COMILLAS
UNIVERSIDAD PONTIFICIA

Facultad de Ciencias Económicas y Empresariales

Sustainability in the brewing industry: Thematic Analysis of beer companies' communications on sustainable practices

Clave: 201601452

MADRID | abril 2021

Resumen

El cambio climático es una situación que afecta a todos los participantes de este mundo, debe ocurrir un cambio radical para poder enfrentar los desafíos que esta situación impone sobre la humanidad. El papel de las empresas más grandes de cada sector es un elemento clave en la transición hacia un sistema sostenible. La cerveza es una bebida que consumen millones de personas anualmente y su proceso consume grandes cantidades de energía y, lo más importante, agua, que es un recurso limitado y vital para nuestra supervivencia. Dada la importancia de estas empresas, es importante comprender cuáles consideran que son los riesgos fundamentales que enfrenta la industria cervecera en términos de sostenibilidad y qué estrategias tienen para mitigarlos. Este informe tiene como objetivo estudiarlos realizando un análisis exhaustivo de las comunicaciones de las empresas y extrayendo conclusiones relevantes para esta industria. Por último, la ambición es comprender cuáles son las prácticas de gestión sostenible más significativas para las empresas cerveceras desde la perspectiva de conceptos como la economía circular.

Palabras Clave: Industria cervecera, economía circular, evaluación del ciclo de vida, prácticas de gestión sostenible, responsabilidad ampliada del productor, agua, eficiencia energética, gestión de residuos.

Abstract

Climate change is a reality affecting every member of this world, a radical change must happen in order to be able to face the challenges this situation is imposing on humankind. The role of the biggest companies in each industry is a key element in transitioning towards a sustainable system. Beer is a beverage consumed by millions of people yearly and its process consumes large amounts of energy and most importantly water which is a limited resource vital for our survival. Given the significance of these companies, it is important to understand what they consider to be the fundamental risks the beer industry is facing in terms of sustainability and what strategies they have to mitigate them. This report aims to study these by carrying out an exhaustive analysis of the companies' communications and drawing relevant conclusions for this industry. Lastly, the ambition is to understand which are the most significant sustainable management practices for beer companies through the lenses of concepts such as Circular Economy.

Keywords: Beer industry, Circular Economy, Life Cycle Assessment, Sustainable Management Practices, Extended Producer Responsibility, water, energy efficiency, waste management.

INDEX

Resumen 1

Abstract 3

Listado de abreviaturas 7

1. Introduction 8

2. Theoretical Framework. Scope, significance and environmental impact of the beer's life cycle. 11

2.1 The brewing industry: history, trends and forecasts. 11

2.1.1 A brief account of the history of brewing 11

2.1.2 Current trends and forecasts for 2023 13

2.2 Frameworks for Sustainable Management. 15

2.2.1Circular Economy (CE) and Extended Producer Responsibility (EPR) 15

2.2.2 Life Cycle Assessment (LCA) 18

2.2.3 Sustainable Supply Chain Management (SSCM) 21

2.3 Defining beer's life cycle and its environmental impact. 22

2.3.1 Beer production process 22

2.3.2 Environmental impact of the beer production process 24

2.3.3 Life Cycle Assessment of beer 27

3. Analysis of annual and sustainability reports of the main industrial brewers and results obtained. 32

3.1 Methodology 32

3.1.1 Selection of companies to be analyzed 32

3.1.2 Gathering information 34

3.1.3 Coding and analysis of the data 34

3.1.4 Obtaining the conclusions 35

3.2 Findings from the Thematic Analysis 35

3.2.1 Company strategy based on Sustainable Development 36

3.2.2 Frameworks and methodologies employed 37

3.2.3 Environmental focal points according to the analyzed companies 39

3.2.4 Sustainable Supply Chain Management Practices..... 41
3.2.5 Circular Economy Principles..... 46
3.2.6 Definition and Practices of Extended Producer Responsibility (EPR)..... 49
4. Conclusions 51
Bibliography 56

FIGURES INDEX

Figure I: Beer production in the nineteenth and twentieth centuries in Europe (Belgium, France, Germany, and the United Kingdom) and the USA (1820–2000), in billion litres 12
Figure II: Basic product flow diagram. 19
Figure III: Summary of SSCM practices. 21
Figure IV: Technological process in breweries and main waste generated. 25
Figure V: Global Warming Potential (GWP) of beer for different packaging and different stages in the life cycle. 29
Figure VI: List of companies to be analyzed in this report. Filtered by region, revenue and core business. 33
Figure VII: Carlsberg's 2020 Materiality Matrix. 38

APPENDIX

Appendix I: Table of data utilized for the Thematic Analysis of the companies' communications.

Listado de abreviaturas

Circular Economy	CE
European Union	EU
Extended Producer Responsibility	EPR
Global Warming Potential	GWP
Green house gases	GHG
International Standards Organization	ISO
Life Cylcle Assessment	LCA
Sustainable Development Goals	SDG
Sustainable Supply Chain Management	SSCM
Thematic Analysis	TA
United Kingdom	UK
United Nations	UN

1. Introduction

Beer is a beverage that carries within both and economic and a cultural value that is difficult to measure and substitute. It is the fifth most consumed beverage in the world according to OECD Health Data (2005) and the industry as a whole is worth approximately five hundred million euros (MarketLine, 2020). This drink has evolved alongside humanity, immersing itself into the day-to-day lives of millions of people who consume beer and see it as more than a simple beverage. Because of these, beer is a product that despite fluctuations in world economy and an uncertain future for the world, it's still projected to grow steadily in the upcoming years (Bart Haas, 2020).

The world is currently facing a climate crisis that must be addressed, there are entire industries such as energy, agriculture, fashion, among others, that are redefining their business models in order to be sustainable in the long term. It is important for large companies responsible for tons of detrimental environmental impacts to transition into a responsible approach to their manufacturing processes, especially for products that are hard to replace and have become a common for humans, such as beer.

The brewing industry is a highly water intensive process. It is estimated that in order to produce one liter of beer it takes approximately three hundred liters of water (Lee, 2009) between the cultivation of water and hops, the mashing, wort boiling, cooling and bottling of it. Additionally, brewers also incur in massive amounts of energy during the wort boiling, mashing and fermentation process which turns into high volumes of emissions released into the environment (Boden, 2012). Other by-products of this process are solid waste from spent grains and yeast as well as wastewater that if not disposed of correctly, are also detrimental for the environment and harmful for those who come in contact with it. According to Amoriello and Ciccortti, 2021, about ten liters of wastewater is generated for creation of one liter of beer. All of these contribute to a larger problem which is the shortage of water, high discharge of emissions, toxicity in the lands and water bodies and scarcity of space to dispose of waste.

Even though the environmental impacts produced by the brewing industry and the whole beer supply chain are considerable, the study of these is limited. There has been an

increase in the amount of industry statements and scholarly articles on the topic, (Bumblauskas, 2017). Reports such as Olajire's (2020) have addressed the harmful effects tied to this product in a general manner, stating which are the main components attributing to the negative impact of this industry. Other studies focus on a specific section of the production process such as energy efficient like Scheller, et al (2008) or water management Merwe & Friend (2002). Nonetheless, few have quantified these consequences, authors such as Koroneos, et al. (2003) and Amienyo and Azapagic, (2016) have provided a thorough analysis of which phases of the process companies should be focusing on. Furthermore, the after mentioned the studies have addressed these topics, have as primary subjects the industrial process of beer rather than the overall commerce of from beginning to end. What this leaves is a void within these studies for the interpretation and understanding of what the larger industrial companies are doing at a grander scale. Since the majority of the negative environmental impacts can be attributed to the greater corporations, it seems necessary to further analyze what is being done among this group to deal with the by-products, emissions and water usage that distinguish this industry.

The aim of this study is to analyze what the main participants of this industry are doing in terms of sustainability, which practices are being implemented and how are they communicating those efforts to the general public. It is important to understand what the greater companies in this industry perceive as the principal issues within their supply chains are. This will give a thorough look into what the sustainable management practices are for beer companies and if those align with what is being demanded from the United Nations, European Union and general public, who are becoming increasingly concerned with responsible manufacturing processes.

The analysis will be done by a Thematic Analysis (TA) of the major companies operating in this sector. This is a methodology that allows the study of a wide array of topics related to sustainability and the beer industry from the lenses of a group of companies, enabling the achievement of conclusions that can be applied to the whole sector and not just one specific company. The list of businesses will be chosen by the application of different criteria regarding geographical scope, amount of revenues and primary business line.

Once the companies are selected, the study will proceed by gathering relevant and public information on sustainability and the environment which is usually found on annual and sustainability reports. The collected records will then be analyzed using a data table that will cross reference relevant concepts defined in the theoretical framework with what is being communicated in the companies' reports. The methodology will be further explained during the course of the report, especially in the findings section.

As it was previously mentioned, reports and studies on sustainability on large industrial brewers is scare. The focus is usually on smaller craft breweries whose overall environmental impact is not as noticeable and obvious as it is for companies on the other side of the scope. The conclusions attained from discourse analysis in this report are highly significant since it provides a necessary glance into the practices and management strategies being carried out by the biggest polluters of an industry that is characterized for its waste of water and energy intensiveness. Because of the power these companies hold and their influence on creating rules and trends within their processes, by providing an inference from an industry wide perspective, this could offer a much needed in depth look on how the key players of the beer industry are responding towards this issue and on what the next steps are for breweries to transition into a sustainable operation capable of withstanding its place for many years to come.

In what follows, we first include the theoretical background for our study in which the relevancy of the beer industry will be stated, as well as the definition of frameworks and methodologies that are relevant for the analysis of the product's supply chain. Once these are stated, the beer's life cycle will be outlined accompanied by the environmental impacts that it carries in each stage. Once the focal points of the analysis are established, we will proceed with the analysis of the companies' communications to discovery what these deem as the major issues affecting their businesses are. These risks they identified will be attached to management practices or strategies that will aid them in mitigating the negative effects in the environment and reducing the threat it may pose on their operations. Lastly, after identifying and establishing which solutions are being carried out, a thorough examination of the results will be in order to achieve that in depth evaluation that is desired for this industry.

2. Theoretical Framework. Scope, significance and environmental impact of the beer's life cycle.

In order to carry out an in-depth analysis of sustainable solutions for the brewing industry, it is important to first describe what this encompasses. The purpose of this section is to clearly outline what the beer industry comprises, how it has behaved in the past and what it is forecasted to look like in the future. This will help to better understand the magnitude of the problem at hand and identify the main companies to analyze later on.

Additionally, it is imperative to define key concepts such a Life Cycle Assessment (LCA), Circular Economy (CE), Sustainable Supply Chain Management (SSCM) and Extended Producer Responsibility (EPR). These relevant methodologies and ideas will allow for a thorough analysis of the brewers' supply chains, documenting where the main issues lie, what areas can be improved and how.

2.1 The brewing industry: history, trends and forecasts.

2.1.1 A brief account of the history of brewing

Historically, beer has been one of the most important beverages consumed by the population. The first appearance of a beer-like beverage can be dated back to 3500 BC in Sumeria, southern Mesopotamia, where one of the first recipes for its production was found. It spread throughout Egypt and eventually extended to Europe around 3000 BC (Poelmans, 2012).

The earliest forms of breweries can be traced to the monasteries in the Middle Ages where beer would be used by monks for a variety of reasons, such as to give to the poor, nutrition and healing (Unger, 2004). Nevertheless, the most prominent motive that prompted beer consumption during this time was that since it was made with boiled water it was regarded as a more sanitary alternative to normal water, which at the time was highly contaminated. (Poelmans, 2012).

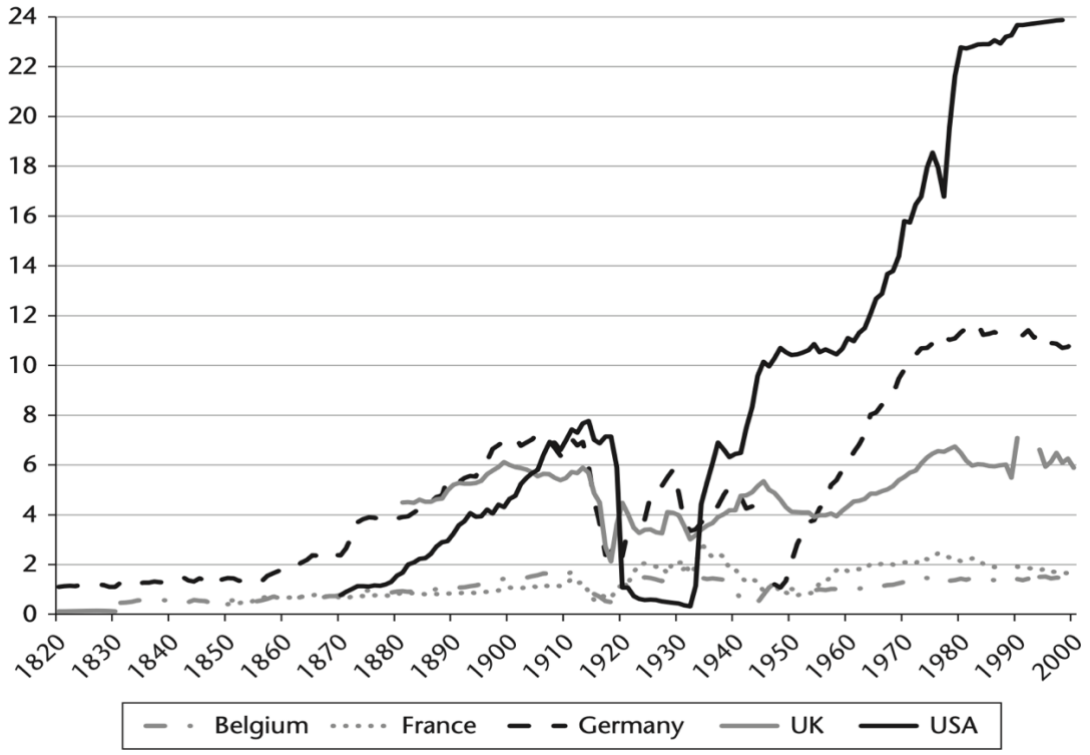
As water pollution increased, so did the demand for beer, which led to the commercialization of it. New centers of production arose creating what became the earliest commercial breweries, and the role of monasteries in this industry ceased to exist.

In the fourteenth century the first set of regulations was introduced, which included tax normative, fixed beer prices, among other matters (Poelmans, 2012).

It wasn't until the eighteenth and nineteenth century, that a variety of technological improvements became a turning point for beer production. With the creation of the steam engine and the refrigerator, it became increasingly easier to produce beer in a larger scale as well as during periods of the year where the climate was not cold, something that had been a limitation before. Furthermore, with the steam engine, came boats and trains that were responsible of accelerating the export and commercialization process, opening a new set of possibilities for European breweries (Meussdoerffer, 2009). Other important breakthroughs were the process of 'lagering', the increase in the knowledge of yeast and the utilization of the glass bottle to distribute the finished good, all of which were instrumental in the globalization of beer (Poelmans, 2012).

The important world events that occurred in the twentieth century greatly impacted the steady growth that had been experienced in the past years. In North America, the prohibition halted the production of alcohol. In parallel, Europe lived through both World Wars which were detrimental for the industry due to the shortages in grains needed for brewing. Nonetheless, by 1950 owing to an increased income and new technological discoveries, breweries were able to reengage in production accompanied by a rise in demand and consumption globally (Poelmans, 2012). By the end of the century, the sector had fully recovered and began a period of consolidation which elevated the most prominent breweries known today such as: AB InBev, Heineken, Carlsberg and more. The following graph exposes the fluctuations suffered by the breweries during this time:

Figure I: Beer production in the nineteenth and twentieth centuries in Europe (Belgium, France, Germany, and the United Kingdom) and the USA (1820–2000), in billion litres



Source: Mitchell, 2007

2.1.2 Current trends and forecasts for 2023

It can be said then that beer is a product that because of its history and uniqueness in flavor and development, has become culturally significant. That is why it enjoys the advantage of having little to no threat of substitution by other alcoholic and non-alcoholic drinks. What this translates into, is a solid industry that despite variations in global economy, still managed to maintain moderate growth and will continue to do so with an anticipated CAGR[1] of 3.4% for the 2018 – 2023 period. (Marketline, 2020).

When discussing the beer industry, for the purposes of this report, the market is defined by the retailing of beer and cider. Where beer comprises ale, dark beer, lager, stout, flavored beer, wheat beer, beer mixes and seasonal beers. The value created by it is calculated taking into account the retail selling price (RSP) (Marketline, 2020).

[1] Compound Annual Growth Rate, CAGR, is the mean annual growth rate of an investment over a specified period of time longer than one year.

Regarding the distribution of this product, four main channels are defined: On Trade, Hypermarkets & Supermarkets, Convenience Stores and Food & drinks specialists. In Europe, 61.1% of the total market value is distributed On Trade, which means that brewers earn the majority of their earnings by consumption in restaurants, bars, hotels, clubs and so on. Followed by purchases in hypermarkets and supermarkets, which accounts for 26.3% of the market distribution share (Marketline, 2020). Distributors are considered to have a moderate bargaining power because of the low switching cost but the pressure to have a wide array of products to satisfy their customers. (Marketline, 2020)

On the other side of the spectrum are the suppliers, that because of the reliance on quality raw material, are a highly important participant in this industry. Beer manufacturers are usually non-vertically integrated businesses which means that they buy the hops, barely, and even malted barley from third-party producers. Although this had been the case for a long time, the biggest companies in the industry are now implementing some vertical integration (Markerline, 2020).

According to a study carried out by Deloitte in 2017, concluded that Europe has the highest per capita consumption of beer. Marketline valued it at € 174,595.1 million euros for a volume of production of approximately 49 million liters of beer annually. Continuing within the European scope, in terms of value, Germany is the country with the most overall consumption (27.5%), followed by the United Kingdom (13.6%) and Spain (6.5%) (Datamonitor, 2011).

The beer & cider market is forecasted to achieve a volume of almost 187.5 million liters and a value of € 704,738.1 million euros for 2023 globally. This would account for a 18.3% increase in value from 2018 (Marketline, 2020). Ultimately, this proves that the industry is by no means slowing down, and because of the fact that Europe has the largest share in world consumption it also means it has the largest share in responsibility to manage their emissions and pollution. With beer being such a prominent pillar for Europeans, a shift has to happen within the industry and its participants in order to make it a more sustainable process.

2.2 Frameworks for Sustainable Management.

Before moving forward with the environmental challenges faced by breweries and the rest of this industry, it is important to define a series of concepts and methodologies related to sustainable operations and reduction of environmental impact that will later be fundamental for the identification of the focal problems and areas of improvement.

2.2.1Circular Economy (CE) and Extended Producer Responsibility (EPR)

One of the most, if not the most, pressing subject that must be addressed by society nowadays, is what will happen with the world as it is today if consumption patterns are not changed. It has been universally acknowledged that civilization cannot maintain the pace it has for the past century if it wants to exist in the future. This challenge that is being faced has been met by a variety of newer alternatives to past conventions, among these prospects, one of the most promising is the concept of Circular Economy (CE) that within itself calls for an Extended Producer Responsibility (EPR). Both are pushing for the same purpose which is a continuous growth of the economy without damaging or compromising the environment.

Presently, the socio-economic system is based on a linear economy where companies purchase raw materials, develop products and services and then sell them without taking part in the waste management of their labors. What this has resulted in, is a society that consumes 1.7 more than what the planet can generate (Sedikova, 2019). The negative consequences are immeasurable, this resource exploitation leads to the reduction of biodiversity and the steep increase in pollution to name a few of its effects. The linear economy that currently reigns within the nations, does not have an easy fix, there must be a radical and fundamental transformation of the way society satisfies its need in order to properly face the systematic challenges and current consumption models (Cuesta, 2020). In this way, CE is offered as a disruptive alternative to the traditional linear model which is based on maximizing the utility of products, materials and value while minimizing the waste of natural resources (Cuesta, 2020).

The concept of Circular Economy cannot be traced back to a specific date or author, but it first appeared around the 1970’s (Cuesta, 2020) and as interest in it rose, so did the

interpretations of its definition. With the current momentum this concept is experiencing, a need for a definition occurred. A study carried out by Kirchherr, Reike and Hekkert in 2017 found that 73% if the definitions of CE were from the former five years, proving that this concept is still young and has to be further developed. CE was born due to the necessity of a system that will maximize the use of its resources without it being detrimental for the environment. Recently it has become more evident that an optimal system will allow a continued growth for the economy without increasing harmful environmental consequences which is, in brief, what CE wants to achieve, the separation of economic growth and environmental impact (Sedikova, 2019).

The main purpose and objective of the Circular Economy is to re-think business models in a way that current development necessities are met without compromising the needs of future generations. For a process to be fully circular it must supply sustainable development for the following dimensions: environmental, social and economic. This way the whole system is optimized and not just fractions of it (Georgantis, 2021). Closed supply chains are what CE is based on, these pioneering business models allow for essential components such as: limited reserves management, redesigned logistics processes and optimization of resource efficiency throughout all the stages in the life cycle of the product. When all of these are taken into account, the outcome is companies and organizations that have limited to no negative effects on the environment (Sedikova, 2019).

As previously mentioned, the current economic model is not strong enough to be sustainable in the long term, this has been acknowledged by entities as prominent as the European Union, who in November 2019 declared a climate emergency and pledged it would achieve net zero emissions in 2050. This commitment has forced companies and organizations to look for alternatives and have found that by applying CE principles, they could meet the carbon emission goals set by the European Union. Circle Economy (n.d), a foundation dedicated to the research of CE, has defined eight key elements that will allow companies to build a business strategy grounded on the CE principles, these are:

- Prioritizing renewable, reusable and regenerative resources.
- Lengthening the lifetime of a product as much as possible by repairing and upgrading them, this way maximizing their use.

- Using waste streams as a resource by incorporating recycling and reusage initiatives.
- Reconsider current linear business models and trading them for closed supply chains.
- Collaborating with internal and external sources along the supply chain to create joint value, especially with the public sector.
- Designing products with the purpose of extended use for the future. Picking the proper materials from the commencement of the process instead of figuring out ways of recycling or reusing them later on.
- A tool that can be taken advantage of is technology, by incorporating it into their research processes, companies can develop solutions faster than before and can also quantify the environmental impact of their processes more easily.
- Knowledge is fundamental in creating circular initiatives within companies. Doing research and encouraging innovation will result in a smoother and more successful implementation of these strategies.

Based on these key elements that have been defined, new management strategies have surfaced. These include: the usage and fabrication of 'smarter' and 'greener' goods, extending the product's useful life and the optimized usage of materials. Thanks to these innovative management practices, different business opportunities are coming to life, all of which will increase the dematerialization of society nowadays.

As it was previously mentioned, the European Union has declared a climate emergency and along with this, they also introduced legislation titled Extended Producer Responsibility (EPR), which hold companies and organizations accountable for the long-term environmental management of their products. This initiative, like CE, intends to transform linear supply chains into a "cradle-to-cradle" system based on recycling, reusage and enhanced product design (Sachs, 2006). In practice, what this means is that manufacturers have to recover the compost they have fabricated and dispose of it, or they can pay a fee to an organization to collect a recycle their merchandises for them.

The shift in responsibility from the public entities and government to the producers is an important goal for transitioning towards a more circular economy because it incentivizes fabricators to design products that are easily recycled and with less hazardous materials to discard at the end of its useful life (Kunz *et al*, 2018). Some of the limitations of this approach have to do with the proper enforcement of recycling standards, suitable incentives for organizations that do comply with them and having a common legislation for all the European Union. Nonetheless, even after taking all of this into account, EPR is still "one of the most significant developments in global environmental policy" (Sachs, 2006, p. 54) and an effective way of forcing entire industries to reconsider the long-term impact of the materials being discharged into the environment and it could be one of the better options into the transition into a Circular Economy.

2.2.2 Life Cycle Assessment (LCA)

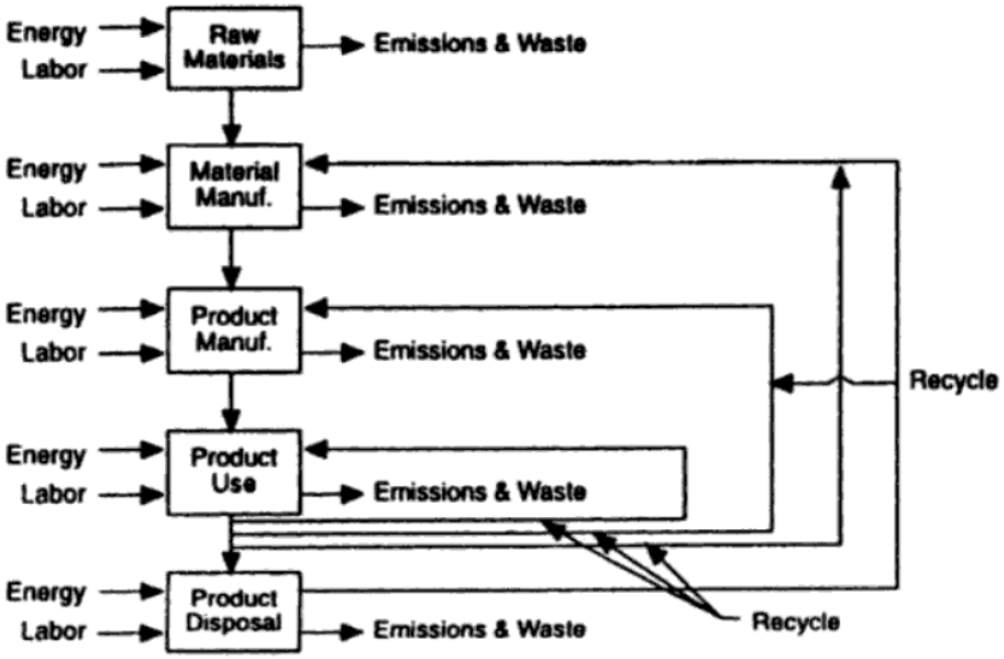
Life cycle assessment, or LCA, is a framework, methodology and tool that aids in the evaluation and quantification of the environmental impact associated with the life cycle of a defined product or activity (Harris and Landis, 2020). This is a significant concept because it helps assess the impact throughout the different stages the product goes through, starting with the raw materials and ending with the managing of waste. With the employment of this framework, companies, governments and other corporations are able to evaluate the processes they complete and come up with alternatives and solutions for the more detrimental parts of their supply chain.

The concept of Life Cycle Assessment was first conceived in the 1960's when Coca-Cola compared the environmental impact of switching from glass to plastic packaging (Harris and Landis, 2020). Afterwards, accompanied by the rise of a "green" movement and newly established Green political parties in Europe, more companies used tools for environmental life cycle analysis (Ciambrone, 1997). An important milestone came when the International Standards Organization (ISO) published the 14000 Environmental Management Standards which are a set of standards and best practices for organizations regarding labeling, greenhouse management, environmental performance evaluation and Life Cycle Assessment (International Standards Organization, n.d). The establishment of these, gave LCA the scalability it lacked before. Now, companies could make use of this

tool in a homogenous way which would then aid in the reproduction and comparison of the findings from these investigations.

Like most studies, the LCA process is begun with the definition of motive and scope of what will be analyzed. Afterwards, it quantifies the inputs and outputs of the life cycle of the chosen product which will be later on assessed environmentally, and finally, interpreted. The phases of the life cycle that can be studied can range from "raw material acquisition, energy requirements, manufacturing, formulation, processing, transportation and distribution, use, reuse, maintenance, recycling, and waste management" (Yang, 2020).

Figure II: Basic product flow diagram.



Source: Ciambrone, 1997

As outlined by the ISO 1040 series, there are four steps to be carried out in LCA:

1. Goal and Scope Definition. The analysis begins with the definition of the target of investigation as well as which aspects of it are relevant in achieving the aim of the study. Additionally, since LCA can be applied to specific parts of the supply chain, there are different approaches that can be followed regarding the length of

the cycle. These are: Full scale life cycle, partial life cycle or individual stages or processes depending on the degree of specificity desired. Defining the scope can mean deciding whether it is significant for the company to analyze their processes as a whole (full scale), choose several stages strategically (partial) or just focus on a specific stage (individual) (Ciambrone, 1997). Once this is defined, researchers begin to conceptualize a model about the relationships between different stages of the cycle and gather relevant information on them to be analyzed later on. (Yang, 2020).

2. Life Cycle Inventory (LCI). Collection and Analysis. As defined by ISO (n.d), LCI is the "phase of life cycle assessment involving the compilation and quantification of inputs and outputs for a product throughout the life cycle". One of the most important characteristics of this stage is the definition of the functional unit which will determine how inputs and outputs will be quantified (Harris and Landis, 2020).
3. Life Cycle Impact Assessment (LCIA). According to the standards published by ISO (n.d), LCIA is the "phase of life cycle assessment aimed at understanding and evaluating the magnitude and significance of the potential environmental impacts for a product system throughout the life cycle of the product." The impact can be quantified based on different classifications that can go from global warming potential to resource depletion (Harris and Landis, 2020).
4. Interpretation of Results. Once all the quantification is done, then comes the understanding of the data obtained. The purpose of this is to be able to draw conclusions of which parts are contaminating the most and for companies to take initiatives towards minimizing the impact.

The establishment of the former standards has increased the amount of available information of studies of this types. It is important to note that there should be caution when comparing LCAs from different companies since this is an analysis whose results can differ depending on variations in methodology and the functional unit chosen. Nevertheless, it is safe to say that the implementation of a Life Cycle Assessment is a useful tool and can be a guide for companies and organizations looking to become more aware of the environmental impact of their products in multiple stages of their lives.

2.2.3 Sustainable Supply Chain Management (SSCM)

Before moving on to the analysis of the beer supply chain, there is one more concept which is gaining momentum and is being implemented in many industrial companies. Sustainable Supply Chain Management (SSCM) can be defined as a set of managerial practices that wish to implement the Sustainable Development Goals (SDG) set by the United Nations, while creating shareholder value and establishing a competitive advantage (Narimissa *et al*, 2019). SSCM aims to create more stable, efficient and ethical supply chains that aligns economic and environmental issues (Zimon *et al*, 2020).

In order for a supply chain to be considered sustainable, it must add value in three dimensions: economic, environmental and social. According to a paper published in the International Journal for Quality Research (2019), the performance is measured as following:

1. Environment: green design and purchasing level, lack of toxic materials, low energy consumption and overall compliance with environmental standards.
2. Economy: Total cost, inventory cost, competitive advantage, profitability, risk management.
3. Social: Public perception, social responsibility, green images.

The implementation of the SDG into the companies' supply chains is a challenge that must be overcome in order for society to fully transform into a sustainable one. A way to achieve this if by merging these two into SSCM practices for all the stages of the life cycle of the product. In the table below, SSCM practices are summarized.

Figure III: Summary of SSCM practices.

Sustainable supplier management (upstream)	Sustainable operations and risk management (focal company)	Pressure & incentive management (downstream)
• Green purchasing • Green raw material procurement • Green packaging • Green transportation • Material recycling • Strategic supplier collaboration • Supplier sustainability assessment	• Green product design • Green process design and planning • Green manufacturing • Product recovery and remanufacturing • Waste, water, and air management • Energy consumption and emissions reduction • Green packaging	• Collaborative inventory management • Green warehousing • Green shipping and distribution • Reverse logistics • Product recycling • Corporate green image management

Source: Zimon *et al.*, 2020

The concepts explained above, Circular Economy, Extended Producer Responsibility, Life Cycle Assessment and Sustainable Supply Chain Management, give a useful framework for the thorough analysis of the activities a company carries out and whether it is implementing practices that will result in a negative long-term environmental impact. Given the current legislation imposed by the European Union, organizations are looking to transition into a "cradle-to-cradle" approach and in order to do so, they must take into account the concepts defined above to utilize as frameworks and methods of analysis. Moreover, the use of these can become a determinant tool for decision-making in the modern company.

2.3 Defining beer's life cycle and its environmental impact.

The brewing industry faces many environmental challenges throughout the course of its supply chain. It is a process that requires large amounts of water and energy consumption, something that is difficult to overcome. During the course of this section, the production process that beer goes through will be defined as well as the environmental consequences each of these stages has.

2.3.1 Beer production process

It is important to note that creating beer is a very complex process that can vary greatly depending on the type of beer (larger, ale, etc.) and the desired flavor and composition of

the end product. The process that will be described is the general depiction of the common beer practice in a standard brewery.

The primary raw material needed for the production of beer is malted barley, who is accompanied by: unmalted grains, hops, water and yeast. The process begins when the malt grains are transferred to the factory from the storage facilities where they are grinded/milled into small particles so a great number of extracted substances can be obtained. The next step is the creation of the marsh which is a combination of the malt grains from the first step plus gelatinized adjunct and water, and the technique of mixing these is called mashing. The purpose of mashing is obtaining a substance called 'sweet wort' by mixing and heating the mash in a tun and it can be done via infusion, decoction or a balance of the two. Decoction mashing is a process by which a part of the mash is removed from the rest, it is heated in the mash cooker till the point of boiling and then it is put back again with the rest of the mashing mixture. Whereas infusion mashing is a process that aims to maximize efficiency of wort extraction by heating up the entire mash with the usage of hot water (Hardwick, 1994). This part of the process is highly energy intensive and not used for the production of all beers, especially the decoction mashing. The type of mashing will vary depending on the desired outcome of the beer (Willaert, 2007). Once the mashing procedure is completed, a liquid called 'wort' is created and separated from the mashing mixture by running it through a filter. There are other more traditional methods of doing these, but the larger breweries do it by the filter bed which amplifies the extraction effectiveness. The remaining grains are mixed and sprayed and denominated 'spent grain' which are used as animal food (Olajire, 2020).

Wort separation (lautering) is the subsequent stage of the beer making activity and the most fuel intensive one. During this phase, hops are added which is one of the most important ingredients in beer and the one that gives flavor and color. The boiling of this liquid is done to sterilize the wort, tee off volatile compounds, stop enzyme activity among other things (Hardwick, 1994). Once the wort is boiled properly, the hops are filtered out and the remaining liquid goes through a clarification process where it is filtered, centrifuged or whirlpooled. After this, wort is cooled which is the final step in the brewhouse portion of the process. Cooling can happen thorough air or liquid in a plate

heat exchanger where the hot wort enters and then exits in pitching temperature (6 – 15 ºC for large breweries) (Olajire, 2020). Some breweries carry out a second clarification at this point by removing hot reub and hop debris (Willaert, 2007).

Fermentation is the other large portion of the beer production process. Once the wort is cooled and oxygenated, yeast is added, and the resulting wort is placed in a fermentation vessel. The interaction between the yeast and the fermentable sugars produces a sequence of biochemical reactions that include the participation of glucose, fructose, sucrose, maltose and maltotriose. All of these reactions generate substantial amounts of warmth that may impair the yeast if not properly cooled off, again using high amounts of energy. Depending on the type of beer, this portion of the process can last from a few days to ten days and is concluded by the carbonation of the beer and the filtering of the yeast which is then either discarded or reused for a second fermentation depending on the brewery (Olajire, 2020).

After fermenting, the beer is aged and cooled. The temperature and duration of cooling will depend on the type of beer being created but it is usually around -1 ºC to -10 ºC and a month of refrigeration. Subsequently, it is filtered again for the removal of any remaining yeast, and brewers sometimes add coloring, hop extracts and flavor additives for commercial and esthetical reasons. Once the beer itself is achieved, then comes the more industrial part of the process, which starts when the beer is sent to a bright tank where sometimes great volumes of specially treated water are added. The remaining step is the pasteurization of the beer which consists of heating it to up to 60 ºC and this way eliminating all damaging bacteria from the beer and enabling it to have a longer shelf life. The heating system is another energy intensive part of this process (Olajire, 2020).

Once all of these steps are completed, brewers finally have the end product that they will sell. The beer is moved from the tanks into the bottles and then distributed to the customer for consumption, ending then, the life cycle of the average beer.

2.3.2 Environmental impact of the beer production process

In the outlining of the beer production process, it is corroborated that besides being complex, it requires high amounts of energy and water. Before quantifying the environmental impact of the beer production process via a Life Cycle Assessment, it is important to give a general overview of what the by-products for this process are. In the following figure, it is summarized what the different derivatives of this practice are for each of the steps that comprise it.

Figure IV: Technological process in breweries and main waste generated.

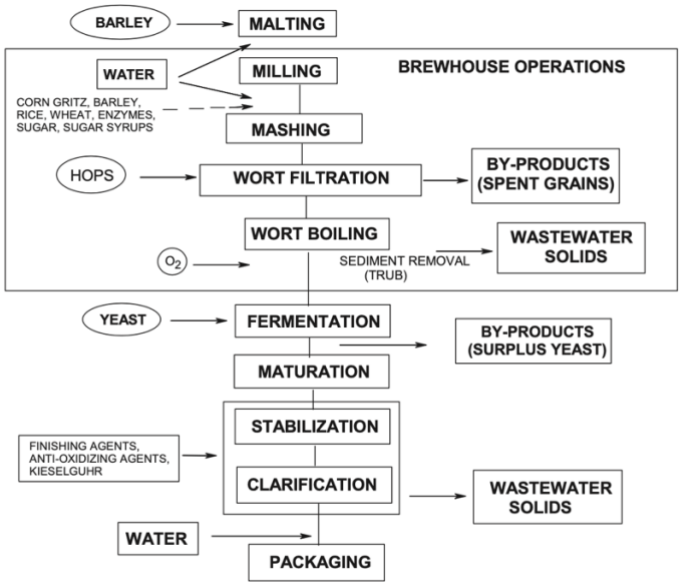


Fig. 4. Technological process in breweries and main waste generated. Source: Unicer SA, 2005; Varmam and Sutherland, 1994.

Source: Unicer SA, 2005

Beer-making process has been described to use immense amounts of water throughout its whole process. According to Lee (2019), if the whole life cycle is taken into account, from the cultivation of hops and barely to the bottling of the final product, it takes approximately three hundred liters of water to produce one liter of beer. The amount of overall water usage will vary depending on the type of beer, size of the brewery and other factors but for the average beer this resource is the most utilized out of all of its raw materials. It is also the case that for the other raw materials such as barely and hops, water is also a necessity. It must be considered that that barely and hops come from agriculture which is another water intensive industry. According to an article in by Deena Shanker published in Quartz (2015), 590 gallons of water are employed to produce the barely and hops required for a gallon of beer. Thus, by looking just at the raw materials there already

is a great deal of water being used that if not treated and optimized properly, causes long term issues for the exploitation of the agricultural fields where barely and hops are being planted. Water is considered a raw material because it is being used for the preparation of the beer itself during the milling, mashing and cooling stages of brewing. Furthermore, this is a resource used for the more industrial side of the process at almost every step. Washing bottles, machines, sanitary water, bottling, boiling are only some of the uses given to water throughout the production process. By adding all of these together, brewers have a problem at their hands in trying to cut back on water usage without impairing the quality of the end product. This constitutes a challenge because like it was previously stated, water is a large partaker in the beer itself. In fact, it accounts for 90 – 95 % of its mass (Olajire, 2020).

Another of the most prominent by-products of the beer production process is wastewater, which as defined by the Cambridge Dictionary (n.d) is considered "water that is not clean because it has already been used in homes, businesses, factories, etc.". Wastewater can be divided into: Industrial process wastewater, sanitary wastewater which comes from human use (toilets and kitchens) and rainwater. From the three after mentioned categories, industrial process wastewater accounts for the larger share of the total and is also the more harmful one because it can contain substances such as nitrogen, phosphorus, nickel, chromium and others. These are harmful for the environment due to the biological contaminants that it holds, and an effort should be made for it to be treated and disposed of in an efficient way.

After the usage of the majority of their raw materials, breweries can incur in high amounts of solid waste to dispose of. The spent grains and yeast that result from the brewing process have a saleable value and can be sold as animal food. On the other hand, there are other types such as trub and kieselguhr sludge which constitute a large portion of the solid waste and are harder to dispose of and present a challenge from a sustainable supply chain management perspective (Olajire, 2020). Finally, packaging materials is another form of solid waste which with the application of Circular Economy and SSCM practices could be minimized.

Lastly, the other main negative impact breweries have over the environment is the emission of greenhouse gases, where the three most prominent ones are carbon dioxide, nitrous oxide and Sulphur dioxide. These come from various stages in the beer production process like boiling and fermentation (Olajire, 2020). The gaseous emissions are categorized depending on their conception into the following: combustion of fossil fuel, emissions particular to breweries and the beer itself, electricity, vehicles used for transportation of the raw materials into the factory and distribution of the final product, on-site fuel cells, refrigeration and so on. Sometimes, gases like Carbon dioxide and nitrogen can be recuperated although without proper ventilation it could be lethal.

The environmental impact of a brewery can be segmented into different categories depending on the geographical scope considered. From a global perspective the main negative impact this industry provides is related to the emissions it discharges. Like stated previously, breweries use massive volumes of fossil fueled energy that then harm the world in a global scale. When reducing to a regional range, the main concerns come from the misusage of water that result in the diminishment of water resources in a specific area. Moreover, the disposal of solid waste and treatment of wastewater can both have undesirable effects if not considered properly. This industry can contribute to land and water bodies eutrophication. Lastly, from a local standpoint, nuisances for the local communities such as odor, dust and noise are the main environmental impacts generated by the brewing industry (Olajire, 2020).

2.3.3 *Life Cycle Assessment of beer*

Once the production process of the beer has been described and the environmental impacts of this practice have been identified, it is pertinent to carry out further analyses to be able to distinguish areas of improvement and eventually achieve a more sustainable operation and supply chain. A tool for accomplishing this is carrying out a Life Cycle Assessment of beer to quantify the impact at each stage of the beer-making process. For purposes of this report, a study that illustrates the LCA for beer has been used. An independent investigation was carried out for the United Kingdom which will be instrumental in further evaluating the quantified environmental impact that breweries release.

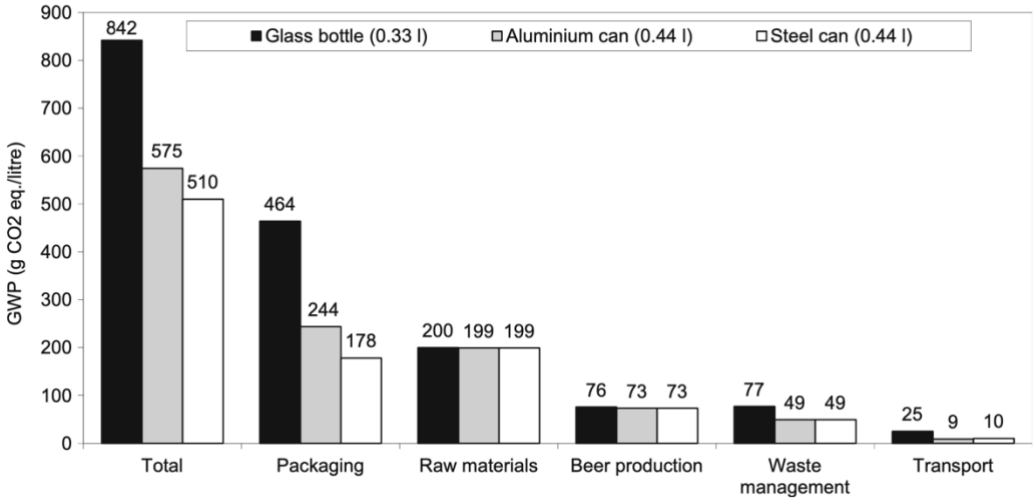
The Life Cycle Assessment carried out in 2016 (Amienyo and Azapagic, 2016) on the beer industry in the United Kingdom has as a purpose the identification and quantification of this process on two different levels: consumer and overall impact for the UK. This is done in order to inform first, the general public on the effect our consumer patterns have, and the latter is for the usage of United Kingdom officials and policy makers to take into account. By carrying out this study and elaborating which are the consequences of this process, the report hoped to shed a light on the magnitude of this industry from an environmental perspective. The LCA was done using the ISO 1400 regulation described previously in this section. Following that, the first step was to determine the goal and scope of the study and afterwards define what the functional unit for the study was going to be. The general goal as defined by the authors is: "The goal of the study is the estimation of life cycle environmental impacts and costs of beer produced and consumed in the UK." (Amienyo and Azapagic, 2016, p.493). Then, as mentioned above, they have also demarcated two dimension which will be studied. For the first dimension that deals with the final consumer, production and consumption of one liter of beer at home was the determined unit. On the other hand, when quantifying the impact towards broader spectrum the unit used was annual production and consumption of beer in the UK. As for the scope of the study, even though the functional units are different, the same life cycle of beer is considered for both and it is similar to the one described in the section 2.3.1 of this report. The authors define the following stages as the scope of the LCA: raw materials, manufacturing, packaging, retail and consumption, waste management and transport.

The third step of the LCA is the Life Cycle Impact Assessment (LCIA) and among the different impact categories Global Warming Potential (GWP) was the most important. GWP is defined by the United States Environmental Protection Agency (n.d) as "a measure of how much energy the emissions of one ton of gas will absorb over a given period of time, relative to the emissions of one ton of carbon dioxide". The purpose of this is to be able to quantify and compare the warmth absorbed by different greenhouse gases, translating them all into the same "currency" allows for the comparison in impacts. Once the LCIA is carried out there is a numerical reference attached to each of the stages

the beer goes through which is fundamental when determining which are the areas producing more damage to the environment because it is easier to interpret and compare to other industries and sectors.

Finally, once the life cycle of the beer is measured by GWP within the scope of the defined functional unit, one liter of beer consumed at home, the study moves on to interpret the results which are shown in the table below.

Figure V: Global Warming Potential (GWP) of beer for different packaging and different stages in the life cycle.



Source: Amineyo and Azapagic, 2016.

According to this study, the type of packaging is an important factor in determining the total environmental impact a beer will have. One liter of beer consumed at home will have a GWP of 842 if it comes in a glass bottle compared to the 510 GWP of a steel can. It can also be appreciated from the results shown above that the majority of the difference between glass, aluminum and steel total GWP comes from the packaging and waste management phase. What can be inferred is that for glass requires more energy to clean a bottle than the other two alternatives. When looking specifically at the different phases it can also be appreciated that packaging and raw materials account for the vast majority of the GWP produced by beer. Raw materials consist of 24% (for glass) to 39% (for steel) of the total contribution to GWP. This is due to the fact that the agricultural component of beer-making has a massive weight on the overall result of the beer which means that a

great deal of emphasis is put onto barely cultivation which is an energy intensive activity detrimental for the environment.

Besides Global Warming Potential there were other impact categories by which the process of beer can be quantified. Since there are different types of damages that can be put into the world, some parts of the process will have higher scoring in some categories and lower on others. What this achieves is an in-depth analysis that allows comparison between different alternatives. In the example of types of packaging, according to this study, steel can package scored lowest on five out of twelve impact categories making it attractive for companies as an alternative. On the other hand, glass bottles excel in categories such as human toxicity potential but then is considered as the most damaging in eight other categories.

One of the biggest contributions this study had was the quantification of this problem at a country wide level. This was done by taking the one-liter impacts mentioned above and scaling that up to the total beer consumption in the United Kingdom. For the 4.5 billion liters of beer produced in the UK in 2014 (Amienyo and Azapagic, 2016). The environmental impact of this industry regarding water consumption was a striking 5.3% of the actual amount of water consumed in the UK. This is the same as the amount of water needed to fill out 74,120 Olympic-size swimming pools (Amienyo and Azapagic, 2016). This is relevant information regarding the water consumption problem that this industry faces, and it will be useful for companies and lawmakers to gain insight in the impacts this industry has on water bodies in the UK.

Lastly, this paper found that packaging and raw materials are the two main hotspots of environmental impact regardless of the type of packaging which hints that this is where companies should be turning their focus on improving in order to diminish their greenhouse gases emissions. Nonetheless, it is important to point out that as it was previously explained, one of the biggest limitations Life Cycle Assessment has is its reliance on the methodology and functional unit defined, which means that results can vary greatly depending on how the study was carried out. Ultimately, finding other similar

studies on beer that use the same method are scarce which is a drawback in achieving a consensus among the industry on what practices should be used.

Due to the lack of quantified evidence on the life cycle of beer, combined with a absence of consensus on which specifically should be the focal point of large beer producers, it is important to understand what these companies are actually doing and what they perceive is the biggest issue regarding their production processes. Using the information given above on the LCA done in the United Kingdom and with the help of the environmental practices also defined above, overlaps will try to be found between what evidence deems as a problem and what is being done by companies.

3. Analysis of annual and sustainability reports of the main industrial brewers and results obtained.

3.1 Methodology

In the previous section, the role of the beer industry from an environmental impression was contextualized. This was done by establishing the importance this industry currently holds and also what it might look like in the future, describing the life cycle the product goes through and what individual impacts are attached to each phase. Additionally, relevant concepts were defined, all of which aid in the development of a sustainability analysis of what major companies in the sector are carrying out. This section will focus on the analysis of what these key players are implementing in their operations according to what they communicate on their sustainability and annual reports.

3.1.1 Selection of companies to be analyzed

The first step in the analysis of sustainability initiatives within the beer industry is deciding which companies are going to be analyzed. For this, different criteria will be used, this will allow for the resulting companies to be compared between them and for conclusions to be extracted among the different standards. The list of companies was selected according to the following principles:

- **The European Union as the geographical scope to be studied**

It is important to define a geographical space where there are enough similarities for the resulting companies to be comparable. There are two main reasons why Europe was chosen as the region of study. The first one is because it is the continent that carries the highest share of beer consumption in the world which in consequence can lead to the assumption that it must be one of the first markets to transition into more sustainable operations. The second reason is that companies that operate within the European Union will have similar legislation and are all obliged to comply with the standards of sustainability set by the EU who have been particularly proactive in the implementation of the Sustainable Development Goals (SDG) established by the UN. From a cultural and legislative perspective, beer companies are affected by similar external factors that play

into their future strategies. This will consist of continuing to provide enough beer for the projected growing demand while complying with the regulation set by the EU.

- **Highest-earning companies in terms of revenue**

As it has been stated before, beer companies contribute to a great deal of energy use, wastewater discharge and use of water which then add to the overall environmental impact that humas are making. Within the industry, craft breweries have taken firmer measures in order to deal with these problems, but this can also be attributed to the fact that since their production is lesser it is easier to control and regulate. For purposes of this report, it will be interesting to analyze what the larger companies are doing to deal with these problems since they are the principal contributors to it. Since there was a lack of information regarding the ranking in terms of volume production, it was decided then, to use revenue as a measure of share in responsibility towards the environment by assuming that the more revenues generated accounts for more bottles of beer sold which then translates into more negative environmental impact. To search for the highest grossing beer companies in Europe, S&P Global Market Intelligence Capital IQ was used.

- **Brewing as the core business**

Finally, the last step in filtering companies and achieving the final list to be analyzed will be to disregard companies whose core business is not brewing. From the list extracted above in Capital IQ, there were some companies who act as distributors, bottlers and commercialize beer and other alcoholic beverages. In the case of this report, only companies whose primary line of business is brewing will be considered. This is because what has been outlined as the problem is the environmental impact created by the brewing process and life cycle of beer. Any company that carries out other activities will have different impacts and overall different strategies to become a sustainable operation. Taking all the after mentioned criteria into account, the list of companies achieved is the following:

Figure VI: List of companies to be analyzed in this report. Filtered by region, revenue and core business.

S&P
Capital IQ

Capital IQ Company Screening Report

Company Name	Industry Classifications	Geographic Locations	Total Revenue [LTM] (€EURmm, Historical ra
Anheuser-Busch InBev SA/NV (ENXTBR:ABI)	Beer, Ale and Malt Beverages (Primary)	Europe (Primary)	38.325,2
Heineken N.V. (ENXTAM:HEIA)	Beer, Ale and Malt Beverages (Primary)	Europe (Primary)	19.715,0
Guinness UDV Ireland Limited	Beer, Ale and Malt Beverages (Primary)	Europe (Primary)	13.362,4
Carlsberg Breweries A/S	Beer, Ale and Malt Beverages (Primary)	Europe (Primary)	8.819,4
Irish Malt Products Ltd	Beer, Ale and Malt Beverages (Primary)	Europe (Primary)	1.484,3
Sociedad Anónima Damm	Beer, Ale and Malt Beverages (Primary)	Europe (Primary)	1.365,8
MAHOU, S.A.	Beer, Ale and Malt Beverages (Primary)	Europe (Primary)	1.330,4
Royal Unibrew A/S (CPSE:RBREW)	Beer, Ale and Malt Beverages (Primary)	Europe (Primary)	1.015,3
Kompania Piwowarska S.A.	Beer, Ale and Malt Beverages (Primary)	Europe (Primary)	956,8
Royal Swinkels Family Brewers Holding N.V.	Beer, Ale and Malt Beverages (Primary)	Europe (Primary)	917,3
Grupa Zywiec S.A. (WSE:ZWC)	Beer, Ale and Malt Beverages (Primary)	Europe (Primary)	821,4
Feldschlosschen Getranke Holding AG	Beer, Ale and Malt Beverages (Primary)	Europe (Primary)	773,2
Brau Holding International GmbH & Co. KGaA	Beer, Ale and Malt Beverages (Primary)	Europe (Primary)	701,7
Corporación Hijos de Rivera S.L.	Beer, Ale and Malt Beverages (Primary)	Europe (Primary)	535,2
Hijos de Rivera S.A.U	Beer, Ale and Malt Beverages (Primary)	Europe (Primary)	535,2
Export Mouterij Nederland (E.M.N.) B.V.	Beer, Ale and Malt Beverages (Primary)	Europe (Primary)	528,3

3.1.2 Gathering information

Once the companies have been selected, it is imperative to gather all the relevant information regarding this subject. In this report, the data to be analyzed consists of public information published by the companies listed above. The material was extracted mainly from annual reports and sustainability reports. Another source of information was the environmental policy made available by the company, and sections on their websites dedicated exclusively to communicating their sustainability goals and initiatives. Since environmental impact has become an increasingly relevant concept and companies have become more aware on how their operations affect the ecosystem, new methods and practices are being implemented. This is the reason why it is imperative for the information be as updated as possible. The vast majority of the reports analyzed in this study were the ones corresponding to 2020 and 2019, which will give us an insight into what is currently being done and what the plans and goals for the future are which is one of the purposes of this commentary.

3.1.3 Coding and analysis of the data

All the information gathered in the previous step has then moved on to be analyzed in a systematic way. This is done via Thematic Analysis (TA) which is a way of "identifying, organizing, and offering insight into patterns of meaning (themes) across a data set"

(Clarke and Braun, 2014, p. 57). The first step for this analysis was to identify which where the pertinent subjects that should be analyzed. In the previous section of this report, a variety of concepts such as Circular Economy, Extended Producer Responsibility and Sustainable Supply Chain Management were defined in order to understand them and their applicability in today's industrial world. This allowed for the identification of relevant themes that should appear on the companies' reports. Furthermore, the description of the environmental impacts associated with the beer life cycle and the quantification of it by the LCA can hint towards which should be the phases of the process that this large companies should be focusing on. Because of the after mentioned section, topics and issues were easily identified, these will be useful when reading the companies' reports and eventually analyzing how they approach the different challenges set up in this industry and how they communicate the solutions they are willing to provide for these problems. All this information was organized within a table compiling all the data, cross referencing the company with each of the topics defined. The table achieved and used in this analysis is available at the end of the report.

3.1.4 Obtaining the conclusions

The table of data developed using the criteria mentioned above was used to draw conclusions on how companies are responding to the most pressing subjects regarding its industry. One of the most important contribution the Thematic Analysis presents is the ability of jointly examining multiple companies on the lenses of one common theme. This focus will lead to the achievement of conclusions regarding the whole industry instead of just centering on a specific company. The purpose of this is to understand where the corporate communications of this large companies are focusing their efforts which indirectly gives inside into what they believe are the most pressing subjects to be addressed in terms of sustainability and what their contributions are.

3.2 Findings from the Thematic Analysis

After a careful evaluation and analysis of the companies' annual and sustainability reports and the coding of this information using a Thematic Analysis approach, different conclusions were drawn on a wide array of topics. Because of this analysis, it was possible

to better understand the challenges the sector is facing in terms of environmental impact and the risk this poses to the company's growth in the upcoming years where climate change is becoming a protagonist to be dealt with. In the following section, the industry wide perspective on the relevant topics defined will be exposed, the majority of which, were defined theorical framework of this document.

3.2.1 Company strategy based on Sustainable Development

Given the current climate emergency, the general public and governments are pressuring large industrial companies to be held accountable on their activities, environmental impact and emissions. This call for action has also forced companies to contribute to society beyond an economic perspective, businesses now have to move past that into other important areas which are the environmental and social scope. This has radically transformed the way strategic actions are framed. Where previously, annual reports consisted mainly of financial data and which were the strategic actions being taken towards achieving higher levels of profit, now this is not the case. Currently, it is an important part of the companies' annual reports to fully disclose what actions are being taken towards achieving a more sustainable operation and managing of resources. Many companies go as far as to develop a full sustainability report where they can go into detail on the contribution being made economically, socially and environmentally.

Companies then, have transitioned towards a strategic approach based on sustainable development which is a broad concept that companies can define differently depending on the scope being used. Of the companies that were analyzed, the vast majority based their definition on the Sustainable Development Goals (SDGs) established by the United Nations. Furthermore, companies like Carlsberg took them as a guide and starting point in the construction of their strategies, guaranteeing their contribution to the achievement of this goals set out by the UN. AB InBev has established that their "2025 Sustainability Goals and overall sustainability agenda align with several of the UN Sustainable Development Goals (SDGs)" (AB Inbev, 2021, p. 53).

All of the companies analyzed defined strategic actions for the three scopes: economic, social and environmental. Even though the purpose of the Thematic Analysis carried out

was focused on environmental challenges, it is still relevant to note that there was a wide array of initiatives designed for the social scope. The most prominent one was establishing procedures that ensure responsible drinking. The main focus was put on creating campaigns with the objective of eliminating underage consumption of their products. Additionally, diversity within the workplace and local purchasing were other of the relevant initiatives defined for the social scope of sustainable development.

3.2.2 Frameworks and methodologies employed

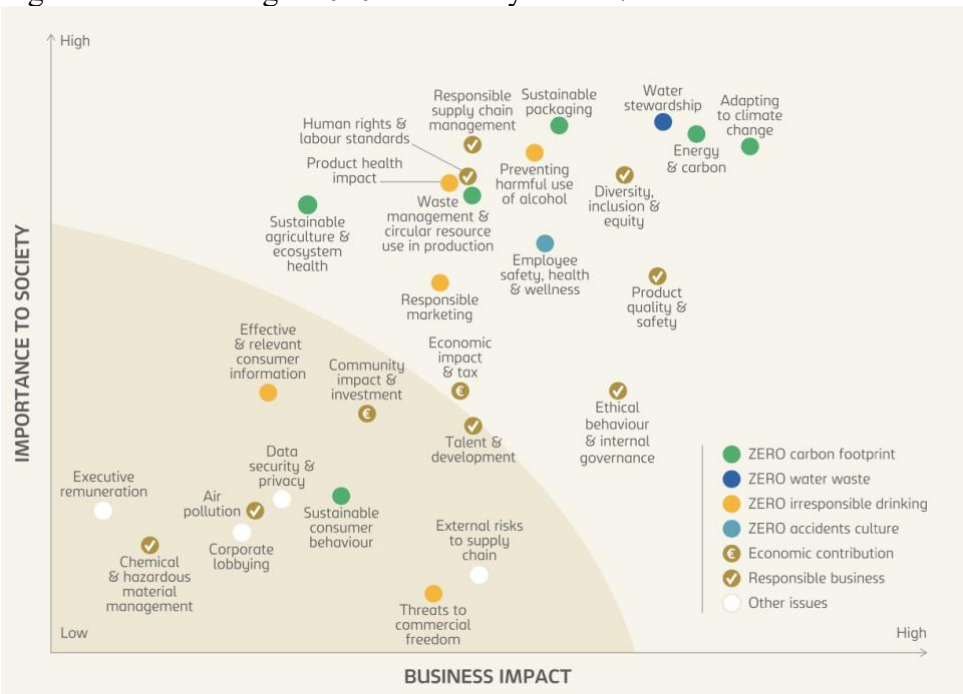
An important part in the formulation of a strategy is identifying possible areas of growth and improvement. In order to do this, it is crucial to establish methodologies and frameworks to quantify the environmental impact of the operations. During this study, Life Cycle Assessment (LCA) has been defined as a tool for this quantification. Nonetheless, there are other ways of evaluating and assessing the effects of the supply chain that are more standardized in the way of conducting the calculation.

The chosen framework is highly important because it will determine the methodology used and the interpretation of results. As it was stated in the theoretical framework, LCA is extremely sensible to the functional unit defined and how it is measured, which then translates to different results. This is a limitation for the businesses and organizations that use it because the results are hardly comparable between studies. Within the chosen companies that were analyzed there where a number of different practices utilized.

One of them was the GHG Protocol Corporate Accounting and Reporting Standard which is imperative in producing the inventory of greenhouse gases and provides information relevant for companies looking to reduce their emissions and assembling a strategy towards that goal. One of the main risks faced by the brewing industry is water shortages, Carlsberg has identified this and decided to use the WWF Water Risk Filter tool, which is “a leading online tool designed to explore, assess, respond & value water risk” (WWF, n.d). Seeing that this is an industry wide problem, it is something that could be interesting to other companies operating within this sector to manage water related risks.

There were multiple companies that also mentioned the use of a Materiality Analysis which, similar to the LCA, has as a goal the recognition of governance risks from an environmental and social perspective, identifying issues that then will influence the companies' strategy and targets (KPMG, 2014). The key difference between a Materiality Assessment and a LCA is the approach it takes toward risk recognition within a company's operations. While LCA is a numerical assessment, a materiality analysis focuses on stakeholder perspectives of what the key issues and risks the business is facing, making it a more qualitative approach. This analysis pointed them towards the most pressing topics regarding the companies' operations and taking that as the starting point for their scheme of future actions. Both Carlsberg and Mahou went as far as to present in a Materiality Matrix that is a graphical representation of what was mentioned above. Charting themes recognized by the relevant stakeholders and placed according to their importance to society and business impact. As Mahou established "over 100 company professionals from different areas participated, as well as customers, suppliers, experts and other Mahou San Miguel stakeholders." (Mahou, 2021, p.12).

Figure VII: Carlsberg's 2020 Materiality Matrix.



Source: Carlsberg A/S, 2020.

It is interesting to note that there was one of the companies analyzed, Royal Swinkels Family Brewers, that defined their own methodology to quantify their environmental impact and "circularity score" which is based on three main criteria: Circular Procurement, Circular Production and High-Quality Reuse. This model is redefined every year and modified to incorporate as many parts of their supply chain as possible. They state that the main advantage of this approach is that it is tailor made to their operations so it is easier to analyze and draw conclusions on which are their areas of improvement and which should be the relevant initiatives going forward. On the other hand, it is simpler to manipulate results and undermine some aspects of their operation when they are the ones defining the methodology and are not being supervised by an external source.

It is essential to reiterate the importance of the methodology and framework definition, because based on it, the results achieved will differ and thus the conclusions achieved will vary from one company to another. For the group of companies analyzed, there was not a clear consensus on which are the steps towards the quantification of the beer life cycle impact across all the supply chain which poses as a challenge for the comparison of results and hinders the achievement of an industry wide agreement especially when comparing numbers which are sensitive to how the calculation was made. Nevertheless, it is also important to note that even though different frameworks were utilized and, in terms of numbers the results achieved differed, all the companies agreed on what the relevant risks were: water supply, energy efficiency, waste, raw materials, packaging and logistics. All of these will be further discussed in the following sections.

3.2.3 Environmental focal points according to the analyzed companies

One of the main objectives of this report was to identify what the most relevant companies in this industry deemed as the biggest issues to be dealt with. During the course of the theoretical framework, the environmental impact of each of the stages of the life cycle of beer was assessed and quantified. According to that description, the phases of the process that generate the most Global Warming Potential (GWP) where packaging and the raw materials needed for the elaboration of beer. Additionally, it was defined that the intensive use of water and energy, as well as the formation of wastewater and solid discharge during the process were also important variables in the overall environmental impact of the final

product. The Thematic Analysis that was carried out tried to understand if what was defined in the theoretical framework was aligned with the companies' efforts and what they believed where the phases most damaging to the environment.

Five of the eleven companies analyzed, disclosed the numerical share in carbon emissions that each phase of the process carries, estimated using the methodologies described above. From those companies, all of them pointed to the alike results. Packaging is undeniably considered to be the most polluting part of the process, accounting for 30 – 45% of the emission of the entire process depending on the company. Of the other six companies that did not release numerical data, some also stated that packaging was the primary source of carbon emissions. The companies also coincided that logistics, which comprises transportation and cooling, and raw materials had the second or third highest percentage of total beer-in-hand emissions. Similar to what was established in the LCA from the United Kingdom, packaging and raw materials both hold a crucial influence on the overall emissions of the whole supply chain, making them the target of most of the companies' initiatives and key in the development of the strategic goals regarding sustainability.

The main difference between what companies portrayed in their annual reports and what was described in the theoretical framework is the position that logistics plays in the environmental impact of beer's supply chain. One of the biggest limitations that logistics carries is that it will vary immensely depending on factors such as where the factory is located, what the distribution network is, which method of transportation is being used and whether or not cooling is taken into account. For this reason, the LCA study for the UK could not cover this section accurately and deemed it the least polluting out of all the phases in the beer's life cycle. On the other hand, individual companies do have a precise recompilation of data of what their logistics services cover, how many miles they travel and in which vehicle, what type of coolers they use and what type of electricity is necessary for it to function. Because companies do have this information, they can accurately assess the environmental impact it carries and according to the analyzed companies it is critical. It is difficult to compare logistics between companies because that will be contingent on the scope they operate in. Nevertheless, it is undeniable that at least for five of the analyzed companies, logistics is either the second or third phase that

releases more carbon emissions. Carlsberg states that 12% of their emissions come from "the logistics of getting our beer from breweries to warehouses and on to bars, restaurants and retailers by road, rail and sea" (Carlsberg, 2021, p.18).

Besides carbon emissions and GWP, in the theoretical framework it was defined that there were other important environmental consequences of the production of beer, water usage and waste. This was translated and portrayed in the examined companies' reports, where water was the primary focus in the plans for the future of the company. It was acknowledged in all eleven of the companies that the need for water conservation was critical for the continuing of operations in the upcoming years. Since water is involved in each stage of the production process of this beverage, all of the enterprises expressed its importance and defined proposals to reduce its unnecessary consumption. The other component that was an important byproduct of this process was wastewater and solid waste such as spent barely, hops and yeast. This also, was addressed in all of the reports published, identifying it as one of the most detrimental parts of the overall process.

Once the focal points were recognized and determined by the companies, they proceeded to establish different strategic plans in order to tackle those limitations and risks. Since all of the companies considered for this report have identified the same threats, the approaches they take towards hedging those can be compared and replicated. After comparing the main concerns defined in the theoretical framework with those determined by companies, it is important to address what solutions are being offered to resolve it.

3.2.4 Sustainable Supply Chain Management Practices

In order to deal with the risks and challenges that the future holds for the beer industry, companies have to redefine the way of framing their strategies and goals. There must be a transition towards a more sustainable supply chain. During the course of the following section, the strategies and practices adopted will be analyzed in order to better understand how the overall industry is responding to the challenges that were established above.

Four of the companies analyzed mentioned the utilization of the ISO 1400 Environmental Management System and certifications of proper application of those standards, as well

as the application of the Best Environmental Management Practices. These can be helpful for companies when establishing the environmental and social targets for the company to achieve because it gives a series of standards and guidelines for implementation. In the theoretical framework, SSCM practices were defined for three different categories within the supply chain: upstream, focal and downstream. While analyzing the annual and sustainability reports, the actions being taken by the companies were sorted between those three categories in order to gain a better understanding on which are the most common initiatives currently taking place in the beer industry to manage environmental impact.

- *Sustainable Supplier Management (upstream)*

Given that the companies evaluated source their raw materials from external producers, their relationship with them is highly relevant. In terms of sustainability, barely and hops are known to be water intensive and require also high amounts of energy to be produced which means that the role of suppliers in the overall environmental impact is great. In order to manage this relationship and achieve a reduction in emissions and discharges, the companies can implement assessments of their suppliers, engage in partnerships and limit their purchasing to "green" or sustainably sourced raw materials. The notion that this is an extremely important portion of the supply chain is reinforced by the fact that eight out of the eleven companies analyzed described a wide array of "upstream" solutions being implemented.

Most of the companies describe a strategic supplier collaboration where they participate in constant dialogue on possible solutions, and they actively invest in programs that might help the optimization of processes. AB InBev describes one program that is a thought-provoking example of what collaboration between supplier and core company might look like. They have developed a program named SmartBarely whose objective is to improve the productivity of agricultural practices by the usage of a predictive model based in satellite and weather analytics. Carlsberg, within its own research laboratory, is working on developing higher yielding barely which will help their suppliers enjoy more profits and aid Carlsberg in the achievement of their sustainability goals. Mahou has even developed a Sustainable Agriculture Manual to provide guidance to over seventy farmers in the production of the raw materials that they will later purchase.

This collaboration then leads to companies increasing their share in green purchasing or green raw material procurement. Most of these companies have set a goal to switch their purchasing to only sustainable sources in the upcoming years. Heineken is one of the companies that has focused on this management practice, they have stated that 58% of their raw materials come from sustainable sources which is an important increase from the 37% of 2019.

It is extremely important for companies to set high standards for the raw materials that they purchase, since barely is water intensive the decision of these key players in the market can translate in the prevention of wasting immense amounts of water and the overall reduction of the GHG emissions in the supply chain. Because of this, having a supplier sustainability assessment could have an important impact in guaranteeing that their providers are actually complying with the set standards. Estrella Damm and Heineken have both mentioned the use of systems that provide information on the energy usage and carbon footprint of their supplier's operations. However, Grupa Zywiec has taken this a step further and have named a Quality and Process Manager within their company, whose job is to organize and carry out audits of their suppliers. They also mentioned that "The key suppliers of Grupa Żywiec S.A. and Capital Group Żywiec S.A., i.e. suppliers of raw materials, strategic auxiliary materials and packaging materials, are additionally subject to regular vendor ratings" (Grupa Zywiec, 2021, p. 55). Practices like this are the most effective in ensuring sustainable sourcing.

- *Sustainable operations and risk management (focal company)*

The implementation of sustainable operations and the management of the environmental risks is an important component in a company's strategy and should be clearly outlined and established if the set-out goals are to be achieved. Given that they have more control over their operations and have fewer external factors affecting their in-house process, it is easier to implement proposals and solutions for this section of their supply chain. For this reason, this was the most relevant segment for most of the reports of the studied businesses and what was more heavily addressed.

As it was exhibited in the previous section, most of the companies identified packaging as the phase of the supply chain that carries the largest share of emissions. Seeing that this is the case, the studied companies had a wide array of possible courses of action in order to tackle this issue. Ten of the eleven companies had a significant section of their reports directed towards packaging. The major focus is on reducing the weight of the bottles, cans and other components, by doing so, the weight carried by transportation is less and that translates into a reduction in carbon emissions. Examples of this are companies like Mahou who have stated that a team dedicated to this matter has successfully cut 268.5 tones of materials from their operations. The other big trend found within the studied companies, was the increase in returnable packaging and percentage of recycled material. Grupa Zywiec states that returnable packaging "can be used even 25 times within 5 years" (Grupa Zywiec, 2021, p. 11). This would decrease the amount of waste released to the environment and would increase circularity in the companies' supply chains. Additionally, there have been some innovations that could revolutionize the industry such as Carlsberg's "Green Fiber Bottle" which would be the first "paper" bottle for beer that is 100% recyclable.

Among the SSCM for the focal company, energy consumption and efficiency were the second most mentioned practice. In most industries, the switch to renewable energy is becoming increasingly common and in the case of the beer industry is becoming progressively relevant. From the reviewed companies, all of them alluded to at least one energy efficiency measure they plan on implementing or already have. The transition toward sustainable sources of energy has led to established partnerships between beer companies and solar or wind energy providers which demonstrates the long-term commitment some of these companies have with reaching their renewable energy goals, an example of this was the pledge made by Heineken to source all its energy from solar farms managed by Iberdrola. Other companies have decided to source this energy themselves such as, Royal Unibrew mentioned the possibility of assembling a solar park that can handle all of the energy consumption. Similarly, AB InBev is planning on building a solar farm in Spain that will provide renewable electricity to their Western Europe operations.

Besides packaging and energy, there are numerous actions that can be taken within the manufacturing process. These can have a smaller magnitude in the overall impact of the supply chain but can be simple to implement and will leave an impression on the company's culture by involving everyone as part of the process in becoming a more sustainable operation. Estrella Damm described some procedures like using LED lightbulbs in all their establishments, cutting the use of paper, changing industrial processes to make them more efficient and participating in projects such as Save The Med which focuses on protecting and increasing biodiversity in the Mediterranean Sea. Brau Holding International created a bus route so that their employees could use public transportation instead of using their individual cars. Another example of sustainable management practice on a smaller scale is the electronic invoicing implemented by Kompania Piwowarska that brings benefits both financial and environmental. All of these are great examples of details that most of the analyzed companies are instigating in their day-to-day workflow that are necessary for a full transition towards sustainability that comes from within the company.

- *Pressure & incentive management (downstream)*

Following along the supply chain, the last part of it entails the distribution of the final beer until it reaches the consumer's hand. Nevertheless, since the intention is to become a sustainable supply chain it is important also what happens after the consumer has finished the product. The following management practices will describe what is being done in terms of shipping, distribution and cooling. Everything regarding recycling, returnability and waste management will be discussed further in the circularity section of this report.

As it was previously established, a large portion of the examined companies named 'Logistics' as the second or third most detrimental part of their supply chains in terms of pollution and environmental impact. Because of this, all of the companies have mentioned operations to improve this issue. For the shipping and distribution of their products, the six companies have opted for the transformation of their fleet by using low-carbon fuel technologies, hybrids and electric powered forklifts which reduces the emissions in this phase of the beer's life cycle. Another important alteration that must be done alongside a

change in fleet is the optimization of the distribution networks. In order to achieve a more sustainable transportation, be able to reduce milage and use fuel efficiently, routes must be improved, and volume of deliveries optimized. For this, companies like Mahou and Estrella Damm have entered into partnerships with logistics operators that allow them to have more control over the implementation of sustainability measures along their downstream supply chains. Other companies like Carlsberg and Heineken apply a similar approach than with suppliers which consists of making their distributors sign sustainability agreements to validate that they meet certain requirements.

The other main concern expressed by three companies, especially Carlsberg and Heineken, had to do with the refrigerators and the cooling of their beers once they reach their partners and consumers. Carlsberg has stated that by the use of efficient fridges powered by renewable sources they were able to "reduce our refrigeration emissions by 21% from 2015 to 2019" (Carlsberg, 2021, p. 18) which is a hopeful statement regarding the impact a transition can have. By sustainable cooling, these companies refer to the use of LED lights and usage of refrigerants with lower environmental impact. Heineken also concerned itself with the circularity of these fridges by refurbishing them when minor defects were encountered and selling them on a secondhand Asset Marketplace, stretching the useful life and keep them running for as long as possible.

During the course of this section, it was put into evidence which were the SSCM practices being communicated by the eleven studied companies in their annual and sustainability reports. These covered all of the life cycle of the beer, starting from supplier agreements, moving on to focal company practices and finishing with distributors and logistics providers.

3.2.5 Circular Economy Principles

One of the most relevant frameworks defined in this report has been Circular Economy (CE), establishing the relevance of allowing economic growth without it having a negative impact in the environment. It has been stated that the beer industry is projected to grow in the upcoming years, so the implementation of CE principles is crucial for companies in this industry. In the previous section, Sustainable Supply Chain

Management practices were defined for a “cradle-to-grave” interpretation of the beer’s life cycle, nonetheless, these was not the case for the companies considered. In this section, the results from the reports analyses will be exhibited from a CE economy perspective to gain knowledge on how these companies are introducing the eight core elements of CE defined in the theoretical framework of in their corporate strategies.

The first element is the prioritization of regenerative resources that come from renewable sources such as wind or the sun. Energy efficiency has been a crucial topic of conversation in the reports of all the examined companies and whose actions towards this have been discussed in the previous sections.

Other central elements of CE are designing for the future and stretching the lifetime of the products being made. It is important to maximize the use of the products by upgrading them and giving them a second life when applicable. This has been one of the most mentioned CE principles within the companies analyzed. Designing for the future entails using the right materials in the right way so the overall product is intended for extended use. An example of this is the utilization of higher yielding yeast and barely that require less energy and water and produce the same results. However, unquestionably the most prominent systems being incorporated specially to stretch the lifetime of the products is returnable packaging and recycling. Ten out of the eleven companies studied described the use of recycled materials in their current packaging efforts and five of them talked about returnable bottles. The Danish company, Royal Unibrew, has rolled out a deposit return system (DRS) that has a +90% return rate for markets like Denmark and Finland, this way, engaging the final consumer and raise consumer awareness on returnable bottles and recycling systems.

Using waste as a resource is another pillar of circularity, as it has been stated previously both in the theoretical framework and in the findings of the companies, wastewater and solid waste are both important byproducts of the beer’s life cycle. Finding a use for it can be a solution for these damaging consequences of the manufacturing process. Nine of the eleven examined companies mentioned the use of biogas, which is a form of energy produced from waste. For instance, Mahou states that “the biogas obtained from the

wastewater treatment system … is used as fuel in these facilities" (Mahou, 2020). This exemplifies circularity because even if wastewater is still produced, it has found another purpose that serves to the overall manufacturing process by becoming a source of energy. Other companies have mentioned the reusage of water by using it again for cleaning or cooling. Sometimes, it can also be treated and reinserted into the environment, this way assuring full circularity. For the solid waste such as spent barely and yeast, the most common solution, used by six companies, is to resell them as animal feed and in the case of sludge, as fertilizers.

Climate change is a situation affecting every industry and company that is currently operating in the entire world and even though individual efforts are appreciated and can make an impact, is important to acknowledge that by with a collective effort the situation can transition more rapidly and smoothly. This is why, one of the CE principles is creating joint value, this can mean partnerships with their suppliers, distributors or peers. In the case of the beer companies this is exceptionally relevant given that most of the emissions in the life cycle of beer come from activities outside the direct control of the company. In their annual reports most of these companies referred to the partnerships they were engaging in along all their supply chain in order to reduce environmental impact. For example, AB InBev formed a partnership with Rio Tinto to reach a "new standard of sustainable aluminum cans" (AB InBev, 2021) or Carlsberg's 'paper' bottle was achieved in company of Coca-Cola. Solutions like this can be extrapolated not only for beer but for other mass-produced products.

It is essential to make use of all the tools available for the improvement and optimization of processes. The incorporation of digital technology and the advancement of knowledge are both CE principles designed to push innovation. These can be applied to a wide array of phases in the process. Companies like AB InBev have focused heavily on technology, it has assisted them in reducing their average water use per beer by using a software that locates irregularities along their water lines. Other uses of technologies by other companies have been route planning software to optimize transportation and reduce emissions. Technology can help monitor internal systems and can even be useful in the protection of biodiversity, like Estrella Damm who has developed a mobile application that will alarm fishers if they are near a field of Mediterranean tape weed so that they will

avoid anchoring there. Regarding the strengthening and advancement of knowledge, three of the companies have stood out. AB InBev held a competition in which small startups could present their ideas towards sustainable solutions, 1.200 applied and thirteen of those were able to present a demo to the management of the company. Carlsberg has established a Research Laboratory that seeks the enhancement of their processes with advancements like high yielding barely. Lastly, Kompania Piwowarska has made strides towards involving their employees and creating a "culture that encourages … employees to seek technical and organizational improvements related to the areas of their responsibility" (Kompania Piwowarska, 2019, p. 83). This is being achieved by the implementation of a program called "Company of ideas" that rewards sustainable propositions made by their employees.

Finally, the last CE principle to be discussed, deals with the rethinking of the business model. This core element is one of the hardest to achieve but if properly carried out, it is the one with the higher impact for the overall industry. It is not easy to transition from a linear to a circular supply chain, nonetheless, is initiatives like this that will make that conversion easier. There were three propositions that stood out, Carlsberg's 'paper' bottle, Estrella Damm's desire to introduce a reusable standard bottle for the whole sector which will then facilitate the reusage of these. And lastly, Kompania Piwowarska who have opened a location where bottles can be returned independently from the producer and then exchanging them with the other breweries. What these proposals point to is a culture of collaboration between different players in the market, which will allow for a more sustainable supply chain and an extended use of circularity.

3.2.6 *Definition and Practices of Extended Producer Responsibility (EPR)*

Extended Producer Responsibility (EPR) was one of the main concepts defined in the theorical framework of this study, especially in relation to Circular Economy. This is because of its increasing relevancy especially in the European Union who have outlined and incorporated the Waste Directive legislation. Companies operating within the European scope will have to comply with this law that embodies the principles of EPR.

From the analyzed companies, some of them alluded to the improvement of waste management systems and initiatives being carried out but only one of them used the term EPR. Kompania Piwowarska stated that their waste management system is a byproduct of constant exchange with their suppliers and consumers and "it is a perfect example of a properly functioning extended producer responsibility (EPR) system within which Kompania Piwowarska assumes full responsibility for its packaging by organizing and financing its "life cycle". Among the other companies, some of the most common measures being taken that allude to a possible EPR are investments in waste management systems in the form of monetary input or, like Mahou, by engaging in partnerships with other entities that are take care of the waste collection of their products. Lastly, another part of the waste generated by beer companies is the fridges and coolers in which the product is stored in and an attempt is being made for those coolers to be reused and given a second life after its demise.

An important part in the application of circularity is taking accountability for the proper disposal of the final merchandise once it is used. This is a challenge because it is difficult to control the recovery of beer cans and bottles after being sold to the general public, the vast majority of the companies analyzed have been implementing a series of procedures in order to increase the number of returnable bottles that they sell and insert incentives for people to do so. If bottles are returned to the beer companies, it will be easier for them to dispose of the material and reuse it as they see fit.

Overall, even though all of the companies have to comply with the Waste Directive only one of them used the term Extended Producer Responsibility within the company's strategy. This seems surprising given that in order to fully implement circularity this is a key concept that should be taken into account so even if most of the companies have set a goal for returnable packaging only a few have directly referenced waste management systems within their operations.

4. Conclusions

It has been established that climate change poses a threat to the survival and well-being of the human species and that business models and industries have to transform themselves in order to achieve a state where there is economic growth without compromising the environment and livelihood of future generations. As it has been explained throughout this report, beer has an economic and cultural implication which makes it an important product for a large amount of people in the world. Its industry consumes enormous amounts of energy but most importantly, water, which is a limited resource indispensable for our existence. The purpose of this report was to determine what the biggest players of this industry were doing in terms of sustainability. First, to understand what they deemed to be the principal challenges faced by the industry and then what initiatives and proposals they took to mitigate those risks. It was important to define how these companies were addressing such an important part of their future strategy, and this way, understand how the industry will behave in the future.

To achieve the set-out goal, a sample of companies was analyzed using a Thematic Analysis. The companies' communications such as annual and sustainability reports were studied to find similar patterns and reach conclusions for the industry as a whole and not only individually. By carrying out this investigation, there were several findings found regarding sustainability within the beer industry. Given that this were large companies and some publicly traded, they all disclosed large amounts of information regarding sustainability practices, this showed that there has been a change in what companies release within their annual reports. Before, it focused on financial information and business operations but now there has been a larger weight assigned to sustainable development and these businesses have had to respond to that calling from the general public and legislators. Most of the companies analyzed references de United Nation's Sustainable Development Goals and described management practices that would add to its completion.

One of the most relevant findings of this investigation, was the lack of harmony within the frameworks and methodologies utilized by companies to measure their environmental impact. Even though there are standardized processes such as Life Cycle Assessment or

the GHG Protocol Corporate Accounting and Reporting Standard, there has not been an industry wide agreement on which of these to use and even if the same methodologies are used, the outcomes can greatly vary if their approach is different. What this results in, is a lack of comparable numerical results within the industry. In this report, I was able to identify what the main topics of conversation were and what were the most polluting phases of the process. Nonetheless, the numerical amount of what each stage of production contributed to the overall environmental impact of the beer could not be compared because different approaches were used in order to achieve this figure. The incompatibilities come mainly due to the lack of a unified framework and because companies define different life cycles for their beers depending on the amount of responsibility they wish to acknowledge.

After identifying which were the most important focal points in terms of emissions, it was important to understand which were the sustainable management practices being used and implemented to mitigate climate risk and transition towards a greener supply chain. From within the company, it was evident that the focus was put especially on packaging and conversion towards the usage of renewable energies which were the most detrimental parts of the process that they can actively control. Also, there were several initiatives in the upstream supply chain regarding the agriculture of barely and hops which was also an important element in what was defined in the theoretical framework as the main environmental impacts within the beer's life cycle. Finally, the downstream proposals towards sustainable management mainly had to do with transportation and cooling of the beer before it reached the final consumer.

The findings from the Thematic Analysis were helpful to answer the questions established in the introduction. By examining the companies' communications, I was able to find similar patterns and discrepancies within the industry and understand what the most pressing subjects for them are and which are the most common approaches to solving these problems.

The discoveries that have risen from the investigation can contribute to the development of sustainable operations within the beer industry by aiding in the identification and

exposure of the most common practices and issues. This information can be relevant for multiple participants in this market and even to the general public who is becoming increasingly interest and concerned on their consumer choices and how it is affecting the environment. The main contribution can be for the beer companies operating in the market. It is important to note that most of the companies analyzed spoke of climate change and environmental impact as a risk to their business and operations, which means that they see some of these problems as a threat to their own growth as a company. For example, if there are water shortages, beer can simply not be produced. What this results in, is companies having a more active role in changing their consumption of water. For businesses operating within this scope, the information found here can be relevant in order for them to apply similar strategies or initiatives within their own operations. Also, competitors can find resemblances and proposals that can complement each other, creating relationships and partnerships that can push plans further than if they were done by one individual company. Collaboration is key in the development and transition of this sector, by finding common ground through studies like this, the switch towards a more circular economy can be enhanced and more rapidly achieved.

Other parties that can benefit from this report are legislators and government entities which can use the findings to identify which are the most polluting phases of the beer's life cycle and impose stricter restrictions on those. Also, the European union regulators can use these reports and conclusions to audit the practices being carried out and make sure that companies comply with the sustainable goals. Lawmakers could see that there is need for a common framework to be applied in this industry and begin to establish one that will give comparable results within the biggest companies' operations. The lack of comparable results can be a challenge for government entities in ensuring the sustainable goals are being met.

Finally, another group that can take advantage of this information is the general public and the end consumers. As it has been established, people have become more concerned with their consumer choices and are asking for larger accountability from the companies within the sector. By understanding the practices being carried out, they can become part of the solution. The vast majority of the analyzed companies mentioned the use of

returnable packaging and described initiatives that allowed for this to become a new standard for the beer industry. However, the success of these proposals also requires a culture of recycling and returnability that many countries do not have. If the end consumers become more concerned in the initiatives being carried out by companies and understand what the environmental impact of their own choices is, then there could be a cultural shift that will allow for the reduction of emissions and the increase in circularity. Overall, the contribution of these study can be conveyed to beer companies, their suppliers and distributors, government entities and consumers. This is because collaboration is key and there must be a change in all these spectrums for the transition towards circularity.

It is important to note that there are limitations in the scope of the study that might have influenced the results achieved. The main limitation had to do with the type of information analyzed, by studying the annual and sustainability reports there can be misrepresentation and biases. These companies are communicating how their operations are improving and what were their achievements, but it is imperative to point out that there may be lack of information on the fragments where they are not achieving positive results in terms of sustainability. These can lead to a sample that is biased towards a more optimistic assessment of their operations than what is factual. Another factor influencing this report, is that even though the theoretical framework established a comprehensive list of different methodologies and definitions relevant for the analysis of a companies' sustainability communications, there is a wide array of other related concepts that were not included but could have also been interesting to pursue further.

One of the most important conclusions that could be reached from this Thematic Analysis was that the majority of the emissions in the life cycle of the beer come from the suppliers and distributors who are in charge of agriculture and transportation. Which means that there is a large amount of environmental impact that the beer company itself cannot control. Even though these companies have described some agreements and measures being implemented to reduce the negative effect of their partners operations, it could be interesting to further question these relationships and understand how much beer companies can influence the sustainable operations of their suppliers of raw materials and

their logistics operators. Evaluating these partnerships could lead to important discoveries regarding the authority of beer companies within their supply chain, studying what would happen if they began to introduce harsher terms in their contracts and would limit their business to only buying or selling to sustainable associates.

The elaboration of studies like this, allow for the thorough interpretation of an industry's concerns on sustainable development and acknowledge that there are important risks to address if companies wish to continue their operations. Furthermore, this investigation can lead to other important topics that should continue to be studied such as the partnerships within the industry and the possible implementation of a common framework on environmental impact reporting. By doing this, and via the collaboration between all the participants in the sector, achieving circularity and sustainable growth can become a reality instead of an aspiration.

Bibliography

Amienyo, D., & Azapagic, A. (2016). Life Cycle Environmental Impacts and Costs of Beer Production and Consumption in the UK. *International Journal of Life Cycle Assessment*. https://doi.org/10.1007/s11367-016-1028-6

Amoriello T, & Ciccoritti R. (2021). Sustainability: Recovery and Reuse of Brewing-Derived By-Products. Sustainability. 2. 13(4):2355. https://doi.org/10.3390/su13042355

Anheuser-Busch InBev NV/SA. (2021). *Annual Report 2020.* Retrieved from https://www.ab-inbev.com/news-media/latest-headlines/2020-annual-report/

Bart Haas. (2020). *Bart Haas Report: Hops 2019/2020.* Retrieved from https://www.barthhaas.com/fileadmin/user_upload/downloads/barth-berichte-broschueren/barth-berichte/englisch/2010-2020/barthhaas_report_2020_en.pdf

Bumblauskas, D. (2017). Sustainable operations management and benchmarking in brewing: A factor weighting approach. Journal of Operations and Supply Chain Management, 10(1), 55–67.

Boden, M. (2012). Achieving Sustainability in the Craft Brewing Industry. *University of Nebraska, Environmental Studies.* 89.

Cambridge Advanced Learner's Dictionary & Thesaurus. (n.d). Wastewater. In Cambridge.Dictionary.org dictionary. Retrieved February 20, 2021, from https://dictionary.cambridge.org/dictionary/english/wastewater

Carlsberg A/S. (2021). *Annual Report 2020.* Retrieved from https://www.carlsberggroup.com/media/42542/carlsberg-group-annual-report-2020_final.pdf

Carlsberg A/S. (2021). *Sustainability Report 2020.* Retrieved from https://www.carlsberggroup.com/media/42556/carlsberg-sustainability-report-2020_final.pdf

Ciambrone, D. F. (1997). Environmental life cycle analysis. Boca Raton, FL. https://doi.org/10.1201/9780203757031

Clarke V., Braun V. (2014) Thematic Analysis. In: Teo T. (eds) Encyclopedia of Critical Psychology. Springer, New York, NY. https://doi.org/10.1007/978-1-4614-5583-7_311

Corporación Hijos de Rivera, S.L (2020). *Estado de información no financiera 2019.* Retrieved from https://www.corporacionhijosderivera.com/estado_informacion_no_financiera_diversidad.php

Corporación Hijos de Rivera, S.L (2020). *Non-financial information state & Diversity 2019.* Retrieved from https://www.corporacionhijosderivera.com/memoria_de_sostenibilidad.php

Cuesta González, M. de la. (2020). Presentación : La economía circular: una opción inteligente. *Dossieres EsF*, *. 37*, 4–6.

Damm S/A. (2020). *Annual Report 2019.* Retrieved from https://www.dammcorporate.com/sites/default/files/paragraph/investors_presentations_attach/2019%20Annual%20Report_EN_compressed_0.pdf

Datamonitor. (2011). Industry Profile: Beer in Europe. (2020). *Beer Industry Profile: Europe.*

Deloitte. (2017). *Craft beer in México.* Retrieved from https://www2.deloitte.com/content/dam/Deloitte/mx/Documents/consumer-business/2017/Craft-Beer-in-Mexico-2017.pdf

Estrella Damm. (n.d.). *Sustainability.* Retrieved March 20, 2021, from https://www.estrelladamm.com/en/sustainability

Fernando, J. (2021, March 1). *Compound Annual Grwoth Rate - CAGR*. Investopedia. https://www.investopedia.com/terms/c/cagr.asp

Garcia, D., Kipnis, E., & Vasileiou, E. (2021). Consumption in the Circular Economy: Learning from Our Mistakes. *Sustainability*, *13*(601), 601. https://doi.org/10.3390/su13020601

Grupa Zywiec S.A. (2021). *Non financial information report 2020.* Retrieved from https://grupazywiec.pl/inwestorzy/raporty/

Hardwick, W. A. (1994). An overview of beer making. Handbook of brewing. USA: Marcel Dekker, 87e96.

Harris, T. M., & Landis, A. E. (2020). Life Cycle Assessment: A Tool to Help Design Environmentally Sustainable Space Technologies. *2020 IEEE Aerospace Conference, Aerospace Conference, 2020 IEEE*, 1–11. https://doi.org/10.1109/AERO47225.2020.9172622

Heineken N.V. (2021). *Annual Report 2020.* Retrieved from https://www.annreports.com/heineken/heineken-ar-2020.pdf

Ilie, M., Ilie, C., & Marin, R. (2019). Management Strategies in Circular Economy. *Ovidius University Annals, Series Economic Sciences*, *19*(2), 944–949.

International Organization for Strandarization. (2006). *ISO 14040:2006 Environmental management -- Life cycle assessment -- Principles and framework.*

Kirchherr, J., Reike, D., & Hekkert, M. (2017). Conceptualizing the circular economy: An analysis of 114 definitions. *Resources, Conservation and Recycling, 127,* 221-232. https://https://doi.org/10.1016/j.resconrec.2017.09.005

Kompania Piwowarska (2019). *Sustainability Development Report 2018*. Retrieved from https://www.kp.pl/files/KP-en-csr-2019.pdf

Koroneos, C., Roumbas, G., Gabari, Z., Papagiannidou, E., & Moussiopoulos, N. (2005). Life cycle assessment of beer production in Greece. *Journal of Cleaner Production, 13*(4), 433-439. https://https://doi.org/10.1016/j.jclepro.2003.09.010

KPMG. (2014). *The essentials of materiality assessment.* Retrieved from https://assets.kpmg/content/dam/kpmg/cn/pdf/en/2017/the-essentials-of-materiality-assessment.pdf

Kunz, N., Mayers, K., & Van Wassenhove, L. N. (2018). Stakeholder Views on Extended Producer Responsibility and the Circular Economy. *California Management Review*, *60*(3), 45–70. https://doi.org/10.1177/0008125617752694

Mahou, S.A. (2020). *Annual Report 2019.* Retrieved from https://www.mahou-sanmiguel.com/en-gb/newsroom/publications

Mahou, S.A. (2020). *Declaración Ambiental 2019.* Retrieved from https://www.mahou-sanmiguel.com/en-gb/newsroom/publications

Mahou, S.A. (2020). *Environmental Statement 2018.* Retrieved from https://www.mahou-sanmiguel.com/en-gb/newsroom/publications

MarketLine Industry Profile: Beer & Cider in Europe. (2020). *Beer & Cider Industry Profile: Europe*, 1–42.

MarketLine Industry Profile: Beer & Cider in Global. (2020). *Beer & Cider Industry Profile: Global*, 1–43.

MarketLine Industry Profile: Beer & Cider in Spain. (2020). *Beer & Cider Industry Profile: Spain*, 1–36.

Meussdoerffer, F. G. (2009). A comprehensive history of beer brewing. *Handbook of brewing: Processes, technology, markets*, *1*, 42.

Mitchell, B. R. (2007). *International historical statistics*. Houndmills, Basingstoke, Hampshire: Palgrave Macmillan.

Narimissa, O., Kangarani, F. A., & Molla, A. S. (2020). Drivers and barriers for implementation and improvement of Sustainable Supply Chain Management. *Sustainable Development*, *28*(1), 247–258. https://doi.org/10.1002/sd.1998

Negrei, C., & Istudor, N. (2018). Circular Economy--Between Theory and Practice. *Amfiteatru Economic*, *20*(48), 498–509. https://doi.org/http://www.amfiteatrueconomic.ro/Arhiva_EN.aspx

Paulaner Brauerei. (n.d.). *Paulaner Umweltbericht 2018*. Retrieved March 20, 2021, from https://www.paulaner.com/assets/static/umweltbericht/2018/index.html

Poelmans, E., & Swinnen, J. F. (2011). A brief economic history of beer. *The economics of beer*, *1*.

Organization for Economic Co-operation and Development (OECD). (2005). *Health Data*.

Olajire, A. A. (2020). The brewing industry and environmental challenges. *Journal of Cleaner Production*, *256*, 102817. https://https://doi.org/10.1016/j.jclepro.2012.03.003

Royal Swinkels Family Brewers Holding N.V. (2020). *2019 Annual Report*. Retrieved from https://swinkelsfamilybrewers.com/en/media/annual-report.html

Royal Unibrew A/S. (2021). *Annual Report 2020.* Retrieved from https://investor.royalunibrew.com/financial-reports/annual-reports

Sachs, N. (2006). Planning the Funeral at the Birth: Extended Producer Responsibility in the European Union and the United States. *Harvard Environmental Law Review*, *30*(1), 51–98.

Scheller, L., Michel, D & Funk, U (2008). Efficient Use of Energy in the Brewhouse. Technical Quarterly. 45. 10.1094/TQ-45-3-0263.

Sedikova, I. (2019). Development of conceptual principles of the circular economy. *Ekonomìka Harčovoï Promislovostì*, *11*(2). https://doi.org/10.15673/fie.v11i2.1394

Shanker, D. (2015). *Here's how much water it takes to make California's craft beer.* Quartz. https://qz.com/403386/heres-how-much-water-it-takes-to-make-californias-craft-beer/#:~:text=The%20most%20water%2Dintensive%20part,an%20590%20gallons%20of%20water

S&P Capital IQ. (n.d). *Company Screening Report.* Retrieved March 10, 2021, from S&P Capital IQ database.

The Key Elements of the Circular Economy. (n.d.). Circle Economy. Retrieved February 28, 2021, from https://www.circle-economy.com/circular-economy/key-elements

Unger, R. (2013). *Beer in the Middle Ages and the Renaissance*. Philadelphia: University of Pennsylvania Press. https://doi.org/10.9783/9780812203745

Unicer SA. (2005). *Sustainability Report 2004*. Retrieved from http//www.unicer.pt

United States Environmental Protection Agency. (n.d). Understanding Global Warming Potentials. Retrieved from https://www.epa.gov/ghgemissions/understanding-global-warming-potentials

Merwe, Ai & Friend, Jfc. (2002). Water management at a malted barley brewery. Water SA. 28. 10.4314/wsa.v28i3.4900.

Willaert, R. (2007). The beer brewing process: Wort production and beer. Handbook of food products manufacturing, 2, 443.

WWF (n.d.). *The Water Risk Filter*. Retrieved March 28, 2021, from https://waterriskfilter.panda.org/

Yang, X. (2020). Life-cycle analysis (LCA). *Salem Press Encyclopedia*.

Zimon, D., Tyan, J. & Sroufe, R. (2020). Drivers of Sustainable Supply Chain Management: Practices to Alignment with Un Sustainable Development Goals. *International Journal for Quality Research*, *14*(1), 219–236. https://doi.org/10.24874/IJQR14.01-14