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Department of Marketing, Operations and General Management

**Sustainability on the Craft Beer Sector – Management Improvements
Towards Sustainable Business and Supply Chain Transparency:
A Case Study on BARONA Brewing Company**

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Master's in Management of Services and Technology

Supervisor:

Professor Isabel Cristina Duarte de Almeida, Assistant Professor ISCTE
Department of Marketing, Operations and General Management

November, 2021



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Department of Marketing, Operations and General Management

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Abstract

Craft beer has revolutionized the beer industry and market worldwide through diversification, innovation, authenticity, and tradition. As a result, these SMEs challenged the large breweries operating in a highly homogenized and consolidated market. Thus, addressing sustainability challenges in the growing craft beer sector is a strong recommendation.

Therefore, this study has two main objectives. The first one is to understand how to improve sustainability in a Portuguese SME craft brewery named BARONA Brewing Company and implement sustainability practices into the business model. The second objective is more geared to operational level and practical improvements, looking to understand how this microbrewery can adapt to a transparent supply chain.

A mixed methodology was used to provide value-added suggestions. Information about the current sustainability and supply chain activities and performance will be collected through direct field observation and semi-structured interviews.

Results analysis showed that sustainability is not a focus for SMEs craft brewers. Even though it can be challenging to improve processes and measures to accomplish it, it is possible to include it in a business model by reducing resource consumption, minimizing waste, and focusing on efficient production. This will be cost-effective and make the company closer to a fully sustainable approach. However, when it comes to the supply chain transparency topic and the use of blockchain technology this is more challenging once it needs an investment of time and money, something some SME craft brewers may not be able to dispose of.

Keywords: Sustainability; Craft beer; Breweries; Small and Medium-sized enterprises (SMEs); Innovation; Sustainable business model; Supply chain transparency; Blockchain.

JEL Classification Codes: Q01 (Sustainable Development); M11 (Production Management); O13 (Agriculture • Natural Resources • Energy • Environment • Other Primary Products).

Resumo

A cerveja artesanal tem revolucionado a indústria e o mercado mundial da cerveja, através da sua diversificação, inovação, autenticidade e tradição. Estas PME's vieram desafiar as grandes cervejarias que operam num mercado altamente homogeneizado e consolidado. Assim, enfrentar os desafios da sustentabilidade no sector da cerveja artesanal é urgente.

Este estudo tem dois objetivos. O primeiro é compreender como é possível melhorar a sustentabilidade numa PME portuguesa fabricante de cerveja artesanal chamada BARONA Brewing Company e implementar práticas de sustentabilidade no modelo de negócio. O segundo objetivo é orientado para o nível operacional, procurando compreender como é possível esta microcervejeira adaptar-se a uma cadeia de abastecimento transparente.

Para fornecer sugestões com valor, foi escolhida uma metodologia mista. Serão recolhidas informações sobre as atividades de sustentabilidade e da cadeia de abastecimento, através da observação direta no terreno e de entrevistas semiestruturadas.

Os resultados evidenciam que a sustentabilidade não é um foco para as cervejeiras artesanais. É um desafio melhorar os processos e as medidas de sustentabilidade, mas é possível incluí-la no modelo de negócio através da redução do consumo de recursos, minimização do desperdício e foco na produção eficiente. Assim será rentável e a empresa ficará mais próxima de uma abordagem totalmente sustentável. Quando se trata do tema de transparência da cadeia de abastecimento e da utilização de tecnologia de blockchain, isto é ainda mais desafiante uma vez que necessita de investimento de tempo e dinheiro, algo que algumas cervejeiras artesanais podem não ser capazes de disponibilizar.

Palavras-chave: sustentabilidade; cerveja artesanal; cervejarias; pequenas e médias empresas (PME); inovação; modelo empresarial sustentável; transparência da cadeia de abastecimento; blockchain.

Códigos de Classificação JEL: Q01 (Sustainable Development); M11 (Production Management); O13 (Agriculture • Natural Resources • Energy • Environment • Other Primary Product).

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CHAPTER 1

Introduction

In this chapter, the problem under study is presented, starting with the current development faced by the sector and the problem faced that led to this research project. Next, the research questions that support this project, as well as the objectives, are here defined. Moreover, an overview of the methodology used in the case study is presented and, as final topics, the project's scope and structure.

1.1. Theme Relevance

Craft breweries have transformed and disrupted the beer market. This phenomenon has been happening in the world for the last decades but is very recent in Portugal and has been rapidly growing and expanding with new breweries entering the market and the consumer appreciating more this type of beer. The craft beer revolution was preceded by a long consolidation and homogenization period in the global beer industry during the 20th century, driven by economies of scale. This led to a dominance of few beer styles and an increasingly homogenized market in terms of flavours and varieties (Drakopoulou Dodd et al., 2018; Garavaglia & Swinnen, 2017; Miller et al., 2019). In Portugal, this consolidation and homogenization are evident with the two leading players of the beer market: Sagres, from Central de Cervejas, and Super Bock, from Unilever.

The high levels of concentration in the brewing industry and low levels of product diversification may have influenced the rise of craft breweries, although there were other reasons. A shift in consumers' choices and taste create new niche markets, align with new and cost-effective technology for new entrepreneurship and government policies and regulations, can support the development of an industry. The availability of better equipment at lower costs and an improved level of control contributed to the expansion of craft breweries (Cambras & Bamforth, 2015). However, the major reason for the growth of the craft beer market appears to be the increasing consumer desire for variety and authenticity (Garavaglia & Swinnen, 2017). Craft beer is a hyper-differentiated product. Its innovative beers' portfolio responds to consumer desire for differentiation (Drakopoulou Dodd et al., 2018) and represents a counter-movement to globalisation by offering a connection opportunity to a place (Sjölander-Lindqvist et al., 2019). Craft beer producers are challenging and changing the beer industry and market structure (Pokrivčák et al., 2019). Craft beer has become an industry of innovation, experimentation, cooperation, and connection to a place and locality, with important implications for sustainable development in rural regions (Sjölander-Lindqvist et al., 2019). Craft breweries are characterised as being small and medium-sized enterprises (SMEs) and micro-enterprises. In this

industry, most companies are young and small, have a low volume production, use traditional ingredients, and have an open attitude to innovation and cooperation (Kraus et al., 2019).

The European Commission (2003) states that “the category of micro, small and medium-sized enterprises (SMEs) include enterprises with less than 250 persons and which have an annual turnover not exceeding EUR 50 million, and/or an annual balance sheet total not exceeding EURO 43 million.” (Extract of Article 2 of Commission Recommendation 2003/361/EC). SMEs are considered by the European Commission the “backbone and the engine of our economy, creating more than 85% of new jobs in Europe”. Moreover, SMEs are the lungs of the world economy (Cardoni et al., 2018). They drive job creation and economic growth and ensure social stability. The European Parliament states that SMEs make up 99% of business in the EU and contribute to more than half of the total added value created by companies. Portugal’s business structure comprises SMEs almost entirely (Jornal de Negócios, 2019, May 15). According to PORDATA data from 2018, 99.9% of all companies are SMEs (PORDATA, 2020). This data shows the importance of SMEs in the Portuguese economy, exportations, and employment (Jornal de Negócios, 2019, May 15). It is SMEs that make up most businesses. Ness (2018) describes that it is also in these independent businesses that new and dynamic sustainability-focused ideas can emerge. SMEs can capitalize on innovative and sustainable practices and can fill local and regional niche markets. Innovation is important for craft breweries to survive, and it happens in production methods, service and relationships with customers and suppliers (Signori et al., 2017).

Sustainability has been an important focus for governments, businesses, and academic research in the last decades, leading to a shift in companies’ commitments (Signori et al., 2017). This is an exciting subject in craft brewing, once it is a resource-intensive industry that requires large amounts of water and organic material and consumes large quantities of energy in boiling and cooling activities (Corsini et al., 2019). Additionally, large amounts of spent grain, yeast, wastewater, and other solid wastes are produced. Given the large number of natural resources necessary to produce beer, it is in the brewery’s economic interest to conserve and preserve resources (Embry, 2018) and shift its attention to sustainability. Nevertheless, SME craft breweries have difficulty improving sustainability within the organisation due to lack of data and methods for this type of business. A possible and efficient way to improve sustainability in SME craft breweries can be the adaptation to a transparent supply chain.

1.2. Research Problem

Craft brewing is a dynamically growing industry that has been identified as a vehicle for economic development and is changing the function of brewing science, brewing technology, branding, and consumer demands (Miller et al., 2019). For these reasons, the overall sustainability of the craft beer

industry is of profound interest (Gatrell et al., 2017; Said, 2019). Though, the literature has a gap of information about how can craft breweries improve sustainability and practical analysis of this. Aligned to this, is the lack of analysis of the craft breweries supply chain and limited understanding of the linkage between (craft) beer supply chain and sustainability. It is by identifying this gap in the literature that this research will be conducted.

1.3. Research Questions

This research project pretends to address the following questions:

- RQ1: How are craft breweries embracing sustainability?
 - RQ1a: How sustainable practises are applied in a SME craft brewery?
 - RQ1b: What are the situations in a SME craft brewery that hamper practises towards a sustainable management?
 - RQ1c: How can a SME craft brewery apply suitable sustainability practises into its business model?
- RQ2: How a SME craft brewery recognise/relate/choose stakeholders?
- RQ3: How a SME craft brewer adapt to a transparent supply chain?
- RQ4: Is blockchain a possibility for SME craft breweries to easily engage in Circular Economy?

1.4. Research Objectives

The project's first research aim is to see how SME craft breweries can improve sustainability by adopting sustainable management and implementing sustainability practices into the business model. This research also seeks to evaluate how an SME craft brewery can adapt to a transparent supply chain.

To structure the research process, the outlined research objectives are:

- i. Define clearly the concepts used to evaluate sustainability improvement;
- ii. Address SD through SDGs, identifying SDG Goals that can aid to the business strategy, material issues and key performance indicators (KPIs) more suitable for a craft brewery;
- iii. Understand the sustainable management and practises of an SME craft brewery;
- iv. Understand the sustainability across the supply chain of an SME craft brewery;
- v. Study ways to foster sustainable practises and transparent supply chain in craft breweries;
- vi. See if blockchain is a proper technology to improve transparency in SMEs craft breweries.

1.5. Methodology Approach

A craft brewery named BARONA Brewing Company was analysed to perform research close to the brewing reality, having factual information. Therefore, this thesis will follow the guidelines of a case study. The research steps will proceed as follows:

Research step 1 – Scope definition and craft beer business sector study: collecting, organising, selecting, and analysing qualitative and quantitative data concerning craft beers production, business scope and sustainability, by comparing advantages and disadvantages in the sector and while considering the creation of a new and more sustainable business model to be applied in the case of an SME craft beer producers.

Research step 2 – Methodological approaches to the case study: collecting primary data through qualitative methods. The methods used will be direct field observation of operations and activities and semi-structured interviews to gather information and perspectives. This step will identify the SDGs more suitable for an SME in the craft beer industry, align it with the company's activity and the SDG targets, and link it with GRI indicators to achieve a more suitable strategy for the craft brewery.

Research step 3 – Case study: scenario-based analysis: considering the results obtained in research step two, the proposals of sustainability improvement in a craft-brewery SME will be introduced. Then, the scenarios will be created, assuming a neutral, optimistic, and pessimistic sustainability context from the perspective of Barona Company, aiming to establish a new business model. The evaluation of the multiple scenarios is based on the set of criteria used in the research applied methods, from which a set of KPIs will be defined in terms of economic, environmental, and social impacts to present results and conclusions.

Research step 4 – Solutions proposal: developing conclusions and proposing solutions and recommendations that can improve the sustainability of a craft brewery business performance, based on the results obtained from the scenario-based analysis performed in research step three.

1.6. Theoretical, Managerial, and Social Relevance

A new segment is emerging in the brewing sector that is changing the current consumption paradigm and production. Craft beer is a source of innovation through diversity and production techniques, being an appropriate theme to be studied in a Master's degree dissertation in Management of Services and Technology. The practices that businesses adopt will impact people's lives and the natural environment. Therefore, it is expected that this study will be a valuable tool for microbreweries in understanding and applying possible sustainability improvements to contribute to sustainable development. Nowadays, all economic sectors, from SMEs to big companies, must contribute to sustainable development.

1.7. Thesis Structure

The thesis is structured with seven chapters. The first chapter introduces the project, its purpose, objective, and relevance. The methodology to be developed is also resumed, and the thesis structure

is outlined. In the second chapter, the main concepts of the research are presented and described. It starts by describing the brewing industry, the craft beer segment, and beer production. Then it is done an investigation of the sustainability of this industry, transparent supply chains, and blockchain technology. The third chapter presents the methodology to conduct the research. It is proposed, explained, and implemented a methodology that is expected to lead to meaningful results for the project's development. It includes in detail all the research steps applied in the development of the project. The fourth chapter is the data and results analysis, being structured in accordance with the research steps. The fifth chapter outlines the case study results and discussion, where a scenario-based analysis will be done. After this, a brief but detailed SWOT analysis, internal and external analysis it will be done with the use of a PEST analysis. The final chapter describes the final conclusions based on the analysis previously developed. This final chapter also addresses the limitations of the study, suggestions of guidelines and next steps for further investigation.

Theoretical Framework

This chapter presents the literature review of the subjects to be studied. This research aims to gather, analyse, and synthesise literature on the topics to identify the theme's theoretical basis, framework, and contextualisation. Therefore, this section will initiate with an analysis of the beer industry, followed by a research and analysis on craft beer, craft beer market, and craft beer production. After this, it will be conducted a sustainability research in this sector, and lastly, it will be addressed the transparency in the supply chain and blockchain.

2.1. Beer Industry

Beer is one of the most popular alcoholic beverages globally (Wojtyra, 2020), with intense production and consumption worldwide (Rodrigues Oliveira & Dutra de Barcellos, 2017). The brewing industry features prominently in our daily lives and significantly contributes to the world economy (Cabras & Higgins, 2016).

Globalisation has created changes in the beer market structure during the last decades and has led to a consolidation of the market, which resulted in a smaller number of active breweries around the world (Pokrivčák et al., 2019). Garavaglia & Swinnen (2017) detail the main reasons for the consolidation of the beer market: (1) The technological progress such as automated production, packaging, conditioning, and better distribution through improved road networks, that led to more significant economies of scale. (2) The global mergers and acquisitions created market-dominant multinationals which control the production and the distribution of beer: Anheuser–Busch InBev (AB Inbev), SAB Miller, Heineken, and Carlsberg (Cabras & Higgins, 2016). Acquisitions and mergers allowed global economies of scale in production, marketing, and distribution, what reduced unit costs for the brewers, increasing the overall efficiency in the industry. The horizontal acquisitions allowed brewers to expand their powers by reducing the number of competitors (Argent, 2018; Cambras & Bamforth, 2015). This strategy eventually resulted in large brewers outcompeting smaller ones based on strong economies of scale (Cambras & Bamforth, 2015).

Consequently, beers became more standardized and homogeneous worldwide. The intense competition and high entry barriers pushed the consolidation of the global brewing industry and the formation of oligopolies (Gatrell et al., 2017; Pokrivčák et al., 2019; Wojtyra, 2020). The alignment of economy, industrialism and modern science enabled not only a productive growth, but also a homogenization of the product and price on a world scale (Drakopoulou Dodd et al., 2018; Rodrigues Oliveira & Dutra de Barcellos, 2017). Globalization promotes the homogenisation of food products and

the creation of the same needs and preferences among consumers worldwide, which resulted in the success of International Pale Lager (Wojtyra, 2020), a lighter style of beer, and was registered a growth in the market share of the light beer segment (Elzinga et al., 2015).

2.2. Craft Beer

In recent times, a rise in the number of micro and craft breweries has been seen almost everywhere in the world. For example, in 1980, the number of breweries in the UK was about 142. In 2014 the number increased to 1285. An even larger growth was registered in the US within the same period, the number of breweries rise from 92 to 3464. A similar trend is registered in Germany, Italy, Spain, Netherlands, Canada, China, Japan, Australia, Denmark, and Brazil. This is explained mainly by the heavy concentration processes in the brewing industry, which left space for new entrants and created a condition for niche markets, in which economies of scale and scope are not significant. In addition, policies supporting small entrepreneurs, such as rate reliefs and financial grants, and an increased level of sophistication in consumers' tastes, motivated them to try different and new products (Cabras & Higgins, 2016; Wojtyra, 2020).

The craft beer movement started in the USA around 1965 and has rapidly expanded across the globe (Baiano, 2020). In recent times, similar developments can be observed in other countries (Poelmans & Swinnen, 2012), with similar growth patterns, although with shaper and more rapid trajectories (Cabras & Higgins, 2016). It has started a new era on the world beer market (Wojtyra & Grudzień 2017).

2.2.1. Craft Beer Definition

The terms "craft brewery", "artisanal brewery", "microbrewery" and "independent brewery," are used to identify breweries that recently started brewing different types of beer on a small scale, distinguishing them from larger breweries mass-producing beer. Given the diversities among countries and their historically distinct traditions in beer brewing, no single definition is generally accepted (Garavaglia & Swinnen, 2017). Baiano (2020) conducted a research on the definition of craft beer, understanding that even though there is no shared definition across the world, there are several legal definitions established by national laws and working definitions supplied by regional or national trade organisation, such as the US Brewers Association, the UK Society of Independent Brewers, and others. Through this research, it was possible to understand that the various definitions from different countries have some shared items. Two elements that distinguish craft beer from industrial beer are the dimensions (small size brewers) and the ownership (independence from multinationals that own the largest breweries). Because there are no clearly defined boundaries between mass-produced and

craft beer, the brewing size alone is not reliable to indicate a beer as craft, as other factors differentiate craft beer from generic beer (Morgan et al., 2020). The most important differences between craft and industrial beer include the types of malts, hops, and yeast used; the possibility to apply not standardized processing conditions; and the crossing of beer styles. Another difference within craft breweries is the small batches of product produced, that allow them to experiment simpler than in industrial production. Craft brewers have greater attention to the quality of the product (Baiano, 2020) Thus, high-quality raw materials are an important and essential characteristic of craft beer (Morgan et al., 2020).

Generally, craft breweries differentiate themselves as small, independent brands that focus on traditional or innovative brewing methods, ingredients; and emphasise quality, flavour, and diversity (Gatrell et al., 2017; Pokrivčák et al., 2019). Craft brewing is done on a smaller scale paying close attention and dedication to the quality, the ingredients, and the brewing method (Wojtyra & Grudzień 2017). Craft brewing is notable for being unique and authentic, in opposition to the generic brewing process (Morgan et al., 2020). It is a new and fresh approach to brewing that, instead of competing with low prices and advertising, competes with the product characteristics, leading to greater quality and diversity of the product in terms of taste, flavours, and freshness (Poelmans & Swinnen, 2012).

2.2.2. Craft Beer Emergence – Drivers

The growing domination of standardised lager and light beer led to the countermovement of craft beer (Poelmans & Swinnen, 2012). Garavaglia & Swinnen (2017) and Pokrivčák et al. (2019) explain in detail the birth and growth of the craft beer market, that resulted of:

- Demand for variety, a reaction to the homogenisation of beer: macro brewers create products with characteristics that appeal to as many consumers as possible (Miller et al., 2019), resulting in a more homogeneous and milder lager beer. The beer market was characterised as a mass-market, with undifferentiated products, monopolising resources and offering a few choices (Poelmans & Swinnen, 2012). Craft breweries began to enter the market, filling product niches left by the homogenisation of macro beer (Drakopoulou Dodd et al., 2018). Consumer tastes were becoming increasingly sophisticated and craft breweries were able to provide for this market. Craft breweries represent an alternative to mass production (Cabras & Higgins, 2016) and offer a diversity of choices to consumers (Morgan et al., 2020).

- Increasing income: craft beers are typically more expensive than standard lager beer. Higher incomes not only stimulate an increase in demand for more expensive products but also stimulate demand for more variety. The craft beer market expanded as incomes increased. Additionally, economic prosperity increases consumer demand for locally produced products, and craft beer usually is a locally produced (Elzinga et al., 2015).

- Consumer associations: consumers created associations to mobilize craft beer enthusiasts. This stimulated the activity of the first entrants in the craft beer segment, sustaining demand for specialized products against mass-produced beer.

- Technology and capital for small brewers: the growth of the craft sector and the entry of increasing numbers of small breweries was enhanced by the growing availability of technical equipment and capital, allowing brewing on a small scale. Technological innovation in fermentation has been growing to suit the need of a wider range of brewers, as so specifically designed brewing systems for smaller scale breweries (Mccullough et al., 2018). The development of brewing technology lowered entry barriers by making the equipment cheaper, more compact, and easier to install (Cambras & Bamforth, 2015).

- Inspiration from traditional markets: contact with foreign countries with stronger beer traditions or where the craft beer market had already developed, helped as inspiration for the firsts craft brewers. The globalisation also made it possible the transfer of ideas, knowledge and information between countries faster and more frequent (Wojtyra, 2020).

- Laws and regulations: the growth of craft breweries has induced changes in regulations that have facilitated the entry of craft brewers. The lower tax for smaller breweries helped in the development of this industry. Government also provided incentives for new firms to enter the market and encourage entrepreneurial activity (Cambras & Bamforth, 2015; Elzinga et al., 2015).

2.2.3. Socio & Competitor Factors

The mainstream macro breweries are the dominant market players, competing with each other. The sales volumes are high but margins per unit are tight. Craft breweries found a niche outside the market core. Though they lack the economies of scale and scope, these firms easily identify and exploit profitable resource segments outside the mainstream market (Argent, 2018; Cambras & Bamforth, 2015; Cabras & Higgins, 2016). Because of the standardised and homogeneous market, there were perfect conditions for a strategy of differentiation and focus on a target (Maier, 2016). In industries that initially present increasing market concentration and a mature market, like the beer industry, the rise that gradually occurs over the long term is usually the entrance of small firms once the market is near saturation (Cambras & Bamforth, 2015).

Large breweries operating on the market for many years did not have strong competitors, but recently small craft breweries, which offer various and different types of beer accompanying content in their offer, are increasingly winning consumers (Dudic et al., 2020). The growth of craft brewing has diversified the brewing landscape and created a new segment market for craft beer (Cambras & Bamforth, 2015). The generalist strategy of large breweries opened up resources that craft breweries accessed through a differentiation strategy (Lamertz et al., 2015).

Large scale breweries have reacted to the “craft beer revolution”. The lack of clarity on the term “craft beer” has left this industry segment open for large breweries to produce new beer ranges of craft-style beer that may not be produced using the traditional methods associated with the traditional craft beer (Garavaglia & Swinnen 2017; Morgan et al., 2020). Some large breweries adapted and included special types of beer into their portfolio; yet consumers still considered these types of beer as an industrial product (Pokrivčák et al., 2019). Another strategic reaction of macro breweries is the direct entry into the craft beer segment through acquisitions. However, craft brewers and consumers criticized this action who consider it to be a departure from craft origins. Macro breweries also reacted using their control over bars and retailers to push their own products (Garavaglia & Swinnen, 2017).

Much of the appeal of craft beer is that it represents a rejection of national culture in favour of something more local. It is usually constructed as a conscious reaction against the corporate domination and the reduction in the variety of beer available. Indeed, this market and industry combination has been considered as analogous to a social movement of opposition to industrial production, which extend to consumer behaviour by avoiding large global brands. Craft breweries tend to connect their brand to a renewed appreciation for localism, using neolocalism to create a sense of place (Argent, 2018; Cambras & Bamforth, 2015; Drakopoulou Dodd et al., 2018).

Neolocalism consists in rebuilding and nurturing local traditions, and it can be defined as the conscious effort of enterprises to promote a relationship with a place (Wojtyra, 2020). Neolocalism connotes a variety of social movements that oppose the homogenisation of mainstream culture by establishing connections with the uniqueness of local communities (Lamertz et al., 2015). Neolocalism can be seen as a strong form of social embeddedness, where local production, place marketing, and authenticity are folded together in support of local craft production. The “sense-of-place” is a branding strategy to attract consumers, highlighting the local place imagery, traditions, and folklore in the marketing of breweries and their beer (Argent, 2018). Neolocalism can support the emergence of the craft beer market due to the growing number of people who want to re-establish connections with local communities and their economies. In turn, the niche was filled with craft breweries that emphasise their locality, small-scale production, and traditional brewing methods. Craft breweries are an expression of a new desire for roots, as well as a conscious rejection of globalised society (Wojtyra, 2020). However, some breweries have a brand more focused on the specificities of their offer rather than on their geographical provenance. This branding pretends to attract consumers more interested in the quality characteristics and range of beer compared to their origin (Cambras & Bamforth, 2015).

This neolocalism of craft beer can revitalize the development in rural locations as well provide means for these economies, cultures, and ecosystems, improving rural development. Craft breweries can have a strong contribute symbolic, social, and financially in their regions, and in helping the sustainable development of rural regions. The craft beer movement brings opportunity for local

economic development in rural environments. By using the community's rural distinctiveness, breweries are reshaping the possibilities for product attractiveness, tourism, and visibility for rural areas (Sjölander-Lindqvist et al., 2019).

A competitive aspect of craft breweries is the agility to make one off, experimental, or seasonal beer and later decide if a new beer should be added to a core range based on consumer feedback. In comparison, brewing in mass-production is limited and heavily marketed (Morgan et al., 2020). Craft breweries have the advantage of proximity with customers, and can achieve faster contact with them, get product information, have more experimenting, develop new types of beer, and have greater flexibility and adaptability to customers (Dudic et al., 2020).

A key feature of this industry is the collaboration, cooperation, and knowledge transfer between stakeholders (Drakopoulou Dodd et al., 2018). This enables brewers to experiment and learn by exchanging information and opportunities (Cambras & Bamforth, 2015). This helps to improve product quality, diversity, and excellence, and to gain strategic knowledge about the industry (Drakopoulou Dodd et al., 2018; Wojtyra, 2020). Collaboration is a strategy for craft brewery industry. Competing with big market players gives a significant importance in joining forces to grow as an individual company and as an entire market. Collaboration is vital for the success of the sector (Kraus et al., 2019).

Nevertheless, it is a developing market with the number of breweries growing. This market expansion increases business risks associated with fast-rising competition (Argent, 2018; Cambras & Bamforth, 2015). The growth of more breweries provides more choices to consumers; therefore, each brewery must find a way to compete in a heterogeneous product market (Mccullough et al., 2018). Craft breweries must customize the classic beer styles and differentiating themselves from other breweries in a very crowded market (Baiano, 2020).

Breweries impact regional economies by creating jobs and supporting local industries (Mccullough et al., 2018). Craft breweries also have a commitment to use brewing ingredients from local and regional providers, and to foster mutualistic relationships with other local business (Argent, 2018).

While the share of craft breweries in the global beer production is still relatively small, these breweries have influenced the beer market significantly and in various ways (Poelmans & Swinnen, 2012). Baiano (2020) researched about the future trends of the global craft beer market (valued to USD 108.91 billion in 2018) and concluded that is expected to reach USD 186.59 billion by 2025, with a CAGR (Compound Annual Growth Rate) of 8% and will account for more than 15% of the total beer market. These numbers will result mainly from the increasingly growth of craft beer in Asia, South Africa, Australia, New Zealand, and Brazil. The craft beer market in Europe is expected to have a CAGR of 13% from 2018 to 2022, mainly because of the increasing demand in Romania, Poland, Czech Republic, Hungary, Russia, Greece, and Turkey. Europe should account for the highest market share in terms of value and volume, with the potential to grow by 1,324.31 million litres within 2024.

2.2.4. Factors Affecting Craft Beer Consumption

Consumers have become more aware, sophisticated, and demanding in terms of desired quality and consumption habits. While industrial beer has standardized flavours, craft beer has an extensive range of flavours and tastes (Baiano, 2020; Carvalho et al., 2018; Maier, 2016). People drink alcohol essentially because of social reasons, for its psychological effects, as an escape or sensation-seeking, and intrinsic reasons, i.e., the pleasure derived from alcohol. However, for products like beer, consumers appreciate mainly its sensory characteristics (Goméz-Corona et al., 2015).

The main motivations for drinking craft beer seems to be the quest for authenticity, desire for more knowledge, new taste experience, and move away from mainstream beer consumption. The desire to try something local and support the local economy is also a strong purchasing motivator, as the search for new, different products and lifestyles (Baiano, 2020; Goméz-Corona et al., 2015; Pokrivčák et al., 2019). According to Rosburg & Grebitus (2020), the top five attributes to drink craft beer are friends and family recommendation, beer style, familiarity with the brewer, and brewery's community involvement.

Craft beer has become a hyper-differentiated, high-quality, and atypical product, with a variety of special flavours (Pokrivčák et al., 2019). Hyper-differentiation leads to reducing the importance of price in consumers' choices among alternative goods and services (Wojtyra, 2020). Craft beer consumers take into account the characteristics and quality of raw ingredients and production and are willing to pay more for a product with higher quality (Carvalho et al., 2018).

Craft beers attract the consumer through creativity, variety, quality, authenticity, experimentation, sense of local, and through extrinsic attributes like packaging and storylines. These consumers have the same characteristics all over the world: mainly male, young adults (millennial generation, 20 – 39 years), higher education level, medium-high income, and interest for quality and locally made products (Baiano, 2020; Goméz-Corona et al., 2015). The millennial generation might have contributed to the growth of the craft beer market segment, once this generation has a higher interest in exploring new tastes and is willing to pay higher prices (Aquilani et al., 2015).

Carvalho et al. (2018) and Goméz-Corona et al. (2015) in their studies searched for the main factors that make it difficult to increase the consumption of craft beer, and identified the price and the lack of availability of the product. However, regarding price it is shown that is not a decisive factor with the overall consumers, and higher prices are associated with higher quality. Regarding the availability, despite the increasing number of virtual stores, bars, pubs, restaurants, and supermarkets that include some craft beer products in their portfolio, still exists a lack of places that sell craft beer near most consumers, making the purchase difficult and preventing the increased consumption. Some consumers wish to buy craft beer everywhere and for those the lack of availability is a barrier. However, for other consumers buying craft beer in small, specialised stores is part of the experience.

Carvalho et al. (2018) also concluded that men consume craft beer for reasons related to sensation of pleasure, to enjoy different flavours, while woman consume craft beer to combining it with good gastronomy and to relax with family or friends.

Craft beer is perceived by consumers as a stimulation and multisensory product in terms of flavours, aroma, texture, and colour, that ultimately provides an experience. It is not an everyday product and in general its consumption happens in special occasions where beer is the centre. Industrial beer is the opposite, consumed in moments of socialisation or with food and snacks. With industrial beer, the experience is centred in its functional characteristics rather than a sensory experience based on flavour (Gómez-Corona et al., 2015). Craft beer is perceived as a symbolic drink with a meaning, while industrial beer is a utilitarian and functional beverage (Baiano, 2020).

2.2.5. Operational Components/Beer Production Process

To produce beer, it is necessary four basic raw materials: barley (cereal), hops, water, and yeast (Karlović et al., 2020). Barley is transformed into malt, hops give beer its bitter taste and the aroma, water affects the beer character and quality, and yeast generates the alcoholic fermentation (Kunze, 2004). The beer production operations are summarised and synthetized in the figure 2.1.

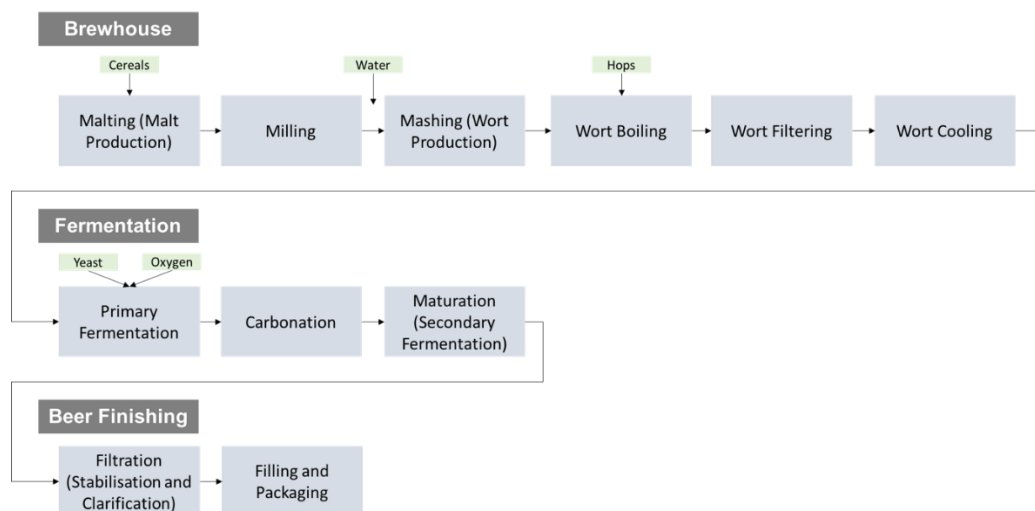


Figure 2.1. Beer production operations (Adapted from Olajire (2020) and Ashraf (2021))

In the brewing production area exist two sections, the brewhouse and the cellar. In the brewhouse happens the malt and wort production, for 5-8 hours (Tokos et al., 2011). The beer production process begins with malt production from grains, usually from barley. It is possible to produce malt from other cereals, but barley malt is the most suitable for beer (Briggs et al., 2004; Kunze, 2004). Barley does not have the amylolytic enzymes necessary for fermentation. Therefore, it is necessary to conduct the malting to activate the enzymes and ensure the levels of sugars (Karlović et al., 2020). Malted barley

is obtained by soaking and draining the barley to germinate the seeds. Germination activates enzymes that convert starch and proteins into sugars and amino acids (Amienyo & Azapagic 2016). Then, malt grains are milled in a wet or dry process to ensure a high yield of extracted substances (Olajire, 2020).

After obtaining the malt, it is possible to advance to the next stage, wort production through mashing. In mashing, the millet malt and water are mixed and heated (Olajire, 2020). Wort is the liquor extracted from the mashing process. Wort contains the sugars that the brewing yeast will ferment to produce alcohol. Next, the wort obtained is boiled, and during this time, hops are added to give bitterness and aroma to the beer (Kunze, 2004). Boiling sterilises the wort and extracts the hops' substance that creates colour and flavour (Olajire, 2020). After boiling, the wort is clarified by removing the spent hops, and it is cooled (Tokos et al., 2011). After filtration and cooling, the wort is oxygenated and blended with yeast and the main fermentation begins (Amienyo & Azapagic 2016; Karlović et al., 2020; Olajire, 2020). The fermentation happens in the cellar (Tokos et al., 2011). In this stage, yeast metabolises the fermentable sugars in the wort to produce alcohol and carbon dioxide (Amienyo & Azapagic 2016). The beer will stay in a fermentation vessel during a period of days or weeks, depending on the beer style - 7 to 10 days in the case of ale, or several weeks in the case of lager (Morgan et al., 2020). After the primary fermentation, follows the beer maturation, involving a secondary fermentation (Tokos et al., 2011). During this time the flavour and aroma of the beer are refined and enriched (Briggs et al., 2004; Karlović et al., 2020). Then, the beer is filtered removing residual yeast, making the beer stable. Filtration is a separation process that removes the yeast cells and other turbidity materials still present in the beer. Later, the carbon dioxide content is adjusted, and the beer is ready for filling (Briggs et al., 2004; Kunze, 2004). Then, beer is transferred into bottles, cans, kegs, or bulk tanks (Briggs et al., 2004). During filling, quality parameters must be retained and every access of air to the beer must be prevented. The end-product of the production process is the packaged, finished beer, ready for distribution (Kunze, 2004; Morgan et al., 2020).

2.3. Sustainability Management in Craft Beer Industry

Sustainability is still a recent concept, and it is tough for scholars to agree upon a standard definition and a set of indicators to measure business sustainability (Jones, 2017). Nevertheless, the most common description for sustainability is a development that “meets the needs of the present without compromising the ability of future generations to meet their own needs” (Du Pisani, 2006: 83). Sustainability includes social, environmental, and economic components of equal importance (Jones, 2017). These three aspects are interconnected once society depends on the economy, and the economy depends on the global ecosystem (Olajire, 2020). Peel (1999) describes sustainable development as a lifestyle within the planet's possibilities. Moffatt (1993) characterises sustainable

development more in deep as the use of renewable resources without its elimination or degradation for the use of future generations; use of resources of an area regarding the future living conditions for the people in that area; and the welfare of future generations must never be compromised.

Peel (1999) refers that ecological sustainability will be a requirement for businesses in the future, something already acknowledged by large corporations, governments, and NGOs. Peel gives particular attention to the brewing industry once it produces one of the most common objects in people's lives and is one of the most wasteful industries in the world.

Sustainability can leverage a business by creating value, cost and risk reduction, reputation, legitimacy, innovation and enchasing business vision and growth (Rosburg & Grebitus, 2021).

2.3.1. Environmental Impact of Brewing

Brewing is not an environmentally friendly industry, in fact, brewing is a resource and energy intensive activity that consumes large volumes of water and creates high amounts of waste (Baiano, 2020; Olajire, 2020). Approximately, each litre of beer produced requires 10L of water and produces 500g of carbon dioxide (Embry, 2018; Karlović et al., 2020). The expansion of the brewing industry in the world has been accompanied by pollution and waste (Milburn & Guertin-Matín, 2019).

In the process of transforming raw materials into the final beer product large amounts of water and energy are used for production, washing and cleaning (Olajire, 2020).

Amienyo & Azapagic (2016) summarizes the beer life cycle in the following stages:

- Raw Materials: barley and hops cultivation, transforming barley into malt, producing carbon dioxide and other materials;
- Manufacturing: electricity and material inputs for beer production in grist preparation, fermentation, carbonation, storage, filtration and filling;
- Packaging: material and energy inputs for manufacturing glass bottles with steel tops, aluminium, steel cans and multi-pack cardboard;
- Retail and Consumption: energy consumption in refrigeration and consumer waste generated.
- Waste Management: treatment of wastewater from the beer production process and effluents from the brewery;
- Transport: energy consumption in transporting material, beer and waste.

Baiano (2020) also used a life cycle assessment method in beer production to individualise the environmental impacts during beer life cycle. It was possible to identify the three types of environmental effects:

- Upstream, regarding production and transportation of raw materials and beer packaging;
- Operational, concerning the resource consumption during brewing;
- Downstream, regarding transport of beer from the brewery to consumers.

According to Baiano (2020); Ness (2018); Olajire (2020); and Sucena & De Oliveira Marinho (2019), the brewing process is intensively water demanding, using large amounts of water for each unit produced; is energy-intensive because of processes such as mashing, boiling, cooling, packaging, and beer transport, among others; and creates vast quantities of wastes. Figure 2.2. illustrates the inputs and outputs of beer brewing.

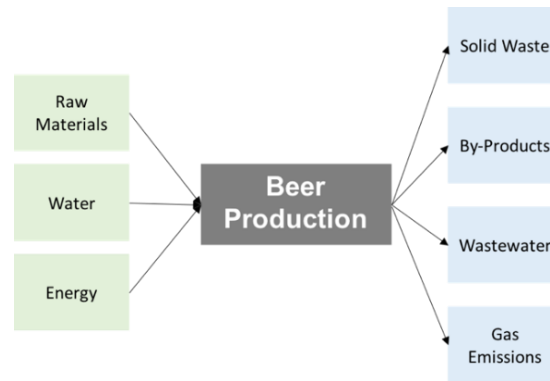


Figure 2.2. Beer production inputs and outputs (Adapted from Olajire (2020))

Olajire (2020) refers that in a brewery, the inputs with bigger impacts are water and energy.

- Water consumption:

Water is an essential ingredient of beer, composing 90-95% of beer my mass. It is also used in all stages of the production process (Olajire, 2020). Producing 1L of beer consumes 10L of water, however, in large breweries the amount of used water can be lower (Karlović et al., 2020). An efficient brewery can use 4L to 7L of water to produce 1L of beer. In addition to water for the product, breweries use water for heating and cooling, cleaning, and sanitary water. The largest amount of water used in breweries is used for cleaning and disinfection (Karlović et al., 2020). Nonetheless, 98% of beer’s water footprint comes before the actual brewing process, for the production of ingredients. Considering the entire process of beer production, since the agriculture of raw material to the finished product, is required around 298L of water to produce 1L of beer (Milburn & Guertin-Matín, 2019).

The large water consumption results in large amounts of wastewater. Producing 1L of beer results in about 7L of wastewater (Karlović et al., 2020). Wastewater is one of the most significant waste products in brewing operations. It can be divided into industrial process wastewater and sanitary wastewater from toilets and kitchens (Olajire, 2020). There are strict laws that require a proper disposal of wastewater, it cannot be discarded into the sewer system without prior treatment once it can negatively affect the flora and fauna. Wastewater can contain residues of the cleaning agents, as well as residues from raw material. Usually it also contains sugars, soluble starches, ethanol, volatile fatty acid, and suspended solids (Karlović et al., 2020; Milburn & Guertin-Matín, 2019).

- Energy consumption:

Brewing is energy-intensive, especially during mashing and wort boiling. It uses intensively electrical, thermal and fuel energy. Thermal energy is used to raise steam in boilers for wort boiling and water heating. Electrical energy is used in the refrigeration system, in bottling and in wastewater treatment. Fuel is primarily used as input to boilers to produce steam for various processes and on-site electricity generation but also used in other activities such as heating, cooling, refrigeration and machine drive (Olajire, 2020).

The outputs of brewing are solid waste, by-products, liquid effluents, and air emissions (greenhouse gas). The solid wastes include urban residues, industrial residues, glass, paper, cardboard, plastic, oils, wood, biological sludge, green residues, etc. The by-products include wastewater, grains, spent hops and surplus yeast (Karlović et al., 2020; Olajire, 2020). Figure 2.3 is a visual representation of the main inputs and outputs of brewing during all stages.

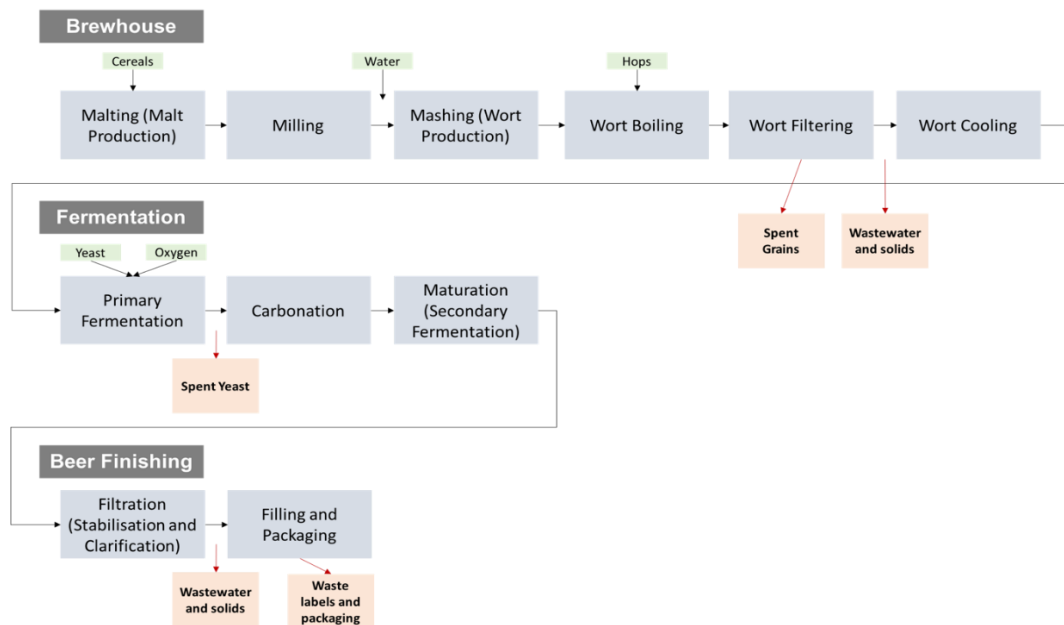


Figure 2.3. Inputs and outputs during brewing activities (Adapted from Olajire (2020) and Ashraf (2021))

The environmental impact from breweries can be divided into three groups: resources availability, nuisances, and toxic effects. The resources consumption is the bigger environmental impact from breweries. The nuisance is related to the emissions of noise, odious and dust mainly from handling malt and adjuncts. The toxic effect is related to the toxic impact from uncontrolled products or chemical spills and wastewater treatment plants. The main problems brewing can cause are scarcity of water, combustion of fossil fuels, utilisation of raw materials, and emissions of gases. The water consumption can impact the exploitation of water resources, and the overexploitation of water resources can cause deterioration of the water recipients and the quality of the water. Another

problem related to water is the chemical that can pollute surface and ground water. The untreated wastewater discharged in surface waters can cause its deterioration, put in risk the aquatic life and aquatic ecosystems. The consumption of energy generated from fossil fuels results in the emission of carbon dioxide, sulphur dioxide and nitrous oxide (Olajire, 2020).

Another part of the sector with a considerable environmental impact is the packaging (Ness, 2018; Sucena & De Oliveira Marinho, 2019). As shown in Amienyo & Azapagic (2016) research, the global warming potential (GWP) of 1L of beer in glass bottles is valued at 842g CO₂ eq., in aluminium cans is 575g CO₂ eq. and in steel cans is 510g CO₂ eq. This research concluded that raw materials and packaging are the main hotspot in beer production and the key contributors to the GWP. It was found that packaging contributes 19-46% to the GWP and raw materials 47-63%, being glass containers and barley malted the major sources of impacts. Raw materials have a big share in GWP due to nitrous oxide emissions resulting from barley cultivation. Electricity, waste management and transportation also have a share of GWP.

The greenhouse gas (GHG) emissions result of the intensive use of agricultural materials, water, energy, and packaging materials needed to produce beer. Barley is a significant source of GHG emissions and is estimated that the cultivation of 1kg of barley produces 0.57kg of CO₂ eq. Packaging also constitutes a source of GHG emissions, accounting for about 85% of the required energy across beer's life cycle (Shin & Searcy, 2018).

2.3.2. Craft-brewery related Sustainable Development Goals (SDGs)

The United Nations drew up 17 objectives to put an end to, among other things, poverty, inequality, and climate change: the Sustainable Development Goals (SDGs) (United Nations, 2018). The SDGs combining political aims with visions of economic development and social justice, enact as robust framework for a new global economy and change the relationship between global capitalism and the local economy. Moreover, this approach implies a new conception of the business corporation contributing to political and environmental goals of the community's development, enhancing the ethical economy and pave the way to the Circular economy paradigm (see Annex A).

In theory, there are many good arguments for integrating the SDGs in business management systems, turning them into a framework for developing new progressive business models concerning large, small, and medium-sized enterprises in the local and global community (Rendtorff, 2019).

This section of the literature review addresses the SDGs that share common ground with the craft breweries core activities. As presented in the previous sections, the concerns over the environmental impact of craft brewing and the sustainability efforts of craft breweries are related to the areas of (i) water use and wastewater treatment, (ii) energy and climate, and (iii) sustainable consumption.

Accordingly, the following SDGs are pertinent to the beverage sector. Craft breweries can use them to think about how their sustainability actions contribute to addressing global issues. In each SDG, a series of indicators are enclosed. Not all are well suited for the craft brewing industry and it is necessary to select the most appropriate according to the case and brewery typology.

- SDG 6: Clean water and Sanitation (Ensure availability and sustainable management of water and sanitation for all)

SDG 6 mainly addresses the availability of water for users by guaranteeing access to water. However, SDG 6 also emphasizes responsible water use and reduced pollution by industries (United Nations, 2018). Water consumption and wastewater disposal issues are inherent to craft brewing and should be dealt with effectively and sustainably.

Craft breweries face a myriad of water issues, and their ability to address those issues can hinder access to safe drinking water and sanitation for all. As stated before, a brewery requires about 3 – 10L of freshwater to produce 1L of beer (Chen et al., 2016). Due to the high-water consumption, large quantities of wastewater are produced, and water and waste management have become a significant cost factor. In addition, most breweries discharge 70% of their incoming water as effluent, wastewater that comes from the brewing process and goes to the sewer system (Simate et al., 2011). If the brewery does not manage its wastewater well, the capacity of the on-site sewage treatment plant can become overloaded. Then, the sewage treatment plant can lead to wastewater discharge into the local body of water. When a brewery takes measures to control or pretreat its wastewater, it helps to ensure that local waterways are not polluted and kept clean.

- SDG 14: Life below Water (Conserve and sustainably use the oceans, seas and marine resources for sustainable development)

SDG 14 deals with marine pollution as a consequence of industrial water use. Plastic production and accumulation in the natural environment are escalating due to indiscriminate use, poor or inadequate recycling, and deposits in landfills. In 2019, the global production of plastic was at 370 million tons, with only 9% of it being recycled, 12% is incinerated, and the remaining left in the environment or landfills (Kumar et al., 2021). As a result, the leakage of plastic wastes to rivers and the plastic macro-litter in surface waters running downstream to seas and oceans is occurring at an unprecedented rate. Consequently, this plastic, which was also used as packaging in the food and beverage industry, poses a major threat to marine life above and below water (Eriksen et al., 2014) and to the environment equilibrium.

Plastic waste accumulates in the oceans and breaks down into small particles known as microplastics (MP) and nanoplastics (NP). These microparticles can be taken up by hundreds of different species that directly or indirectly become part of complex food chains, in which humans are included. Depending on the period and region, MC and NP are absorbed by physical or biological

processes or a combination of both (Kelly et al., 2020). Thus, NP and MP that affect ecosystem services are disseminated through three media: terrestrial ecosystems, aquatic ecosystems, and the atmosphere (Figure 2.4).

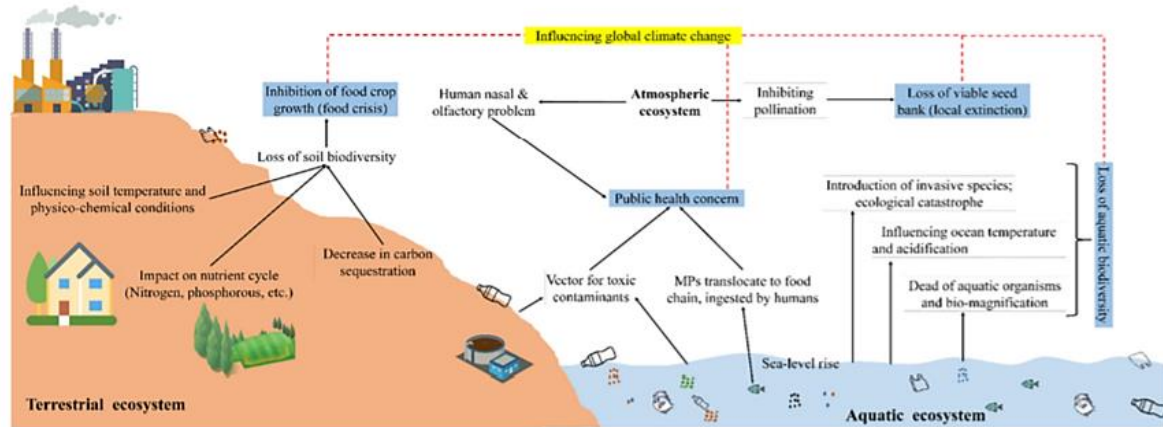


Figure 2.4. Illustration of micro- and nanoplastics affecting various ecosystem services and climate change on terrestrial, aquatic, and atmospheric ecosystems (source: Kumar et al., 2021)

A new IUCN (International Union for Conservation of Nature) report finds that an estimated 229,000 tonnes of plastic are leaking into the Mediterranean Sea every year, equivalent to over 500 shipping containers each day (Boucher & Billard, 2020). Unless significant measures are taken to address mismanaged waste, the primary source of the leakage, this will at least double by 2040 (Garofalo et al, 2020).

In previous studies of mass-produced beer, it has been found that packaging was a hotspot driving the largest share of environmental burdens (Becerril Arreola & Bucklin, 2021). Plastic packaging burdens for micro-breweries are modest because most of the beer is distributed in reusable casks, kegs, bottles, and cans rather than in plastic containers. Nevertheless, plastic increased transport requirements are significant where bottles or cans were used, so micro-breweries plastic waste production should not be overlooked. Thus, distribution and packaging present opportunities to reduce the environmental footprint of craft beers (Morgan & Lane, 2021). However, it is noteworthy that small scale brewing has its own set of environmental hotspots and challenges distinct from larger brewing organisations. Better water management will not only benefit firms in the food and beverage industry, but it is also essential to achieving global goals.

The craft beer industry must help ensure access to clean drinking water and reduce water pollution through its activities and processes to achieve SDG 6 and SDG 14. In addition, good water management, including its water footprint, is an essential part of the industry's contribution to responsible production and consumption (Aivazidou et al, 2016; Weber & Saunders-Hogberg, 2020).

- SDG 12: Sustainable Consumption and Production (to understand and know material flow and their change inside society, to reduce waste, promote recycling, minimize environmental impact, and rationally plan waste management infrastructures.)

SDG 12 emphasizes the sustainable management and efficient use of natural resources, including water. The brewing industry's type and extent of consumed materials can show how dependent the industry is on these natural resources and how its needs and use affect their supply. SDG 12 recommends the application of footprinting methods to estimate natural resource input per GDP. Morgan et al. (2021) evaluated the ecological footprint of microbreweries in Wales based on their life cycle assessment across the Supply chain. Stages in the value chain where resources are consumed include barley and hops cultivation, upstream processing, and distribution of the brewing ingredients, brewing production, packaging, beer distribution and waste management. Water use and packaging have the largest share of resources consumption and environmental impacts.

Promoting sustainable consumption is a critical element of sustainable development, which depends on achieving long-term economic growth that meets present and future generations' environmental and social needs. To better understand what sustainable consumption means, it might be helpful to refer to "Brundland's definition" of sustainable development, which has two clear criteria: the satisfaction of human needs and the observance of conditions aimed at preserving the capacity of the environment to meet these needs (WCED, 1987). The same concepts apply if they regard sustainable consumption. Indeed, in 1994 the Oslo Parliament defined sustainable consumption and recalled the principles of the Brundtland Report on the use of goods and services that meet basic needs and minimize the depletion of resources to meet the needs of future generations.

Based on evidence from various research areas suggesting that the need for natural resources for human activities exceeds what is sustainable for the planet (Peattie & Collins, 2006) the focus on sustainability in the last few decades by research and institutions is not surprising. Moreover, since current consumption patterns are no longer sustainable, new forms of sustainable approaches are increasingly being promoted (Lim, 2017).

Although organic food directly aims at protecting human health, sustainably brewed beer is based on raw materials and does not change the product's composition and has no positive or negative effects on human health. However, using a survey of beer consumers in the U.S., Carley and Yahng (2018) investigated the consumers' willingness to pay for sustainable beer. The authors found that most consumers were willing to pay more for an environmentally sustainable beer.

- SDG 7: Affordable and Clean Energy (towards the transition to a zero-carbon and climate-resilient society)

SDG 7 ensure access to reliable, sustainable, and modern energy at an affordable price. Due to rising fuel costs and the urgent need to reduce the industry's carbon footprint (Bocken & Allwood,

2012), renewable energy sources are becoming increasingly important in the beverage and food industry. As mentioned above, the brewing process uses much energy. In places dependent on fossil fuels, an intensive process means that more fossil fuels are used. Therefore, craft breweries that can find ways to source or generate clean energy through the installation of solar panels or other means are in line with SDG 7.

- SDG 13: Climate Action (towards urgent action to combat climate change and its impacts)

The carbon dioxide (CO₂) emissions and additional anthropogenic GHGs at the current or higher rates cause meaningful changes in the global climate system (IPCC, 2007). Despite organisations being one of the main responsible for GHGs emission, they are critical in developing solutions (Wright & Nyberg, 2017), and under "green pressure" from stakeholders (e.g. shareholders and customers), the industry is reducing its ecological footprint (Liesen et al., 2015).

Reducing GHGs that cause climate change is a hallmark of climate protection. Some craft breweries are pledging to reduce GHGs emissions in their value chains, demonstrating their commitment to clean energy sources, reducing the amount of waste going to landfills, and minimizing GHGs from trucking and flying. All these efforts aim to combat climate change and reduce its effects. Some brands strongly embrace this change. Heineken aims to become a carbon-neutral beer producer by 2030 and to have a carbon-neutral supply chain that includes agriculture, packaging, distribution, and refrigeration by 2040¹. To achieve this, the utilisation of renewable energy to power breweries is critical. In Spain, Heineken signed a contract with the energy company Iberdrola to supply four Spanish breweries and their offices with solar power. Moreover, biomass boilers will replace the existing gas boilers. Through this, beer production will be made with renewable energy by 2023, when Heineken Spain strives to be 100% carbon neutral.

2.3.3. Sustainability Challenges in the Craft Brewing Industry

Ness (2018) and Sucena & De Oliveira Marinho (2019) highlight some areas that SMEs craft breweries should improve under environmental parameters: water conservation, energy consumption, raw materials waste, spent grain reuse, solid wastes (other than spent grains) reuse, and packaging.

Ness (2018) also describes additional areas beyond the environmental parameters, such as socioeconomic priorities. It is necessary to create positive and fulfilling working conditions for employees. Additionally, although becoming more balanced in recent years, men dominate the craft beer world as beer consumers and brewers. It is essential to create a better balance between the genders and create a more equitable sector. Another significant challenge is the brewery involvement in the local community since these organizations most often depend on local customers, local

¹ <https://www.theheinekencompany.com/>

employees, and the local environment for ingredients. A sustainable practice of craft breweries is using organic or local ingredients to reduce upstream impacts. Nevertheless, it is hard to find organic raw materials and ingredients such as hops because they are grown in limited geographic areas, making it difficult to reduce the impact related to their transport (Baiano, 2020). In addition, the lack of adequate supply, uneven ingredient quality, and higher costs makes it difficult (Jones, 2018).

While many breweries orientate themselves toward sustainable development, sustainability assessment is still not a primary issue, especially for smaller ones who find it too difficult. Smaller breweries point out that sustainability assessment and reporting is complex and challenging. The major obstacles are the availability of reliable data and figures needed for evaluation, and the lack of knowledge on the proper indicators for overall sustainability assessment. Despite many existing frameworks for sustainability assessment, none of them specifically addresses breweries (Tokos et al., 2012). Another big obstacle is financial barriers to sustainable technology (Embry, 2018).

Small breweries recognize social and environmental sustainability as an essential factor; however, big breweries are more transparent in their environmental performances, reporting their processes and sustainability (Shin & Searcy, 2018). Large breweries can perform better sustainability metrics because of the economies of scale advantages, achieving more measurable sustainability metrics (Jones, 2018). Sustainability innovation can be expensive, and SMEs are limited in financial resources and potentials to devote to it, while large brewers have easy access to the latest technological innovations (Signori et al., 2017). Therefore, craft breweries need to improve sustainability. The current state of natural resource scarcity combined with population growth requires an urgent change (Brun et al., 2020). However, craft beer is a relatively new phenomenon, so it can take time to develop sustainability priorities and create programs to support them (Ness, 2018).

2.3.4. Improvement Opportunities in the Craft Brewing Industry

Brewing is water intensive, therefore there are needed measures to increase water efficiency and to promote water quality. It is also energy intensive, so measures to increase energy efficiency and use of renewable energy systems are important. Brewing creates vast quantities of waste, so by-products reuse is important. Packaging is another impactful area, so it is necessary to create more sustainable packaging systems (Ness, 2018).

As Olajire (2020) refers, sustainability and environmental changes in the brewing industry start in eliminating material losses, improving brewing and packaging efficiency and find sustainable ways to managing waste. But recycling and reusing are also critical (Bumblauskas, 2017). Trough the literature review it was possible to collect the best environmental management practises focusing on resource consumption (water, energy, raw materials), emissions reduction, and recycling. These actions will

result in reduced environmental impact and operational costs (Olajire, 2020). First, it was possible to conclude that breweries environmental practises must start with the following practises:

Table 2.1. First sustainable practises that a brewery should follow

Practices	References
Annual assessment to evaluate operating procedures and identify opportunities for improving practises, as so as a policy to support the environment.	Rosburg & Grebitus (2021)
Reduce resources consumption (water, energy, and raw material)	Ness (2018); Olajire (2020); Baiano (2020); Karlović et al. (2020)
Reduction of emissions and waste (solid waste and wastewater)	Olajire (2020); Karlović et al. (2020); Ashraf et al. (2021); Rosburg & Grebitus (2021)
Packaging	Ness (2018); Olajire (2020); Baiano (2020); Amienyo & Azapagic (2016)
Staff education	(Baiano, 2020); Olajire (2020); Bumblauskas (2017)

After understanding these practises, it was possible to individualise specific modifications in areas of impact, detailed in the next table:

Table 2.2. Some sustainable modifications in a brewery and its relations with SDGs

Area of impact	SDG	Modifications	Reference
Water	SDG 6	<ul style="list-style-type: none"> • Water tracking; 	Rosburg & Grebitus, 2021
		<ul style="list-style-type: none"> • Installation and monitoring of water meters; • Stopping water flows during breaks; • Dry milling of malted barley; • Installation of low flow control valves and an automatic valve to interrupt the water supply when there is a production stoppage; • Reduction of solids in wastewater discharge; • Use low-volume high-pressure washers or equipment for mixing water jet and a compressed air stream; • Use compressed air instead of water whenever possible; • Fit hoses with shutoff nozzles to prevent wastage when not in use; • Preventive maintenance is essential once substantial amounts of water can be lost due to lack of maintenance; 	Olajire, 2020
		<ul style="list-style-type: none"> • Rooftop water harvesting systems; 	Ness, 2018
		<ul style="list-style-type: none"> • Installation of modern equipment, like clean-in-place (CIP) system and other water reclamation systems to decrease water usage in the brewing process; 	Ness, 2018 Baiano, 2020
		<ul style="list-style-type: none"> • Reuse process water; • Monitoring water to beer ratio. 	Rosburg & Grebitus, 2021
		<ul style="list-style-type: none"> • Energy tracking; 	Rosburg & Grebitus, 2021
Energy	SDG 7	<ul style="list-style-type: none"> • Using more efficient equipment when replacing old equipment; • Installation of computerised controllers to better regulate motor output; • Installation of timers and thermostats to control heating and cooling; • Preventive maintenance to improve efficiency and minimize losses; • Performing a hot water balance of the facility to determine when, where and how hot water is being used and identify areas where reductions can be made; • Pipes and process lines free of leaks; • Efficiency of heating, ventilation, and air conditioning; 	Olajire, 2020

		<ul style="list-style-type: none"> • Improve isolation on heating and cooling lines; 	Baiano, 2020 Olajire, 2020
		<ul style="list-style-type: none"> • Installation of efficient wort boilers; 	Ness, 2018 Olajire, 2020
		<ul style="list-style-type: none"> • Use natural light as much as possible; • Installation of LED lighting systems; 	Ness, 2018
		<ul style="list-style-type: none"> • Use of renewable energy and alternative energy sources; 	Ness, 2018 Baiano, 2020
		<ul style="list-style-type: none"> • Heat recovery during boiling. 	Baiano, 2020
Emissions	SDG 13	<ul style="list-style-type: none"> • Tracking and measure GHG emissions and carbon footprint; • Policy to reduce GHG emissions; • Efficient transportation; 	Bumblauskas, 2017
		<ul style="list-style-type: none"> • Change fuel; • Optimisation of the burner or change the burner. 	Olajire, 2020
Waste	SDG 12	<ul style="list-style-type: none"> • Spent grains are mainly used as animal feed component for cattle, once they are rich in proteins, vitamins, and water. Although it has less nutritional value than barley, the moisture makes it very easy for digestible of livestock. But there are other uses for it in food technology and human nutrition. For example, it can be used as ingredient for breads and pizza, energy bars and dog biscuits. Spent grains have become the focus of various studies that have found good results for it in biofuel production, isolation and production of phenolic compounds, lactic acid, growth and cultivation of microorganisms and many other applications. Spent grains are also bought by farmers to increase the storage life of silage. Another use is drying and burning the spent grains to convert to energy; 	Ness, 2018 Baiano, 2020 Karlović et al., 2020 Olajire, 2020
		<ul style="list-style-type: none"> • Spent hops used as fertilizer or compost; 	Karlović et al., 2020
		<ul style="list-style-type: none"> • Surplus yeast can be used multiple times in beer production. Another use for it is animal feed and food supplements for animal industry, and food flavouring for human consumption. It has high contents of proteins and vitamins; 	Baiano, 2020 Karlović et al., 2020 Olajire, 2020
		<ul style="list-style-type: none"> • Other solid wastes can be used as organic waste composting; • Labels and paper can be recycled and reused for cardboard and paper manufacturing; • Glass bottles can be recycled and reused in glass manufacturing; • Metals can be recycled and reused in various metal products; • Wastewater sludge can be reused as soil improvement and organic fertilizer. It can also be used as substrate for the growth of microalga, for hydroponic plan cultivation, and the production of biogas rich in methane and hydrogen. 	Olajire, 2020
Packaging	SDG 12	<ul style="list-style-type: none"> • Use of recycled glass bottles; • Reusable bottles and keg systems; 	Ness, 2018 Baiano, 2020
		<ul style="list-style-type: none"> • Switch from conventional bottle to lightweight bottles or cans; • Returnable bottles; • Recycled cardboard for 6-pack. 	Ness, 2018

- Reduce resources consumption (water, energy, and raw material):

Much of the water used in brewing is lost to evaporation or down the drain. The first way to reduce the amount of wastewater is to reduce the water consumption (Baiano, 2020). The reduction of water consumption will have environmental and economic benefits. Water conservation will result in lower wastewater discharge volumes and less wastewater treatment (Olajire, 2020).

The reduction of energy consumption will prevent pollution and lower operational costs (Olajire, 2020). A lot of energy is used in heating water during different stages of the brewing process. A craft

brewer might consider some alternatives to the use of energy: solar heating; recovering of steam produced during boiling; use of the warm water produced during the thermal process to begin another brew. In refrigeration, the energy need can be decreased through airlocks and proper insulation. Alternative energy sources can also decrease the energy costs (Baiano, 2020).

The reduction of raw materials consumption will save the company money in reduced purchasing costs, reduce the amount and cost of waste production, lower effluents, and reduce the strain on natural resources (Olajire, 2020).

- Reduction of waste (solid waste and wastewater):

When possible, breweries can resell materials and by-products (spent grains, surplus yeast, and spent hops), which eliminate the need for disposal and provides a source of revenue. Some of the by-products are nutritious and valuable, cheap, and affordable, therefore they can be incorporated into various industries oriented towards food, pharmaceuticals, or biotechnology production. It is also necessary to find new ways to safely dispose them, or reduce their consumption (Karlović et al., 2020).

Wastewater treatment is complex. If it is to be discharged into municipal sewers it must be treated to meet the standard regulations. If it is to be discharged in another place, then a stricter treatment is required. The treatment can be physical, chemical, biological or a combination of these (Ashraf et al., 2021).

- Packaging:

A way to reduce the brewery environmental impact is to reduce glass production. This can be achieved by increasing the use of reusable bottles and recycling (Baiano, 2020). Packaging modification is also a method; some examples are the replacing of glass bottles with recyclable polyethylene terephthalate (PET) bottles, waterproof labels, and reducing the use of glue (Olajire, 2020).

In addition to returnable and reusable glass bottles, increasing the use of canned beer could be a measure to reduce impacts, especially steel cans as they have lower impacts than aluminium. Though, consumer perception is a strong factor in this change, once many believe that bottled beer has higher quality and cans can change the taste of beer (Amienyo & Azapagic, 2016). Therefore, Amienyo & Azapagic (2016) gives two options that may be more feasible: recycled glass containers and light-weighting of bottles. Recycling of glass can reduce the GWP around 3% due to lower energy consumption in bottle production and reduced amount of post-consumer waste. Light weighting of glass bottles is another interesting area for the beverage packaging sector and is being used by several multinationals like AB InBev and Heineken. Reducing the weight of glass bottles by 10% results in reductions of 5% of the GWP, due to lower energy and material consumption in production and transport.

- Staff education:

Process, technological, equipment, and management changes can help in reducing the impact of a brewery, nevertheless changes in staff behaviour and attitude can have a big impact. Staff should be trained to have an approach to sustainability in day-to-day activities. Personal at all levels should be aware of suitability plans and objectives. A practise for improving these subjects can be programs with regular feedback on staff behaviour, such as reward systems and benefits for employees with green behaviours (Bumblauskas, 2017; Olajire, 2020).

Making a wrap up of the Amienyo & Azapagic (2016) study, the most problematic areas in the beer life cycle are the raw materials and packaging, specifically the malted barley and the glass bottles. Therefore, these should be targeted for sustainable improvements in the supply chain.

Brewers can analyse their brewing sustainability and manage water, energy use and waste generation using benchmarking of key performance indicators (KPI's) such as water-to-beer ratio and total diversion rate. This allows to analyse performance, compare to other breweries, and develop sustainable plans and strategies. A systematic review on operations and metrics allows an understanding about the sustainability performance. Another possible way to increase SME adoption of sustainable practises is trough networks of influence. The network among breweries plays a major role in the adoption of new practises, techniques, and sustainability initiatives (Rosburg & Grebitus, 2021). Craft brewers are characterized by collaboration and collective actions among stakeholders, therefore motivations for sustainability actions from these enterprises are related and supported by local networks and stakeholders' relationships. Their situated embeddedness and peer influence may help in sustainability initiatives and actions (Luederitz et al., 2021).

2.4. Transparency in Supply Chain

The occurrence of several food scandals in recent years has made consumers more demanding and careful, and they are now more interested in how products are produced (Guido et al., 2020). Consumers are concerned about food quality, safety, and the reliability of food labels information (Stranieri, 2021). Consuming trends are now sustainably, organically and origin certified products, mainly related to increase income and environmental awareness (Parra-Domínguez & Roseiro, 2020). Food and beverage adulteration are a major concern, as production is not a completely transparent process (Astill et al., 2019). This aligned with the social, environmental, and economic problems faced in the last few years, results in increased pressure from stakeholders (customers, employees, suppliers, non-governmental organizations, and regulators) for companies to improve the sustainability performance of their supply chains (Saetta & Caldarelli, 2020; Shafiq et al., 2020).

Social (e.g., working conditions and labour practices) and environmental (e.g., waste and pollution) sustainability issues have become increasingly important (Chen et al., 2018). These concerns lead to a growing interest in sustainable supply chain management (SSCM) (Brun et al., 2020). Sustainability goes beyond organizational boundaries, therefore is necessary to pay attention to the relations throughout the supply chain and spread sustainability across it by pursuing collaborative approaches. Transparency is a mean to improve sustainability in the supply chain by providing information available to the public (Brun et al., 2020). By increasing the transparency of the operations, the levels of traceability and sustainability should also improve due to the quantity of new data and information (Astill et al., 2019). Consumer also has a growing demand for transparency and the desire to know more about where the food comes from, how it is produced and if it is a safe and sustainable product (Morgan et al., 2020).

Sustainable supply chain is an extension of the traditional supply chain, in which the goal is to maximize profitability, minimise the environmental impacts along the supply chain, and respecting the social well-being of the suppliers involved. An optimised and sustainable supply chain involves traceability (Germani et al., 2015).

2.4.1. Traceability

The use of a traceability system is essential for today's food and beverage companies for compliance with regulations, confirmation of product origin and identity, fraud prevention, and especially possibility of effectively addressing any sanitary outbreak. A well-implemented traceability system can give information about the product and enrich its perceived value by the consumer (Guido et al., 2020). Traceability has become necessary in global food supply chains because consumers expect reliability and safety. It can improve food safety by identifying food sources and providing better information about the causes of potential food contaminations; guarantee products authenticity, quality and safe production practises (Westerlund et al., 2021).

Olsen and Borit (2013, p.7) define traceability as "the ability to access any or all information relating to that which is under consideration, throughout its entire life cycle, by means of recorded identifications". A traceability system should be able to perform efficiently two fundamental operations: track and trace. Tracking means being able to follow a product from upstream to downstream along the supply chain. Tracing is the reverse process, which reconstructs the history of a product, using the information stored at each step of the supply chain (Guido et al., 2020). Traceability should give information about the origin of raw materials, the process, the distribution, and the final location of the product (Germani et al., 2015).

When talking about suitability and traceability in supply chains it is essential to consider the entire network of stakeholders and suppliers involved, from the ones in raw material procurement to the

ones responsible for product delivery and disposal. Traceability is only possible when knowing all the subjects involved and their relationships and exchanges (Germani et al., 2015).

It is quite difficult to determine a unique traceability framework, suitable for all contexts since traceability is an interdisciplinary research field (Guido et al., 2020). Transparency is not easy to ensure and enhance, especially for industries with globally dispersed supply chains. As a result, firms are looking for new technologies and advanced tools to help navigate the complexity of supply chains and supply chain management. Data-driven information technologies that enable gathering and analysing large amounts of data could improve supply chain performance (Shafiq et al., 2020). The technologies that can enable transparency within supply chains related to food and beverage production must be able to collect information and data throughout the entire supply chain. Importantly, these technologies must allow data to be collected by devices automatically as processes along the supply chain occur. Also, these devices must collect data that can then be made available to stakeholders in real-time (Astill et al., 2019).

2.4.2. Blockchain

Blockchain is a tool that can be an enabler for transparency, traceability, and sustainability in supply chains. It is a distributed database of encrypted records or digital events that can be shared among collaborating parties, on a peer-to-peer network. Depending on the rights of the users, it can be decentralised, giving equal rights to all users and the decision-making is shared among multiple users; or centralised, providing specific users with special rights and one central entity is the decision-maker. Data are collected in a secure format, and originality of data can be validated at any time (Astill et al., 2019; Esmaeilian et al., 2020; Saetta & Caldarelli, 2020). Blockchain became very popular with the cryptocurrency Bitcoin. Though its first applicability was cryptocurrencies and financial applications, the potential of this technology quickly moved to non-financial sectors (Kouhizadeh et al., 2020).

Blockchains, also referred as a distributed ledger technology (Xu et al., 2020), are created using cryptography in which each block (data) is linked to a previous block by a cryptographic pointer. A block is added to the previous and form a blockchain. In blockchains, data are converted to digital codes, stored in databases, have higher transparency, and limited risk of deletion and revision. It is as digital record of every agreement, payment, and transactional activity (Esmaeilian et al., 2020; Kouhizadeh et al., 2020). This digital technology allows “secure, real-time data handling with monitoring and controlling of data in a virtual environment” (Dede et al., 2021, p. 24). Also, it allows the flow of transactions and information without the need of intermediaries (Stranieri et al., 2021).

There are specific rules on how the data is added to blockchain. The data must be consistent and cannot be in conflict; new data cannot be inserted into a previous recorded block because data in blockchain is immutable; the computing system operating the blockchain protocol must be the same;

a public blockchain is not own by any party, and thus no single entity can unilaterally modify the state of blockchain (Xu et al., 2020).

Exist three types of blockchain: public, private, and hybrid. Public blockchains are open to the public, and everyone can participate. It is decentralised and provides full transparency of information and transactions. Private blockchains are managed by one entity that controls access and restricts participants, and so is a more centralised system. Finally, hybrid blockchains combine the best of public and private blockchains by providing transparency and defining permission and restriction for users (Parra-Domínguez & Roseiro, 2020).

Blockchain technology improves efficiency and visibility, allowing product information disclosure (Brun et al., 2020). Furthermore, it enhances transparency and traceability, providing consensus, secure, traceable, verified, and transparent information. There are many blockchain applications, and the literature has many examples, including baking, healthcare, energy sector, food industry, circular fashion, and supply chain management (Kouhizadeh et al., 2020).

Supply chains are complex networks with several stakeholders who need to share information but exist some difficulty when transferring documents because it is a time-consuming process, and there is some lack of trust between parties (Dede et al., 2021). This complexity makes it more complicated to do efficient transactions, trace products and data, and assess information. Align to this, is the major demand of customers to sustainable supply chains that has increased importance over the last decades. Blockchain can be solution for both challenges, however, is needed to point out that “any supply chains innovation adoption will face barriers and require careful planning” (Kouhizadeh et al., 2020, p. 3). Some benefits of implementing blockchain in supply chains are tracking of cargoes, enchased visibility, fewer customer doubts and problems, reduced risk, cost efficiency, and reduction of paperwork. All benefits combined enable supply chain flexibility and efficiency (Dede et al., 2021).

According to Esmailian et al., (2020), blockchain can promote green behaviour, enchasing product lifecycle visibility, improving operations and systems efficiency, and improving sustainability reporting and monitoring. In addition, it can be an efficient tool to identify wasting in supply chains due to its ability to share reliable data between multiple stakeholders (Astill et al., 2019). Technologies like this can address sustainability problems and help companies move towards a circular economy. “A transparent and traceable product lifecycle can close lifecycle loops, decrease waste generation and emissions, and engage governments, stakeholders, and users” (Esmailian et al., 2020, p. 9).

Blockchain has the potential to revolutionise supply chain sustainability, enchase SSCM and move to a circular economy (Esmailian et al., 2020; Kouhizadeh et al., 2020). It can verify a product sustainability authenticity by tracking its flows in supply chain (Kouhizadeh et al., 2020); solve challenges related to data reliability; provides more secure, transparent, and accurate information

than other systems; and helps reduce trust-related problems among supply chain actors thanks to the transparent and secure information (Stranieri et al., 2021).

In agri-food supply chains may arise problems in any stage that can be a risk for health. During pre-post harvesting, the quality and safety of products can be compromised by excessive use of pesticides, fertilizers with chemicals, and heavy metal residues. During production it can happen the adulteration of products and mislabelling the origin of products. A reason for these issues can be the lack of efficient tracking systems (Xu et al., 2020). In the food industry, retailers and food companies have started using blockchain to increase food safety and the traceability of products in food supply chains. Companies like IBM and Walmart have been developing programs to trace products' journeys over the entire supply chain with blockchain and have identified improvements in the food safety management (Esmaeilian et al., 2020; Stranieri et al., 2021). Some benefits of blockchain in the agri-food industry are related to supply chain management, food quality, company's economic performance and reduction of costs. It enables the reduction of food waste, improves logistics operations, makes information directly available to consumers, improves food safety and quality, proves the origin of raw materials, and gives information about the production process. In addition, it can help in mitigate food fraud and preserve the company's reputation (Stranieri et al., 2021).

In Stranieri et al. (2021) study on the impact of blockchain in an agri-food supply chain, the findings reveal that the implementation of blockchain provided economic benefits in profits and ROI, improved levels of customer's satisfaction, improved relationships of trust and collaboration of stakeholders, and improved information management along the supply chain, thanks to information accessibility, availability and sharing. Stranieri et al. (2021) also concluded that introducing this technology improves company's know-how, which turns into a strength and help the company in terms of competitive advantage, innovativeness, and ability to recognise weaknesses.

Westerlund et al. (2021) analysed five case studies using blockchain in food supply chain management. This study concluded that most value of blockchain was cost and time savings in tracing items through the supply chain and solving food crises. Another key finding was that "operating with a shared distributed ledger is automatically achieving compliance with government standards" (Westerlund et al., 2021, p.11). Other conclusions align with the literature on this theme, is that it provides better quality control over food, traceability from "farm to fork", and increased trust with stakeholders.

A Blockchain is an excellent tool for agri-food supply chains, as it is shown in Mercuri et al. (2021, p.12) research, this is a "sector where the traceability of the production chain is a key element to obtain a competitive advantage both from the point of view of the reduction of transaction costs and strengthening stakeholder confidence in the company".

Large retailers, like Walmart, and food producers, like Nestlé and Dole Gusto, have been exploring since 2016 the opportunities of blockchain in collaboration with IBM, using IBM Hyperledger, to

provide traceability along the food supply chain. In Europe, retailers like SONAE and Auchan also have explored these opportunities (Parra-Domínguez & Roseiro, 2020). The two projects of Walmart and IBM to trace packaged mangos from México sold in US stores, and pork sold in China stores are good examples of the utility and success of blockchain-based food traceability systems. Walmart created bar codes and labels to define data attributes to upload to the blockchain, and IBM wrote the blockchain code. The new system allowed Walmart to authenticate the origin of pork and mangos, and the time to trace the mangos decreased from 7 days to a few seconds (Bajwa et al., 2020).

Zhao et al. (2019) mentions several cases where blockchain provides secure and transparent information, allowing the tracking across the value chain of tuna and olive oil. Antonucci et al. (2019) gives other applications for this technology is the supply chains of coffee, beef, beer, fresh food, milk, and pasta. Regarding the beer case, DOWNSTREAM beer² is the first beer using blockchain to reveal information about ingredients and brewing methods. By framing the QR code printed on label, the whole raw materials and brewing process is identified. Another case illustrate in the literature is the Wine Blockchain, a project of EzLab³ that uses blockchain to enhance traceability and authenticity of wine. The project was created to fight adulteration and fraud of Italian wines. It works very similar to DOWNSTREAM beer, by placing a QR on the bottle and when framing it, the consumer can verify the authenticity of the products, their certification, and the production process. The data is stored on a blockchain and on a platform called AgriOpenData to automate the supply chain and to give producers a way to format and control the access to their data. “Wine Blockchain wants to build transparency and trust among the producer and the final consumer” (Motta et al., 2020, p. 8).

Blockchain does not guarantee a solution for all supply chain problem. However, it can be an approach for better monitoring the agri-food industry from “farm to fork” as well a tool to connect stakeholders and regulators. The transparency provided may reduce the food safety risk, fraud, poor management, and lack of regulation. All the information uploaded to blockchain is provided by first-hand sources (farmers, warehouse centres, transport vehicles, retailers, consumers) (Xu et al., 2020).

Nevertheless, switching to a new disruptive technology such as blockchain involves disruptive changes for a company, internal and external (Kouhizadeh et al., 2020). It also has current limitations before broad adoption, like scalability, regulations, security risks, and energy consumption (Esmailian et al., 2020). New technologies have advantages and disadvantages. A major sustainability concern of blockchain is the considerable energy consumption. The system, and the decentralised ledgers, consume a lot of computational power that consumes a lot of energy. High energy consumption means higher carbon emissions (Kouhizadeh et al., 2020).

² <https://www.down-stream.io/>

³ <https://www.ezlab.it/>

There is also a lack of understanding of the economic benefits of blockchain adoption in agri-food supply chains (Stranieri et al., 2021). Zhao et al. (2019) illustrate the main challenges for applying blockchain in alimentary supply chains: storage capacity and scalability, privacy leakage, regulation, high cost, and lack of knowledge. Some of the biggest challenges are also integration with vendors and supply chain partners. To overcome these, it is required careful considerations, preparation, and collaboration among supply chain partners (Bajwa et al., 2029).

Methodology

This chapter presents the research methodology used in the dissertation that intends to explain and describe how the research will be conducted, highlighting the methods and strategies used to answer the research questions and achieve the research goals.

3.1. Research Approach

To fully adhere to a realistic paradigm and understand the craft beer business, it is necessary to participate in a real-world situation, namely in an SME of craft beer. Craft beer phenomena must be considered part of the real world, which may only be imperfectly understood. Accordingly, it was taken the perspective that craft beer it is not a temporary business endeavour, but it is a phenomenon that reflects tendencies. Therefore, research findings should be thought of not as the reality of the world but as a window to reality, and that further insight can be gained through triangulation with results of other studies (Perry, 1998).

For this study, an exploratory case study and a qualitative methodological strategy were chosen, using the inductive method, which starts from the particular to the general. The case study is a social science research method that analyses a social phenomenon's specific context. It is a methodological approach that allows for in-depth analysis of a phenomenon, situation, or problem. This approach facilitates understanding of social phenomena because it answers the "why" and "how" research questions by analysing a particular case in its situational context (Stake, 1978). Case studies are helpful when the actors' behaviours cannot be controlled (Yin, 2018) and when the research wants to investigate "how" questions, which might require gathering data over an extended time (Miles & Huberman, 1994). Using a case study method makes it possible to take a holistic view and explore business and social processes in rich and complex detail.

According to Yin (2018), when the objective is to obtain preliminary information about the object of study, an exploratory approach is used. The qualitative case study is a desirable research approach for realists whose goal is to describe and explain phenomena, capturing the appropriate level of complexity (Bhaskar, 1979).

This study will have a pragmatist approach. The approach will tackle different perspectives to help collect and interpret data that help corroborate the hypotheses raised during data analysis. An inductive approach will be used, based on practical observation for theoretical conclusions about the study (Saunders et al.2009). The case study involves an empirical investigation of a contemporary phenomenon in a practical context by collecting data from multiple sources.

3.2. Research Strategy

It is essential to define the strategy that best suits the type and methods of the project. The research strategy allows to conduct the study to meet the research questions and objectives initially proposed. The methodology comprises four steps, as previously referred (section 1.5) and briefly described below.

3.2.1. Research step 1 – Critical Literature Review

The literature review is the first step to understanding the context of the research project. Therefore, it was investigated about craft beer, craft breweries, sustainability, SMEs, supply chain transparency, and blockchain through an extensive literature review based on data collected from scientific publications, white papers, books, and institutional websites. To conduct the research, multiple key words were used, such as “sustainability”, “craft beer”, “breweries”, “small and medium-sized enterprises (SMEs)”, “sustainable business model”, “transparent supply chain”, “SDGs and craft breweries”, and “blockchain”. After that, the theoretical background was explored related to brewing, sustainable development goals, operational improvements, and transparent supply chains. It was possible to obtain an overview of sustainability in craft breweries and supply chain transparency. This allowed developing a conceptual model to guide the case study analysis.

3.2.2. Research step 2 – Methodological approaches to Barona’s Case Study

Studying the sustainability within a single organization, the BARONA Brewing Company, bring us to a single-case study where the study has a subunit of analysis. The main unit is the sustainability management within the organization, and the embedded subunit unit is the sustainability within the supply chain. This is an embedded, single-case design and a qualitative study.

This 2nd step is designed to put in perspective the craft-brewery related SDGs previously found in the literature review and look for their fitness to the BARONA case. Thus, it is hoped to identify the SDGs more suitable for a microbrewery (e.g., governance, workers, health and safety, climate change, innovation, social responsibility, responsible consumption, and sustainable production), so it can be possible to define a sustainability strategy. Focusing on the SDG targets and indicators, and in keeping with evolving best practices, will be the most effective and measurable way for BARONA Brewing Company to support the SDGs. Therefore, it is necessary to track the inputs and outputs of the brewery’s project in alignment with the SDG targets and indicators. The goal is to measure the brewery’s outcomes within this framework, which will enable it to understand and demonstrate the impact of its work. That is why it is necessary to identify SD goals, targets and indicators that can contribute to the business strategy, material issues and key performance indicators (KPIs).

It will be necessary to collect primary data to analyse and evaluate (i) the current practices, (ii) the supply chain activities, and (iii) the performance at BARONA Brewing Company. This data and information will be acquired through qualitative methods, namely:

- Direct field observation to clearly understand the company's operations and activities;
- Semi-structured interviews directed to the Company's managers and stakeholders, and it will be used to gather information about goals and perspectives regarding sustainability.

3.2.3. Research step 3 – Case study, data analysis and scenario-based elaboration

Considering the results obtained in research step two and targeting the research questions (presented in subsection 1.3), the 3th step is to analyse and evaluate the current practices at BARONA Brewing Company and the different phases and activities of the supply chain in which the SDGs previously found in the literature review exist or should be applied. After this information has been collected will be necessary to investigate and search for the best sustainable practices and improvements to the business model and the supply chain of a SME craft brewery.

Based on Börjeson et al.'s typology (2006), we consider three types of scenarios: predictive (forecasts and what-if scenarios), explorative (external and strategic scenarios), and normative scenarios (preserving or transformative) answering the respective questions:

- What will happen (if...)? → predictive scenarios to address.
- What can happen (if...)? → explorative scenarios to address.
- How can a specific target be reached? → predictive scenario to address, related to preserve or change the processes towards sustainable business and supply chain transparency in the SME BARONA.

The role and applying of scenarios in the practices at BARONA Brewing Company and in different supply chain sustainability approaches are to discuss. It will also be investigated if blockchain is a suitable technology to improve transparency and traceability in the craft brewery sector.

3.2.4. Research step 4 – Solutions proposal

The last step is to develop conclusions and propose solutions and recommendations that can improve the sustainable performance of the selected scenario, firstly in BARONA Brewing Company and secondly in the supply chain. This step is based on the results obtained from the scenario-based analysis performed in research step three.

Case Study

This chapter presents and details the case study. It starts by presenting its context in the market, followed by the presentation of the company to be studied. Afterwards, is presented the methodology adopted to conduct the case study and to gather information. Finally, the data collected related to the company history, management, production, sustainability, and supply chain is here displayed, as also its analysis.

4.1. Case Study Context

Portugal is a country with a strong passion for beer. In Portugal, the beer consumption in 2019 was 548.258.00 litres, the average consumption “per capita” was 53 litres, and the exported beer was 176.495.000 litres (Cervejeiros de Portugal, 2017). Nielson (2019) data support that beer is the most valuable category of consumer goods, with the highest growth in the last decade in the first semester of 2019, growing by 19% in value and 15% in volume. The On Trade/Horeca channel (restaurants, snacks, bars, hotels, and conveniences stores) is the more important for beer since 80% of sales in value and two-thirds of sales in volume are made through this channel (Nielson, 2019).

In Portugal, the craft beer impact has been increasing from year to year, with this product registering a growth five times greater than the market average, according to Nielson (2019) data. Even though this category is still emergent in Portugal, craft beer has been conquering the consumer (Sousa, 2019, June 9). According to Nielson (2019), between April 2017 and April 2019, beer sales had a growth of 88% in value and 112% in quantity in a global market that evolved 8% in value and 5% in quantity, in the same period. However, the craft beer market is still very recent and only has a total of 1% of the Portuguese global beer share (Pinto, 2019, May 24; Sousa, 2019, June 9). Portugal is the 15th biggest European beer producer (Pinto, 2019, May 24), with 100 active craft breweries (Lista de Cervejas Artesanais Portuguesas, 2019). Some breweries with more recognition in the market are Sovina (one of the first craft breweries in Portugal, launched the first beers in 2011) LETRA, Dois Corvos, Maldita, Vadia, Praxis, and MUSA. The Portuguese beer market is a duopoly, with two big players dominating the market, Sagres (Central de Cervejas) and Super Bock (Unilever). Both companies introduced a craft beer line in their portfolio; Sagres created Hoppy House Brewing and Super Bock created The Brewers Company. Both companies see craft beer as a phenomenon that will create a new dynamic for the sector, improving diversity, sophistication, and value (Pinto, 2019, May 24; Sousa, 2019, June 9).

4.2. Company Presentation

The case to be studied is the BARONA Brewing Company, founded in 2015 and located in Marvão, in the heart of Alto-Alentejo (BARONA Brewing Company, 2018). This was the company chosen for this research because it is a small, local, family microbrewery, recent in the market. Therefore, it is the perfect example to study sustainability in the craft beer sector. Microbreweries may encounter difficulties to apply sustainable management and practises, and contribute to a sustainable development, so this resource aims to study improvements these enterprises can take.

BARONA is a company made up of six workers, three working in the brewing factory and three working in the pub. It has a diverse beer portfolio, including Pale Lagers, Pale Ales, Blonde Ales, IPAs, Porters, and Sour Ales. BARONA has several base beers, produced continually during all year: Seara Lager, Blonde Ale, APA – American Pale Ale, IPA – India Pale Ale, Porter, and Entruda – Soul Ale. Other than this, the brewery also produces especial and limited editions of beers throughout the year. These beers result from experiences with local fruits and exploring classic styles, to expand the various styles and flavours that exist in the brewing sector. Some beers are also produced in collaboration with other craft beers. The preferred sales market is the Horeca channel, allowing a greater margin on the product. BARONA's beers have received several awards and recognitions since 2016. BARONA has received gold, silver and bronze medals at the Iberian Awards, Concours International of Lyon, Polish Craft Beer Competition, Barcelona Beer Challenge, and World Beer Awards.

BARONA is a growing company, and annual beer production has been growing significantly every year. The company produced 9 166L of beer in 2017, and in 2020 the production was 52 810L.

4.2.1. Vision and Mission

Barona's vision is evident in its website and is based on a philosophy of inland development, with a model of constant innovation, where new products are manufactured upon consumer's preferences and market studies. This is possible because the company develops its production.

Barona has its own manufacture, producing in their facilities the products it markets. As stated on their website⁴: "Break old habits and take a look at the brewing world that expands beyond the industrial one". Indeed, the entire production, promotion and marketing process for Barona products comes from the company itself, where everything is done: initial idea, concept, innovation, manufacturing, bottle design, bottling, quality control, marketing, logistics, distribution, customer relations, and products deliverance whenever the customer is, through e-commerce.

In addition, that is Barona's mission: to make BARONA Beer the best craft beer in the Alentejo and at the same time to achieve national recognition in the market of reference' craft beers.

⁴ <https://www.cervejabarona.pt/>

4.3. Case Study adopted Methodology

The theoretical analysis of sustainability in craft breweries, sustainable improvements opportunities, transparency in supply chains, and blockchain as mean to achieve transparency in agri-food supply chains offers the opportunity to compare the theoretical results of the literature review with the reality of a typical craft brewery, in a case study. The goal is to understand how sustainability, transparency and blockchain are perceived and the potential it has for a craft brewery to improve sustainable management practices.

The primary data collection is direct field observation, and interviews with stakeholders and the entrepreneurs of BARONA. This will allow to analyse and evaluate the current practices, the supply chain activities, and the performance of the company. For the realisation of the interview, a semi-structure approach is applied. During interviews, it will be asked open questions so that the information content can be higher. Is necessary to define the interview questions and therefore develop a guide.

4.4. Data Collection

Before field observation and interviews, it is necessary to become familiar with the subjects, and so the research literature carried out in advance is the foundation for this. A visit to BARONA's fabric, located in Santo António das Areias, a village that belongs to the municipal of Marvão, was conducted on 20th September 2021. During this visit it is possible to get to know the three founders and the whole installations and observe the brewing process. Two of the three founders were interviewed on 30th September 2021. One more linked to sales and marketing, the other, to the facility and production process. These interviews were held virtually due to the different locations of the participants and were recorded⁵. It lasted two hours and had the goal to be a conversation and discussion about the several topics to be analysed in this master thesis (Annex B presents the interview script).

4.5. Data Analysis

In the following section, the results from the direct field observation and semi-structured interview are described and analysed.

4.5.1. Company

BARONA was founded in 2015 by Diogo Barrigas, João Nabo and Rui Roque. The name comes from the founders' first letters of the last name, Barrigas, Roque and Nabo. They started the company with their

⁵ If necessary, the audio of the interviews can be attached to this thesis or sent if requested.

own money, and as the business grew slowly, they invested the profits. The business has been developing slowly with some challenges in organisation, but the business is growing.

In 2017, with the incentives program S2E (Entrepreneurship and Employment Incentive System, launched in the context of Portugal 2020 support program), the company decided to invest in an equipment line with more fermenters that allowed to reduce production time and increase production capacity. In 2019 it was created the BARONA Craft Beer House, a pub in the village of Castelo de Vide, with the goal to provide beer lovers a place to taste and get to know the beers. The pub allows to have a more direct and stable flow of money. The payments to suppliers are done right after the bough, but the payments from clients can take some time, causing a gap. The pub helps filling that gap by being a direct spot of sales, generating more flow of money and allowing the company to evolve monetarily. In 2021 it was possible to acquire new installations with larger dimensions and space that allows to increase production capacity and has room to grow and develop future projects.

The company has a mix team of workers, with the total of six. Three men in the fabric, the owners Diogo, Rui and João, and three women at the bar. João and Rui are responsible for the brewing process and control, Diogo is responsible for marketing and sales and for managing and developing the business in Lisbon. The welfare of the employees is a concern for BARONA, that wants to deliver good working conditions to the employees, give a salary higher than the Portuguese minimum wage, secure a comfortable working place and has a transparency policy with employees so that working for BARONA can be seen as added value.

BARONA uses the Horeca channel as the preferred market because it allows more significant margins on the product; however, the company has been doing some sporadic actions in Lidl to increase the visibility of the brand.

During the covid-19 pandemic in 2020 the company did not reduce the invoicing in the fabric, and 2021 is exceeding 2020. The pub had to close during lockdown, but the help from the state and the lay-off assured the support of the BARONA Craft Beer House. This time was helpful to invest in training online in subjects like marketing and digital marketing.

BARONA is a growing company with several projects for the future, like the development of a yeast laboratory in the fabric, opening a restaurant and the acquisition of a nitrogen generator. The annual beer production has been growing a lot:

- 2017: 9,166 L;
- 2018: 34,625 L;
- 2019: 40,903 L;
- 2020: 52,810 L.

4.5.2. Market

The information received during field observation and interviews considering the market coincides with the literature review. Breweries are generally small companies, and brewers started in the same

way, by brewing at home, researching autonomously, and learning with the available information. This makes the market very small and highly collaborative, where brands share knowledge and help each other. There are collaborations to boost brands, namely with national and international brands, and pubs that sell craft beer also collaborate and help improve beers with their feedback and inputs. The company has grown a lot with the feedback from pubs that help in adjusting recipes and processes. It is usual to place orders together with another craft brewery; if a product is missing, other breweries can provide it, or if there are any doubts, other brewers quickly help. It is a market with healthy collaboration, and there is friendship besides the business. Brewers are worried about creating good products, putting good products in the market, or looking for diversity, so competition is not the number one concern. Craft beer is still a market in which, who operates in it truly loves the product and enjoys helping to improve it. Nevertheless, the market has these characteristics because is still very recent and in a state of growth; the wine market, for example and in contrast, is a stable very closed and competitive market.

4.5.3. Marketing Strategy

BARONA does not have a marketing strategy. The company focuses on production and selling the product on the Horeca channel and the pub, so marketing planning and strategy are not a concern for the company and are not defined. Communication is done through the online channels, website and social media, and through beer fairs and competitions.

4.5.4. Production

BARONA uses three raw materials: malt, hops and yeast. The production process of beer in BARONA follows the discoveries in the literature review and it is described in following stages:

1. Mashing the malt to obtain the wort;
2. Boiling the wort, to be sanitised and sterilised; to be added hops that give aroma and bitterness to the beer and act as a natural preservative not letting certain types of bacteria to develop; and clarifies the beer, as malt proteins aggregate.
3. Filtering, cleaning and cooling the wort;
4. Fermenting the wort;
5. Maturation of beer;
6. Filtering beer;
7. Pack beer and put in cold because it is not done pasteurisation.

Brewing involves big amounts of waste of water. In the beginning the company did not reuse the water, but now it is done during cooling. In this stage of production, cold water comes in and hot water comes out, and this water is now reused in production. Initially, this water was used for cleaning but

ended up being discharged. This was a loss of water and energy, that was generated due to the heat transferring and without cost. Now, practically all water is reused in production, allowing higher efficiency with less waste of energy and water. This was a big improvement point.

The company has been having more work and production flow once two other beers are being produced in the fabric, besides the beer BARONA: Velhaca, also a brand from the region, from the city Portalegre, that closed the fabric; and Invisible, a Spanish brand. Occasionally it is produced beer for other Portuguese brands but is something sporadic when it is needed and when the fabric has availability. In this way it is possible to monetise the fermenters.

4.5.5. Economic Performance

Financially and economically, BARONA is not in a good situation. The ratios to assist the financial and economic analysis of company are detailed in Annex C.

The main economic issue of BARONA is the negative equity in 2020. In 2019 this value was 36038,42 and in 2020 suffered a big change, decreasing to -59029,75. This constitutes a big issue once the company is not capable to generate results, has liquidity problems and is dependent of financial help and external capital to finance its assets. This is also shown by the financial autonomy and solvability ratios, by presenting negative values, lower than 1 (Annex C). The company is in a situation of insolvency and cannot meet its responsibilities.

4.5.6. Supply Chain

All raw materials come from a supplier in Spain (Barcelona). Suppliers are chosen based on quality. The demand of BARONA is quality and availability. Malt is produced in England and some in Germany, although it has higher distribution costs it has higher quality, which pays off. Hops are bought international because of variety. To have a differentiated product, the quality of malt and hops are very important. Some products, mainly fruits to produce certain types of beer, are bought locally due to quality and availability. In this way it is also possible to help the local economy.

The raw materials quantity forecast is made every three months. The malt acquisition is easy and usually has no problem, however hops are more difficult. It is necessary to forecast production to ensure that it is being used the same hop in production and that it comes from recent harvests. There is competition between breweries to obtain this material, that is scarce. Yeast is produced on-demand.

When the material arrives, the beer production takes between one month and a month and a half to be ready. Although the company does not forecast sales, it produces to fill stock in order to avoid stock breaks.

The packaging (glass bottles, cardboard, and labels) is acquired from Portuguese suppliers. All products and raw materials arrive quickly, except labels that must be developed in advance. After the

labels are approved, the graphic takes two weeks to develop the final product and send it. This means that new beers must be planned at least one month in advance to the filling.

Distribution is done by a transportation company but proximity distribution and distribution in Lisbon is also done by the company, thanks to the warehouse in Lisbon.

Stakeholders are chosen based on price but also for the relationships and friendships developed. Primacy is given to stakeholders that care for the product and recognise the work of the company.

4.5.7. Sustainability

The company is starting to address some SDGs however it does not exist a sustainable report (non-financial report). There are some actions and attitudes of the company connected to social and environmental responsibility however, BARONA focus is on efficient production. The goal is to (i) guarantee that the company survives; (ii) monetise to the fullest the equipment, materials, and processes; (iii) have the minimum waste and losses so that processes can be efficient; and (iv) ensure working conditions.

BARONA is aware that brewing is a resource-intensive process, with intensive water use for production, cleaning, and energy. The company is also aware that sustainability is an important factor nowadays and considers that sustainable brewing beer is a production that should minimize the use of raw material and the waste generated.

Some ways to improve sustainability already identified by the company are:

- Collecting used bottles. However, this implies a washing and sterilisation process.
- Use cans instead of glass bottles. It is a better package for beer because it does not let pass light, transportation is cheaper, and the aluminium can be recycled several times. Nonetheless, this is not a measure preferable in Portugal because the consumer does not see it as a premium product.
- Investing in a nitrogen generator. One of the future projects is to buy a nitrogen generator, so that it can be possible to use the gases in the air in the production instead of buying it.
- Investing in a yeast laboratory. Another future project is a yeast laboratory, that would eliminate the need to import yeast.
- Use renewable energy. Energy efficiency is a problem in the brewery, it is used electrical energy and equipment consume a lot of energy, renewable energy can be a solution.
- Reuse of spent grain. Right now, the company cannot find a way to reuse spent grain and its being wasted. It used to be given to farmers, but they stopped picking it up.

The company already adopted some measures that is right now applying and that can be connected to SDGs:

- Recycling glass bottles (SDG 12).
- Reusing water - the water used during cooling is now reused in production (SDG 6).
- Reusing cardboards - cardboards used to transport beer to the pub come back to the fabric to be reused, and with some clients the cardboards are return and can be reused. With other clients it is impossible to do that because the cost of returning (SDG 12).
- Reusing yeast - the same yeast can be used for several productions, and usually with the same yeast it is done two productions of beer (SDG 12).
- Reusing CO2 from fermentation - the isothermal fermenters withstand the pressure and allow to close all valves, so that the air is accumulated in the beer. The bad compounds are released in the beginning, but a great part of CO2 goes to the beer (SDG 13).

4.5.8. Issues and Challenges

BARONA has some challenges due to the location in the country's interior, mainly related to distribution and workforce. Products' distribution can sometimes be complex because the fabric and the main warehouse are in a remote location, increasing distribution costs higher. In addition, in Alentejo, there are very few qualified professionals in craft brewing.

The website is not a focus for BARONA, and right now is very rudimental.

An issue in production is the utilisation of spent grain. This by-product used to be given to farmers; however, they stopped going to the fabric to get it. This situation ends up being a waste because the spent grain goes bad due to the sugars fermentation process and cannot be used to feed animals. It is an issue to BARONA because they no longer close the cycle and have larger amounts of waste. There are a lot of things that can be done with the by-products of brewing, but there are missing initiatives of the region to explore this and to see the use of brewing by-products as opportunities for business instead of extra work.

4.5.9. Supply Chain Transparency and Blockchain

The company agrees that supply chain transparency would help in improving control of the whole process and give information to the consumer about the product. An informed consumer of craft beer would easily return because the more information available would create a sense of belonging. The company believes that it would also add value to the company by increasing transparency and trust between all stakeholders. It would be easier to sell products because it is possible to give all details about harvesting, materials, and production. This could add value to the product and to the market because of the tracking offered.

However, there are perceived challenges, mainly at the level of bureaucracy. Some stakeholders would not like to disclose some information and be afraid to reveal "the secret" of production. It would

be difficult to aggregate everything of the supply chain, and it demands the tracking since the beginning of production of raw materials. Implementation and aggregation of all information would be difficult, especially for a small company with limited resources. This implementation would also require a lot of time and investment in the beginning, but once done maintenance would be easier.

The company views blockchain as a very interesting idea with several benefits. “Is an advance technology, almost impossible to break that creates a connection between information.” It is a good opportunity and would help solve issues, develop, and achieve some goals. It would help in registering every lot of material; create an invoice system by lot of beer that would allow to track the beer sold around the country, tracking beer could be very helpful once it is a product subject to variations and if some product has a problem it can be easier to find the cause; and it would allow to track barrels and make a better inventory, so that it could be easier their recovery. For craft beer consumers, it would be a tool for curiosity and not so much for food security.

BARONA considers blockchain “the best way to aggregate all information and improve the supply chains”. Nevertheless, it requires time and money. In a company where all profits go to investment and growth, this this may be an idea to put on hold.

Case Study Outcomes and Discussion

This chapter aims to examine hypothesis-based scenarios are elaborated to BARONA Brewing Company, so it can be possible to achieve a sustainable business model or the integration of a new value chain. This chapter focuses on finding hypothetical changes to the company and possible, to the industry, based on different scenarios. This will also address the research questions. Considering the research questions (see section 1.3) as guidelines, six hypothetical scenarios were developed following Börjeson et al.'s typology (2006) (see section 3.2.3).

Scenario 1 (predictive): What will happen if BARONA Brewing Company decides to adopt a sustainability approach?

Sustainability can create shareholder value, lead to cost, and risk reduction, enhance reputation and legitimacy, promote innovation, create, or increase market position, and articulate the business vision and growth trajectory (Rosburg & Grebitus, 2021). In BARONA, a sustainable production and vision will have economic benefits by lowering operational costs through resources consumption and operational efficiency.

Right now, the mind-set and way of operating and embrace sustainability on a very high-level at BARONA is to reduce resource consumption and produce efficiently. By embracing sustainability in its full framework, this mind-set and operations will be leveraged, and it will be visualised in the reduction of costs, risks, waste, and the engagement with circular economy. The appliance of the SDG 6 (clean water and sanitation) and SDG 14 (life below water) will emphasize the responsible water use and reduce water pollution caused by the beer production and leading the craft brewery to conduct water management and water footprint. SDG 12 (sustainable consumption and production) will emphasize in the company the need to reduce waste materials and to recycle, in terms of raw materials and packaging. Brewing industry is dependent on natural resources therefore, the sustainable management, consumption and efficient use of these resources are critical for the business survival on the long-term. By following the SDG 7 (affordable and clean energy) and SDG 13 (climate action), BARONA will combine efforts to find alternative sources of clean energy what will result in lower costs, reduced GHGs emissions, and carbon footprint. These actions will not only decrease operational cost and increase operational efficiency but will also preserve ecosystems that the planet is dependent on and improve the local environmental situation and awareness. In terms of branding, this also beneficiate the company by creating an image of a concern company with the well-being of the planet, society, consumers, environment, and the future.

Scenario 2 (normative): How can sustainability be reached at BARONA Brewing Company?

BARONA is a small company with limited resources, and the main goal is to ensure the business survival and to provide appropriate working conditions to employees. In a brewery like this, sustainability can be reached by focusing on resources consumption. Brewing is an activity with intense consumption of resources, especially water and energy; therefore, to address sustainability, the first path should be reducing the consumption of these resources. The data collected from field observation and interviews show that BARONA already focuses on reducing consumption and making water and energy use as efficient as possible. By reducing and reusing resources consumption, costs and prices will decrease and production will become more efficient.

Raw materials and suppliers of BARONA are chosen based on (i) quality, a critical factor in a market seen as premium and provided of high quality and differentiated products; (ii) availability; and (iii) cost. Attacking sustainability upstream is more difficult for SMEs in the brewing industry once the focus is to produce high-quality products with available resources. To produce high-quality products, the quality of raw materials is extremely important. SMEs do not have much flexibility in this area. For companies like BARONA located in remote areas, this becomes a more challenging option once availability and distribution are significant obstacles. In the downstream is possible to have more control in sustainability processes, and there is a shift in consumer demand that look for more ethical products. However, in SMEs the cost will always have a great weigh in choices.

The best approach to sustainability, illustrated by BARONA case, is in the operational and production activities - produce as efficient as possible in a way to reduce resource consumption and operational costs, making the most out of materials and processes and minimizing waste and losses. By the literature review and comparing with the case study, it was possible to identify some activities that BARONA can adopt, some already putting into use or pretends to. These activities were chosen based on BARONA's capabilities and resources and alignment with the company's goals.

Table 5.1. Activities for BARONA to reach sustainability

Reduce Resources Consumption	Water
	<ul style="list-style-type: none"> • Reuse processes water; • Stopping water flows during breaks; • Installation of water meters at various sections of production; • Reduction of solids in wastewater discharge; • Use low-volume high-pressure washers; • Recycle or reuse process water; • Preventive maintenance of equipment, once water can be lost due to lack of maintenance.
	Energy
	<ul style="list-style-type: none"> • Implementing policy to turn off equipment and lights when not in use; • Using more efficient equipment when replacing old equipment; • Installation of timers and thermostats to control heating and cooling;

	<ul style="list-style-type: none"> • Performing a hot water balance of the facility to determine when, where and how hot water is being used and identify areas where reductions can be made; • Improve isolation on heating and cooling lines to prevent energy loss; • Installation of LED lighting systems; • Use of renewable energy; • Preventive maintenance to improve efficiency and minimize losses.
Recycling and Reusing	Raw Materials
	Surplus Yeast – reuse the same yeast for several productions.
	Spent Grain – as spent grain in BARONA is longer used by farmers for animal feed, it can have other uses. There are other uses for it in food technology and human nutrition. It can be used as ground mulch, ingredient for breads and pizza, and ingredient in dog biscuits and energy bar for humans. Another way is in drying and burning the spent grains to convert to energy. This is an issue area, and probably the one where will be more difficult to find a proper solution and close the cycle of production in BARONA. From interviews it was possible to understand that spent grain can have multiple uses, however there is a lack of understanding and commitment of the community to use and apply it in different industries.
	Spent Hops – used as fertiliser.
	CO2 – with isothermal fermenters is possible to reuse CO2 from fermentation to create the gas of the beer.
	Packaging
	Glass Bottles – recycling glass bottles and create partnerships with glass disposals; collect and reuse glass bottles, however for this is necessary a washing and sterilisation process. Cardboards – collect and save cardboards from clients to be reused; when not able to reuse it, recycle it.
Alternative Use	Raw Materials
	Renewable energy – a way to combat the intense electrical energy consumption.
	Production
	Nitrogen generator – allows to use the gases in the air instead of buying it.
	Produce yeast in-house (yeast laboratory) - eliminates the need to import yeast.
	Packaging
Cans instead of glass bottles - aluminium can be recycled more times that glass; Recycled glass bottles; or Light-weighting glass bottles.	
Staff Education	All staff should be trained to have an approach to sustainability on daily-based activities and be aware of sustainability plans and objectives. Implement rewards systems to stimulate this.

The brewery can follow a set of KPIs defined in terms of economic, environmental, and social impacts. Of all the indicators in the brewery’s operations, some are key to ensuring good performance.

There are a variety of internal KPI’s that are used to quantify brewery results, examples include:

- Brewhouse yield, overall process yield, and filler efficiency;
- Beer loss during production;
- Brewing and packaging labour hours per barrel;
- Key product attributes (such as alcohol by volume, carbonation, beer gravity, colour, bitterness units, pH, sensory, and microbiological condition);
- Water and energy usage;
- Wastewater generated;
- Inventory physical count accuracy.

Scenario 3 (explorative): What can happen if BARONA Brewing Company decides to implement supply chain transparency?

Transparency in supply chains can provide information about ingredients and their origins, processes, and production available to the public. By providing transparent information about the operations on the supply chain, traceability and sustainability should improve due to the abundance of new data and information (Astill et al., 2019).

BARONA acquires raw materials from a Spanish supplier, and these materials are produced in other parts of the world (for example, the malt is produced in England and Germany). This can create some limitations in the information about the origin, plantations and harvesting of these materials. Supply chain transparency would help improve control of the whole process and give the final consumer more information about the product. It would add value to the products by increasing transparency and trust between the company, suppliers, and clients. It is evident that consumers now have a demand and desire to know more about where the food comes from, how it is produced and whether it is a safe and sustainable product (Morgan et al., 2020). By giving transparent information about the product (the farming and harvesting of ingredients, and the production methods), it will be easier to sell products because consumers can easily access all its details. All this information disclosed about the upstream and downstream supply chain of the product will create a sense of trust and belonging. It will help creating relationships between stakeholders, something extremely important and characteristic of craft brewing industry. Concerns such as the origin of products/raw materials, the use of pesticides and if products are truly organic will be eliminated. Transparency in craft beer supply chains can boost the development and growth of companies, of the industry and improve control of the whole production process.

Scenario 4 (normative): How can supply chain transparency be reached at BARONA Brewing Company?

Sustainability and traceability in supply chains involve the entire network of stakeholders, from raw material procurement to those responsible for product delivery and disposal, their relationships, and exchanges (Germani et al., 2015). This will be a challenging process initially as it is difficult to aggregate all information of the supply chain and trace and track all information since the beginning of raw material production. To reach supply chain transparency in BARONA it will be a necessary investment of money and time to collect and aggregate the information about every stage of the supply chain and properly making it available to the client. Therefore, it would be necessary resources dedicated to this job. Transparency in BARONA Brewing Company can be reached with the technology blockchain, allowing the disclosure of all the information from upstream to downstream. This transparency and the technology will establish codes of conduct between stakeholders of the brewing

supply chain. These codes of conduct should define actions aligned with the SDGs mentioned above, related to water conservation, sustainable production and consumption, reduce waste, recycle, minimize environmental impact and combat climate change.

Scenario 5 (explorative): What can happen if BARONA Brewing Company decides to use blockchain?

Blockchain is a secure decentralised database technology that creates connections between information. It can be a tool for BARONA to develop and achieve transparency in the supply chain. Besides improving tracking and making available all the information of the supply chain, it can help in some issues of the company by: (i) an increasing control and tracking of materials used in beer production, ensuring its proper conditions; (ii) control and tracking sold beer and its distribution - since craft beer is a product that can easily suffer alterations, this would be extremely helpful to know when the product has some problem and to find the cause; (iii) making the barrels' tracking easier, as so as its devolution and inventory (this would make it possible to use reusable barrels of stainless still, instead of plastic, once the company can easily recovering it).

Blockchain would be the best tool to aggregate information, achieve supply chain transparency, improve supply chain operations and relationships from upstream to downstream between all stakeholders. It would reduce risk, costs, and paperwork. For craft beer consumers, it would be used more for curiosity and not so much for food safety. However, it would answer to the demand of the market of interest, curiosity, and desire to explore new products with different ingredients.

Blockchain can improve BARONA supply chain by providing secure, traceable, verified, and transparent information. It would enhance sustainability by identifying wasting and lack of efficiency of processes in the product's lifecycle and improving sustainability reporting and monitoring. The visible and transparent processes can provide warnings of dangerous behaviours that can be identified and corrected. The two significant benefits of blockchain in BARONA are enhanced accountability and trust among stakeholders.

Supply chains are complex and have several stakeholders, making difficult the sharing of information and the trust among parties. For this reason, it is difficult to access pertinent data and information. Blockchain can be the tool to solve this problem and an opportunity for SMEs to reduce information asymmetries, transactions cost, facilitate trade, have efficient and quality products and services.

Scenario 6 (normative): How can blockchain be used in BARONA Brewing Company?

As said before, blockchain can improve BARONA supply chain by providing secure, traceable, verified, and transparent information. This could be very advantageous for the company in terms of

tracking materials and the beer itself when in transportation. It also helps in developing the brand as a secure and organic beer, but also fill the curiosity of consumers in learning and get to know more about the materials, production and all the supply chain actions until it is achieved the final product.

Blockchain is s very useful tool in terms of sustainability and security because all the information and all steps are documented in the platform, and every user can have access to these data. This technology will ensure the codes of conduct of the stakeholders are accomplished and with the alignment with the appropriate SDGs framework for the craft brewing industry (SDGs 6, 14, 12, 7 and 13) it will be a tool for sustainable manage water, waste, energy and lead the path to achieve a sustainable production, consumption, recycling and reusing. With the demanding current stated for sustainable practises and environmental concern, companies from all industries will have to adapt its processes to fit sustainability and include it on the businesses model. Blockchain will be a very helpful tool for that once it shows if the company actions follow the demanded.

Blockchain requires a lot of investment of money and time, which is challenging for young SME whose goal is to survive and grow. Nevertheless, it is a very interesting idea, and BARONA sees its potential for the company itself, the business, and the industry. However, it is an idea to put on hold for now and invest when the company is in a more stable position or with the help of financing projects. For bigger craft breweries, it can be an appealing investment and development.

CHAPTER 6

SWOT Analysis

The SWOT analysis is an easy tool that analyses four company's components: strengths, weaknesses, opportunities, and threats. This analysis enables the company to plan and solve organizational problems strategically. It is possible to break these four components down into two factors: internal and external factors. Strengths and weaknesses are internal factors, which means the company is in control, and opportunities and threats are external factors, which means they are getting out of control. The following table 6.1. summarizes all information about Barona:

Table 6.1. BARONA's SWOT analysis

INTERNAL FACTORS	
STRENGTHS (+)	WEAKNESSES (-)
<p>Strong relationships with stakeholders.</p> <p>The pub gives a steady financial flow and is a point of contact between the owners, the beer producers, and the consumer. Allows to create a relationship with consumers.</p> <p>Award-winning beers around the world.</p> <p>High-quality ingredients.</p> <p>Strong local roots, included in the products history, branding and ingredients.</p> <p>Unique branding and products.</p> <p>Diversified portfolio of beers, variety of flavours, innovative productions, and products.</p> <p>High level of customer satisfaction and great customer service.</p> <p>Reliable suppliers. The strong base of suppliers and trustworthy relationships built with them enables the company to overcome any supply chain bottlenecks.</p> <p>Care for employees and concern for their welfare. Goal do ensure excellent working conditions.</p> <p>Production strategy to reduce resource consumption, minimise losses and be as efficient as possible.</p> <p>Vision to grow the businesses with other activities (for example, a restaurant) and investment.</p> <p>The business is also being actively developed in Lisbon, with a decentralised warehouse and the allocation of resources to this city.</p>	<p>Limited presence in super and hypermarkets, creating more difficult for clients to acquire the products, compared to large beers.</p> <p>Lack of capital to compete with bigger companies.</p> <p>Lack of focus on online communication and online channel.</p> <p>Remote location in the interior of the country, making distribution more difficult and distribution costs higher.</p> <p>Small scale operation, with limited production capacity.</p> <p>Lack of strategic planning, goals, and organisation.</p> <p>Scarce availability of professional brewers in Portugal, and specially in Alentejo.</p> <p>Understaffed fabric.</p> <p>Young company, with few knowledge and still learning. Additionally, lack of reputation and awareness compared to other breweries.</p> <p>Cannot compete on price, once craft beer price is more expensive than the large-scale beer.</p> <p>Low profit margins.</p> <p>Payment from clients takes more time than the payment to suppliers.</p> <p>Inexistence of a sustainability report or strategy.</p> <p>Lack of marketing strategy.</p>

EXTERNAL FACTORS	
OPPORTUNITIES (+)	THREATS (-)
<p>Fast growth in the sector with increasing demand.</p> <p>Specific niche with appreciation for high quality beer and new tastes.</p> <p>Portuguese consumers are looking for the taste, ingredients, and innovation of craft beers.</p> <p>The new generation of consumers has a far greater appreciation of sustainable products and sustainable packaging (image conscious).</p> <p>Collaborative market, with open knowledge and opportunities for collaborations.</p> <p>Partnerships with other craft beers, national and international.</p> <p>The re-opening of bars and allowing of parties (after covid-19) that boost the alcohol consumption.</p> <p>Monetise the equipment by producing other craft beers.</p> <p>The online channel had a major development with the pandemic and is now a frequent and active channel of sales.</p> <p>New facilities of the fabric with space to grow and increase production capacity.</p> <p>The location of the brewery (Castelo de Vide/Marvão) is a touristic place.</p>	<p>New marketing strategies and tactics by established products and industrial beer companies.</p> <p>High competition between Portuguese craft breweries.</p> <p>Difficulty to seed Circular Economy solutions destined to support sustainability and circularity in Barona's supply chain.</p> <p>Covid-19 pandemic and the actual crisis of the country.</p> <p>Downturn in the economy.</p> <p>The high homogenised and monopolised beer market in Portugal, polarised by two big beer producers (Sagres and Super Bock) that produce their own lines of craft beer.</p> <p>Craft beer might be a temporary trend and not a legitimate change in taste and preferences.</p>

6.1. Internal Environment

6.1.1. Barona's Objectives

BARONA does not have clear and defined strategies, plans and objectives to follow however, from the research, interaction, and analysis to the company, it was possible to highlight some objectives:

- Monetise to the fullest the equipment, materials and processes;
- Have minimum waste and losses, so that the processes and operations can be as efficient and cost-effective as possible;
 - Ensure good working conditions to employees, by giving a salary higher than the minimum wage and having a transparency policy with employees so that working in BARONA can be perceived as added value;
 - Invest in the factory and improve brewing capacity, to grow the business;
 - Produce high quality, differentiated and unique beer, exploring and expanding the craft beer industry.

6.1.2. Barona’s Internal Organization and Human Resources

BARONA is a company made up of a six workers mixed team, three people working in the brewing factory and three working in the pub. Three men are work in the factory, the owners Diogo, Rui and João, and three women at the bar. João and Rui are responsible for the brewing process and control, Diogo is responsible for marketing and sales and for managing and developing the business in Lisbon. A defined hierarchy or organogram of the company’s structure does not exist, but the owners have equal parts of the company, nevertheless different roles and responsibilities.

6.1.3. Barona’s Products

BARONA has several base beers, produced continually during all year. Other than this, the brewery also produces especial and limited editions of beers throughout the year. These beers result from experiences with local fruits and exploring classic styles, to expand the various styles and flavours that exist in the brewing sector. BARONA ‘s beers have received several awards since 2016 (table 6.2).

Table 6.2. BARONA's portfolio of beers and correspondent awards

Beers	Awards	Special Beers	Awards
Seara Lager	Silver medal at Concours International of Lyon 2020	Boleima (interprets a typical Alto Alentejo sweet, the apple boleima, through beer. It results from a partnership with the brewery Burra)	
Blonde Ale	Bronze Medal at Iberian Awards 2019	Castanhas (made with chestnuts from Marvão)	
APA – American Pale Ale	Bronze Medal at Polish Craft Beer Competition 2017; Gold medal at Barcelona Beer Challenge 2018; Silver medal at Concours International of Lyon 2018; Silver Medal at Iberian Awards 2019; Portugal Best American Pale Ale at World Beer Awards 2019; Silver medal at Concours International of Lyon 2020	Vila Morena (results from a partnership with the brewery Aroeira to draw a 25th of April commemorative beer)	
IPA – India Pale Ale	Bronze Medal at Iberian Awards 2016; Gold medal at Iberian Awards 2017; Silver medal at Polish Craft Beer Competition 2017; Gold medal at Barcelona Beer Challenge 2019; Portugal Best Specialty India Pale Ale at World Beer Awards 2019	Gravitational Collapse (produced in collaboration with the brewery Totenhopfen Brauhaus)	Silver Medal at Iberian Awards 2019
Porter	Gold medal/Best beer of the Iberian Awards 2016; Silver medal at Concours International of Lyon 2018; Portugal Best Strong Porter at World Beer Awards 2019	Devaneios (four beers created in collaboration with Velhaca bee9	

6.2. External Environment - PEST Analysis

PEST analysis is a tool utilised to understand the external factors that affect organizations. It can be used to assess the factors influencing an existing business or product, new product, potential partnership, purchase, or entry into a new market. It is very useful for strategic planning and helps identify opportunities, understand the main threats, and encourage certain types of a company's decisions. PEST analysis focuses on political, economic, socio-cultural, and technological factors.

6.2.1. Political Factors

Portugal is living a political crisis and threats to democracy, with the government divided; the growth of extreme right parties, not only in Portugal but throughout Europe; the extreme polarised political environment that has been living; and more recently, the rejection of the state budget by the left parties, causing the end of “geringonça”, the division and fall of the government, leading to anticipated elections in January.

The covid-19 pandemic accentuated Portugal's political issues, by causing a period of uncertainty, the economic downturn and the pressure on the healthcare service that showed how poorly the country is prepared for a crisis like this, forcing the government to take extreme measures and combat the instability.

Tax rates are extremely high in Portugal, and even though there are some incentives for entrepreneurship and SME, it is tough to keep businesses active and growing. Portugal is one of the European countries with the highest taxes on companies and even on individuals.

Other regulations that will impact BARONA's operations are the industry safety regulation, product labelling laws, wage legislations and mandatory employee benefits, and alcohol consumption regulations.

6.2.2. Economic Factors

The covid-19 pandemic created tremendous economic instability, with businesses having to close doors to the public and stop activity, and when unable to support costs, ultimately had to close. Most Portuguese companies are SMEs, and these are the companies that, in a crisis like this, are more affected. However, the state helped businesses survive with lay-offs. With the world back to normal after two lockdowns, the economy is also recovering. However, the lockdowns effects are still to come in the next year when support from the state is stopped. The present global economic crisis and slow economic growth in Europe, aligned with the after-effects of the past crisis, is still very recent. It has affected society's lifestyle, with consumers spending less time in restaurants, pubs, and leisure.

Covid-19 created uncertain times where we live with an unclear and changeable virus. The possibility of outbreaks and another lockdown are still valid, creating a volatile economy. Nevertheless, 88,47% of the population already having received at least one dose of the vaccine and 86,82% are fully vaccinated (Barros et al., 2021, November 2) give some hope and possibility of life to come back to normal. Bars, pubs, and nightclubs can re-open and be fully operational as usual, opening some margin for the economy to recover and stimulate these businesses.

Another alarming factor to consider in the country's present economy is the extremely high fuel costs, resulting in higher distribution costs for companies.

6.2.3. Social Factors

The covid-19 pandemic changed our everyday lives. After being lockdown for months, society's habits and patterns have changed. Online shopping is the best example of this; once before, it was a sporadic thing, now is the normal and usual way of shopping, and it was the only way of surviving for many businesses.

Consumer habits regarding beer have changed in the last decades, with the consumer now being more demanding and with the desire to explore new and differentiated beers.

6.2.4. Technological Factors

The covid-19 pandemic showed us in the last year the potential of technology and the digital in our lives, especially in businesses. Now, more than ever is visible the impact and necessity of technology in businesses. The online channel is now vital for businesses after months of consumers using the internet as the only possible way of contact.

Technology is evolving every day and becoming more accessible. Exist efficient harvesting and production technologies for raw material. Industry 4.0 and the Internet of Things (IoT) can revolutionise businesses. Blockchain is one example that can bring new opportunities and expand operations in the beverage industry. However, it is a technology still in development that has risks and limitations, such as regulation, high costs, lack of knowledge, privacy leakage and integration with supply chain stakeholders. To overcome these challenges, it demands careful preparation and collaboration.

CHAPTER 7

Conclusions

Sustainability has been a topic of increasing concern. With the world suffering dramatic climate changes, resources scarcity and ecosystems suffering consequences, society has realised that sustainability must be a concern in our lifestyles and businesses. Therefore, the main topic of this research project is sustainability in a growing business, a recent SME, and in a developing industry, craft brewing. The main goals of this project is to understand (i) how a craft brewery can improve sustainability by adopting and/or improve operations measures and management strategy; (ii) if supply chain transparency can be used and beneficial it can bring for these companies to achieve sustainability; and (iii) to realise if blockchain is a possible technology to support that.

Few studies have investigated these topics together, their opportunities and implications for a business, but even fewer have studied them (separately and together) in the craft brewing industry. Therefore, this research project was conducted to support craft brewers and open minds for sustainability and technology to continue and in-progress studying in this growing industry.

After an intensive literature review and understanding of the theoretical background, the first step of this project was a direct field interview followed by a semi-structured interview to collect data for the analysis of the case study. The case study outcomes appear to be linked and in agreement with most of the theoretical background propositions. BARONA does not have a sustainability strategy or management thinking because it is not a concern for a company of this size and with these resources. Even though the company is aware and has improved some practices to decrease resources consumption, it is not a focus for this stage of the business. However, BARONA is receptive and ready to improve, within its means, and some of the actions the company already applies are connect to sustainability and follow the SDGs. In terms of supply chains transparency and blockchain, the company sees this as a powerful potential technology and opportunity. Yet the lack of opening for investment once it demands money and time is a significant barrier.

Considering the research questions presented in the first chapter, is now possible to answer them.

- RQ1: How are craft breweries embracing sustainability?
 - RQ1a: How sustainable practises are applied in a SME craft brewery?
 - RQ1b: What are the situations in a SME craft brewery that hamper practises towards a sustainable management?
 - RQ1c: How can a SME craft brewery apply suitable sustainability practises into its business model?

Craft breweries, like BARONA, are embracing sustainability as best as possible and implementing measures and management to decrease resource consumption and have an efficient production. The

sustainable practices applied are the ones they allow to minimise the wastewater, energy use, and raw materials reuse. Sustainability is something achievable, that can be aggregated into the business model of SME craft breweries, nevertheless, is highly challenging. The companies need to be cost-effective and expand the business, and sustainability measures can be out of range for the financial resources available. However, acting on small measures and operating to contain resources and limit waste is easy and possible ways to include sustainability in the company and the business. By including the SDGs 6, 14, 12, 7 and 13 to the businesses models craft breweries are one step closer to achieve a full sustainable paradigm. These SDGs are the ones more suitable for the craft brewing industry and aligned with the sustainability goals and actions these enterprises can have: water conservation, sustainable consumption and production, reduce waste generated, recycling and reusing, use clean energy and combat climate change minimize emissions.

- RQ2: How a SME craft brewery recognise/relate/choose stakeholders?

Because of the limited financial base, there is a lack of flexibility to choose suppliers. Therefore, money is the decisive factor. Quality and uniqueness are the number one concern for craft breweries since craft beer is a high-quality and differentiated product, so suppliers are chosen based on a quality-price ratio. Nevertheless, these businesses are also characterised by strong relationships with competitors and suppliers, leading to relations of knowledge change, helping to improve and collaboration between parties. Trustworthy relationships between stakeholders are fundamental in this industry, and for that is needed transparency between parties and the share of transparent and reliable information. A transparent supply chain can be very beneficial for this industry, bringing awareness, reliability, transparency, tracking; improving trust, communication and the relationships between suppliers, producers and consumers.

- RQ3: How a SME craft brewer adapt to a transparent supply chain?

In terms of supply chain transparency, even though it is a very interesting idea for a business, for the supply chain operations and for the increasing trust between stakeholders, it is challenging for one stakeholder with limited resources (the craft beer producer) to implement it in all the supply chain extension, from upstream to downstream, mainly because of the extensive bureaucracy it will take and the tightness of some stakeholders. Blockchain will bring amazing opportunities, but it will face some problems.

- RQ4: Is blockchain a possibility for SME craft breweries to easily engage in Circular Economy?

The Circular economy is a new economic paradigm that proposes a resource-efficient alternative to the linear end-to-end model. The Ellen MacArthur Foundation (2013, p.7) defines the circular economy as “an industrial system that is restorative or regenerative by intention and design”. Instead of disposal at the end of a product lifecycle, the circular concept aims for restoration, the use of renewable energy, the elimination of waste and the design of new concepts and business models (Ellen

McArthur Foundation, 2013). Based on the model of cyclical ecosystems, that are characterized by feedback-rich systems and waste-free mechanisms the concept has the purpose to create a zero waste, zero emission supply and value chain (Murray et al., 2015).

Blockchain can be an efficient technological tool for craft breweries engage in Circular economy once all information is disclosed and available, the processes occurring in the supply chain in terms of management of resources, waste and production are evident to outside parties. Blockchain can show the practises a brewery has taken and evidence the processes of materials and by-products. If a company is being efficient and sustainable active, by-products will be re-incorporated in processes and the circle of production will be closed. Blockchain can help companies to achieve this by identifying the failures of the supply chain and showing the mistakes that are being committed, is term of sustainability but also in terms of efficiency.

When conducting this study, a limitation encountered was the gap in the literature about these topics and the lack of studies that mentioned the problems it was intended to explore. Being a very recent industry in Portugal, the lack of studies and research applied to the Portuguese market was even more limited. The dimensions and conditions of the company in analysis also brought some limitations to the results. Topics of sustainability, supply chain transparency and blockchain are very interesting to study and possibly apply to this industry however, the limitations of the company do not let margin to explore the application. Further research on these topics should be done. An interesting study would be to apply this analysis to a bigger craft brewer, with more financial and market stability (e.g. Musa, Sovina, Dois Corvos), with some sustainability actions already in action and the possibility of investing in blockchain technology.

An improvement and next step in the research, would be to identify the SDGs targets and link them with the Global Reporting Initiative (GRI) indicators to achieve a more suitable strategy for the craft brewery. This step is included in the methodology however, given the conditions and the limitations of the case study was not possible to accomplish. Moreover, this is a research based entirely on qualitative data, so an improvement would also be to find quantitate data to support the findings. Craft beer sector should continue to be study, given its growth and impact. More research on these themes will generate and consolidate information that will benefit the industry. More breweries should be studied, using multiple case studies, in order to have a stronger view on the sector. Multiple case studies “create a more convincing theory when the suggestions are more intensely grounded in several empirical evidence. Thus, multiple cases allow winder exploring of research questions and theoretical evolution” (Eisenhardt & Graebner, 2007, p.27). It is necessary to emphasise that this is an exploratory case study with limited results that cannot be generalised for the rest of the industry. This is a study of the unique conditions of BARONA Brewing Company.

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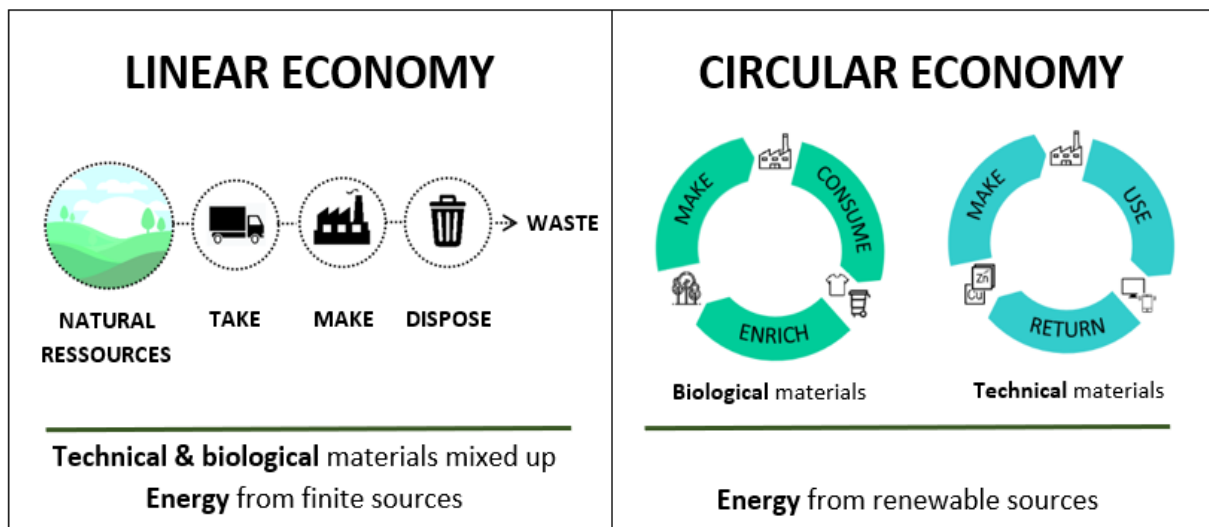
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Annexes

Annex A: Circular Economy paradigm

The circular economy (CE) proposes a resource-efficient alternative to the linear end-to-end model. The Ellen MacArthur Foundation (2013) defines the circular economy as “an industrial system that is restorative or regenerative by intention and design”. Instead of disposal at the end of a product lifecycle, the circular concept aims for restoration, the use of renewable energy, the elimination of waste and the design of new concepts and business models (Ellen McArthur Foundation, 2013). Based on the model of cyclical ecosystems, that are characterized by feedback-rich systems and waste-free mechanisms the concept has the purpose to create a zero waste, zero emission supply and value chain (Murray et al., 2015).

Generally, the circular economy is defined as a circular system with closed-loop material flows. Instead of disposing the product after its useful life, as it is done in the linear economy, the closed-loop system recovers the good by returning or enriching products and materials.



The linear vs the circular economy

(Source: <https://www.datadriveninvestor.com/2018/10/19/circular-economy-is-the-solution-for-a-sustainable-future/>)

As a result, the circular economy creates a further value by extending the lifetime of products and materials. Furthermore, the concept aims to reduce waste by adopting the 3R principle: reduce, reuse, recycle. Reducing refers to the reduction of resource extraction and the decrease of resources in production and consumption. Reusing expands the lifecycle of a product for example through

redistribution on the second-hand market. Recycling describes the process of recovering a product or materials wither to use them for their initial or for a new purpose (Ellen McArthur Foundation, 2013).

According to the Ellen McArthur Foundation (2013) the circular economy is based on three principles: preserve and enhance natural capital, optimise resource yields and foster system effectiveness. The first principle, the protection of natural capital, should be achieved by controlling finite stock and by balancing renewable resource flows. Virtual delivery of demand should be considered and if necessary, renewable energy sources should be used. Material flows should include the whole system and should ideally be regenerative. The second principle aims to optimise resource yields through circulation. Products, components, and materials should be designed to operate in technical and biological cycles. Remanufacturing, refurbishment, and recycling of technical, as well as decomposition of biological components should be implemented into the system. The last principle, foster system effectiveness, attempts to prevent negative externalities through the reduction of damage to systems, and through managing external effects of pollution or land use.

Annex B: Interview Script

Area of Impact	Questions
Company Characterisation	<ul style="list-style-type: none"> - What reasons led to the creation of the company? - Is it your first business?
Sustainability	<ul style="list-style-type: none"> - What does sustainability seems to you? - How could sustainability be a leverage to your company?
Sustainable Development Goals (SDG)	<ul style="list-style-type: none"> - Are you familiarised with the SDG's? <p>If yes:</p> <ul style="list-style-type: none"> - Which SDG's does the firm follow? <p>If no:</p> <ul style="list-style-type: none"> - Which SDG's do you think the company can apply?
Sustainability - Reporting	<ul style="list-style-type: none"> - Does the brewery produces a sustainability report (non-financial report)? - There is a record of sustainability practises? - Do you have protocols with other institutions/stakeholders to follow practises within the scope of SD or Circular Economy?
Sustainability – Production	<ul style="list-style-type: none"> - What comes to your mind when you think of sustainable beer production? - Do you work with any local farms or include any organic or fair-trade ingredients?
Supply Chain	<ul style="list-style-type: none"> - Can you describe the brewery's supply chain? - How do you choose suppliers and stakeholders?
Supply Chain Transparency	<ul style="list-style-type: none"> - Are you familiar with the supply chain transparency concept? - In your opinion, how supply chain transparency would add value for your company? - And for the market?

	- If supply chain constitutes a possibility to your brewery, refer the advantages and the issues to overcome?
Blockchain	<ul style="list-style-type: none"> - Are you familiarised with blockchain technology? - In your opinion, which are the main problems you would face to implement blockchain paradigm in your brewery? <p>If answer indicates facility:</p> <ul style="list-style-type: none"> - Why have you not taken up this process (technology/mind-set) yet) <p>If answer indicates difficulty:</p> <ul style="list-style-type: none"> - Under what conditions/situation do you think it is possible to apply this technology in a brewery?

After having this conversation/discussion, in which important points were mentioned about the company's situation and other similar companies, how do you think the company needs to improve in terms of sustainability?

Do you think transparency and blockchain can help in those improvements? If so, in what ways?

Environmental Impact	<ul style="list-style-type: none"> - What measures does the brewery take to improve water efficiency or promote water conservation? - What measures does the brewery apply to decrease energy use? - It is used renewable energy? - Does the brewery promote the use of spent grain for other purposes? - How does the brewery handle solid waste? - Does the brewery has a protocol with stakeholders that facilitates the disposal of brewing waste? - What measures has the brewery use to decrease the impacts of beer packaging? - What measures are used for more sustainable ingredients use?
Socioeconomic Impact	<ul style="list-style-type: none"> - How does the company function in terms of employees' working conditions? - And how does the company intend to improve? - There are measures to seek a gender balance and promote equality at the company? - What actions does the company carry out to support and engage itself in the community?

Annex C: BARONA's Financial and Economic Analysis

Financial Autonomy Ratio:

$$Financial\ Autonomy = \frac{Equity}{Asset}$$

$$Financial\ Autonomy\ 2020 = \frac{-59029,75}{275699,82} = -0,21$$

$$Financial\ Autonomy\ 2019 = \frac{36038,42}{277444,49} = 0,13$$

Solvency Ratio:

$$\text{Solvency} = \frac{\text{Equity}}{\text{Liability}}$$

$$\text{Solvency 2020} = \frac{-59029,75}{334729,57} = -0,18$$

$$\text{Solvency 2019} = \frac{-59029,75}{241406,07} = 0,15$$