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Cinderby, Steve and McKendree, Jean (2024) Bottlenecks to glass return and refill in the United Kingdom: User Journeys to explore industry perspectives. *Sustainable Futures*. 100197. ISSN: 2666-1888

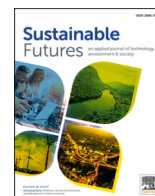
<https://doi.org/10.1016/j.sfr.2024.100197>

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Bottlenecks to glass return and refill in the United Kingdom: User Journeys to explore industry perspectives

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ARTICLE INFO

Keywords:

Glass
Refill
User Journey
Qualitative methods
Industry
Perceptions

ABSTRACT

Currently, only about 36 % of collected glass in the UK is remelted to make new glass bottles. Exporting of glass has increased recently, causing supply issues. This raises the question of why there are not large-scale refill schemes for glass bottles. User Journey interviews were conducted with four senior representatives of key stakeholders to explore glass manufacturers' and distributors' perceptions about national refill schemes for the UK. Six themes emerged: policy/regulation, logistic, economics, industrial/technological areas, sustainability, and social arenas. Stakeholders agreed that investment in increasing the recycling rate in the UK could be a cheaper, faster and more sustainable approach.

1. Introduction

Many countries are moving away from the model of governments and taxpayers being responsible for the management of waste and toward the implementation of Extended Producer Responsibility (EPR) schemes in which companies are accountable for the safe disposal and recycling of their products. As of 2020, twenty-five European countries have EPR policies and the UK is intending to extend their scheme in 2024 (delayed from the original start date of 2023) to require producers of certain types of packaged products to pay the costs associated with manufactured goods throughout their full lifecycle [26].

As part of this enhanced legislation, there are currently plans to introduce a deposit return scheme (DRS), in which consumers pay a deposit on drinks bottles which is repaid when they are returned to a retailer in England, Wales and Scotland in 2025. However, this scheme only includes single-use plastic bottles and cans, not glass, primarily due to push-back from business, and is aimed solely at increasing recycling rates (UK [33]). Scotland was to introduce a DRS to begin in August 2023, also aimed at increasing recycling rates, including glass bottles [27] but the initiative has been postponed for 10 months due to strong opposition from businesses [20].

British Glass, the UK glass trade organisation, is opposed to a return scheme for glass in favour of an EPR scheme with greater investment in recycling infrastructure, setting a target of 90 % collection rate by 2030 [4]. Glass is one of the few materials that can be recycled infinitely without losing any of its properties in a closed-loop system [22]. In

2019, the UK recovered about 71 % of single-use glass by mass, but only about 36 % was used to make new container while in Germany the figure is 65 % [35]. This low circular use rate is partly because the UK has a mixed collection system which requires the glass to be sorted into different colours before remelting, resulting in higher losses than in a colour separated collection system [35]. Much of the collected glass is therefore used in aggregates for roads, resulting in nearly 50 % of potential glass cullet not being used for new container glass bottles [7], though the UK and EU glass industry has goals to increase the closed-loop recycling of glass in the near future [5].

Another issue is that exporting of unsorted, collected glass from the UK has increased recently, causing supply issues for recycling of glass. This is due to high prices for unprocessed glass so that exporters make as much as they would by selling it for recycling in the UK without having the additional costs of processing, energy, staff, and colour sorting [12, 13].

These challenges to circular-loop recycling of container glass raise the question of why there are not large-scale refill schemes for glass bottles in the UK. Such schemes were common historically but have greatly reduced worldwide in the last few decades [18]. For instance, in the 1970s in the UK, 94 % of milk was put into glass bottles and 99 % of those bottles were delivered to the door with the empties collected for refilling, but currently this is around 3 % [2,10].

Glass production is one of the six Foundation Industries in the UK, along with metals, cement, ceramics, bulk chemicals and paper which all require large amounts of energy and resource materials and

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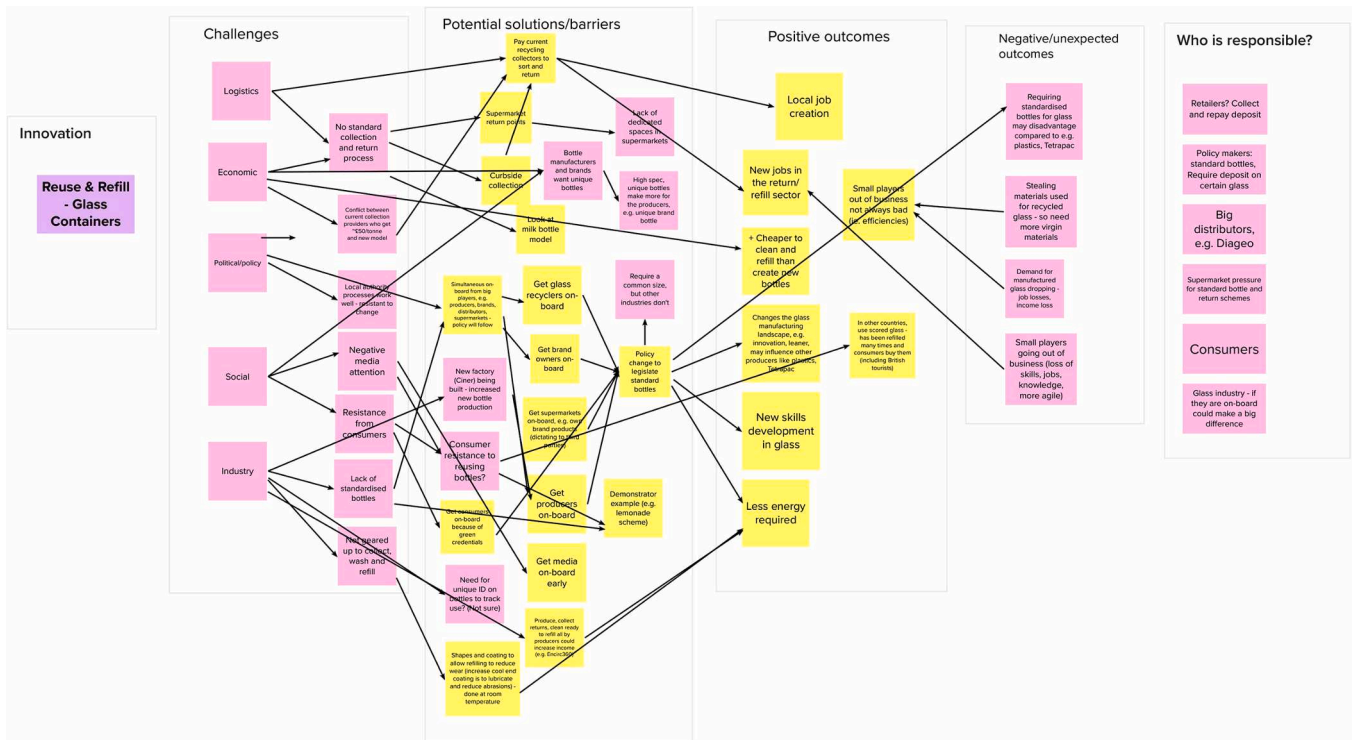


Fig. 1. Glass expert user journey example [NOTE: color on the Web and in black-and-white in print].

subsequently produce large volumes of greenhouse gases (GHGs). These industries, to varying degrees, recognise the need for innovation to create more sustainable processes, including greater reuse and reduction of materials. However, identifying promising innovations and mapping routes to overcome the multitude of barriers to implementation is often an initial hurdle for companies.

This study aimed to test the efficacy of a User Journey approach as a method to explore the container glass manufacturers' and distributors' perceptions about the possibility of a national bottle refill scheme for the UK and to help articulate barriers and potential solutions. Given that it is essential to have these key stakeholders on-board for any innovation to be successful, it is crucial to explore their perspectives in detail.

2. Method

This study, as part of a larger TransFIRE project looking at transformation in UK industries [31], has as one of its goals exploring the use of participatory methods to gather input of multiple stakeholders in the drive to innovate in FIs. One of the methods that can be used to explore innovations and the possible impact on stakeholders is the User Journey. This method originated in user experience, marketing and product design where it is used to create a step-by-step representation of how a user interacts with a service or system. A User Journey captures a description of what happens at each stage of the interaction, the user reactions, and what obstacles and barriers they may encounter. The method can be employed to explore actual experience of users or a "to-be" journey which looks at what people would like a service to provide or to build a consensus about what needs to be done [15]. The advantage of the User Journey is, while similar to a semi-structured interview, the process focuses more closely on the perceptions of stakeholders of a particular intervention or experience, allowing comparison over time and between stakeholders and enabling prioritisation of actionable insights.

The User Journey method has recently expanded in its use beyond design of a particular product or service to projects that involve multiple

stakeholders' expectations before an innovation or process is introduced, their experiences as it happens, their satisfaction, and unintended consequences that may result. An example is the exploration of a mini-solar grid in Tanzania which found from User Journeys that expectation management was crucial to avoid dissatisfaction among users and that continuous engagement after connection of the grids could mitigate the risk of service disuse [8,36].

For the exploration of container glass return and refill, User Journey interviews were held remotely over Zoom as it was found in an earlier pilot that there was more success with obtaining interviews than if face-to-face meetings were requested. Because our stakeholders have a deep knowledge of their domain, the User Journey approach allows a rapid interview process focusing on current friction points and possible opportunities for actions. Interviews lasted no more than one hour, with SC facilitating the discussions and JM capturing the points made using Mural [21], a web-based software package that can be used to create "node and link" diagrams.

The User Journey interview began with the presentation of the innovation, in this case "return and refill" of bottles instead of recycling. The interviewee was asked to cover topics around Friction Points which are challenges presented by the innovation, then any potential Solutions, and the barriers to those that would need to be addressed. They were also prompted during the discussion to think about what needs to happen to implement solutions, who would be the Responsible Party, what resources would be required, whether these would need to happen as a specific location (within the factory, at retailers, local hubs etc.) and any positive or negative outcomes for their business or for other businesses or communities that they could foresee.

2.1. Participants

Senior representatives of four key stakeholders covering different aspects of the UK glass industry were recruited for interviews between October 2022 and February 2023. The four representatives were:

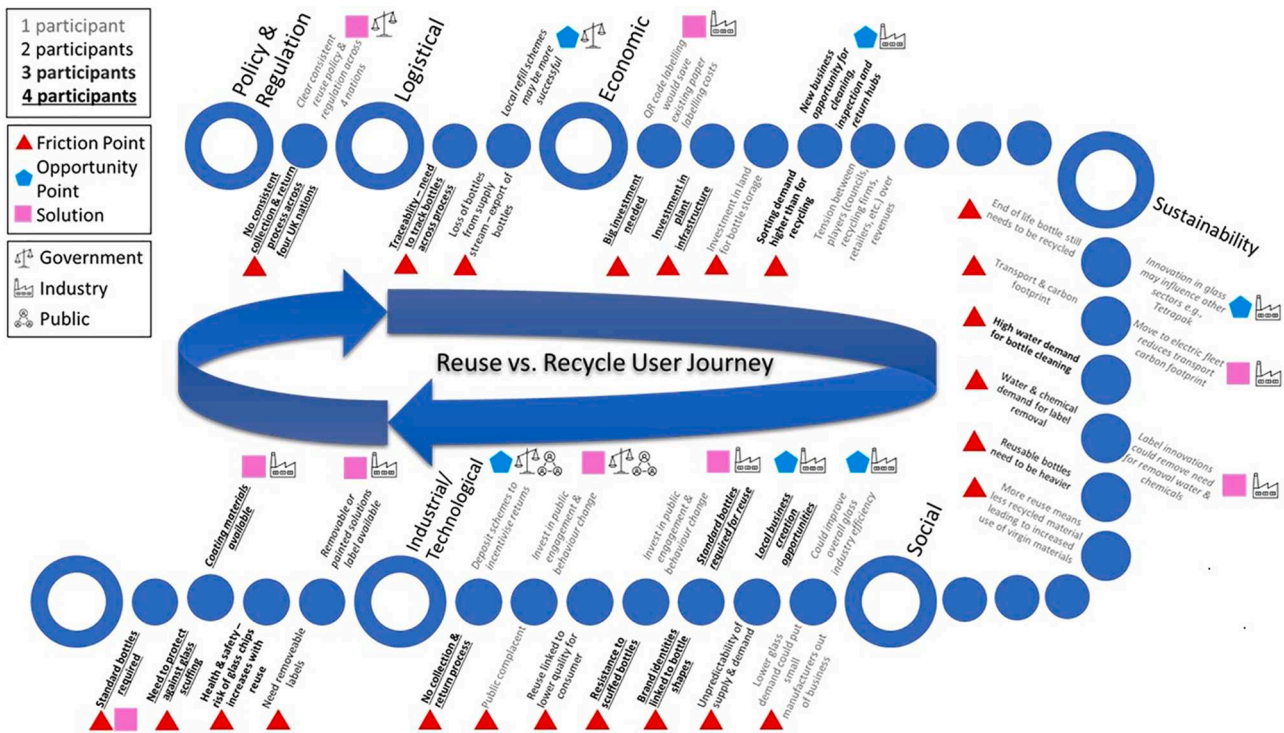


Fig. 2. Themes emerging from User Journey interviews [NOTE: color on the Web and in black-and-white in print].

- An academic expert and Technical Working Group lead for glass in TRANSFIRE with over 25 years of experience in working with the glass industry on production and sustainability issues;
- The lead for a large UK container glass company who is responsible for creating a more efficient and sustainable supply chain including innovative technology, integrated glass making, bottling, pallet creation for direct delivery to vendors, and more integrated logistics;
- The Global Procurement Sustainability Manager for Circular Economy & Packaging in a major international drinks distributor;
- The Technical Director for the UK glass industry representative body.

All participants were sent an Information Sheet and signed a Consent Form ahead of the interview in line with ethical procedures at the University of York.

3. Results

An example User Journey from the Glass Expert is presented in Fig. 1.

The User Journeys were collated and the two authors and another TRANSFIRE researcher who had not previously seen the maps categorised the challenges resulting in the emergence of six themes:

- Policy/regulation
- Logistics
- Economics
- Industrial/technological
- Sustainability
- Social

Each of these themes included sub-topics or details expounding on the main points raised by participants. Each theme was analysed for 1) which stakeholder(s) mentioned the issue: *Expert, Glass Manufacturer, Drinks Distributor, or Glass Trade Organisation*, 2) the type of statement: *Friction Point or Challenge, Solution* for a particular challenge, or *Opportunity Point* for affecting change or creating new business

opportunities, and 3) the responsible party(s) who would be responsible for the action: *Government/regulators, Industry, or Public*. The results are described for each theme and finding are represented graphically in Fig. 2 below. The full data with statements and analysis can be found in Appendix A.

3.1. Theme 1: policy/regulation issues

All interviewees mentioned the lack of a current collection and return process (as Friction Points in the User Journey). The other comments in this category were elaborations on such a scheme including mentioning the challenge of the four UK nations having different collection schemes inhibiting collective coherent action. Other comments reflected that solutions that would include a mandatory deposit return scheme and putting investment into increasing recycling for a circular system rather than refilling for a more sustainable process. The trade representative mentioned Germany as an example approach where brand owners are taxed to fund the collection process.

Two interviewees also mentioned the requirement in the UK for product labels to present a large amount of information on ingredients, health warnings, etc. in different languages. Embedded QR codes could replace the need for paper labels that must be removed for refill.

As would be expected, all of the issues were considered to be the responsibility of government (or the devolved nations) or regulators.

3.2. Theme 2: logistics

The comments in this theme fell into three categories: Traceability, Local area schemes, and Bottle loss.

Traceability was mentioned by all interviewees with Friction Points noting that tracing bottle usage is critical since bottles must be withdrawn after a certain number of uses and that standard bottles would be required for reuse which raised the question of who “owns” the bottle. Solutions suggested were embedded QR codes and one interviewee noted that, if presented effectively, this information could appeal to

Table 1
Policy/regulation issues.

Topic: collection and return process			
Subtopic/details	P	T	RS
No current collection and return process	DD, EX, GM, GT	FP	G
Steer and pressure for a successful refill scheme must come from policy/regulation	DD, EX, GM	S	G
Any refill scheme would require a mandatory deposit return scheme	DD, EX	S	G
The trade organisation has actively opposed a return scheme in favour of putting the investment into increasing the UK recycling rate for glass which is currently just under 50 %	GT	S	G
The four nations of the UK all have different collection schemes and brands have to operate across all of them	GT	FP	G
Consistency of collection across nations is being considered, but would require new infrastructure and processes	GT	FP	G
Looking at Germany as comparator, the brand owners are taxed on packaging to fund collection processes	GT	S	G
Topic: Large labels required			
Subtopic/details	P	T	RS
UK regulations require a great deal of information on labels including ingredients, different languages, health warnings, etc. Changing regulations to allow embedded QR codes replacing large labels could reduce the need for label removal for return and refill	DD, GM	S	G

Table 2
Logistics.

Topic: traceability			
Subtopic/details	P	T	RS
Traceability is critical	DD, EX, GM, GT	FP	I
Bottles cannot be used indefinitely so there would be a need for tracking number of uses	DD, EX, GM, GT	FP	I
If standard bottles were used for refilling, the question of ownership of returned bottles would need to be addressed	DD, GM	FP	I
Embedded or laser etched QR codes or other ID could be a solution	DD, EX, GM, GT	S	I, G
Embedded information could also appeal to consumers who may like to see the “journey” of their bottle	EX	S	I, P
Topic: Local area schemes			
Subtopic/details	P	T	RS
Local area refill schemes may work better than national ones	DD, GM, GT	OP	I, G
Logistics around transport and ownership would be easier locally	DD	S	I
Already happening in some areas:	DD, GM, GT	S	I
• DD already provides some cases of refilled beer bottles to off-trade retailers and spirits in kegs to pubs and restaurants in certain areas			
• A number of local breweries already use standard bottles and refill them			
• Local return and refill business is a small but growing area currently			
Topic: Bottle loss			
Subtopic/details	P	T	RS
Bottles are lost from the supply stream for many reasons	DD, GM, GT	FP	
85 % of spirits are exported from UK so bottles are not available to refill	DD, GT	FP	
Bottles are not returned in as high volume as numbers that are recycled; a less responsive system	GM	FP	P
8 billion single trip bottles/year in UK are made, many for export, which makes it difficult to standardise bottles widely	GT	FP	

Table 3
Economics.

Topic: Investment			
Subtopic/details	P	T	RS
Big investment needed for transition	DD, EX, GM, GT	FP	I, G
Need retooling or new plants for refill/new coatings/new labels	DD, EX, GM, GT	FP	I, G
Need for bigger production lines & double coating which is not done currently	GM	FP	I
Storage areas required for empties at manufacturers, retailers, collection points	DD, GT	S	I, G, P
Collected glass has a value, so need secure storage	GT	S	
Retailers are moving toward minimising footprint which dictates against large storage areas	GT	FP	
Collection and return process implementation required, e.g. local council/current recycling, retailers, transport logistics	DD, EX, GM, GT	FP	G, I
Sorting, cleaning, inspection facilities required	DD, EX, GM, GT	FP	G, I
This could be a new business opportunity, creating hubs for sorting, cleaning, inspection and return to refillers	DD, EX, GT	OP	G, P
Topic: Sorting			
Subtopic/details	P	T	RS
Amount of sorting required is inefficient in comparison to recycling	GM	FP	G, I, P
Proprietary/unique bottles make sorting very expensive	GM	FP	G, I, P
Topic: Tensions/opportunities among stakeholders			
Subtopic/details	P	T	RS
Councils are paid around £50/tonne for recycled waste glass. Who gets money for collect and return?	EX	FP	G, I
Possible to pay current recycling collectors to sort and return	EX	OP	G
Waste contracts are typically 10–20 years and companies aren’t going to change processes and types of lorries for recycling while contracts are in place	GT	FP	G, I

consumers who could see their bottle’s “journey” and might be more inclined to return bottles. Most of these actions were seen to be the responsibility of Industry, but also with some aspect of regulatory and public action.

Local area schemes were mentioned by all but the Glass Expert. Having bottle refill implemented in a local area scheme, as milk bottle collections are currently, could be an Opportunity Point that might work more efficiently and effectively rather than a national scheme. This solution offers easier logistics around transport and ownership and is already happening in some areas, such as with local breweries, the refilling of spirits in kegs for off-trade (restaurants and pubs), and small businesses offering milk, juice, and cleaning products. These actions were seen to be the responsibility of Industry, including small businesses.

Bottle loss was mentioned as a Friction Point by all but the Glass Expert. Bottles are not returned for refill in as high volume as are collection in recycling schemes. It was noted that 85 % of spirits are exported from the UK, removing a large portion of bottles that could be refilled by that sector and that 8 billion single trip bottles are made in the UK each year, many for export, which makes standardisation very difficult. No solutions were offered for this issue, though the rate of bottle return was considered to be the responsibility of the public, were such a scheme to be implemented.

3.3. *Table 3: economics*

Economic themes raised full under *Investment*, *Sorting*, and *Tensions/opportunities among stakeholders*.

Under *Investment*, all interviewees noted that a refill scheme would

Table 4
Industrial/technological.

Topic: standard bottles			
Subtopic/details	P	T	RS
Standard bottles are required for cost effective refilling	DD, EX, GM, GT	FP	I
Premium brands want unique bottles	DD, EX, GM, GT	FP	I
Consumers identify custom bottles with quality	DD, EX	FP	P
Easier to counterfeit a standard bottle	GM	FP	
Plastics aren't required to have standard bottles which could disadvantage the glass industry	EX	FP	G, I
Topic: Scuffing			
Subtopic/details	P	T	RS
Need to protect against scuffing	DD, EX, GM, GT	FP	I
Would need to use cold coating, new coatings, and/or double coating	DD, EX, GM	S	I
Would potentially need to recoat with each use	GT	S	I
Different bottle types required, e.g. shoulders on bottle to reduce scuffing, heavier for multiple use	EX, GM, GT	S	I
Topic: Health and Safety			
Subtopic/details	P	T	RS
Health and safety issues are the biggest concern for risk management	DD, GM, GT	FP	G, I
Glass chips in bottle is the biggest risk with reuse; likely after 4-5 uses	GM, GT	FP	I
Risks are higher with reuse than recycling	DD, GM	FP	
Need rigorous cleaning process, e.g. microbiology	DD	S	I
Topic: Label removal			
Subtopic/details	P	T	RS
Could use removable/peel-off labels that remove easily with reduced need for solvents and water	DD, GM	S	I
Could use painted labels that wash off; already used for some brands	GM	S	I

require a very large investment for retooling existing plants or building new ones for cleaning, recoating, relabelling and refilling. A collection scheme would also require negotiations with local council/current recyclers, retailers, logistics and others. A solution offered was to require storage areas at retailers but Friction Points associated with this were that retailers are moving toward minimising physical footprint and that collected glass has a market value which would necessitate secure storage, adding additional cost. It was noted that there could be an Opportunity Point for the creation of new businesses innovating hubs for collection, cleaning, inspection and return to refillers. These issues were seen to be a mix of government and industry responsibilities.

Sorting was only mentioned by the Glass Manufacturer who noted it as a Friction Point because it is a more inefficient process than recycling. If there were proprietary branded products, it would make sorting even more difficult.

Tensions/opportunities among stakeholders around economic issues were mentioned by the Glass Expert, noting that councils are paid for recycled glass but it is unclear who would get money for collect and refill. There could be an Opportunity Point for paying recycling collectors to sort and return, but this would likely require regulatory action. The Glass Trade interviewee noted that waste contracts are typically 10–20 years and companies aren't going to change processes and types of lorries for recycling while contracts are in place without regulatory intervention and public investment.

3.4. Theme 4: industrial/technological

Under this theme, the main topics raised were *Standard Bottles*, *Scuffing*, *Health and Safety*, and *Label Removal*.

All interviewees mentioned challenges around the *need for standard bottles* for cost effective return and refill schemes. Friction Points

Table 5
Sustainability.

Topic: Innovation in glass industry			
Subtopic/details	P	T	RS
Pressure to innovate and be more sustainable in glass may drive change in other industries, e.g., plastics, Tetra Pak	EX	OP	I
Topic: Carbon footprint			
Subtopic/details	P	T	RS
If returned, likely bigger transport carbon footprint – transport to collection point, sorting/cleaning facilities, then refiller, then back to retailer; also heavier bottles	GT	FP	I
Electric vehicles could reduce the carbon footprint	GT	S	I
Refill uses less energy than remelting	EX		
Topic: Sustainability of refill vs recycling			
Subtopic/details	P	T	RS
Is refill more sustainable than recycling? Needed research on full environmental footprint in UK	DD, GM	OP	
Putting a smaller investment into increasing recycling rather than a large investment in refill could be cheaper, more efficient and more sustainable	GM, GT	OP	G
Glass industry is moving toward net zero for manufacturing and transport by 2030; what is the clear advantage of reuse?	GT		
Will be high losses of bottles in process of collection, washing, rejects on inspection; still have to be recycled at end of life	GM	FP	I
Stealing glass from recycling may ultimately require more virgin materials	EX	FP	
Topic: Cleaning			
Subtopic/details	P	T	RS
Cleaning for refill uses a lot of water	DD, GM, GT	FP	I
Find other cleaning methods, e.g., DD uses spoiled alcohol in Mexico for cleaning to save water	DD	S	I
Labels have to be removed, requiring water and chemicals	GM, GT	FP	I
Label glues gunge up machinery and require more demanding cleaning; more energy and cleaning solutions	GM	FP	I
Painted or peel-off labels could be removed more easily but are more expensive	GM	S	I
Topic: Weight of bottle			
Subtopic/details	P	T	RS
Reusable glass needs to be heavier for durability so more resource intensive to produce and transport	DD, GM, GT	FP	I

associated with this issue were that premium drinks brands and consumers identify custom bottles with quality, that standard bottles are easier to counterfeit, and that plastic bottles are not required to be standard which could disadvantage the glass industry. No solutions were offered to this challenge. *Scuffing* was also identified as a friction point by all interviewees. Bottles would require more robust coatings and would potentially need to be recoated after each use. Also, bottles would need to be redesigned to reduce scuffing, such as creating shoulders on the bottle shapes. Again, no solutions were offered for this challenge. *Health and safety* issues were noted by all but the glass academic expert. Glass chips in bottles were considered the biggest risk and chips would be much higher with reuse than recycling. Bottles would also require a rigorous cleaning process to remove any potential microbiological hazards. Finally, *need for label removal* was mentioned by the Drinks Distributor and the Glass Manufacturer. Solutions offered were to redesign labels to be removed easily without greatly increasing the need for solvents and water and permanent painted labels which are already being used for some brands.

3.5. Theme 5: sustainability

The Friction Points that emerged under the theme of *Sustainability* were *Carbon Footprint*, *Refill vs Recycling*, *Cleaning* and *Weight of Bottles*.

Table 6
Social.

Topic: design of return process			
Subtopic/details	P	T	RS
National/UK collection and return process required	DD, EX, GM, GT	FP	G, I
All actors need to act in concert, e.g., manufacturers, distributors, retailers, regulators, policy makers	DD, EX	S	G, I
Deposit scheme must be attractive enough to incentivise returns	GM	OP	G, P
Topic: public engagement			
Subtopic/details	P	T	RS
Public are complacent. Need to get recycling up to 90+ percent as in Germany & Scandinavia	GT	FP	G, P
Irn Bru and Britvic in Scotland had returnable scheme until recently, but stopped because of public confusion and disinterest	GT		
Need to invest in getting better public engagement	GT	S	G, P
Topic: Public perception of standard refillable bottles			
Subtopic/details	P	T	RS
Reuse means lower quality to a proportion of the public	DD, EX, GM	FP	P
Public don't like scuffed bottles	DD, EX, GM, GT	FP	P
Create a market for "artisanal" reused bottles that include scuffs	DD	S	I, P
Need to change consumer opinion	GM	S	G, I, P
Premium brands are known for unique bottles	DD, EX, GM, GT	FP	I
Consumers identify custom bottles with quality	DD, EX	FP	P
Topic: counterfeiting			
Subtopic/details	P	T	RS
Easier to counterfeit standard bottles	GM	FP	G, I, P
Topic: unpredictability			
Subtopic/details	P	T	RS
Unpredictability of supply/demand	DD, GM, GT	FP	
No control over when bottles come back	GM	FP	
Hoarding is a problem in some places and at some times	GM	FP	P
Times when need a bigger production is required, e.g., Christmas, World Cup	DD		
What percentage of bottles would actually be returned?	GM		
Recycle vs refill will confuse consumers and wrong bottles will be returned or right ones not returned	GT	FP	G, P
Topic: local business opportunities			
Subtopic/details	P	T	RS
Could create local business opportunities for facilities to collect, clean, inspect and return to fillers	DD, EX, GM, GT	OP	G, I, P
Locate facilities near refillers or in places of highest demand	DD	OP	G, I
New opportunities for expanding local return and refill business	GM, DD, GT	OP	G, I, P
Topic: small manufacturers			
Subtopic/details	P	T	RS
If demand drops for new glass, small glass manufacturers may go out of business. A win on some levels like efficiency, but not for jobs unless new skills, businesses are promoted	EX	FP, OP	G, I, P

The trade representative noted that returning bottles for refill could result in a bigger *Carbon Footprint* depending on distance of transport to collection point, sorting/cleaning facilities, refilling, and transport back to retailer. This interviewee also noted that electric vehicles could help remediate some of this increased footprint. This increased carbon footprint would need to be compared to the higher energy use required for

remelting bottles vs refilling.

The related topic of *refill vs recycling* was noted by all interviewees who raised different Friction Points. There was a belief that putting a smaller investment into increased recycling rather than a large investment in refill could be cheaper, more efficient and more sustainable. The glass manufacturer noted that there will be significant losses of bottles in process of collection, washing, and rejects on inspection that will still have to be recycled at end of life. The glass trade representative noted that the UK glass industry is on track to reach New Zero for manufacturing and transport by 2030 and wondered whether there is a clear advantage of reuse. The glass academic expert also noted that stealing glass away from recycling may ultimately require more virgin materials, especially if export patterns remain unchanged. Finally, interviewees noted the need for research on the full life cycle environmental footprint for both options in the UK.

Under the topic of *Cleaning*, all interviewees except the academic expert noted the increased need for water for cleaning and removing labels for refill. The Drinks Distributor noted a Solution could involve other cleaning methods, such as using spoiled alcohol from distilleries which they are doing in Mexico to reduce water use. The manufacturer also noted that label glues can gum up machinery and that a Solution would be to use painted or peel-off labels but these are more expensive. Finally, there would also be the need for more robust and hence *heavier bottles* which would be more energy intensive to produce and transport.

The glass expert also noted as an Opportunity Point that pressure to be more sustainable in the glass industry could drive change in other container manufacturers such as plastics and Tetra-Pak.

3.6. Theme 6: social

The final theme emerging from the interviews was *Social* factors. These issues fell into the topics of *Innovation*, *Public Engagement*, *Public Perception*, *Counterfeiting*, *Unpredictability*, *Local Business Opportunities*, and *Small Manufacturers*. Under *Innovation*, all interviewees mentioned the need for a national UK collection and return process. Two interviewees noted that this will require all actors to act in concert – manufacturers, distributors, retailers, regulators and policy makers. The manufacturer added that any national deposit scheme must be attractive enough to incentivise a high return rate. A related point was raised that the *Public Engagement* is quite low as shown by recycling rates in the UK being well below places such as Germany and Scandinavia. The trade representative noted that Irn Bru and Britvic had a return scheme until recently, but people did not return bottles at a high enough rate, so this was stopped. Under *Public Perception*, most interviewees mentioned that the public don't like scuffed bottles and that reuse is often perceived as meaning a lower quality product by a proportion of customers. Relatedly, all interviewees noted that heavier, custom bottles are also perceived as containing higher quality products. Solutions offered were to create a market for "artisanal" bottles that might be scuffed and a general need for campaigns to change public perceptions. The glass manufacturer noted that it is easier to *Counterfeit* standard bottles and this is already a problem with products such as vodka that are often in a standard bottle shape. The logistical issue of *Unpredictability* was mentioned by all except the academic expert. There can be an unpredictable supply and demand throughout the year with hoarding being an issue in some places and higher production needed at other times to meet demand peaks, such as Christmas and during major sporting tournaments such as the World Cup. The trade representative mentioned that not all bottles will be returnable which will confuse consumers and could result in the wrong bottles being returned. All interviewees noted that this could be an Opportunity Point for creating *Local Business Opportunities* for collection, inspection, cleaning and return, especially if facilities were located near refillers in places of highest demand. The issue was raised by the expert that if demand for new glass drops, small manufacturers may be driven out of business, a win for efficiency, but a loss for job opportunities.

The User Journey interviews with stakeholders in the glass, glass research and drinks industry revealed a number of legitimate regulatory, logistical, economic, social and industrial challenges to large scale, nation-wide refill schemes. Fig. 2 visualises the main points in the User Journeys by theme, type and the parties that would be responsible for addressing each issue.

4. Limitations of the study

While we interviewed a small sample of stakeholder representatives, they are key senior players within the UK glass industrial sector. The goal of this study was to reflect the views of a particular group of influential and knowledgeable stakeholders in the dynamic context of the UK glass industry. Therefore, this study is not intended and likely will not be generalisable to the challenges or opportunities of other countries, contexts or industries. We would argue, however, that it does give a valid snapshot of the views of the major UK players at this point in time [9]. It would be useful to replicate the interviews in the near future as policies are currently being discussed and rolled out that may affect the glass industry, including Extended Producer Responsibility, Consistency of Collections, and Deposit Return schemes.

5. Discussion

The diagram in Fig. 2 indicates a high commonality of concerns amongst participants around Policy & Regulation, Logistical, Economic, Industrial/Technological, and Social themes. There was somewhat greater diversity of views on problems and solutions related to the Sustainability theme, with a greater proportion of issues mentioned by a single interviewee. Most solutions identified are within industries' sphere of influence with exceptions around the need for clear legislation mandating the approach and stipulating the deposits. Additionally, the behaviour change linked to education means that the public would also be a key stakeholder in any successful adoption of reuse. These findings highlight that if clear, consistent policy were introduced, most factors influencing success are related to industry innovation but would require support and investment for transition as well as behaviour and attitude change to help ensure consumer acceptance of the reuse of glass.

If such a scheme were introduced in the UK, it would clearly require legislation which is the responsibility of National Governments, necessitating coordination across the four devolved legislatures to ensure consistency. All parties would need to act together to introduce a cascade of changes from collection and storage processes to sorting, cleaning, refilling and relabelling. It is likely that only a subset of bottles could be refilled, such as beer and soft drinks which could use standardised bottle types. The Glass Expert also noted that if requirements for standard glass bottles were introduced, it is possible that it would drive drinks producers to more use of plastics or Tetra Pak for brand differentiation, thereby disadvantaging the glass industry and harming sustainability.

Some of the technical and logistical issues have technological solutions such as QR code labelling for tracking use, easily removeable labels or organic paint that won't clog washing machines, and different coating methods to reduce scuffing. These challenges which are under the control of the manufacturers seemed of less concern to most of the stakeholders as the other barriers that were in the hands of other players. Indeed, some glass container producers are already using methods such as painted or etched QR codes to encode information for traceability, as is done with other glass products including windows and laboratory equipment. Embedded codes could help reduce the counterfeiting of standard glass bottle shapes.

There are also challenges with the international nature of glass production and trade. A large percentage of the glass bottles manufactured in the UK are exported, resulting in a loss of materials over which the industry has control. Imported glass can be recycled but would be more difficult to reuse because of the specific requirements for

standardised bottle production unless all participating countries followed the same route.

Participants asked the fundamental question: What is the most sustainable way to use glass bottles? They noted that while refilling uses less energy than remelting, it is important to look at the entire lifecycle including collection, cleaning, transport, need for heavier bottles, etc. It could be that a smaller investment in increasing recycling rates from the current low levels in the UK rather than a large investment in return and refill could be cheaper, more efficient and more sustainable, especially since glass will still need to be recycled at the end of life. Also, the UK glass industry is moving toward net zero for manufacturing and transport by 2050 without including refill in their strategy [6], so a clear environmental advantage for reuse needs to be shown. A full environmental, economic, and behavioural analysis of UK glass production and consumption would aid in making decisions more evidence-based and transparent.

A Life Cycle Assessment modelling study of German wine production concluded that packaging materials accounted for 57 % of GHG emissions from "cradle to grave" and that the mitigation potential of reuse of a standard weight bottle (~0.5 kg) exceeded that of reduction in weight of single-use bottles to 0.4 kg by more than threefold (36 % reduction vs. 11 %). They acknowledge limitations of a national scheme, most of which were mentioned by our interviewees, including lack of infrastructure for collection, transport and cleaning, high transport cost and associated emissions for long distances, and additional cost for reusable bottles. They note a resistance from wine producers, retailers, and supermarkets, which distribute approximately 87 % of the wine consumed, to limiting themselves to standard bottle types and the reduced individuality of packaging design. They also note a need for wine consumers to make the extra effort to return glass bottles to a collection point instead of disposing of them into a recycling container. They did not consider the impact of increasing recycling because the rate in Germany is already high, at around 90 % [25].

The increase in local refill schemes was mentioned by three interviewees, noting the potential to expand local refill solutions. The drinks distributor already does refills of beer and spirits for some pubs and restaurants where demand is high. A growing number of companies in the UK offer deliveries of milk, juice, cleaning solutions, and other products in returnable glass containers. Tua, et al. [32] analysed the environmental impact of single use vs reuse glass bottles and concluded that within a 200 km range when compared to single-use glass, refillable bottles were by far preferable starting from two deliveries. However, the distance between the bottling plant and the local distributor played a key role in the impact. For a 400 km distance, at least 4 uses of the refillable bottles were required to achieve better environmental performance and for 800 km or more, returnables did not achieve better performance even after 30 uses. This suggests that local refill schemes may be viable and desirable for products that are produced in the area, such as milk or beer, but would depend greatly on distance to refill sites for less local products such as wine or cosmetics. Nevertheless, it could be viable for products such as wine if imported in bulk and then bottled in the UK, assuming other challenges such as standard bottles and a collection and cleaning process were overcome. It is estimated that bulk import of the most popular wine brands already reduces emissions by 50 % over shipping in bottles [11] and reusing bottles could reduce them even more.

The population density of the four constituent countries could make the UK ideally suited to an efficient reuse scheme from a transport logistics perspective. It had the fourth highest population density (266 people per square kilometre) of the EU countries in 2014, most similar to Germany (227 people per sq km). England has the highest density of more than 400 people per square kilometre making introduction of an efficient network of reuse hubs potentially feasible in terms of transport and energy efficiency [24].

While there is a growing interest in refill, at a consumer level most of the discussion is around reuse of plastic containers and reduction of

single use plastic with much less about glass refill [30]. Some supermarkets and retailers offer refill stations or bulk bins where shoppers can fill containers. However, supermarket chain Tesco ended its pilot scheme in 10 stores offering shoppers the option of paying a deposit for returnable and refillable containers, deeming it to have “strong potential”, but requiring industry, policymakers and supply chains “to work hard and work collectively to support and incentivise customers to adopt new shopping behaviours” [19]. Other food retailers, Marks & Spencer, Morrisons and Waitrose, are all running pilot schemes currently as part of the Refill Coalition [14] and product manufacturer Unilever is running pilots of returnable, refillable metal bottles for household and beauty products [16]. Again, none of these pilots prioritise returnable and/or refillable glass containers and are aimed primarily at reducing single use plastic.

Social barriers were mentioned in all the User Journeys and raised the challenge that any return scheme requires both consumer and producer behaviour change. Social factors play a large role in any successful scheme and more research is needed to indicate the willingness and capacity of the UK public to participate in the high return rate needed. The public would need to have a willingness to sort and return properly. Concerns were raised that consumers would be confused by the fact that some bottles could be returned and some recycled, but the differences are often not readily apparent. Such confusions are already problematic for plastics and other materials in the UK, creating a need for expensive and time-consuming sorting or rejection of whole loads [23,28]. For example, Irn Bru (a Scottish carbonated soft drink company) saw a fall from 90 % returns to less than 50 % as people began recycling rather than returning bottles and stopped the scheme in 2015 after 110 years [3]. Britvic, another British soft drink producer, stopped its returnable scheme for bars and restaurants in 2007, citing a number of reasons including fewer lorry journeys, much lighter bottles, easier storage and disposal, and appeal to customers who dislike scuffed bottles (Let’s [17]).

Some of these social challenges may not be as insurmountable as interviewees suggested. For instance, there is research that indicates that at least in some sectors the public may be relatively accepting of scuffed bottles. Vaughn et al. [34] investigated attitudes toward refilling of milk bottles which is still a sector that exists in many areas of the UK. They found that all the participants felt that knowing the lifetime of the bottle was a positive indication of sustainability and the care given to the process, with one participant noting, ‘*If I had a milk bottle that had been used 200 times, I would feel pleased and handle it with great care.*’ Nevertheless, the dairy that was being studied chose to withdraw scuffed bottles via automatic scanners because of a belief that customers did not like the marks.

There has been speculation that return schemes will result in lower consumption of glass and higher rates of collection, but an analysis of a wide range of countries with different collection methods found that deposit and return schemes for glass did not show significant effects in consumption or waste reduction compared to countries that use other collection means such as kerb-side recycling, often because return schemes cover only limited types of glass containers, e.g. beer bottles, mineral water bottles, but not jars or wine bottles [1]. An environmental and economic analysis of the full lifecycle of container glass in both pathways as well as a better understanding of social challenges would help in decision making and design of any return and refill process.

While these four major stakeholders expressed a great deal of consensus, they are only four representatives. Future research could explore a larger sample and a wider range of industrial partners for validation and prioritisation of actions via User Journeys, larger targeted questionnaires and/or Delphi processes (Tables 1,2,4–6).

6. Conclusions

Key glass container stakeholders raised a wide range of challenges and possible solutions for a UK return and refill scheme that covered

challenges in policy/regulation, logistic, economics, industrial and technological areas, sustainability, and social arenas. Most issues were raised by multiple interviewees, though there were some interesting points raised by a single stakeholder, such as the ease of counterfeiting standardised bottles. These interviews demonstrated the efficacy of the User Journey method to elicit a range of responses in a structured, but open manner from a variety of stakeholders in a relatively short time. All the interviewees were very engaged and found the interview process stimulated them to think of areas they might not have considered before.

It was agreed that encouraging local return and refill schemes for certain product ranges could be an effective and environmentally beneficial approach, reducing the transport costs significantly and creating local jobs. This was also the conclusion of an analysis of the circular potential for beverage containers in the USA, recommending expansion of localised glass bottle refill/reuse systems, with unusable bottles directed towards glass recycling [29]. However, there was also stakeholder consensus that given the high recyclability of container glass and the complexity of having both recycling and refilling schemes, it may be that investment in promoting colour-separated glass collection and increasing the recycling rate in the UK to over 90 % could be a cheaper, faster and more sustainable approach, especially given the strategy for net zero manufacture of container glass in the UK. There was also concern that unless processes are carefully monitored and balanced, return schemes may encourage more use of virgin materials and higher energy use because of the removal of waste glass from the manufacturing process.

It is very clear that any successful reintroduction of reuse schemes into the UK would require national coordination of all parties involved including legislation to ensure efficiency and effectiveness along with support for education and promotion to consumers. Only this national level of oversight and investment into behavioural change would ensure that any such schemes are attractive to producers and consumers and are efficient in meeting Net Zero ambitions.

CRedit authorship contribution statement

Steve Cinderby: Conceptualization, Formal analysis, Funding acquisition, Investigation, Methodology, Validation, Visualization, Writing – original draft, Writing – review & editing. **Jean McKendree:** Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Software, Writing – original draft, Writing – review & editing.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available on request.

Acknowledgements

Thanks go to Juan Ramon (JR) Candia for his helpful discussions and contribution to theme analysis and Professor Paul Bingham of Sheffield Hallam University for his help in understanding the glass manufacturing landscape. Thanks to all our interviewees for their strong engagement and enlightening discussions.

Funding

This work was supported by the TransFIRE project funded by UK Research and Innovation [grant number EP/V054627/1].

Appendix A. Tables of Analysis of Stakeholder Statements

Column P (Participants mentioning issue):

EX (Academic Glass Expert)
GM (Container Glass Manufacturer)
DD (Drinks Distributor)
GT (Glass Trade Organisation)

Column T (Type of Statement):

FP (Friction Point/Challenge)
OP (Opportunity Point)
S (Solution)

Column RS (Responsible Party)

G (Government/Regulatory)
I (Industry)
P (Public)

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