

# **Sector-Specific Barriers to Implement Circular Economy Practices in the Craft Beer Industry**

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## **ABSTRACT**

A circular economy constitutes a closed-loop system, which fosters the prolonged use of materials and products, thereby reducing virgin resource extraction and waste generation. Despite the recent popularity of the concept, companies struggle with the implementation of the concept, attributed to various “circular economy barriers”, which might differ depending on the occupied industry. Thus, the study aims to understand the sector-specific barriers that hinder the implementation of a circular economy in the craft beer industry. A qualitative multiple case study approach through six semi-structured interviews is conducted.

The findings align with previous literature on circular economy barriers in SMEs, with the exception of two barriers, which were unexpectedly revealed as drivers within the craft beer industry. Additionally, sector-specific and context-specific insights emerged, providing a deeper understanding of the particular challenges the industry faces with implementing a circular economy.

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## INTRODUCTION

Driven by the concept of economic growth, humanity is actively pushing the limits of the planetary boundaries that could lead to abrupt and irreversible environmental changes (1). A compelling illustration of this is the current "take-make-waste" approach whereby natural resources are extracted to manufacture goods that are then discarded, based on the flawed assumption of the infinite availability of resources, perpetuating their depletion. To depart from the current unsustainable model of production and consumption, a transition towards a circular economy (CE) is proposed, which entails a closed-loop system where products, components and materials remain in use at their highest value, thereby minimising waste and reducing the need for virgin resource extraction (2). Though the increased attention towards CE for its benefits for sustainable development (2), the transition remains in its infancy (3).

With the practical implementation of the CE being particularly challenging, a body of recent literature has emerged on the barriers hindering CE implementation (4–7). Takacs et al. (4) propose a holistic framework, highlighting the interaction of six internal and twelve external barriers falling under the following areas: company-internal, technology, market, legislative, society and consumers. Ultimately, the recent studies call for a more detailed analysis of sector-specific differences with respect to the identified barriers (4,5). Hence, this study explores how the identified barriers hinder the implementation of a CE in the craft beer industry in the Netherlands.

This industry in the Netherlands is selected for the following reasons: 1) there has been a rapid expansion in the industry since 2003, resulting in over 900 microbreweries in the present (8,9); 2) it faces sustainability challenges as the production of beer is water and energy intensive and generates a significant amount of waste – biological and technical (10); 3) being small- and medium-sized businesses, microbreweries face unique challenges to

implementing CE than large volume producers (4,11); 4) although one microbrewery might have negligible impact on the environment, collectively their impact is relevant.

With the aim to contribute to recent literature on barriers hindering the implementation of a CE, provide practical recommendations to overcome sector-specific barriers and promote resource efficiency in the craft beer industry in the Netherlands, the following research question guides this study:

*What are the sector-specific barriers to adopting circular economy practices in the craft beer industry?*

Thus, this study employs a qualitative case study approach, interviewing five craft brewery owners, head brewers and one water expert to understand the challenges of implementing circularity within this industry.

## **THEORY**

This study investigates the sector-specific barriers to implementing circularity in the craft beer industry. An overview of the existing literature and relevant theoretical frameworks is presented to address this research objective. First, the broad concept of CE is introduced, followed by a section which discusses the existing frameworks on barriers to a CE. Lastly, what CE would constitute for the craft brewing industry is considered.

### **The Circular Economy**

The concept of the CE emerged, influenced by the work of Boulding (12), who emphasised the closed system nature of the earth, highlighting that humans inhabit a finite planet with finite resources and limited capacity to absorb waste. This led to the idea that resources should be utilised for more prolonged periods within the economy to limit environmental degradation and preserve long-term ecosystem productivity, highlighting the need to internalise externalities (13). With time the concept developed further and evolved into an umbrella term consisting of various concepts with the common idea of closed loops (14).

The concept emphasises that the economy should transition from the current linear system, where products and materials are not used to their full potential, to a circular one, where resource input and waste, emission, and energy leakage are minimised (15). To achieve a circular system, organisations must transform their business models in line with the strategies such as cycling (reusing, refurbishing, remanufacturing, recycling), extending product use, intensifying product use, or dematerialising (providing product utility without hardware) material and energy loops (15).

## **The Barriers to Circular Economy**

Despite the recent popularity of the CE concept, there is limited progress in implementing CE (3), which a handful of studies have attributed to various CE barriers (4–7) faced by organisations in general. This study adopts a framework for the barriers to a CE in the context of SMEs, which classifies the barriers into internal and external under the thematic levels – company-internal, technology, market, legislative and society and consumers (4).

Within the company-internal level, there are six barriers: risk aversion, short-term orientation, economically dominated thinking, unwillingness to engage in trade-offs, shortage of resources, and lack of knowledge (4). Implementing a CE is often associated with radical innovation and structural change within small and medium-sized enterprises (SMEs) (16). Consequently, these barriers build internal resistance to implementing a CE.

Within the technology level, three barriers hinder the implementation of a CE. First, the immaturity of technological solutions is concerned with the limited practical implementation of solutions, which are technically feasible but limited by economic and market limitations (7). Second, the limited circular potential is related to the chemical and physical mechanisms, which decrease product usefulness and CE potential (4). Third, constraining product design choices refer to the requirements that present a challenge for the product to be designed for CE (5), which can hinder the possibility of being recycled, repaired and reused.

Within the market level, four barriers take place. First, lack of transparency refers to the imperfect information in the market in the context of CE. For example, imitating role models can bring about sustainable change in companies (17); however, there is a lack of role models demonstrating how to implement CE (4). Another market barrier – price premium – is concerned with the high upfront investment cost and low virgin material prices, which prevent CE adoption (4–6), as recycling is uneconomical relative to the production of virgin

material (18) and CE practices are so expensive that subsidies are required to ensure economic viability (19). Additionally, unequal market power hinders CE, as SMEs are pressured by large competitors exploiting their power (4). Lastly, high cross-sectoral collaboration is required to achieve the circularity of products and materials (20). However, businesses lack the willingness to collaborate as collaborations across the supply chain might be intrusive and hamper the competitive nature (21); therefore, a lack of willingness to collaborate serves as a barrier (4,5,22).

Within the legislative level, three barriers are prevalent. First, hindering legislation refers to policies that hamper the implementation of CE. For example, by-products are categorised as waste even if they can still be used (4,6,7). The second barrier is the lack of institutionalised systems and standardisation, which hinders the reuse of products and materials (4). Lack of standardisation has also appeared in other studies (5) but is categorised as a market barrier. The third barrier, the lack of clear signals from legislators, refers to the lack of signals in the form of laws and procurement favouring CE (4,5).

Within the society and consumers level, two barriers hinder CE. Distorted societal values concern the prevailing consumer attitudes, such as cheapness, throwaway mentality, and fast-changing trends, which hinder CE (4). Another barrier is the lack of consumer awareness of CE and the circularity of purchased goods (4,20), including consumer preferences and willingness to pay for the product (4).

The complete framework is provided in Fig.1, illustrating how organisations are embedded in the external environment and how the different levels of barriers to implementing CE are interconnected. Internal barriers influence each other and are also influenced by external barriers. While the external barriers are interwoven and impact one another (4).

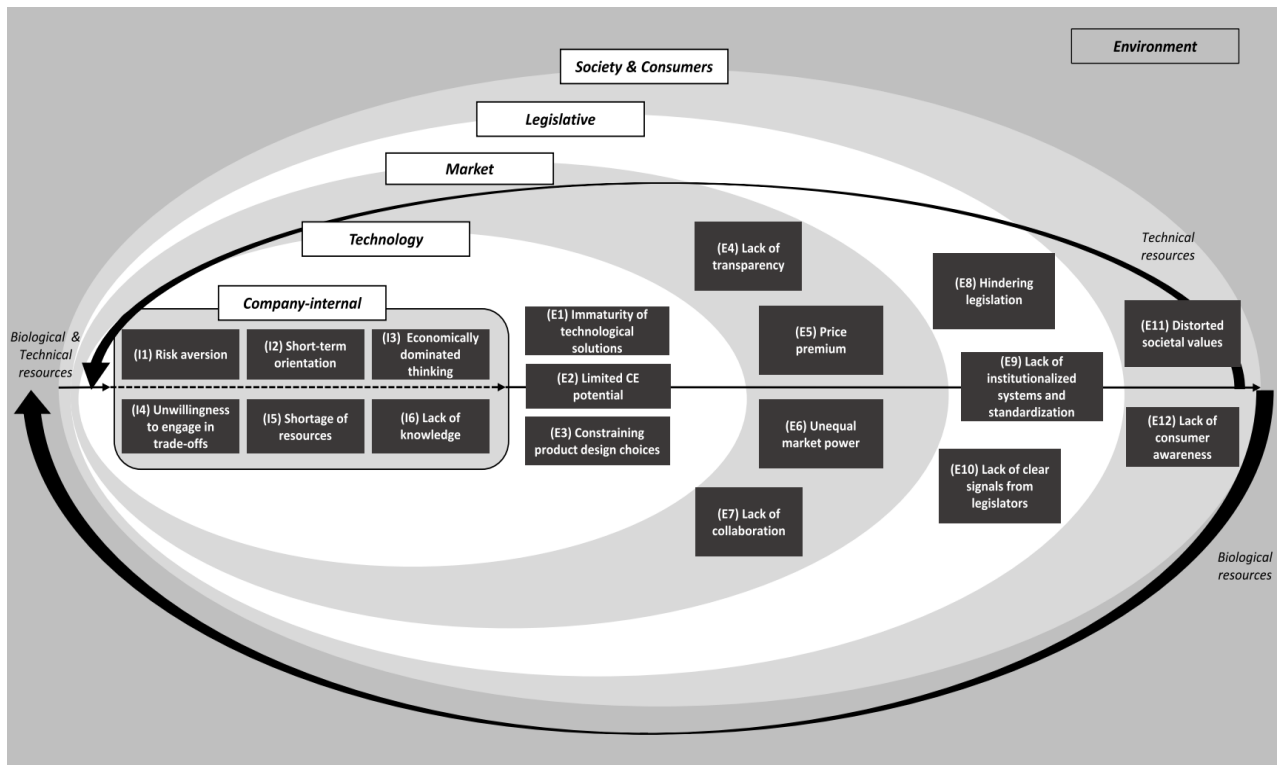


Fig. 1 Multi-level framework with integrated barriers (4).

## Circular Economy in the Craft Beer Industry

Although the definition of craft brewing may differ across countries, two distinctive elements that set craft breweries apart from conventional ones are their small size and independent ownership(23). Following these distinct characteristics, craft breweries face different environmental challenges (11) stemming from energy- and water-intensive processes and significant generation of organic and technical waste (10). Thus, craft beer breweries can close the open loops by implementing practices aligned with CE.

Within existing literature, several CE practices for craft breweries have been identified. For instance, craft breweries could install a condensate recovery system to minimise energy use, enabling heat energy recovery and reuse for subsequent batches (24). Similarly, a water recovery system can be installed to capture hot water (24). Regarding biological waste

generation, such as spent grains, a common practice is providing the by-product to cattle farmers (11,24,25). Furthermore, craft breweries use reusable steel kegs and glass bottles to reduce technical waste, with the life-cycle analysis also proposing using aluminium cans as another less-footprint alternative (26). Additional CE practices, derived from academic literature and business examples, can be found in Appendix A.

## **RESEARCH METHODOLOGY**

This study aims to investigate sector-specific barriers that hinder the implementation of a CE in the craft beer industry in the Netherlands and to develop a deeper understanding of these challenges. To achieve this objective, a qualitative research method is selected as it is suitable to study in-depth the participants' attributed meanings and associated relationships regarding the challenges of implementing CE practices (27). Hence, emphasising words rather than quantification is necessary (28).

### **Research Design**

#### ***Multiple Case Study Design***

A multiple case study design is selected as a framework to guide the collection and analysis of data, as it is suitable to answer "What" research questions and conduct an in-depth analysis of contemporary phenomena (29), namely the barriers microbreweries face when striving to implement circularity. Furthermore, it allows for emphasising the complexity and precise nature of the cases in question (28). Multiple cases are selected for the advantage of comparing and contrasting the different cases to come up with differences and similarities across them (30), which in turn will allow extending the theory on CE barriers in the context of the craft brewing industry. Additionally, this study was conducted in a single moment in time due to the timeframe set in the master's program.



### *Sampling*

To answer the research question of this study, the cases of interest are microbreweries operating in the craft beer industry in the Netherlands. The researcher employed purposive sampling, a non-probability form of sampling, to identify and deliberately select breweries that can provide rich insights on the topic (28). The sampling ensures that the selected breweries have knowledge and experience in circularity implementation in the industry, as they have implemented different practices.

First, relevant breweries were contacted during a craft beer conference on the topic "Efficient and Responsible", focused on energy and water efficiency and minimisation of waste generation. However, out of eight invited breweries, only three agreed to participate in the study. Consequently, more breweries were contacted per a list of the "Most sustainable craft breweries in the Netherlands" (31) obtained through a Google search with the keywords such as "craft breweries", "circularity", and "the Netherlands". As the list was acquired from a blog post, breweries were contacted if their website had a page devoted to sustainable or circular practices. Thus, out of 16 emails sent, only two additional breweries agreed to an interview, resulting in an overall response rate of 20%.

Ultimately, interviews were conducted with five craft breweries with different circular practices (see Appendix B). Despite the efforts to secure a brewery, which has incorporated residual flows in the brewing process, this study does not benefit from such perspectives.

Additionally, since efforts to include more participants continued until after some of the interviews were conducted, a lack of sufficient inputs was identified on reducing water use in the brewing process. No other brewery agreed to participate; therefore, an interview was also conducted with a water expert involved in institutional work within the craft beer industry, who provided interesting insights on reducing water use.

## **Data Collection**

### ***Semi-Structured Interviews***

This study makes use of semi-structured interviews for the collection of data. It is best suited as it allows both a structure in discussing the barriers to CE and flexibility in asking additional questions to obtain new insights as interesting topics emerge during the interview (28). The interviews follow a guide (see Appendix C) with predetermined main themes based on the theoretical framework of CE barriers in small and medium-sized enterprises (4).

### ***Conducting the interviews***

Prior to conducting the interviews, informed consent (see Appendix D), following the Ethics guidelines of the University of Groningen, was distributed to the participants. The interviews took place face-to-face, online and by phone to accommodate the availability of the participants. Due to a lack of availability, one participant provided the answers to the interview guide in written form.

Additionally, the discussions were conducted in English in April and May and recorded (see Appendix D) with OBS Studio (32) after consent was obtained. The interviews lasted from 30 minutes up to an hour and a half.

## **Data Analysis**

After conducting the interviews, the recordings were transcribed with the software Descript (19) and inspected for any errors and the presence of sensitive information. Then, the transcripts (see Appendix D) were reread multiple times to gain an understanding of the data.

Consequently, the transcripts were uploaded to Atlas.ti (33) for coding and thematic analysis. First, each case was coded with different colours assigned to represent the various barrier levels according to the applied framework (4), which provided a structured approach to

categorise and analyse the data. Then, a within-case analysis of each separate case was undertaken to identify themes specific to that case, followed by a cross-case analysis to find similarities and differences across the concepts and subthemes that emerged from the single cases (4). In Appendix D, a link to the extended visualisation of the data structure can be found. The process was iterative and reflexive, as the codes, themes and subthemes were constantly reviewed and refined throughout the analysis.

## **FINDINGS**

This section presents the study's findings, which aimed to find the internal and external barriers craft breweries face with implementing circularity in their production practices. A visualisation of the data (Fig. 2) by concepts, subthemes and themes is provided for an overview of the findings. The section is structured by barrier themes derived from theory (company-internal, technology, market, legislative, society and consumer) with corresponding subthemes. Finally, the section concludes with unexpected findings.

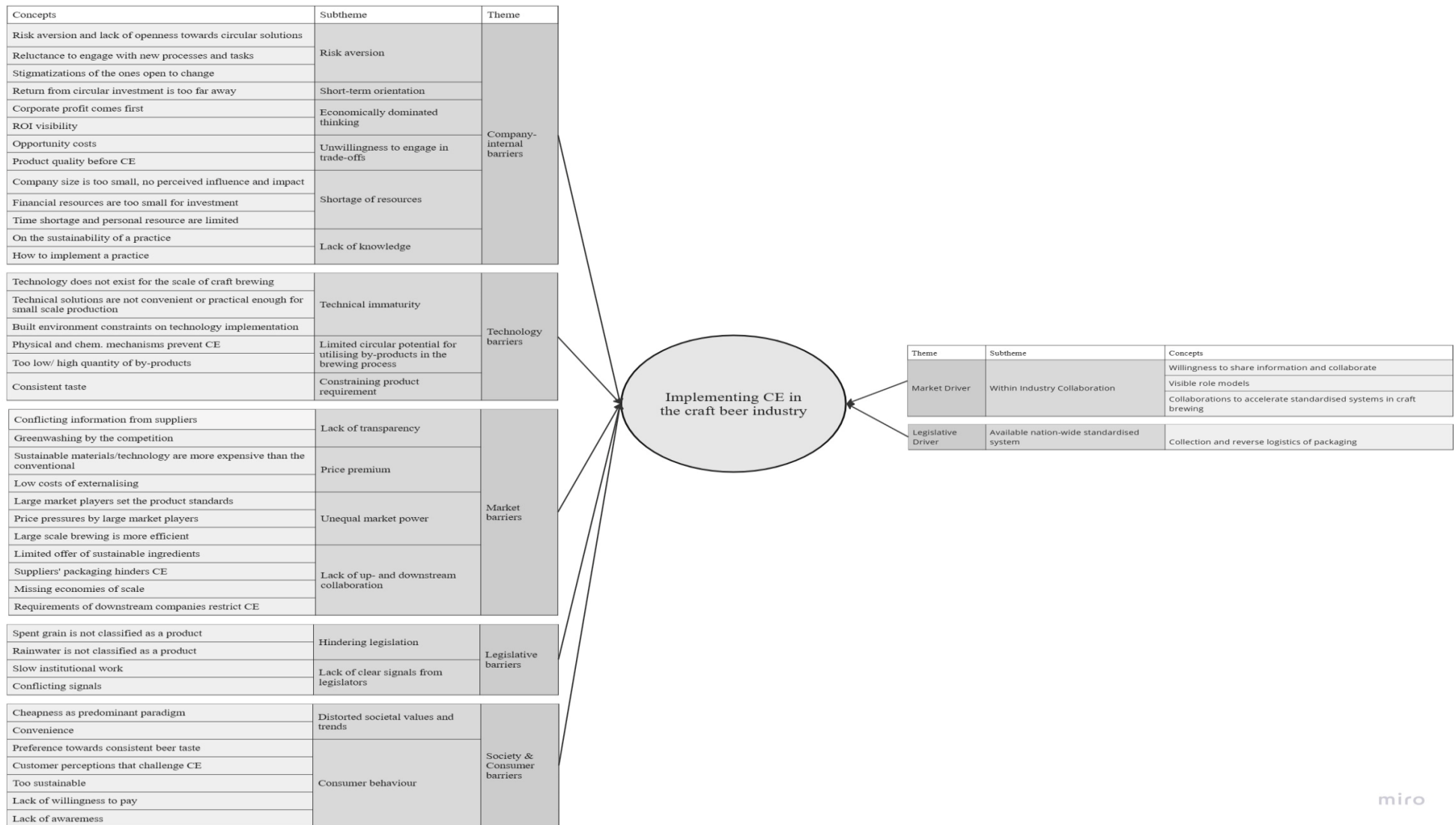


Fig. 2. Visualisation of the data structure

## **Company-internal Barriers**

This theme describes the subthemes of barriers that build the foundation of internal resistance to change within breweries.

### ***Risk aversion***

A recurring concern expressed by participants is the perceived risk associated with implementing circular solutions, mainly product quality and business viability. Despite having adopted some circular practices, participants demonstrated a lack of openness to specific changes, highlighting the resistance to certain practices even among breweries, which have accepted other aspects of circularity.

*"Is it sustainable with the amount of chemicals you use to clean them, as opposed to just making new ones?" (B)*

In addition, adopting circular practices requires handling new tasks, such as tracing the origin of ingredients to qualify for organic certification. However, some participants expressed reluctance to engage with new processes.

*"Cleaning (the bottles) is the responsibility of the brewery... it is a hassle to take the (empty) bottles back to the brewery and clean them, have them ready for filling... not even mentioning the labour and storage space it would take...we use the single-use, disposable bottles" (B)*

### ***Short-term orientation***

Breweries B, D, and E expressed reservations about implementing specific technological solutions due to the significant investment with returns either too distant in the future or potentially impossible to recoup. This sentiment suggests a short-term orientation, where immediate financial concerns take precedence over long-term sustainability and circularity.

*"It is really hard to earn that back, or you cannot earn it back the same cause your investment is much higher" (E)*

### ***Economically dominated thinking***

Although participants from the breweries demonstrated awareness of the sustainability challenges inherent in brewing, such as the energy and water-intensive nature of the process and the generation of both biological and technical waste, a fundamental barrier to making investments in circular technologies became apparent: financial viability.

*"No matter how green we want to be, we are still just companies, and companies need to make money." (B)*

Similarly, Brewery C acknowledged that investments should ultimately generate a return, and Brewery A pointed out that many technologies are available. However, in the end, *"it is an economic discussion – are they worthwhile or not?"*

In addition, while participants from the breweries showed eagerness to engage in discussions on energy efficiency and waste reduction, there was limited attention given to reducing water use, which in some cases can result in a ratio of 8 litres of water to 1 litre of beer. Regarding this issue, the water expert commented that energy efficiency tends to receive more attention due to the straightforward returns on investment that breweries can observe. In contrast, water, one of the most inexpensive ingredients, is often undervalued and receives less focus in sustainability discussions.

### ***Unwillingness to engage in trade-offs***

Various trade-offs can act as significant barriers to adopting new practices in the pursuit of circularity within breweries.

An example of a financial trade-off is the opportunity cost of investing in new technological solutions, considering the rapid advancement. This can pose a challenge for breweries, as they must carefully consider their investment decisions' timing.

*"But next year, there is a pretty good chance that we are gonna have solar panels on the market for the same price that are twice as efficient." (B)*

In addition, switching to organic production might constitute the need to give up the use of certain ingredients that are either not available in organic form or not permitted for use in organic production. Consequently, by giving up these ingredients to obtain organic certification, breweries might be unable to produce the same product. This is a significant trade-off, as a recurring concept in discussions with Brewery A and C is the importance of product quality and the hesitance to adopt changes which might potentially affect the quality or taste since *"making beer is the number one factor"* to the business.

### ***Shortage of resources***

Being a small to medium business, Brewery A emphasised that *"it is difficult to build full circularity as we are too small of a chain element,"* implying the lack of perceived influence.

Furthermore, the small scale of craft breweries constitutes a challenge to the availability of financial resources to make circular investments.

*"If you are small, you do not have much investment possibility" (C)*

Additionally, a shortage of personnel and time hinders the implementation of other sustainable practices.

*"We have three brewers, and there is no person with all the time" (A)*

### ***Lack of knowledge***

A recurring concept of lack of knowledge on the sustainability of a given practice compared to another emerged with the participants from Brewery A and B in a discussion on packaging solutions – single-use glass bottles, reusable glass bottles and aluminium cans. Brewery A stated that it is difficult to obtain *"the true statistics"* of which packaging option is the most

environmentally suitable, which resulted in them switching to a canning operation, as their "*belief is that cans are the most sustainable*". On the other hand, Brewery B raised concerns that there is a "*lack of information on how sustainable it is*" to use reusable glass bottles, which require extensive cleaning prior to reuse, instead of using single-use glass bottles collected in glass containers and recycled. For this reason and others, Brewery B uses the industry standard single-use glass bottles, highlighting that the lack of knowledge can hinder the implementation of more environmentally friendly practices.

Similarly, Brewery C explained that a lack of technical knowledge about beer production might also hinder the implementation of more efficient practices, such as the reuse of heat, as some brewers are more experimental and creative than technical. However, brewing constitutes both being creative with recipes and knowing the equipment and how to make it more efficient.

## **Technology Barriers**

This theme describes how the external barriers concerned with technology hinder the implementation of circular practices in craft breweries.

### ***Technical immaturity***

During the discussions on the technology available to make the brewing process more efficient, three implications emerged: technology does not exist for the scale of craft brewing, technology solutions are not convenient or practical for small-scale production and technology implementation is constrained by the built environment.



Firstly, breweries provided examples of some technologies, which are not available for small-scale brewing, such as a CO<sub>2</sub> recovery system that captures CO<sub>2</sub> from yeast fermentation and reuses it for the carbonisation of the beverage.

*"There are so many things that you can do in a circularity that that in the end do involve technology that's not out there yet" (A)*

Additionally, other technological solutions utilised by large-scale producers are not convenient or practical enough for craft breweries. For example, implementing a solution to reuse the generated heat from boiling requires brewing frequently enough; otherwise, the heat is wasted. Yet another example is the fact that, unlike large-scale producers, bottle rinsing systems are not convenient enough to implement in craft breweries, as they do not have the capacity to undertake this additional activity. Brewery C has implemented a rainwater collection system for brewing. However, due to its novelty, rainwater needs to be tested with every batch, making this solution less practical and more expensive than tap water.

Lastly, Brewery A, B and D, as well as the water expert, stated that building limitations further hinder the implementation of technologies, such as a network that cannot support a full-scale electric operation, a structure that cannot withstand more than 1,000 solar panels, or a lack of space to accommodate other technologies.

### ***Limited circular potential for utilising by-products in the brewing process***

The challenge to utilise by-products in the brewing process boils down to the physical and chemical mechanisms and the too-high or too-low quantity of by-products. To illustrate, spent grain can be used to make bread, but it is *"very poor in keeping"* and *"you always have to mix the spent grain with 50% or 70% new wheat flour, otherwise the bread will not rise"*; therefore a bakery would need to very quickly use a large quantity of spent grain to bake

bread and sell it. Another example is the use of wasted beer to produce gin, but in this case, the quantity of wasted beer is too low and such production is feasible only for beers with higher content of alcohol, so *"not all of the beer that is lost turns into gin. And not all of the gin that we sell is lost beer."*

### ***Constraining product requirement***

In discussions, it became apparent that the consistent taste of beer is a fundamental requirement for breweries because this is the quality standard in the industry. However, implementing certain circular practices presents a challenge to maintaining taste consistency.

*"But your clients also want the same beer. You want to make the beer that you produced that got you popular and was popular in the bar. So it was difficult to brew the same beer with the ingredients that were available in an organic form." (A)*

*"For beer, however, every batch needs to be exactly the same. That is the golden standard... if I serve you of Weizen now and serve you Weizen in one week from now, from a completely different batch, those two will still taste the exactly the same. That is a very big problem, especially if you are using waste ingredients because you have no control over the waste that you are getting" (B)*

Because beer taste is essential and these practices can easily alter it, switching to organic and incorporating residual waste is challenging.

## **Market Barriers**

This theme deals with how market barriers hinder the implementation of circularity in craft breweries.

### ***Misleading information***

In searching for alternative practices, breweries might encounter conflicting information from supplier representatives, aiming to ensure their solution is the most environmentally sustainable. For instance, Brewery A has adopted aluminium cans as a sustainable packaging option. However, the brewery representative explained that "*in a presentation by someone in the glass manufacturing business, glass is the most sustainable way to pack your beer. And then there is another presentation by someone who ends up being in the canning business, and then cans are the most sustainable way.*" Such conflicting claims can make it challenging for breweries to determine which practice to follow or support their reluctance to engage with change.

Lastly, Breweries A, B, C, and D highlighted that the topic of sustainability is getting closer to becoming mainstream within the industry, but greenwashing claims are also not uncommon. The breweries highlighted that it is easier to go for the low-hanging fruits and use them for marketing purposes, instead of focusing on the real hotspots in the brewing process.

*"Some competitors deliver all beers by bike, trying to limit their carbon footprint, but they use one-way bottles, plastic kegs... they are focusing on the wrong thing, not the overall picture" (C)*

However, it was mentioned that such practices perform well on social media, but it begs the question of whether they are beneficial for the environment or just implemented for marketing purposes.

### ***Price Premium***

All breweries agreed that following circular measures, using more sustainable ingredients and state-of-the-art, efficient equipment is more expensive than the conventional operation of the business.

*"The ingredients are more expensive, and you need someone to work on this topic. So you are paying someone also to be involved in sustainability." (A)*

*"We bought (state-of-the-art) equipment from Germany, but from another country, it would have been millions cheaper." (D)*

Consequently, this can constitute a negative incentive to adopt new practices as breweries need to make additional investments to pursue circularity, but also that the more expensive production costs can lead to higher prices for the final product, which customers need to accept.

While it is expensive to implement sustainable practices, disposing of some waste and extensive, inefficient use of water is perceived as cheap, therefore breweries are not motivated to invest in reducing their residual output and use of raw resources, as the low price does not account for the long-term negative consequences to the environment.

*"the price of just throwing your waste out is so low that you must have some ideological motivation to do this because for money, you do not have to do it. It is easy to throw your leftover beer into the sink and pay the fines for it" (C)*

*"water is not as expensive as (energy)" (A)*

*"water is the most important ingredient, but it is the cheapest ingredient" (Expert)*

### ***Unequal market power***

When it comes to more efficient beer production, small-scale breweries cannot compete with the large market players, who have the financial resources to invest in efficient technology, but also have the scale for this technology to be applied. However, their influence goes beyond just producing more efficiently; they also set the standards within the industry, which could influence the diffusion of circular solutions.

*"We have been conditioned through the world of pilsners, (they) are always the same. That level of brewing, that scale of brewing, they will always make the same product." (B)*

Such standards of consistent taste in line set the expectations of consumers and retailers for a consistent product taste.

*"the supermarket wants a product that's always the same because the customer wants that" (B)*

Hence, circular practices, which can affect the consistent taste of the final product, can be more challenging to implement. Moreover, the big market players also set standards, which could make the production process more energy-intensive, for instance, filtering the beer to look clear and offering the beer through cooling taps.

In addition, Brewery A mentioned that more and more craft breweries are being bought by the big market players, allowing them to market a "craft beer" for a much lower price than independent craft breweries can charge, making it difficult to compete on price. Such price

pressures can act as a barrier for craft breweries to adopt investment-intensive practices, which might result in a higher price for the final product.

### ***Lack of up- and downstream collaboration***

Achieving circularity requires collaboration in the value chain, as all companies depend on the efforts and requirements of the upstream and downstream partners. Hence, the lack of such collaborations can result in implications for breweries becoming more circular.

Concerning the upstream partners, interviewees mentioned that a limited offering could hinder sourcing organic or local ingredients.

*"3,4 years ago, it was difficult to find American hops in organic form. Then you cannot make the same beer anymore" (A)*

As highlighted before, offering quality products and maintaining a consistent taste are of utmost importance to the breweries, so such difficulties with sourcing the required ingredients can pose a barrier to switching to local or organic ingredients. In addition, examples were provided on how specific packaging solutions are not designed with circularity in mind, demonstrating that all supply chain representatives must embrace circularity.

*"There is a bag in the keg, and that is a different plastic. Then the keg itself, and the grips, that is also different plastic. So it needs to be disassembled to be recycled" (A)*

Additionally, brewery A highlighted that it has adopted the practice of using steel kegs due to the emergence of a startup, offering the service of collecting used kegs, washing them and delivering them back to the brewery. At the same time, other interviewees mentioned that more companies providing such services would be helpful with the implementation of circular practices. These statements emphasise that there is still room to improve when it

comes to supporting services and collaborations to exploit economies of scale for implementing circular practices concerning the reuse of steel kegs and glass bottles. However, the statements also showcase that such activities would help to switch to such practices.

Regarding downstream partners, the breweries mentioned that they could restrict the implementation of certain practices in line with the idea that retailers require a beer with consistent taste.

*"the supermarket wants a product that's always the same because the customer wants that"*  
(B)

## **Legislative Barriers**

Under this theme, legal barriers to implementing circular practices in breweries are reported.

### ***Hindering legislation***

The craft beer industry is part of the food and beverage industry, and as the final product is intended for human consumption, it is strongly regulated. However, breweries demonstrated a desire for more freedom to experiment, highlighting that strict regulation can be a barrier to innovations.

In the following practices, legislation hindering the implementation of circularity was found: the use of rainwater for the brewing process and the use of the by-product spent grain for cattle feed and further human consumption,

Concerning the use of rainwater, legal obstacles arose from the fact that rainwater is not a product, which is why it was not included in food regulations as clean drinking water for the production of food and beverages. Brewery C, which has implemented the practice of using

rainwater, mentioned, *"We were given an okay to make it (beer), but by law, it is not technically allowed"*, and for this reason, rainwater has to be tested with every batch, making the process more impractical and costly. Moreover, the water expert added that the lack of official rainwater regulation makes this practice risky. Though it is unofficially allowed, if reviewed by authorities, breweries might be warned to stop using the practice despite the significant investment in installing the technology and recall all products from the market.

Similarly, once the grains are brewed, the by-product is not considered a product but is labelled as garbage; therefore, by law, it cannot be used for other food products.

*"It is unusable as a product for a human food by legislation" (A)*

Thus, to use spent grain for cattle feed and food products intended for human consumption, spent grain has to be included in food regulations as a product. This will allow for it to be reviewed for being clean and safe for human consumption, allowing breweries to sell it to cattle farmers. Surprisingly, only Brewery A is concerned about this legal aspect of providing the spent grain for cattle feed, resulting in the brewery disposing of the by-product. One possible reason for this is that Brewery A is certified organic for beer production, but to sell the by-product to organic cattle farmers, it needs to obtain an additional organic certification for the spent grain. To do that, spent grain has to be certified as a product for feed. Another reason could be similar to using rainwater – breweries follow this practice, but it is not technically allowed.

### ***Lack of clear signals from legislators***

Although there are signals from legislators on the importance of the transition to circularity, as demonstrated by the government-wide programme for a CE in the Netherlands by 2050, the participants communicated a lack of clear signals for certain developments.



For example, the water expert stated that due to the increasing prevalence of draughts in the Netherlands, more and more companies would need to communicate their water use and how they plan to reduce it; otherwise, they will not be supplied the water they require. However, the water expert added that this development *"is not communicated (widely) by the government, but per company"*. Thus, many breweries either might not be aware of this future development or might not acknowledge its severity, as it is not officially communicated.

Regarding the use of rainwater, Brewery C and the water expert mentioned that there is institutional work being done to lift the legal barrier by introducing rainwater in the food regulation. However, both participants hinted that implementing new laws takes time due to governmental bureaucracy, which is *"frustrating"* when the technology is available and safe to use.

### **Society and Consumer Barriers**

In this theme, the emphasis is on how society-wide values and consumer behaviour hinder the implementation of circularity in craft breweries.

#### ***Distorted social values***

Another challenge to the breweries implementing circular practices is the prevalence of convenience and cheapness in the consumers' values. In a discussion about whether the packaging of beer can be eliminated by motivating customers to consume in local pubs or breweries, Brewery C highlighted that it is a general practice to have beers in supermarkets because people want to consume the product at home, though this requires packaging, which

is "a large part of the footprint of beer and a lot of times it is one way, and it is turned into garbage".

*"In our world, everything is made as easy as possible for the consumer. So yeah, that is a very big problem, and it is a hard thing to challenge; at some point, you have to give the consumer what they want; otherwise, you can go out of business." (C)*

Additionally, breweries addressed the fact that customers want lower prices, which is challenging to accomplish given that the costs of ingredients are rising when sourcing local or organic.

### ***Consumer behaviour***

As mentioned in previous sections, a customer preference which hinders the implementation of certain practices is the consumer demand for consistent beer taste because customers *"have been conditioned that every beer needs to be the same every single time"*(B). However, any transition that requires a change in the ingredients comes with a risk that either the taste that made the brewery famous will be lost or that not every batch will produce the same result.

Another theme that emerged related to customer preferences is customer perceptions, which impede circularity adoption. Firstly, Brewery A shared that the implementation of cans was a challenge because beer in cans might be perceived as "cheap beer", leading to customers switching to other brands because of the new packaging. Similarly, Brewery B commented that customers perceive the product as good quality when it is clear, *"but that means that it needs to be filtered, and that is an extra step, costing energy"*. Lastly, Brewery B added that some of the marketing efforts of large-scale producers have led to the perception of cold beer as a higher quality marker, which has led to the implementation of cooling taps or freezing glasses because *"customers want the beer to be really cold"*.

*"the biggest challenge is to convince consumers that some things are not important"*(C)

Yet another factor is the customers' willingness to pay for the product, as adopting certain practices might lead to an increase in the product price. It was also highlighted that customers need to see the value of the product being produced more sustainably but not find the product "too sustainable", as some customers are "pushed away" from this category.

Finally, Breweries A, B and C mentioned that customers also lack awareness regarding what is considered sustainable or circular within beer production. For example, Brewery A mentioned that customers *"have the feeling that small scale is sustainable"*, but that is not the case – large-scale production can be a lot more efficient. While Brewery B and C highlighted that customers might rush to judgement on what is better for the environment without having all the needed information.

### **Drivers to Adopting Circularity**

Although the study aimed to understand the sector-specific barriers to adopting circularity in the craft beer industry, unexpected findings emerged from the interviews, revealing factors that enable the acceleration of circularity within the industry.

#### ***Industry collaboration***

Contrary to the findings of other studies on CE barriers, which state that the lack of collaboration acts as a barrier to implementing circular practices, this study found that within the craft beer industry, this does not hold. All interviewed breweries' representatives agreed that the industry is transparent, as craft breweries are willing to share information to improve the industry and the product.

*"It is my favourite part of being in the craft beer world. All the craft beer breweries are united and share knowledge, standard operating procedures and lessons learned on a daily basis. It is really awesome." (D)*

Furthermore, every interviewee mentioned breweries, which are perceived as role models in general or in a particular practice.

*"(brewery name), I find a visionary that they saw this (circularity trend) 30 years ago, and I always make a deep bow for them." (E)*

*"There are several breweries in the Netherlands that do a lot with circularity and do a lot with sustainability." (B)*

The interviewees were not only aware of the many role models but also mentioned that role models are not an exception to being open to sharing their experience with implementation.

*"if we were to build a new brewery, I would get in touch with them and ask them how did you do this? Who did you hire? How can I do this on my scale" (B)*

*"I was at (brewery name) two weeks ago, and they are very open on explaining the steps that they have made in the past 40 years on circularity." (E)*

In addition, Breweries A and E also provided examples of new developments, which rely on further collaboration within the craft and broader beer industry. However, they will be launched in the summer of 2024. First, the two industry associations, Dutch Brewers and Dutch Craft Brewers, have developed a sharing solution for reusable bottles between larger and craft breweries. The solution boils down to implementing reusable bottles in craft breweries, which, when collected by supermarkets, will be returned to breweries with rinsing facilities. As mentioned earlier, the current responsibility for the bottles lies within the distributing brewery, but craft breweries lack the capacity to carry out bottle rinsing activities. Thus, this novel solution will allow more craft breweries to switch to reusable bottles, for which collection and reverse logistics already exist. Second, a few craft

organisations have established a non-profit joint keg organisation, which will offer a joint pool of standardised steel kegs for rental. This will allow craft breweries to give up using single-use, plastic kegs with slow rotation time without investing in cleaning facilities. In summary, both developments will address current barriers to adopting reusable packaging solutions, further advancing circularity in the industry.

Lastly, cross-industry collaborations were also reported by the breweries, with the most common "win-win" practice of distributing spent grain to cattle framers. This particular practice is economically-driven, as the breweries do not have to pay waste disposal fees, while cattle farmers receive free feed.

#### ***Presence of institutionalised systems***

Another finding, differing from previous studies, is related to the presence of institutionalised systems for the collection and reverse logistics of beer packaging. In the Netherlands, a deposit system is available on a national level, allowing customers to return glass bottles, aluminium cans and plastic cases so that they are reused or recycled.

## DISCUSSION

This study builds upon the framework for barriers to a CE in SMEs (4), consisting of six company-internal barriers and twelve external barriers, divided into technology, market, legislative, and society and consumers. By applying this framework to the craft beer industry, this study aims to identify the specific barriers this industry faces in implementing CE practices.

The findings reveal that the barriers to implementing CE in the craft beer industry align with the applied framework (4) except for the market barrier, "Lack of collaboration", and the legislative barrier, "Lack of institutionalised systems and standardisation". Although lack of collaboration with upstream and downstream partners is identified as a barrier, collaboration within the craft beer industry is a driver to implementing CE. Similarly, the presence of institutionalised systems and standardisation, such as collection and reverse logistics, enable CE implementation. Therefore, an unexpected finding of the study is the identification of drivers for CE implementation within the industry.

Additionally, while the findings replicate the framework at an aggregate and subtheme level, sector-specific (craft beer industry) and context-specific (specific CE practices) differences emerged on a conceptual level, such as "Consistent taste" as a constraining product requirement to implementing incorporation of residual streams in the brewing process and the "Build environment constraints on technology implementation".

However, the remaining findings are consistent with the literature on CE barriers, and the most prominent are further highlighted.

Regarding the company-internal barriers, a significant barrier is the high upfront investment costs, which pose a significant challenge, especially when there is a lack of information on the benefits of implementing CE, supported by (20).

Concerning technical barriers, many technical solutions are available, but they are either not available for small-scale brewing or are impractical to operate due to economic limitations, which is in line with (7,11). This is particularly apparent in the case of not using bottles and keg rinsing systems in the industry, as it is not feasible, resulting in the common use of single-use glass bottles.

Regarding the market barriers, implementing CE in the craft beer industry is dependent on high upfront costs. At the same time, externalising is incentivised by the low market prices of disposing of waste and using excessively non-renewable resources, such as clean water, also discussed in general CE barriers (4–6). Therefore, breweries which engage with CE might have to drive their prices higher, which might be a disadvantage since competitors can continue charging lower prices. As mentioned in other studies (4–6), coping with this CE barrier would require involving legislators' power, such as introducing higher taxes on virgin raw materials.

Within the legislative barriers, the classification of by-products as waste poses a challenge to use further (4,6,7), as exemplified by the case of spent grains in the craft beer industry. However, in the craft beer industry, though the innovative solution of using rainwater to reduce tap water use, the legislation makes this practice risky, as rainwater is not listed as a product in food regulations.

Regarding the social and consumer barriers, consumers lack awareness about the CE concept and assign low priority to CE in their decision-making process (20), making craft breweries

hesitant to adopt practices that might affect consumers' preferences for the product, such as consistent taste.

Furthermore, the applied framework (4) proposes that the barriers influence one another. Thus, the following example of the barriers within the craft beer industry is provided.

The barrier *Constraining product requirement* concerns how the requirement to produce beer with a consistent taste might hinder the implementation of organic ingredients or the incorporation of residual waste. This barrier is related to *unequal market power*, whereby large-scale producers set industry standards, influencing *consumer behaviour*, particularly taste preferences, and reinforcing *risk aversion* within craft breweries.

### **Practical Recommendations**

Two practical recommendations are proposed in line with the interconnectedness of barriers, which might result in a chain reaction of breaking other CE barriers.

First, a lack of consumer awareness and interest in CE results in hesitant company culture regarding its implementation (4,5). However, craft beer breweries should recognise being embedded in society (4) and while their activities might have little control over the consumer's values, attitudes perceptions (34), they can contribute to raising awareness about environmental challenges and the importance of CE. Moreover, craft breweries should leverage the industry's strong collaboration to raise consumer awareness and promote the adoption of CE practices.

Second, legislative barriers that impede the implementation of CE should be addressed to allow the legal use of spent grain for cattle feed and rainwater in beer production. Thus, craft breweries should engage in lobbying or agenda-setting activities within their industry association or broader industry associations, such as the food and beverage industry, to advocate for changes in legislation.



## **Contribution**

Firstly, this study contributes to the nascent literature on CE barriers by expanding the knowledge on CE barriers in the context of a specific industry. Furthermore, it identified sector-specific differences between the general framework (4) and the industry, including the presence of drivers and contextual challenges, emphasising the need for tailored approaches to address the CE challenges in different industries.

Secondly, the study contributes to practice, as it outlines the particular barriers to CE and demonstrates their interconnectedness, which can help guide efforts to tackle the root causes of CE failures in the industry.

Lastly, by identifying CE drivers, the study can guide efforts to leverage existing strengths and foster stakeholder collaboration.

## **Limitations and Future Research**

Despite employing rigorous methodology, this study has limitations that should be acknowledged. Firstly, the study was conducted with a small sample size due to the limited time frame. Additionally, although efforts were made to include a brewery which has successfully incorporated residual streams in the brewing process, this study lacks the perspective of such a case. Hence, all insights on the barriers to implementing such a practice in this project are biased as perceived by the non-adopting breweries only. Secondly, to accommodate the availability of the participants, the interviews took place over four different mediums. Thus, this variation in communication methods may have impacted the quality and length of the interviews and the participants' comfort in disclosing information. Thirdly, the interviews were conducted in English, a non-native language for both the researcher and participants. Although the good level of language fluency, the use of non-native language

might have posed a barrier to expression and interpreting meaning. Lastly, the study focused on a particular industry and geographic area, namely the craft beer industry in the Netherlands; therefore, the findings are not generalisable to other industries and geographic areas.

With the findings and limitations of this study, future research areas are outlined. First, the particular topic of barriers to implementing circular practices in the craft brewing industry can benefit from a subsequent quantitative study to test the identified barriers and drivers and explore how strongly they affect CE implementation. Additionally, such a study can investigate how the developments, launched in 2024, will affect the diffusion of reusable glass bottles and steel kegs within the industry. Second, the topic could benefit from an in-depth analysis of each circular practice with its corresponding barriers. Though the findings of this study provide insights into this topic, a sample of breweries which have implemented additional practices is necessary. Lastly, further research is needed to investigate the barriers to implementing circularity in industries other than craft beer.

## REFERENCES

1. Steffen W, Richardson K, Rockström J, Cornell SE, Fetzer I, Bennett EM, et al. Planetary boundaries: Guiding human development on a changing planet. *Science*. 2015 Feb 13;347(6223):1259855.
2. Bocken NMP, de Pauw I, Bakker C, van der Grinten B. Product design and business model strategies for a circular economy. *J Ind Prod Eng*. 2016 Jul 3;33(5):308–20.
3. Ghisellini P, Cialani C, Ulgiati S. A review on circular economy: the expected transition to a balanced interplay of environmental and economic systems. *J Clean Prod*. 2016 Feb;114:11–32.
4. Takacs F, Brunner D, Frankenberger K. Barriers to a circular economy in small- and medium-sized enterprises and their integration in a sustainable strategic management framework. *J Clean Prod*. 2022 Aug;362:132227.
5. Kirchherr J, Piscicelli L, Bour R, Kostense-Smit E, Muller J, Huibrechtse-Truijens A, et al. Barriers to the Circular Economy: Evidence From the European Union (EU). *Ecol Econ*. 2018 Aug;150:264–72.
6. Grafström J, Aasma S. Breaking circular economy barriers. *J Clean Prod*. 2021 Apr;292:126002.
7. De Jesus A, Mendonça S. Lost in Transition? Drivers and Barriers in the Eco-innovation Road to the Circular Economy. *Ecol Econ*. 2018 Mar;145:75–89.
8. Statista [Internet]. Statista. 2023 [cited 2023 Mar 3]. Available from: <https://www.statista.com/statistics/447402/netherlands-number-beer-breweries/>
9. van Dijk M, Kroezen J, Slob B. From Pilsner Desert to Craft Beer Oasis: The Rise of Craft Brewing in the Netherlands. In: Garavaglia C, Swinnen J, editors. *Economic Perspectives on Craft Beer* [Internet]. Cham: Springer International Publishing; 2018 [cited 2023 Apr 11]. p. 259–93. Available from: [http://link.springer.com/10.1007/978-3-319-58235-1\\_10](http://link.springer.com/10.1007/978-3-319-58235-1_10)
10. Olajire AA. The brewing industry and environmental challenges. *J Clean Prod*. 2020 May;256:102817.
11. Nitkiewicz T, Pachura P. Conditions of Introducing Circular Business Models into Craft Breweries - LCA Approach. 2022;
12. Boulding KE. *The Economics of the Coming Spaceship Earth*. In Johns Hopkins University Press; 1966.
13. Pearce DW, Turner RK. *Economics of natural resources and the environment*. Baltimore: Johns Hopkins University Press; 1990. 378 p.

14. Geissdoerfer M, Savaget P, Bocken NMP, Hultink EJ. The Circular Economy – A new sustainability paradigm? *J Clean Prod.* 2017 Feb;143:757–68.
15. Geissdoerfer M, Pieroni MPP, Pigosso DCA, Soufani K. Circular business models: A review. *J Clean Prod.* 2020 Dec;277:123741.
16. Korhonen J. Theory of industrial ecology. *Prog Ind Ecol Int J.* 2004;1(1/2/3):61.
17. Wamsler C, Brink E. The role of individual adaptive practices for sustainable adaptation. Jerry Velasquez D, editor. *Int J Disaster Resil Built Environ.* 2015 Feb 9;6(1):6–29.
18. Preston F. A Global Redesign? Shaping the Circular Economy. In 2012.
19. Ranta V, Aarikka-Stenroos L, Ritala P, Mäkinen SJ. Exploring institutional drivers and barriers of the circular economy: A cross-regional comparison of China, the US, and Europe. *Resour Conserv Recycl.* 2018 Aug;135:70–82.
20. Rizos V, Behrens A, van der Gaast W, Hofman E, Ioannou A, Kafyke T, et al. Implementation of Circular Economy Business Models by Small and Medium-Sized Enterprises (SMEs): Barriers and Enablers. *Sustainability.* 2016 Nov 23;8(11):1212.
21. Agyemang M, Zhu Q, Adzanyo M, Antarciuc E, Zhao S. Evaluating barriers to green supply chain redesign and implementation of related practices in the West Africa cashew industry. *Resour Conserv Recycl.* 2018 Sep;136:209–22.
22. Mont O, Plepys A, Whalen K, Nußholz JLK. Business model innovation for a Circular Economy : Drivers and barriers for the Swedish industry – the voice of REES companies. 2017 [cited 2023 Jun 1]; Available from: <http://lup.lub.lu.se/record/833402ef-b4d4-4541-a10e-34d1e89d2146>
23. Baiano A. Craft beer: An overview. *Compr Rev Food Sci Food Saf.* 2021 Mar;20(2):1829–56.
24. Bahl HC, Gupta JND, Elzinga KG. A framework for a sustainable craft beer supply chain. *Int J Wine Bus Res.* 2021 Jul 13;33(3):394–410.
25. Bonato SV, Augusto de Jesus Pacheco D, Schwengber ten Caten C, Caro D. The missing link of circularity in small breweries' value chains: Unveiling strategies for waste management and biomass valorisation. *J Clean Prod.* 2022 Feb;336:130275.
26. Morgan DR, Styles D, Lane ET. Thirsty work: Assessing the environmental footprint of craft beer. *Sustain Prod Consum.* 2021 Jul;27:242–53.
27. Saunders MNK, Lewis P, Thornhill A. Research methods for business students. Eighth Edition. New York: Pearson; 2019.
28. Bryman A, Bell E, Harley B. Business research methods. Fifth edition. Oxford, United Kingdom ; New York, NY: Oxford University Press; 2019. 642 p.
29. Yin RK. Case Study Research and Applications: Design and Methods [Internet]. SAGE Publications; 2017. Available from: <https://books.google.nl/books?id=6DwmDwAAQBAJ>

30. Halkias D, Neubert M, Thurman PW, Harkiolakis N. *The Multiple Case Study Design: Methodology and Application for Management Education* [Internet]. 1st ed. New York: Routledge; 2022 [cited 2023 Apr 11]. Available from: <https://www.taylorfrancis.com/books/9781003244936>
31. Duurzaam bier: De duurzaamste brouwers en bieren - StapjeBeter [Internet]. 2023 [cited 2023 May 23]. Available from: <https://www.stapjebeter.nl/duurzaam-bier/>
32. Open Broadcaster Software | OBS [Internet]. [cited 2023 May 30]. Available from: <https://obsproject.com/>
33. ATLAS.ti | The #1 Software for Qualitative Data Analysis [Internet]. ATLAS.ti. [cited 2023 May 25]. Available from: <https://atlasti.com>
34. Starik M, Kanashiro P. Toward a Theory of Sustainability Management: Uncovering and Integrating the Nearly Obvious. *Organ Environ*. 2013 Mar;26(1):7–30.
35. Toast Ale [Internet]. Toast Ale. [cited 2023 Apr 11]. Available from: <https://www.toastale.com/>
36. Lowlander Botanical Beers [Internet]. Lowlander beer. [cited 2023 Jun 2]. Available from: <https://lowlander.nl/pages/duurzaamheid>
37. Rosa M, Beloborodko A. A decision support method for development of industrial synergies: case studies of Latvian brewery and wood-processing industries. *J Clean Prod*. 2015 Oct;105:461–70.
38. Rainbeer. Beer with a mission [Internet]. Rainbeer. 2023 [cited 2023 Mar 3]. Available from: <https://www.rainbeer.nl/missie>

## APPENDIX A

<b>Process</b>	<b>CE practice</b>	<b>Source</b>
Brewery	Waste bread as input	Toast Ale Brewery (35)
Brewery	Waste fruits and vegetables as input	Lowlander Botanical Beers (36)
Brewery	Spent grain as cattle feed	Nitkiewicz (11)
Brewery	Spent grain for mushroom substrate	Bonato (25)
Brewery	Spent grain as human feed (cookies, bread)	Bonato (25)
Brewery	Spent grain for anaerobic digestion	Rosa (37)
Brewery	Hot water recovery system	Bahl (24)
Brewery	Condensate recovery system	Bahl (24)
Brewery	Use of rainwater	Rainbeer (38)
Brewery	Wastewater treatment	Nitkiewicz (11) Bahl (24)
Bottling	Use of aluminium cans	Morgan (24)
Bottling	Use of refillable kegs	Morgan (24)
Consumer	Surplus beer for the production of vinegar or gin	CRAFT Event
Consumer	Recycling glass, paper, steel	Nitkiewicz (11)

## APPENDIX B

Brewery	Role	Practices	Interview Duration	Medium
A	Head brewer	Condensate recovery system	01:07:42	Online
		Organic ingredients		
		Stainless steel kegs		
		Use of by-products		
		Aluminium cans		
B	Head brewer	Condensate recovery system	01:26:42	Face-to-face
		Spent grain is used for bread		
		Spent grain is used for cattle feed		
C	Owner	Condensate recovery system	00:32:00	Face-to-face
		Spent grain is used for cattle feed		
		Surplus beer is turned into mustard or gi		
		Use of rainwater		
D	Sales Manager	Spent grain is used for cattle feed	-	Written form
		Aluminium cans		
		Condensate recovery system		
E	Owner	Condensate recovery system	00:48:12	Phone call
		Spent grain is used for cattle feed		
		Spent grain is used for bread		
		1000 solar panel installation		
		Stainless steel kegs		
		Collaboration to purify and reuse water		
		Collaboration to use the discarded e-scooter batteries for storing energy		
Water Expert	-	-	00:52:03	Online

## APPENDIX C

### Interview Guide

#### Starting Questions

- Can you introduce the brewery and your role in short?
- The principles of the circular economy are eliminating waste and pollution, circulating products and materials and nature regeneration. How important is this concept for your business?

#### Main Questions

- Your brewery has implemented (circular practice). Can you tell me whether these practices were implemented with the establishment of the brewery or later on? Why?
  - Was it easy, or did you encounter any difficulty? If so, which ones and why?
  - What was the biggest challenge or most unexpected challenge your business has faced with the implementation?
- Are there other practices that your brewery can implement? What stops you from doing so, and what further obstacles could you face?

#### Company-internal Barriers

- To what extent do you perceive the implementation as a risk to the business?
- How challenging has it been to secure resources for the implementation?

#### Technology Barriers



- How available are technology solutions to accelerate CE in craft brewing?
- Can you tell me whether there is limited potential for implementing circularity in certain stages of beer production and consumption?

#### Market Barriers

- Which characteristics of your business make it particularly difficult to follow CE?
- When implementing CE, do you think there is sufficient knowledge-sharing and collaboration among different breweries?
- What is your opinion on role models in your market?
- How does competition affect the implementation of CE?
- How do you compete with breweries that do not implement CE?

#### Legislative Barriers

- As part of the food and beverages industry, what rules and laws make it difficult for your business to be circular?
- What support could be beneficial for craft breweries?

#### Society and Consumer Barriers

- What is important to craft beer consumers?
- To what extent does/would consumer awareness affect the implementation of CE in craft brewing?

#### Final questions

- What do you think stops other breweries from implementing circular practices?
- What makes it difficult for craft breweries to implement CE?

- What do you think would help breweries the most to implement CE?
- Can I contact you for a potential follow-up?
- Do you have any questions for me?

## **APPENDIX D**

[Signed consent forms](#)

[Interview recordings](#)

[Interview transcripts](#)

[Extended data visualisation structure](#)