After reading the scenario, participants were asked to rate their willingness to engage with the reuse system and the extent to which they agreed with a number of statements about the reuse system. As in Study 2, the order in which the belief statements and measure of willingness were presented to participants was counterbalanced, and three attention checks were included (no participants failed the attention checks). Participants were then asked to complete measures of potentially relevant individual differences, namely, concerns over privacy, technology anxiety, current reuse behaviour and past experience with digital reuse systems. They were then asked questions about their demographic characteristics, including their age, the gender that they identify as, their ethnicity and their household income. Participants were also asked about their shopping habits (e.g., whether they typically shop online or in-store). Finally, participants were given the opportunity to read additional information about reuse systems that have been developed for food and grocery shopping (namely, the trial that Loop conducted with Tesco). At the end of the study, participants were fully debriefed.

#### 4.1.5. Data Analysis

To examine the effect of the three independent variables—(i) emphasis on tracking the containers, (ii) information about how the technology works, and (iii) information about the benefits of using technology in reuse systems—a one-way ANOVA with willingness to engage with the reuse systems as the dependent variable and a one-way MANOVA with the three categories of beliefs about the reuse systems as the dependent variables were conducted. In addition, to examine whether there were any differences between those who were presented with information about the non-digital reuse system and those presented with information about the digital reuse systems described in the other 12 conditions, in line with Himmelfarb [55], one-way (M)ANOVAs were conducted collapsed across the conditions, followed by 12 planned, Bonferroni-corrected contrasts comparing the non-digital reuse system condition to each of the experimental conditions.

### *4.2. Results*

#### 4.2.1. Willingness to Engage with Digital Reuse Systems

Table 5 shows the descriptive statistics for willingness to engage with the reuse system and beliefs about the reuse systems. As can be seen, in all conditions, participants were very willing to engage with the reuse system as described in the scenarios (overall $M = 4.34$, $SD = 0.79$), and there was no significant difference in willingness to engage with the reuse systems between the different conditions (see Table 6). To examine whether there were any differences in willingness to engage with the non-digital reuse system and the 12 (digital) reuse systems described in the other conditions, a one-way ANOVA was conducted with condition (13 levels) followed by 12 planned, Bonferroni-corrected contrasts comparing the non-digital reuse system condition to each of the experimental conditions. The main effect of condition was non-significant ($F(12, 677) = 0.85$, $p = 0.597$), as were the planned contrasts (all $p$ values $> 0.05$). These findings suggest that participants were equally willing to engage with digital and non-digital reuse systems and that the nature of the information provided about digital reuse systems did not influence how willing participants were to engage with that system.

**Table 5.** Descriptive statistics for willingness to engage with the reuse systems described in the scenarios and the factors of beliefs about the reuse systems by experimental condition.

| | What Is the Technology Tracking? | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Ambiguous | | | | | | Specific | | | | | | |
| | Information on How the Technology Works | | | | | | | | | | | | |
| | Provided | | | Not Provided | | | Provided | | | Not Provided | | | |
| | Information on the Benefits of the Technology | | | | | | | | | | | | |
| **Belief** | **For System** | **For Consumer** | **Not Provided** | **For System** | **For Consumer** | **Not Provided** | **For System** | **For Consumer** | **Not Provided** | **For System** | **For Consumer** | **Not Provided** | **Non-Digital System** |
| Willingness | 4.36 (0.78) | 4.25 (0.92) | 4.32 (0.87) | 4.56 (0.53) | 4.39 (0.68) | 4.43 (0.67) | 4.24 (0.98) | 4.26 (0.71) | 4.37 (0.73) | 4.24 (0.79) | 4.34 (0.78) | 4.23 (0.89) | 4.42 (0.67) |
| Practicality and tracking aspects | 2.59 (0.71) | 2.69 (0.84) | 2.61 (0.77) | 2.50 (0.83) | 2.56 (0.72) | 2.54 (0.75) | 2.73 (0.71) | 2.88 (0.78) | 2.56 (0.78) | 2.78 (0.84) | 2.57 (0.77) | 2.67 (0.75) | 2.50 (0.66) |
| Benefits | 4.12 (0.37) | 4.04 (0.62) | 4.08 (0.53) | 4.16 (0.39) | 4.03 (0.49) | 4.67 (0.36) | 4.09 (0.57) | 4.03 (0.45 | 4.12 (0.48) | 3.99 (0.54) | 4.05 (0.47) | 4.05 (0.52) | 4.11 (0.54) |
| Concerns about cleanliness | 2.08 (0.94) | 2.02 (0.74) | 2.18 (1.01) | 4.03 (0.49) | 2.19 (0.90) | 2.13 (0.90) | 2.13 (0.91) | 2.16 (0.76) | 2.02 (0.72) | 2.29 (0.76) | 2.13 (1.00) | 2.23 (0.94) | 2.21 (0.85) |

**Table 6.** Effect of different aspects of the information provided to participants on willingness to engage with the reuse system.

| Independent Variables | df | *f* Value | *p* Value | $\eta p^2$ |
|---|---|---|---|---|
| Emphasis on what is tracked | 1, 626 | 2.76 | 0.097 | 0.004 |
| Information on how technology works | 1, 626 | 1.11 | 0.292 | 0.002 |
| Benefits | 2, 626 | 0.13 | 0.881 | 0.000 |
| Emphasis*Information | 1, 626 | 1.99 | 0.158 | 0.003 |
| Emphasis*Benefits | 2, 626 | 0.95 | 0.388 | 0.003 |
| Information*Benefits | 2, 626 | 0.47 | 0.628 | 0.001 |
| Emphasis*Information*Benefits | 2, 626 | 0.22 | 0.806 | 0.001 |

As in Study 2, participants who rated willingness to engage before reading the belief statements were more willing to engage with the digital reuse systems ($M$ = 4.40, $SD$ = 0.79) than those who rated their willingness to engage after reading the belief statements ($M$ = 4.28, $SD$ = 0.76), $t(688) = 2.09$, $p = 0.037$.

#### 4.2.2. Beliefs about Digital Reuse Systems

With respect to participants' beliefs about the reuse systems, participants did not tend to have concerns about tracking or the practicalities of using the system ($M_{\text{Factor 1}}$ = 2.64, SD = 0.77), typically agreed that there are benefits to using reuse systems ($M_{\text{Factor 2}}$ = 4.08, SD = 0.49), and did not have concerns about the cleanliness of containers ($M_{\text{Factor 3}}$ = 2.13 (SD = 0.87). There were no significant differences in beliefs about the reuse systems between the conditions (see Table 7). These findings suggest that presenting participants with different types of information regarding the emphasis of the tracking technology (i.e., ambiguous vs. specific), information about how the tracking technology works, and information about the benefits of the system for the system or for consumers did not influence their beliefs about reuse systems.

**Table 7.** Effect of different aspects of the information provided to participants on participants' beliefs about the reuse system.

| Independent Variables | df | Wilks' Λ | *f* Value | *p* Value |
|---|---|---|---|---|
| Emphasis on what is tracked | 3, 624 | 0.994 | 1.23 | 0.298 |
| Information on how technology works | 3, 624 | 0.993 | 1.97 | 0.251 |
| Benefits | 6, 1248 | 0.993 | 0.70 | 0.654 |
| Emphasis*Information | 3, 624 | 0.998 | 0.50 | 0.681 |
| Emphasis*Benefits | 6, 1248 | 0.994 | 0.62 | 0.711 |
| Information*Benefits | 6, 1248 | 0.990 | 1.08 | 0.372 |
| Emphasis*Information*Benefits | 6, 1248 | 0.996 | 0.46 | 0.842 |

To examine whether there were any differences in beliefs about reuse systems between participants who imagined using the non-digital reuse system and those who imagined using the 12 (digital) reuse systems described in the other conditions, a one-way MANOVA with condition (13 levels) was conducted, followed by 12 planned, Bonferroni-corrected contrasts comparing the non-digital reuse system condition to each of the experimental conditions. The main effect of condition was non-significant ($F(36, 1995.09) = 0.87$, $p = 0.694$, Wilks' $\Lambda = 0.955$), as were the planned contrasts (all $p$ values > 0.05). The univariate effects were also all non-significant. These findings suggest that participants did not have different beliefs about the non-digital reuse system and the digital reuse systems.

### *4.3. Discussion*

Study 3 investigated whether the information that consumers receive about a digital reuse system influences their willingness to engage with the reuse system and beliefs about the reuse system. Scenarios were developed that differed in the information presented

to consumers about the emphasis of the tracking system (i.e., on tracking containers vs. tracking generally), the amount of detail provided about how the system works (e.g., RFID technology), and the benefits conferred by digital (over non-digital) reuse systems. Contrary to our hypotheses, no differences in participants' willingness to engage with reuse systems depending on the information provided to them were identified. As can be seen in Table 5, participants seemed to be willing to use (both non-digital and digital) reuse systems, regardless of the information that was presented to them. Indeed, one explanation for the finding that the nature of the information provided to participants did not influence willingness is that levels of willingness were so high that there could be ceiling effects (i.e., participants were willing to engage with reuse systems however described).

Study 3 also investigated whether the information provided to participants about digital reuse schemes might influence other beliefs about the systems (e.g., how easy/difficult the systems would be to use, the extent to which people are concerned about tracking and/or hygiene). Again, contrary to our hypotheses, we did not find any differences in participants' beliefs about the reuse system depending on the information provided to them. Taken together, it seems that the information that consumers receive about reuse systems does not influence how willing they are to engage with the reuse system, nor does it shift their beliefs about the reuse systems.

## 5. General Discussion

Reusable packaging and containers can help to reduce plastic waste and offer a more sustainable alternative to single-use plastic packaging. However, while research has investigated consumers' beliefs about engaging with non-digital reuse systems, to our knowledge, no research has investigated the barriers and enablers that consumers associate with engaging with digital reuse systems despite digital reuse systems being increasingly available and potentially conferring advantages over non-digital systems. Therefore, the present research aimed to (i) identify what issues are likely to be salient when consumers think about engaging with digital reuse systems and (ii) examine which barriers and enablers are (a) most strongly endorsed and (b) predict how willing consumers are to engage with digital reuse systems. Study 1 identified potential barriers with respect to storing the containers, forgetting to return them, having confidence in the return, concerns about cleanliness, hygiene and contamination of products, concerns about tracking, and (a lack of) social norms around returning the containers. Study 1 also identified factors that might enable consumers to engage with digital reuse systems, including information about how to return containers and packaging and being incentivised to do so, anticipated emotions (e.g., feeling good about using reusable containers), the design of the containers (e.g., whether they could be stacked), having central return points (i.e., not just in specific stores) and being sent reminders about the containers that need returning. Study 2 developed statements to reflect each belief and investigated the extent to which consumers' beliefs about digital reuse systems predicted their willingness to engage with digital reuse systems when shopping online or in-store for food or when buying food and drink 'on the go'. The findings suggested that key issues include the beliefs about the environmental and individual benefits of using the system (e.g., anticipating feeling good for reusing, receiving an incentive), practicalities (e.g., the design of the container, convenience of using the system) and concerns over tracking and being penalised if the containers are damaged. The findings also suggested how participants think they will feel (i.e., their anticipated emotions) and their concerns over the tracking aspect of digital reuse systems, which are two key predictors of willingness to engage with digital reuse systems.

The findings of Studies 1 and 2 support previous research examining how consumers engage with reuse systems (e.g., [17–19]) and extend insights to reuse systems that incorporate digital technology. In this latter regard, the findings suggest that consumers may be concerned about the tracking aspect of digital reuse systems. The idea that some people are anxious about advancements in technology is not new, but digital platforms have led to an almost exponential increase in recording, tracking, and targeting practices [44,56].

While most countries have clear standards for data protection (e.g., GDPR provides regulation on Information privacy in the European Union) and responsible organisations can be expected to comply with relevant regulations and legislation, regulation may not be sufficient to reduce anxiety, especially in the light of high profile information leaks (e.g., on store loyalty cards) that can lead people to feel uncomfortable sharing information with organisations [57]. Indeed, concerns about tracking may reflect a general unease about being observed that is not correlated with the actual use of monitoring [44]. Such concerns may be related to trust in organisations, government, etc. see [58] for a similar discussion with respect to the adoption of voice-activated personal assistants, potentially even conspiracy theories [59]. The present research suggests that these concerns might be relevant to consumers' engagement with digital reuse systems, and so the nature of the concerns warrants further examination, along with strategies for reducing concern and providing reassurance.

Given that some participants expressed concerns about the tracking aspect of the digital reuse system and that these beliefs were associated with their willingness to engage with the systems, Study 3 considered potential ways of presenting information about digital reuse systems to consumers. Specifically, Study 3 manipulated the emphasis on what was tracked (specifically that the container, not the person, was tracked vs. ambiguous), how the technology works, and the benefits of using technology in reuse systems (emphasising benefits for the system vs. the consumer vs. no information on benefits). In contrast to our expectations, however, the information that participants were provided did not influence how willing they were to engage with the digital reuse system or their beliefs about the reuse system. Additionally, no differences were found between participants' beliefs about non-digital and digital reuse systems. One possible explanation for these findings is beliefs about reuse systems are difficult to shift—at least by changing the information that people receive about reuse systems. Extensive research has attested to the limits of relatively passive forms of persuasion (e.g., written information; [60]), especially if beliefs are strongly held (e.g., [61] for a review). Thus, future research may aim to examine the influence that other factors may have on an individual's beliefs about digital reuse systems, such as the source of the message (e.g., the credibility of the source) [62], the quality of the message, and the influence of others (i.e., social influence) [63].

An alternative explanation is that reuse systems are quite new, and so people do not yet distinguish between types of reuse systems (e.g., digital vs. non-digital, with/without certain benefits) but rather view reuse systems as a single, generic category. For example, Poole [16] suggests that less than 1 in 5 people actually engage with reuse systems, and Study 3 found that only around 7% of participants had engaged with a digital reuse system. This explanation may fit with construal level theory, which suggests that people focus on broad, decontextualised features of a situation when it is construed as temporally distant (i.e., something that will happen in the future) or hypothetical (e.g., something that is unlikely to happen), compared to more concrete construals of current and likely situations [64]. Future research may want to consider the influence of providing consumers with information about the digital reuse system when they have the opportunity to actually use the system (e.g. when trialling a digital reuse system).

It is also interesting to note that both Studies 2 and 3 found differences in how willing participants were to engage with digital reuse systems as a function of whether they rated their willingness before or after rating their agreement with statements reflecting potential beliefs about reuse systems (e.g., that reusing containers would reduce waste at home, that reusable containers may be dirty or unhygienic). Participants who rated how willing they were to engage with the digital reuse system after rating their level of agreement with belief statements were less willing to engage with the systems than those who rated how willing they were to engage with the reuse system before rating their level of agreement with the belief statements. One possible explanation for this effect of the order is the mere-measurement effect, which refers to the idea that completing a questionnaire can increase the saliency and accessibility of the issues that are asked about and affect subsequent

responses [65]. For example, people may not have considered that reusable containers may become dirty or unhygienic with repeated use; however, indicating the extent to which they agree that this might be the case serves as a 'cue to contamination' [20,66,67] and essentially renders the issue of cleanliness more salient. The same argument might be made with respect to whether consumers have considered if their security might be compromised by digital reuse systems. Taken together, interpreting the effect of order in terms of the mere measurement effect suggests that consumers' responses (e.g., their willingness to engage with digital reuse systems) are likely to be influenced by what is accessible at the point of action or when considering how to act.

## 6. Limitations and Future Directions

The findings of the present research need to be considered in the context of some limitations. One limitation is that each study focused on participants' responses to hypothetical scenarios rather than providing participants with the opportunity to actually engage with reuse systems. That said, willingness has been found to be a good predictor of behaviour (e.g., [39]), and the barriers and enablers identified in Study 1 are in line with those identified by Maio et al. [19], who asked participants to engage with a reuse system in the lab. Thus, while hypothetical scenarios were used (and this may have influenced how participants construed the situations, as detailed above), the findings are similar to those reported when people have been able to engage with reuse systems and so should serve as a basis for understanding how people think about and are likely to respond with respect to the digital reuse systems that were the focus of the present research. Future research could, however, look at barriers, enablers, and willingness to engage when participants have had the opportunity to experience reuse systems (e.g., to see if their beliefs and/or willingness changes before and after engaging with reuse systems).

Future research may also want to separate the various behaviours involved in engaging with reuse systems rather than viewing engagement as a single process. For example, successful engagement with a reuse system involves consumers firstly purchasing products in reusable packaging/containers (i.e., uptake), potentially eating/drinking from these containers (e.g., reusable bottles for drinks), storing the used packaging/containers, and then returning them. Study 3 went some way toward separating these behaviours by measuring willingness to engage in specific behaviours (e.g., the uptake and the return of the containers), but these measures were combined for the purposes of the analysis with the consequence that the findings reflect engagement with the reuse system as a whole. Future work may want to consider whether the aim is to increase uptake, improve return rates, or both, and what factors influence consumers' behaviours at different stages of the reuse system.

## 7. Conclusions

Reusable packaging systems can help to tackle the plastic problem, and embedding technology within these systems makes it possible to trace the reusable items as they move through the reuse process, which has potential benefits across the supply chain. The present research investigated consumers' beliefs about digital reuse systems and how these might influence engagement. Overall, people seemed willing to engage with digital reuse systems; however, a number of issues presented barriers and/or enabled engagement. Some of these issues were in line with previous research that has focused on non-digital reuse systems (e.g., that consumers are motivated by incentives and that the practicalities of the system are important); however, some of the issues are specific to digital reuse systems, such as concerns over tracking, and warrant further exploration. Contrary to our hypotheses, Study 3 found no evidence to suggest that providing information about digital systems influences consumers' concerns about tracking or their willingness to engage, suggesting that these beliefs are seemingly difficult to shift—at least by changing the information that people receive about reuse systems. Having said this, it might be too early in the development of such systems for consumers to take the nuances between the systems

into account, suggesting that further research is warranted as people gain experience with digital reuse systems.

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