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Using Artificial Intelligence to positively impact the beer brewing process

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The beer brewing industry has always been a creative and innovative one, with new beers being introduced to the market each year. Even though the COVID-19 pandemic crisis has truly tested the hospitality industry e.g. in terms of how bars, cafés, and nightlife properties can remain open, the beer brewing industry has found ways to endure and, in some cases, even flourish. However, to continue remaining competitive in the future, new ways of conducting business are required. In particular, as Artificial Intelligence (AI) is becoming increasingly popular and integrated into both our personal and business lives, its beneficial aspects can no longer be overlooked. This product-type thesis will discuss the beer brewing process in detail, including the planning, improvement aspects, trends, and the Finnish beer market, and contrast these discussions with how AI can be used to positively impact the beer brewing process now and in the future.

In essence, the research presented here aims to bridge the gap between the beer industry and AI technology. The scope of this thesis will be limited to the Finnish beer market, and the end product of the thesis will be a strategic roadmap intended to help and inspire the beer brewing sector to integrate AI into their operations. Specifically, the strategic roadmap will explore three types of breweries, from early-stage breweries to micro-breweries and finally, medium-sized breweries, as it is recognized that both requirements and available resources will significantly vary depending on the type of brewery.

Insights have been generated by analyzing relevant literature, including reading books, academic articles, scientific blogs, and industry expert reports. Overall, the research has been approached by adopting a qualitative approach. Primary data was collected by conducting six semi-structured interviews between March and May 2021. Five interviews were conducted with representatives of five different beer brewing companies. The aim of these was to highlight and further elaborate on key challenges and friction points different types of breweries face. These were compiled, and in the sixth interview, presented to an AI expert who evaluated how AI technology could best be applied to address issues raised by the breweries.

By analyzing the data carefully and referring to the theoretical knowledge the author had the capability of methodically assembling the Strategic Roadmap. The solutions that will be presented are based upon real-life problems faced by the different breweries in their respective market. The findings help beer breweries identify opportunities for leveraging AI to positively impact their business operations.

Keyword
Beer, beer brewing, micro-brewery, Artificial Intelligence, trends, strategic roadmap, semi-structured interviews

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1 Introduction

This thesis seeks to explore how Artificial Intelligence (in the remainder of the paper referred to as AI) could be used to positively impact the beer brewing process. The technology of AI is being developed to enable smart machines into performing tasks that naturally require human intelligence. These machines are being trained to at least indicate some human intelligence behavior such as reasoning, planning, learning, problem-solving, or perception. (McCarthy, 1950) However, the term AI is broad and includes several distinctive elements. Discussing the readily available elements and what could be adopted into the beer brewing process will be further discovered throughout this report.

Beer brewing is one of the oldest practices in the world. With early records indicating that beer brewing emerged more than 5000 years ago in the grasslands of southern Babylonia, modern-day Iraq. (Hornsey, 2003) Although the basic process of beer brewing has not changed over the centuries. There have been significant developments made possible by technology and hygiene legislation (Evans, 2011). And at this point, new developments could be possible due to AI technology.

Combining the technology of AI with the vibrant industry of beer brewing has come from my interest in both these subjects. Personally, I would like to start brewing my own beer and therefore I have invested quite some time and resources in, for example, books and materials to indulge myself in that field. Besides, learning about beer brewing I have followed classes for basic coding and AI. During these classes I found myself having a significant interest in the subjects of coding and AI. This has led to the motivation of bringing both topics together.

1.1 Thesis objectives

The objective of this thesis is to create a clear roadmap for starting breweries, micro-breweries and, medium breweries in how to incorporate possible different AI technologies. The roadmap should both encourage and drive AI usage for these three groups. The structure of this paper will consist of a theoretical part, personal insights from different brewers, and an analysing part where AI technologies are matched with wants and needs from brewers. Overall, the goal is to highlight the positive benefits of this technology. However, limitations will not be overlooked.

Furthermore, this thesis will be exploring the possibilities of integrating the technology of AI into the Beer Brewing process. AI is a new technological trend that is rapidly being developed and merged into companies from different branches. It appears that companies are

seeing benefits in this technology and some beer breweries have started exploring this technology as well. However, this subject is still fairly new for the beer brewing industry and especially for the beginning and smaller (micro) breweries. Therefore, there is a considerable opportunity to explore the possibilities of these two topics.

At last, the thesis will focus on gaining in-depth knowledge on AI, the beer brewing process, and various roadmaps. Gaining this knowledge will serve as a solid foundation for the second part of the thesis, which will consist of acquiring feedback and insights from experts.

1.2 Scope of the Thesis and Key concepts

The nature of this roadmap is a product-orientated thesis. It will rely on qualitative research in which the purpose is to create understanding in the combination of AI technology and beer brewing. Apart from gathering opinions from different perspectives and sources. There exist limitations to the thesis, at first the thesis will not be explaining and exploring the creation of AI tools. It will merely focus on what technologies are already available on the market as of now. Furthermore, the final product will not discuss benefits for big breweries as they, firstly, already integrate this technology in some sort of way and secondly, have more resources available to benefit from this technological advancement. At last, the roadmap will be written for the Finnish market as the scope will otherwise be too broad.

As two different industry practices will be researched and discussed throughout the thesis, prior knowledge must be gained before getting into detail during the theoretical part. As discussed earlier, the main notions are AI and Beer brewing. However, the eventual end product will be a roadmap for the beginning, micro, and medium beer brewer. Therefore, discussing the main points of the roadmap will clarify the structure of the theoretical framework and empirical part.

1.2.1 Artificial Intelligence

The idiom AI is an umbrella term that refers to any human-like intelligence exhibited by a computer, robot, or other machines. (IBM Cloud education, 2020) Furthermore, AI is not just one technology. It is a combination of technologies that enable computers, robots, and machines to reproduce certain human traits. (Accenture, 2021)
Determining whether or the above-mentioned machinery has human-like intelligence is based on three capabilities. It needs the ability to adapt, reason, and provide solutions. At last Artificial Intelligence can be divided into two categories; Weak (Narrow) AI and Strong (General) AI. Weak AI focuses on one objective in contrast to strong AI that could have to

ability to be self-aware and develop emotions. The thesis will only focus on Weak AI as of now strong AI is still fictional.

1.2.2 Explainable Artificial Intelligence

AI is a complex technology that has the capability to help businesses grow and achieve their goals. However, the technology that converts information into actions is difficult to understand, opaque and non-intuitive. Nowadays the technology depends on the chain of data, learning process, learned function and that creates output. Nevertheless, the output may not make sense to the end-user and might generate more questions than answers. Therefore, Explainable Artificial Intelligence (XAI) strives to generate a clear output and reasoning to what has led to a certain conclusion. (Gunning, 2017)
Another reason why XAI matters is to gain trust from the people that make use of an AI system in their business. They need to rely on the outputs that are given by AI and that can only be achieved when people understand why an AI system has come up with a certain recommendation. (Purohit, 2019)

1.2.3 Beer brewing

The concept of beer brewing has not changed much over the centuries. The brewing process requires 4 main ingredients; water, malted grains, hops, and yeast. The beer brewing process which will be discussed in the thesis will consist of five steps. The first step in the brewing process, which is actually a natural chemical process, is milling. During this step, the grain is crushed. The second step is mashing where the crushed grain is mixed with hot water. The thirds step is boiling, during this step, the mixture of hot water and crushed grains have become, “wort”, a sugary liquid. By boiling this “wort” you will create the basis of what will become beer in step four. During step four the beer is fermenting and mixed with yeast. This mixture will create the alcohol and bubbles in the beer. The fifth step is racking, here the beer is almost ready to be consumed. However, it is still kept in a “Bright Tank” to either be kegged, bottled, or canned. In short, the beer brewing process involves heat exchange, separation, and clarification. (Sinha, 2007)

1.2.4 Roadmap

The ultimate objective of this qualitative report will be to build a clear roadmap for starting, small and medium brewers in which they will be able to match certain AI technologies to their own strategic plan. The roadmap will seek to start a conversation on where and why to invest in this upcoming technology. Nevertheless, there are different kinds of product roadmaps that speak to different audiences. These product roadmaps are the portfolio, strategy, releases, and features roadmaps. For this thesis, the choice has een made to

develop a strategic roadmap. The reasoning behind choosing a strategic roadmap is how it highlights the need for investment and it creates an understanding of how certain investments contribute to the overall business strategy. (Benthien, 2021)

The roadmap layout that will be used in this report will consist of 6 steps as following;

1. Layout the challenges.

The question that will drive the research will be: Why do a certain strategic vision for beginning, small and medium brewers exist?

2. Setting objectives

The question that will drive the research will be: What must be achieved to address the challenges for beginning, small and medium brewers?

3. Assess the capabilities

The question that will drive the research will be: What capabilities need to be invested in meeting the objectives?

4. Determine the course of action

The question that will drive the research will be: What do beginning, small, and medium brewers need to do to bridge the capability gaps?

5. Formulate initiatives

The question that will drive the research will be: How can actions be executed?

6. Visualize the roadmap

The question that will drive the research will be: In what order should actions be executed?

2 The Beer Brewing process

The first question that needs to be researched is “How can brewers at different stages make use of AI”. To answer this question, different aspects of the brewing process need to be analyzed. Therefore, this chapter will be dedicated to the beer brewing process and the end product of the beer itself. By diving deep into the beer brewing process certain questions may arise and those will be asked to a specialist. This will be further elaborated on in the empirical part of the thesis.

2.1 Overview of the Beer Brewing process

Brewing beer is nowadays a scientific discipline and has transitioned from an uncontrolled practice into a natural science. (Meussdoerffer, 2009) However, the beer brewing process we know nowadays has come a long way. According to (Thomas Mann, 1945) three essentials need to be met, the first one being the availability of grains, the second a source of energy, and the third suitable brewing vessels. These essentials were first met by humans around 5000 BC. (Meussdoerffer, 2009) Since then the Brewing Process has been incorporated into many different cultures and can be found in every major historic civilization. From the time of the Greeks and Romans to the Celts and the Germans and later into the middle ages and the age of exploring and trading. During all these times, the consumption of beer has played a significant role in human society. Beer Brewing has remained a valuable and profitable industry to this day.

The process of making beer nowadays is roughly the same for each beer brewery regardless of the size of it. To introduce the reader to this process, the thesis will explain the brewing process of a known brewery, the Aslan brewery. The Aslan Brewing Company is stationed in Bellingham, Seattle and the figure below represents the brewing process in five steps. The reason behind selecting this brewing process is the limited number of steps it contains. This makes it clearer and easier to follow, as the purpose of this thesis is not to become a beer brewer but to understand the basics and gather knowledge on where possible AI enhancements could be added.

The first step in the beer brewing process is Milling. As mentioned before, one of the three essentials is grain. Therefore, starting the beer process happens by crushing malt, a sort of grain, with a mill. The crushing of the malt is very important as it needs to dissolve in water and it helps expose the starches, a type of carbohydrate that reside in products such as corn, rice, and grain (Melina. J, 2021), for the mashing process.

The mashing process revolves around turning the milled malt into a liquid. This happens by adding water to the crushed malt in the mash tun, a vessel used to mix ground malt with temperature-controlled water. (Buttrick, 2021) By adding water to the milled malt it activates the enzymes inside the malt, which turns the starches into sugar. This sugar will be on a later stage used by the yeast. Furthermore, this mash will be the basis for the beer. It will determine the colour, body, and flavour. (Flowers, 2014)

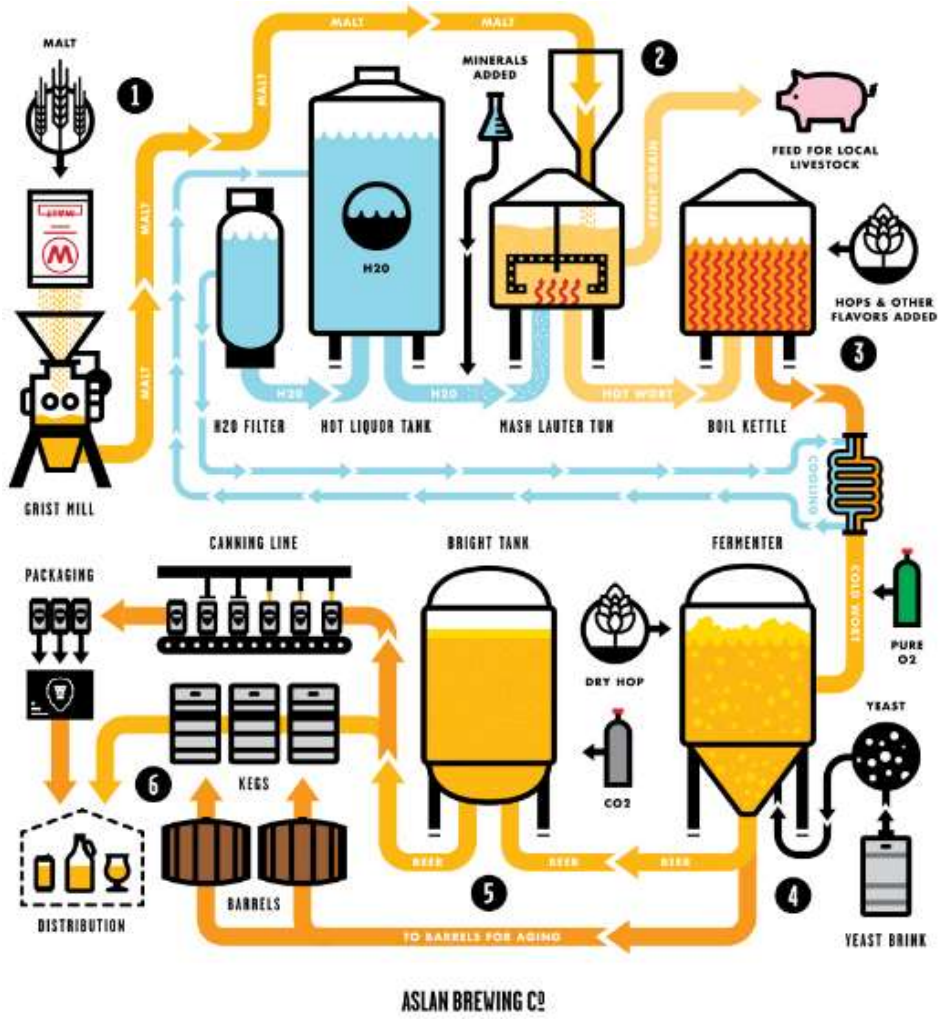
The third step is boiling the wort, the sugary liquid created in the mashing process. By boiling the wort you destroy any unwanted enzymes or harmful oxygen. Furthermore, the wort will become pasteurized due to the continuous boiling temperature. Apart from “cleaning” and pasteurizing the liquid the boiling process also includes the adding of hops. Hops are the flowers of the Humulus lupulus plant and aid in preserving the beer and adding flavour to the beer, especially the bitter flavour. (Allagash Brewing Company, 2020) Without the natural bitterness of the hops, the beer would be sweeter and less protected against bacteria.

After the wort has been boiled with the hops it is ready to be cooled down again. It is important to cool the wort down as during this step the wort will be combined with yeast. Yeast is a living organism and therefore the temperature in which it survives is limited. Therefore, the temperature is most of the time kept between 4 and 18 degrees. The temperature differences when the yeast is added depending on the type of beer that is being brewed. I.e. 12 degrees is for Ale type of beers and 15 degrees is for Lager type of beers. The yeast will over a period of time consume all the sugars in the wort and convert it into alcohol and carbon dioxide. When this process is completed the beer will be cooled down again to ensure all the yeast will be cleared out of the beer. Most of the yeast will sink to the bottom of the tank and will be harvested again to be used again. (Aslanbrewing, 2021)

The fifth and final step is racking. During this step, the beer gets filtered again and cleared of any remaining substances. The end result is a beer with a clear colour. However, apart from filtering the beer, the process is also about either kegging, bottling, or canning the beer. To make sure the beer remains with the same level of carbon dioxide (The bubbles in the beer) when transferring the beer from the tanks into either a keg, bottle, or can. The beer is filled with counter pressure. The reason why brewers pressurize their beer by adding CO_2 is to make sure the beer has higher clarity and the filling of the beer in the correct container takes less time. (Beer connoisseur, 2016)

To get a clear overview of the brewing process, see the figure below of the Aslan Brewery. Figure 1 below highlights each step in the process discussed above.

Figure 1. Beer brewing process, Aslan Brewing Company (2019)



2.1.1 Beer fermenting styles

In general, there are three forms of fermenting beer. There is top fermentation, bottom fermentation, and spontaneous fermentation. Each fermentation form characterizes its specific style of beer. For instance, IPA beers are fermented by using a top-fermenting yeast. This yeast rises to the top of the beer after it is finished making alcohol and carbon dioxide. The yeast used for top-fermenting is from the Saccharomyces Cerevisiae MUCL 38485 strain. The main characteristics of this yeast strain are a higher tolerance to alcohol and it ferments at a higher temperature. Therefore, this yeast will gather at the top of the alcoholic liquid. Pilsner beer is being fermented by making use of bottom-fermenting yeast. The yeast used for bottom-fermenting is from the Saccharomyces Carlsbergenisis MUCL 28285 strain. This yeast will sink to the bottom of the alcoholic liquid after it is finished converting all the sugars in the alcohol and carbon dioxide. However, the main characteristic of this yeast is being slower in fermenting and it needs to be in a much cooler environment compared to top-fermenting yeast. Moreover, this yeast has a lower tolerance to alcohol (Pascale. B Dengis, 1994). The creation of for example sour beers is dependent on spontaneous fermentation. This process occurs by mixing yeast with natural bacteria, leaving the liquid to be fermented

both by Saccharomyces and Non-Saccharomyces yeast. This spontaneous fermentation style is actually the oldest in the world. People before the time 17th century did not know of yeast and how it worked up until 1859 when Louis Pasteur discovered the role of yeast in the fermentation process. (Delany, 2018)

2.1.2 Fermenting process

Exactly calculating the fermenting process is still not 100 percent certain. The fermentation process is dependent on multiple factors and happens in multiple stages. As of now, there are three stages in which fermentation occurs. The first stage is also the shortest stage as rough estimates put the fermenting time anywhere between 6 hours and two days. During this first stage, the beer is being “pitched” with yeast. The pitching stands for the number of yeast cells that are being added to the beer. This timeframe is called “lag time” and refers to the amount of time between pitching the beer and seeing visible signs of fermentation.

The second stage is active fermentation, at this point the yeast is operating at its full potential. All the sugars are being converted into alcohol and carbon dioxide. Interestingly, the fermentation temperature is now the most important factor. It has to be at the exact temperature that is preferable for the used yeast as having either a too high or too low temperature will result in the process being abruptly stopped. This process will generally take 5 to 10 days.

The final stage of the fermenting process is the longest and has a timeline from 2 to 3 weeks. At this point, the yeast is becoming less effective and has consumed almost all the sugars. Depending on the yeast used for fermentation the remaining by-products will either sink to the bottom (bottom-fermenting yeast) or raise on top of the beer (top-fermenting yeast). After the 2 or 3 week timeline, the beer is finally ready for bottling or kegging. (Fermentation solutions, 2021)

2.1.3 Beer brewing process planning

Planning the brewing process as optimal as possible can be quite complex as the process goes through multiple production stages. However, it is highly important to plan the brewing process as efficiently as possible. Furthermore, having key insights into the brewing process can give an understanding of in-stock supply, purchase behavior, and production time. Having this important information can benefit the brewery in the long term and therefore planning the process could consist of one of the following conceptions: 1) Forecasting demand, and 2) choosing the most effective production option.

To Forecast demand, each brewery is required to estimate how much beer it needs to produce for a certain period in time, how this is estimated relies on the model used by each brewery. There is, for example, forecasting based on historical data, where a brewery takes into consideration what the current sales are compared to last year's sales. By comparing historical data over years certain patterns could indicate the demand for the current year. This model is called the Time-series model and relies on mathematical data. Furthermore, this is part of quantitative methods to determine demand. (Nau, 2017) However, this is argued by (BIECC, 2009) as they state that current information is more valuable than historic data. Especially in the beer industry as things tend to change quickly due to competitors and SKU, Stock Keeping Unit; a scannable barcode that keeps track of the inventory (Hudson, 2020). They do acknowledge historic data as being valuable but not the main driving force. Another way of forecasting demand is by qualitative methods (Cervoni, 2018). With qualitative methods breweries rely on judgments and opinions from customers as well as personal experience. For these methods, there is no data based on forecasting demand.

Choosing the most effective production option, In order to optimize the beer brewing planning, breweries should take a finer look at their production process. By mapping out the whole production process with all the elements such as manpower, machinery, and equipment the brewery could reduce costs and maximize its operational capacity. The mapping out of the process could be portrayed in a flowchart. By using a flowchart, breweries can graphically document a sequence of operations and improve the process wherever a bottleneck occurs. (Chapin, 2021) This in turn can result in a brewery's capacity of meeting the forecasted demand at all times. (Bespokebrewingsolutions, 2021)

2.2 Improvements in the Beer

Once establishing a beer beverage it is essential to either keep improving the beer beverage or keeping the quality of the beer beverage consistent. Beer is the main product of a beer brewery and just like any other product it needs to stay ahead of its competitors if it wants to remain in the market. Three main factors determine why companies, in this case, breweries, are forced to invest in product development. These factors are competitor influence, changing customer needs, and technological improvements. (Fripp, 2021)
During this chapter, three major points where improvements can be made will be discussed. These include a more in-depth look into the beer quality, feedback of the customer, and trends that are happing as of now in the beer brewing industry.

2.2.1 Establishing Beer Quality

In 1516 the first guidelines concerning beer quality were set in the Bavarian Purity Law. At this point, brewers were only allowed to use the ingredients of malt, hops, yeast, and water. These ground rules are still applied in modern-day brewing and form a basis for establishing beer quality. (Narziss, 1983) At this moment for every beer brewery, it is important to have proper quality assurance. This QA guarantees the quality of the beer by “systematic monitoring the raw materials, in-process product, and end-product” (J.Amad, 2016). The quality of the beer is interdependent with consistency, therefore maintaining the consistent flavor of the beer is one of the main reasons why modern-day QA and QC (Quality controls) are in place in every brewery. According to Parker (2020) every brewery must have at least the following two quality control measurements.

1) Quality instrumentation This might seem as logical and easy to understand. However, it is more than important that adequate instrumentation is used while brewing beer. As mentioned before, quality is linked to consistency. Therefore having a perfectly working, pH meter1, a scientific device that measures the acidity or alkalinity of water-based solutions (Green, 2021), or hydrometer2, a device that measures the Specific Gravity in a liquid ready to be fermented to establish the Alcohol By Volume (Love Brewing Limited, 2021), is essential. Apart from a pH meter and hydrometer, it is important to have a spectrophotometer, a device that accurately measures color, taste, bitterness, and carbohydrates (Mettler Toledo, 2021). As seen in the picture below, Figure 2, these instruments are used to maintain control of quality. By using the consistent readings of these instruments a brewer is highly likely to brew the same beer over and over with the same quality.

Figure 2. Three quality instrumentations (2021)

1

2.

3.

1. “PH meter. (2021)”.
2. “Spectrophotometer. (2021)”.
3. “Hydrometer. (2021)”.

2) Sensory program, apart from using quality instrumentations a beer brewery should also take into consideration the human testing aspect. Having a panel of well-trained people evaluate your beer can have any inconsistencies before release be identified. During the testing, the panel will discuss the following aspects of the beer; color, freshness, quality, balance, and drinkability. These aspects are related to four segments being appearance, aroma, flavor, and mouthfeel. Even though having a sensory program is not as objective or precise as using laboratory tests or instruments. Still having the sensory program has added value for breweries as it better reflects the customer experience rather than data.

2.2.2 Feedback on the Beer

According to (Cambridge dictionary, 2021) feedback can be described as “information or statements of opinion about something, such as a new product, that can tell you if it is successful or liked”. As a beer brewery, you want to receive feedback as much as possible as customer feedback helps improve the product, improve the marketing and operations of the beer brewery. It is important that companies, or in our case breweries, take the time to actively check what kind of customers they have and what their customer base is. By listening and utilizing customer feedback it can help a business move forward. (Greenberg, 2021) The easiest way to capture customer feedback is by asking them directly. Apart from directly going to the customer, there are certain platforms in the beer brewing industry that provide global feedback to breweries. An example of such a platform is Untappd, a mobile social application that drives its users to try different beers and share their experience on it. Moreover, Untappd provides breweries the possibilities to manage, engage and analyze the customer market. Especially the engaging part provides breweries direct feedback on their product. (Untappd, 2021).

2.2.3 Beer brewing trends

Even though the current situation has stalled some of the trends that just started to become bigger, it created other trends that will carry on this year and perhaps even in the future. By looking at some of the beer brewing trends, the author will gather more in-depth knowledge on what is in store for the beer brewing industry.

1. Low and non-alcoholic beers

A trend is driven by the pandemic situation, as more people become more health-conscious and thinking twice about their drinking habits. More people decided to drink low and non-alcoholic beers. According to one of America's largest breweries, Lagunitas, in the American beer industry, the non-alcoholic IPA gained significantly more interest. Furthermore, in 2020 the American non-alcoholic beer sales increased by 38%. (Vorel, 2021). Nonetheless, the Non-alcoholic market is still dominated by large multinational breweries such as Heineken and AB-InBev. At last, the low and non-alcoholic beers have become much more than they used to be. Nowadays they are in multiple flavors and have fewer calories than a normal beer.

2. Outdoor spaces

Yet another trend that has derived from the current pandemic situation. As in most countries, the bar areas indoors have been closed to prevent rapid contaminations, bars have had to rethink their "serving" areas. Depending on where the bar would be geographically located the investments would either be in fans, for bars in warm weathered countries, or heathers for bars in cold weathered countries. There have been many examples of bars upgrading their outdoor facilities and creating even new ones. According to Garret Oliver from Brooklyn Brewery, outdoor community gardens are here to stay. (Bernstein, 2021)

3. Variety and mixed-pack deliveries

Whilst some bars are opening their doors in some countries, others still remain closed and rely on their delivery efforts. Delivery has become very popular for businesses apart from the brewing industry. And now, breweries are rethinking their delivery items. Apart from just delivering beer, they have started to create special delivery boxes with their products and merchandise. The expected trend will be that breweries will move forward in providing more content to their delivery boxes (Weitz, 2021)

4. Breweries go digital

The form of going digital is concerned with the menu of the bars and breweries. Instead of making use of printable menus some bars and breweries have switched to making use of a QR code with a digital menu. Aside from being environmentally conscious by not having paper menus, there are more benefits to having a digital menu. It Is easily updated and maintained and it can be effortlessly be linked to ordering and payment systems. According to Jeff Smith, founder of Luki Brewery, the key to success in 2021 will be "Making it as easy as possible for the customer to consume your product". Therefore, by embracing technology in the beer brewing industry many might get interested in possibilities they never have thought of before. (Norman, 2021)

5. Subscriptions to breweries

A new trend has been growing in America and is linked to delivery. This trend is to get new customers to try a brewery's beer by delivering a customizable beer pack. Apart from attracting new customers it is also meant to retain loyal customers by delivering their favorite

beer to their doorstep. A brewery that has successfully launched this subscription service is East Brother Beer Company in California. (Lightner, 2021)

2.3 Beer Brewing in Finland

The Finnish Beer Brewing culture can be traced back to at least the Viking Age of the 9th century. The most ancient and traditional beer that can be linked to the Finnish Beer culture is this, a strong, unfiltered rustic brew that is usually made at home. (Ovell, 2021) Up until the 17th-century beer was the main alcoholic beverage in Finland until it all changed in 1917 where, shortly after the Finnish independence, the government voted for a ban on alcoholic beverages. This would be later changed and saw the rise of the Alko monopoly which is still active to this day. Due to the Alko monopoly, the number of craft breweries in 1990 was limited (Tuhkanen, 2021). However, due to the rise in popularity, the amount has steadily grown to 85. (David, 2018)
In this sub-chapter the author will take a look at hygiene rules in Finland, reporting to Valvira, Finnish National Supervisory Authority for Welfare and Health, and Finnish alcohol legislation.

2.3.1 Hygiene

Whenever a person is entering the food and beverage industry in Finland, they are required to obtain a hygiene passport. This passport is required to be obtained at the latest 3 months after starting to work at a food and beverage outlet. The hygiene passport is issued by the Finnish Food Authority and ensures the recipient knows how to handle unpacked easily perishable foodstuffs. Furthermore, it guarantees that businesses have employees that have been supervised and instructed in hygiene matters. At last, businesses are required to keep records of the (food) hygiene competence of the person working at the premises and be able to present this to the control authority at all times.
These records should at least contain one of the following items: 1) copies of hygiene passport, 2) list of persons who are required to have a hygiene passport, or 3) employees hygiene passport card. (Finnish Food Authority, 2021)
The reason why these hygiene measurements are in place is first and foremost to protect the consumer as well as the quality of the product. Beer is a product that is made with a live organism, the yeast, and therefore without maintaining proper hygiene the beer flavor will change over a course of time as the yeast and bacteria will keep on “growing” in the materials. It is therefore critical that breweries clean their instrumentation regularly. However, there is a difference in sanitation and cleaning. First by removing any visible dirt and other deposits from the instrumentation you are cleaning. By rinsing the instrumentation one more time with specific chemical products you are sanitizing.

At last, it can be very useful for any brewery to walk over their whole brewing process and identify any possible areas where new or updated measurements must be taken. (Goldman, May)

2.3.2 Reporting to Governmental organisations

Valvira is the Finnish National Supervisory Authority for Welfare and Health. They enforce the Alcohol Act that “prevent detrimental societal, social and health effects caused by alcoholic substances by controlling the consumption of alcohol”. (Valvira, 2021) Furthermore, they are in charge of giving out licenses and supervise the guidance activities. Some of Valvira’s licensing activities are the following:

1. Alcohol production

Valvira issues licenses for 1) teaching and research purposes, the alcohol that is being produced may only be used for analyzing and quality control. 2) home production of alcoholic beverages, the alcohol that is being produced may only be used for private use and not be sold. Furthermore, Only fermented type of alcohol may be produced. and at last 3) to producers of spirit and alcoholic beverages, this type of alcohol may only be produced by companies that are supervised by e.g. market control, inspections, and sampling. These companies are also required to report to Valvira three times a year about their production volume and every month about their sales.

2. Alcohol wholesale

Wholesale companies have to comply with the same rules as the producers of spirits and alcoholic beverages. The main difference is in the reporting guidelines. Alcohol wholesale companies are obligated to report every product that is important by them and specifically into Valvira’s product register. Furthermore, the alcohol sales need to be reported monthly to Valvira.

3. Industrial use of alcohol

This type of alcohol is not meant for sale directly to the consumer. This type of spirit is needed by companies to either manufacture another product or quality assurance of products in business operations, such as medical products or pharmaceutical products. In order to use these licenses, companies are required to store the alcohol in a locked storage area and keep a record of consumption.

4. Alcohol import

A private person is allowed to import alcohol without any license issued by Valvira. However, this alcohol might not be sold for commercial purposes and may only be used for private consumption. Moreover, when importing alcohol as a private person you are required to make sure that the ordering, payment, and transport of the alcohol is carried out in a legal matter that does not violate the Alcohol Act.

5. International transport

This type of license concerns the ship and aircraft business in other words, cruise ships, and commercial airplanes. Valvira only issues a license to these companies whenever the following information is been given: information on the premises where alcohol is sold, what the control of sales is and what arrangements on maintaining public order are. (Valvira, 2021)

Apart from Valvira, there are also The Regional State Administrative Agencies. They are at first responsible for supervising advertising, promotion of alcoholic beverages and supervise the serving of alcoholic beverages in their area. Effectively they are responsible for the following licenses:

1. License to serve Alcoholic beverages

The requirements for receiving a license from The Regional State Administrative Agencies are serving alcoholic beverages with an alcoholic content higher than 2.8%. Also, the company should have a personal and local license to sell alcoholic beverages and at last, you should either be a natural or legal person to be granted a license.

2. License for extended serving hours

In general, serving alcohol of 2.8% is allowed from 09:00 to 01:30. However, The Regional State Administrative Agencies have the power to shorten the serving license operating hours if either it causes disturbance in the neighborhood or to maintain public safety. It can also extend the operating hours but this is subject to yet again the neighborhood and public authorities if it may be extended to 04:00.

3. Alcoholic beverage retail licenses

The same rules apply for retail licenses as for licenses to serve alcoholic beverages. However, there are some differences in the time where alcoholic beverages may be sold. The time frame in which it may be sold is now 09:00 to 21:00. It is not allowed to sell alcoholic beverages after 21:00 in retail shops. (Regional State Administrative Agency, 2021)

2.3.3 Legislation

The Finish alcohol legislation is long and complex as it is constantly been rewritten and updated. Just recently, in 2018, there has been a fundamental change to the Alcohol act that impacted the selling of alcohol in a major way. This subchapter will therefore highlight the most important changes that have been made in the Finnish Alcohol Act. The changes are divided into two segments. The first segment is off-premises sales where the first change allowed supermarkets to sell alcoholic beverages up untill to 5.5% ABV (Alcohol By Volume). This was previously only sold by the government-owned Alko. The second change allowed supermarkets to sell also alcoholic beverages that were not only made by fermentation. Therefore, the supermarkets are now also selling Bacardi Breezer or other products alike. The third change allowed craft breweries to sell their beers up to 12% ABV straight

from their brewery. Another change that concerned the supermarkets and Alko stores was the extended opening hours to 9 am. This was previously 8 am. At last, restaurants are now allowed to sell alcoholic beverages until 5.5% ABV, provided that they have applied for a license.

The second segment is on-premises sales. The first change in this segment was the serving hours extension until 4 am. Yet again, only if the premises have the right licenses. The second change allowed bars and restaurants to promote happy hour with discounts, previously this was banned. The last change was mostly administrative and allowed bars and restaurants to operate with one license that covered all alcoholic beverages. (Karssson, 2020)

These legislation changes in the Alcohol Act together with the enforcing agencies represent the Finnish Alcoholic views and guidelines which need to be respected by all companies operating in the field of Food and Beverage.

3 Artificial Intelligence

The technologies that make it feasible for machines to learn, reason, and self-correct, to the point it can perform human-like tasks, are achieved by AI. However, for the machines to be able to do so. It heavily relies on processing large amounts of data and concocting directives that turn the data into actionable information. For instance, anyone who uses Apple products is familiar with Siri, the personal assistant activated by voice commands. This machine feeds off data to get smarter and perform more personalized tasks. This is one of many examples of how AI is being integrated into either our personal or business lives (IBM, 2020).

To bring together AI technologies with the beer brewing process, this chapter will discuss AI, AI's applicability's and possibilities, as well as AI trends that might be beneficial for the beer brewing industry and at last, the author will touch upon the legislation that needs to be taken into consideration while making use of this technology the line of thought will be to answer the question: "How do brewers see AI?".

3.1 Artificial Intelligence in general

To get a better understanding of what AI is, the illustration below will visualize the three different layers of the technology. The first layer is AI, this is the science that drives machines to mimic certain human behavior. Overall, AI can be perceived as a general umbrella term for a lot of different approaches and application areas. The second inner layer is machine learning that is a subcategory of AI. Machine learning is concerned with receiving data and making decisions based on that specific data. Important to notice is the usage of algorithms, a set of rules that give specific instructions to make sense of the data (Davis, 2021). The third inner layer is Deep learning and is the subcategory of Machine learning which uses neural networks to solve complex problems. The usage of neural networks is inspired by the human brain and tries to replicate the conclusion-making process of humans. (Opperman, 2019) These three layers are interconnected and make AI solve data problems with both machine and deep learning activities.

Figure 3. Layers of AI (Istep, 2019)

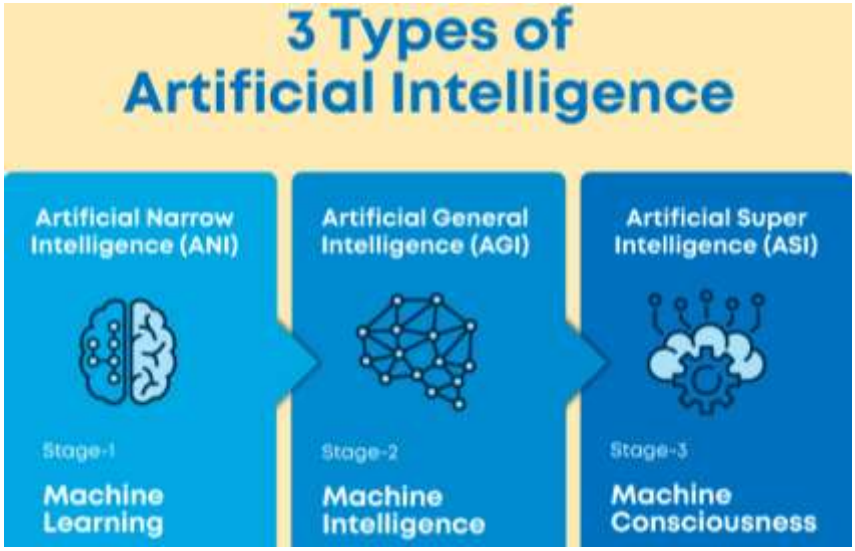
3.1.1 AI categories

As of this moment, AI can be divided into three categories or types, and can be seen in Figure 4. Currently, our technology is limited to the first stage of artificial narrow intelligence (ANI) or weak AI. This type of AI has only a limited set of tasks it can perform and is built for. Examples of such tasks are facial recognition, speech recognition, self-driving a car, etc. The machine performing this task is very intelligent and highly effective. However, in basic the machine can only learn and be taught, there is no self-awareness or consciousness and is not able to replicate human intelligence. The intelligence that drives ANI is through natural language processing (NLP). (SAS, 2021)

3.1.2 AI Types and Languages

There are many different “languages” that drive the first stage of ANI. As mentioned earlier there is NLP. “NLP makes it possible for humans to talk to machines” (Overby, 2020)
Machines that make use of AI do not directly interpret human written language as they communicate in a different language of zeros and ones, which derives from Binary code. Through the use of NLP, it is possible for machines to understand our written language and be able to carry out commands such as translate or respond to our questions like chatbots do on certain websites. Then there is Automatic Speech Recognition (ASR). This technology allows humans to speak with machines in a “human” like matter. In basic, the machine picks up our soundwaves (voice) and processes them to either answer-back or carry out commands like Siri, Alexa and many others do. At last, there is computer vision, this technology trains a computer or machine to describe visual imagery. Furthermore, it can also identify objects and react to what it sees. The accuracy of this technology is significantly high and even surpasses human capabilities. (SAS, 2021)

Figure 4. The 3 types of AI (Mksaad, 2020)



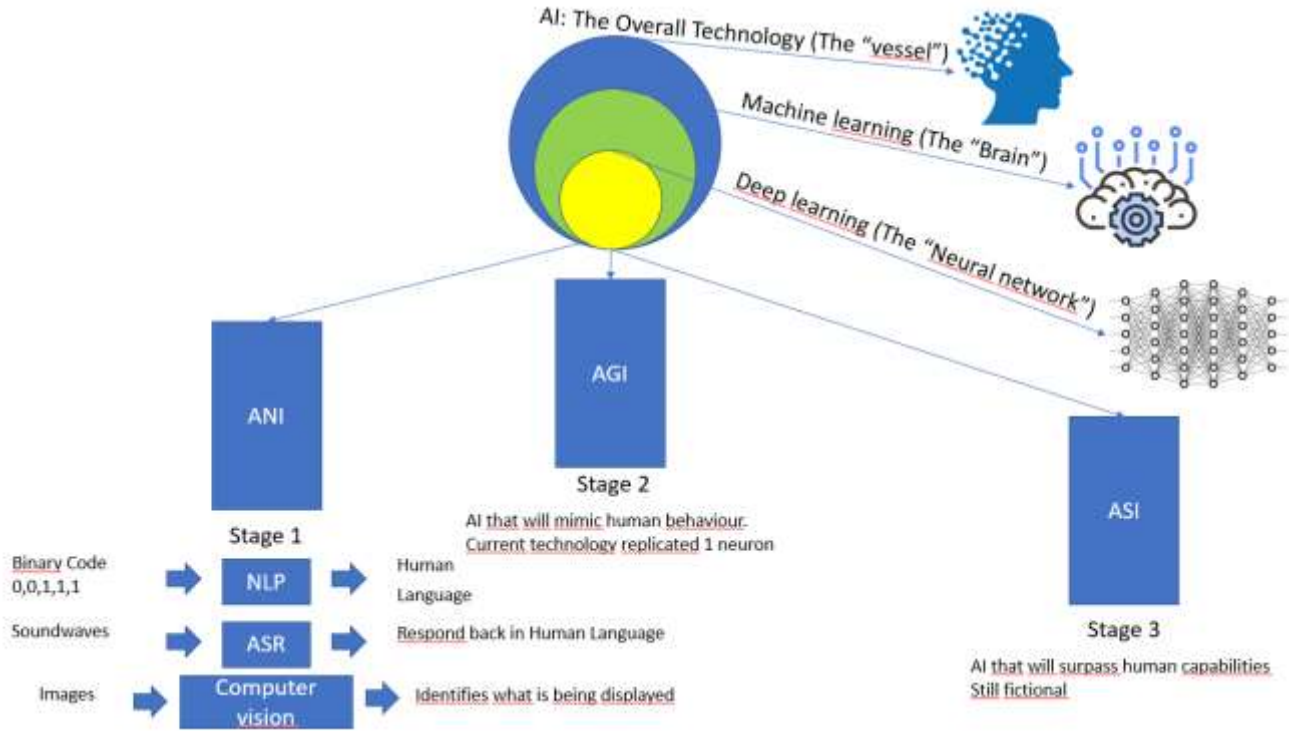
The second stage of AI is Artificial General Intelligence, also referred to as AGI. As mentioned previously, the current technology is limited to stage 1 and therefore AGI is still a theoretical concept In Theory AGI will be able to mimic a human brain and reasoning. To put this in perspective, the most advanced systems like IBM's Watson took 40 minutes to imitate one neural activity. In comparison to our human neural activity of 86 billion neurons. (Voytek, 2013)

The third stage of AI is Artificial Super Intelligence, referred to as ASI. This type of technology will be the next natural step after AGI. However, the concept is still science-fiction and not in our reach for the long future. AGI will be capable of surpassing human capabilities and even improve our capabilities. (Mksaad, 2021)

3.1.3 Conclusion

To conclude, AI is an umbrella term for many different technologies that make it for machines possible to interpret data and act upon it. Now that we have discussed in general what types of AI interconnect with each other, the different stages of AI and what type of languages exist in the specific stages. The author can now more clearly interpret the usage of the different technologies and what can be applied to the beer brewing industry. Figure 3 below gives a clearer overview of what has been discussed previously. In the following subchapter
The author will discuss the possibilities of AI and its current capabilities.

Figure 5. AI overview (Geilings, 2021)



3.2 Artificial Intelligence possibilities

Even with the current pandemic situation, AI implication in businesses has grown significantly. Reasons for the increase of AI comes from the lockdowns all over the world and how that forced business to become more digitally connected. Moreover, the work from home adaptation further fuelled the use of AI and other technological tools. (Bahirat, 2021) To gain more knowledge on what AI could contribute to the beer brewing industry. The author will discuss some areas in which it is currently being applied and is excelling in.

AI in Quality control is currently being used by manufacturing companies as they require their products to be top quality products. AI is therefore a technology that assists in quality inspections that are faster, more accurate, and cost-effective. Moreover, they surpass human inspection capabilities. How AI keeps control of the products is by the implementation of smart cameras combined with deep-learning quality control software. (Greenfield, 2020)

A trending topic currently is sustainability and the reduction of waste. Especially in the food and beverage industry where last year 931 million tonnes of waste was registered. (United Nations, 2021) Fortunately, many innovations are trying to tackle this problem and AI is one of them. There are two areas where AI is being used, the first area is software that keeps track of the manufacturing and supply chain. Any waste in this process will be picked up by the software and highlighted. The second area is computer vision and machine learning as they keep track of food waste. By making use of the vast amount of data available, this form of AI can even recognize processed foods. (Martin, 2019)

Another possibility for AI integration can be in product optimization. When we talk about product optimization, it is all the processes and efforts that are being made to create the best possible product or services. (Flovik, 2018) In order to do so, AI can play a huge role in detecting possible bottlenecks before they even happen. I.e. by training an algorithm with historic data and by means of machine learning, it can predict potential future blunders.

The packaging industry is now experiencing growth in the combined use of AI and robots. The robots working in the packaging industry are being equipped with AI to perform human tasks that are either time-consuming or physically demanding. Moreover, the robots are faster, more efficient, and can work longer hours per day. An example of where this technology is being used is in the recycling industry as the robots are the ones picking used materials that can be later made into new recycled materials. (Day one Tech, 2020)

Personalization is a current trend that is not only bound to marketing but also impacts other industries such as the Hospitality industry. AI is playing a significant role in this trend as certain aspects of AI are integrated into a variety of products and services. The main driving force for companies to invest in personalization is the ability to be able to offer future customers tailor-made offers/products or services. Examples of how AI is being used in personalization are via AI chatbots on websites such as Booking, com, the personalized albums suggest in the Spotify application, or receiving ads from a website you have visited on a different platform. (BasuMallick, 2019)

To conclude, AI is widely being integrated with different industries. Overall, the main reoccurring themes of why AI is being used is to either streamline a process, make future predictions based on historic data or replace and even exceed simple human tasks. There are many more examples that could be discussed, however, due to the limited time of the thesis and the scope being the beer brewing process. The choice has been made to focus on the most reoccurring AI possibilities and trends that are discussed at the present moment.

3.3 Cases of Artificial Intelligence in the beverage industry

After discussing the current possibilities and trends of AI, this chapter will focus on actual cases in the beverage industry that make use of AI and why they make use of this technology. Three major examples will be highlighted, these are Sugar Creek Brewery, MN microbrewery, and Intelligent X Brewing company.

Sugar Creek Brewery is a North Caroline based brewery that since 2019 has integrated both the Internet of Things (IoT) and AI into their brewing process. This task was carried out by IBM (A large American multinational company that specialized in business machines). At first, they focussed their efforts on resolving Sugar Creek's spilling problem. Before the integration of sensors, to gather vast amounts of data on the bottling, Sugar creek was spilling at least 30 000 dollars a month. The spillage occurred in inaccurate bottling and oxygen overflow that killed the quality of the beer. After IBM used all the collected data and feed them into their AI system, areas of improvement started to become much clearer. This resulted in Sugar Creek Brewery a beer product with better quality and a greater overview of the brewing process. However, in the future Sugar Creek's, the main goal is to become the first brewery that creates a beer from scratch with the use of AI, they will even name it IPAI. (Vogelbacher, 2019)

MN micro-brewery worked jointly with Jaywalker digital (A software development company) and the University of Lucerne to create and prove that AI would be possible of creating beer recipes. The eventual end product is named Brauer AI and it successfully made an IPA beer

recipe last year September. Brauer AI works as following, it gathers one random ingredient from a large pre-defined database. After selecting the one ingredient, the machine will search for matching malts. Next, it will search for Hops that can be used with the malt and starting ingredient. At last, the machine will calculate if the selected ingredients can be brewed within 60 minutes as that is the standard for MN micro-brewery. Eventually, the machine has created an IPA recipe that could be brewed and eventually was. Furthermore, the Brauer AI is freely accessible on the following website https://beer.abiz.ch/, so everyone can try and create their own beer recipe employing AI. (Brewer World, 2020)

At last, Intelligent X Brewing company started in 2016 to create AI-brewed beer based on customer feedback. The concept of Intelligent X is based upon a subscription service. Customers are required to download the app and create a profile. The customer will then receive four different beer flavors in ten cans, at their own chosen delivery schedule. The price of the beer subscription is 29 pounds. Whenever the customer tastes the beer they are suggested to fill in their feedback in the application, eventually, this process will be repeated to the point that the beer best fits the taste of the customer. The AI is integrated with the application and measures the feedback to generate suggestions for the brewer. (Hasenbeck, 2018)

3.4 Artificial Intelligence and European Legislation

Laws and regulations can unfortunately not keep up with the same pace as technology is being developed. Some estimations proclaim the law to be at least five years behind developed technologies. (Griffith, 2019) Nonetheless, with the ever-increasing use and importance of AI, specific laws need to be set into place. These laws need to ensure the protection of fundamental rights. The scope of this paper is limited to Finland and therefore EU legislation will be discussed in general. Contrarily, the Finnish regulations regarding AI will be elaborated on more in detail.

3.4.1 Ethical use of AI

Ethics and the Law often are combined to ensure our human behavior is aligned and seek the protection of public health, safety, and welfare. Often, ethical questions set by society enable the creation of new laws and regulations. Ethical questions are now also been asked by not only society but also large tech companies such as Amazon, IBM, and Microsoft. As the possibilities of AI are becoming nearly limitless, some questions have been asked by AI experts. These involve unemployment, AI bias, and Security. (University of Texas, 2020)

Unemployment is probably one of the main concerns apart from security. AI has the capability of eliminating more jobs than can be created. An example of how this might happen is the truck drivers in the United States, where they depend on this large workforce for their supply distribution, which might be replaced by self-driving trucks if that technology is being further developed and refined. Other areas where AI might eliminate jobs are in the financial sector and customer care sector, wherein machine learning will deliver faster and more accurate services. (Krasadakis, 2018)

There have been cases in which AI has shown to be biased and even racial. The most recent case was Google's Vision AI that predicted, based on an image, who carried a gun or not. The results showed that a gun, which actually was a drill, was identified mostly by black-colored skin humans is contrary to white colored skin humans. Although, machines do not have feelings or are self-conscious. We must not forget that these AI systems are been created by humans and therefore could be biased. (Bossmann, 2016)

At last, the security of the AI systems can cause serious risk. AI systems could be altered and therefore the decision-making process can deliver undesired results. An example of how AI is causing serious security issues is by deep fakes. This is AI that recreates certain photos or videos and therefore spread disinformation. The most recent use of this AI threat was in the 2020 American political environment wherein the video candidate Biden stated the democratic disunity instead of his original message that only the people could re-elect Trump. This shows the capabilities of how AI could be used in a harmful way and especially in a secure way of stealing someone's identity for unacceptable purposes. (Frum, 2020)

3.4.2 European Legislation

Recently, on the 21st of April 2020, regulation of the European Parliament and the council created new regulations for the harmonized use of AI in the EU. The main purpose of this new agreement is the collective agreement that "AI can bring a wide array of economic and social benefits across the entire spectrum of industries and social activities. (European Commission, 2021,p.12) By compiling this agreement the EU countries can cooperate together to achieve the following set goals:

- Ensure AI applications are safe to use and respect EU rights and values
- Enhance governance to effectively enforce EU laws and regulations
- Create a singular market for AI systems that are trustworthy and safe

The set goals can only be achieved by keeping in mind specific sets of fundamental EU articles such as Article 1 that concerns respect for private life and protection of personal

data, Article 7 and 8 which have as main theme anti-discrimination, Article 21 equality between men and woman and Article 31 that protects the consumer. There are many more articles that are mentioned throughout the report however these are the most applicable to the scope of the paper. (European Commission, 2021,p.18)

To conclude, the European Union has set goals regarding the use of AI, and together with articles, that ensure our rights as EU citizens are being guaranteed, they created a new framework for the safe use of AI.

3.4.3 Finnish AI objectives and regulations

As the EU just presented the new regulations, it is still unclear what the Finnish regulations exactly are. Finland has set for itself the goal to become the leading country in AI. (Ministry of Employment and the Economy, 2017) At the moment Finland is still creating ethical guidelines for AI, however, they already established eight key actions for taking Finland towards the AI age.

1. Creating a competitive advantage for companies through the use of AI

Finland has recognized that before having a competitive advantage they, first of all, have to create an innovative international ecosystem, especially in the areas where they will make strong use of AI. At the moment they have identified three fields being energy, healthcare, and transport. Nevertheless, Finland will also invest in other emerging fields. The requirements set for the use of AI are to be open and encouraging for international cooperation. (Ministry of Employment and the Economy, 2017, p.41)

2. Data will be used in all sectors

Progress in the AI field can only be accomplished by the use of large amounts of data. Especially, quality data is important for AI progress. There is a misconception that all data can be used for AI algorithms. However, preparing the data for machines to interpret them costs a lot of time. (Correa Gandia, 2021) Finland plans to create a data bank that has the quality and readily available data so companies can make use of it. (Ministry of Employment and the Economy, 2017, p.44)

3. Speeding up and simplification of AI integration

To become a world leader in AI, the government of Finland will assist companies in creating tools that will advance the development of new technologies and innovative activities. Furthermore, they are planning on removing any obstacles regarding legislation in order to advance the usage of AI. (Ministry of Employment and the Economy, 2017, p.46)

4. Assuring AI expertise and experts are attracted to Finland

Without brilliant minds that assist in the development of AI, Finland will not become a world leader. Therefore, the Finnish government is planning on attracting experts in the field of AI and they will also invest in the education of the society. An example of how it is already being prepared is the free accessible website of elementsofai.com.

This website is been created by Reaktor (a company that specialized in strategy, design, and engineering) and the University of Helsinki. (Ministry of Employment and the Economy, 2017, p.49)

5. Implement bold decisions and investments

In the case of Finland, the resources that can be used are limited, especially when compared to international tech companies. For this reason, the government of Finland will carefully decide in what field they will invest. Overall the goal is to be as efficient, and impactful as possible. Also by smart investments, the government of Finland wants to protect its innovative system. (Ministry of Employment and the Economy, 2017, p.52)

6. Create a role model for public service

Overall, the standard of public service in Finland is very high, especially digital public services. Finland is ranked in the top three of all EU member states. (Ministry of Finance, 2018) Now the Finnish government is trying to implement AI in the public sector. With AI they are aiming to provide a service not limited to time or location. Furthermore, the digital services should, with the help of AI, be able to correct information at any time and with the best possible security. (Ministry of Employment and the Economy, 2017, p.54)

7. Create new cooperation models

This action goes together with action 3. By connecting companies from the private sector with the public sector, the Finnish government aims to eliminate “unnecessary legislative obstacles from the path of AI development and minimize the effects of the work revolution” (Ministry of Employment and the Economy, 2017, p.57) These new partnerships will be established by Prime minister’s office and other ministries and agencies.

8. Make from Finland a trendsetter in AI

By implementing all the previously mentioned actions Finland will become a trendsetter in AI. At the moment, both the EU and Finland’s AI agenda are being developed and therefore it is still possible for Finland to be the one leading the charge. They are now actively pursuing other EU countries to create a singular platform and rules for the fair usage of AI. (Ministry of Employment and the Economy, 2017, p.58)

This shows that Finland is serious about their commitment to AI and innovation but also deeply care about regulation that must ensure protection for the end-users.

4 Roadmap

The purpose of creating a roadmap is to create a long-term strategic plan. Companies nowadays make use of road mapping to create a strategic plan that includes all the steps needed to achieve a certain set goal. It is however different from a business plan as a roadmap focuses on the bigger issue of reaching major objectives. Having a clear roadmap ensures that every employee of a business is aligned and knows the company's future. (Andrei, 2020) During this chapter, the importance of having a roadmap will be further highlighted as well as discussing what roadmaps are being used nowadays and which roadmap will suit best for the thesis objective of clarifying the positive effect AI can have on the beer brewing process.

4.1 The importance of having a roadmap

According to Haaff (2014) each successful company or organization has a roadmap. By creating a roadmap, businesses are forced to critically think about their own process. Eventually, as mentioned before it will clarify where the company is going and how everyone in the company can actively contribute to the process. In other words, by having a clear purpose the company will match the daily work with long-term aspirations. This is further confirmed by Galvin (1998, p.3) as he describes a roadmap as "an extended look at the future of a chosen field of inquiry composed from the collective knowledge and imagination of the brightest drivers of change in that field". To summarize the importance of having a roadmap, 1) It forces businesses to look ahead, and perfecting everyday processes will eventually be key in reaching future objectives. 2) By clearly communicating the "bigger picture" the process of road mapping will connect various employees, departments, and stakeholders of the company together. At last, 3) road mapping is a flexible tool that can support innovation and the business strategy (Galvin, 1998)

4.2 Common types of roadmaps field

Before building a roadmap, companies need to decide who their audience is. For example, a graphic roadmap for board members of a company will display strategic decisions instead of release dates for certain products or services. That would be rather presented on a graphic roadmap for customers. The audience will therefore drive what and how certain roadmaps are being presented. (Haaff, 2014) There are 4 common types of mapping that will be discussed to determine which will best suit the end product of this thesis.

According to Applied Frameworks, (2021) Portfolio road mapping, is a type of roadmap that is concerned with bringing a total overview of how different products will be managed together and what the strategic plan will be for the future. Furthermore, this roadmap is aimed at higher company officials as they need to manage their teams according to the strategic plan. (Applied Frameworks, 2013)

On the other hand, Strategy road mapping, by using this roadmap a company will create an overview of what needs to be invested in achieving certain goals. This type of road mapping is meant for company teams to highlight why certain plans are prepared to contribute to the overall business strategy. Moreover, a strategy road map is not a graphical representation of plans that will happen with beginning and end dates. It focuses more on describing what needs to be changed and why the changes are needed. (Seet, 2020)

Then there is Releases road mapping, whenever a product or service needs to be delivered to the customers within a certain time frame, companies opt for the usage of a releases road map. It is a detailed plan that communicates all the activities that need to happen before release. Furthermore, the release road map incorporates who, when, and why certain activities need to be taken care of. This brings all the different departments of a company closer together. (Haaff, 2014)

And at last, there is Features road mapping, this type of roadmap is the least complicated one and focusses more on communicating release dates for products or services to both internal employees as well as external customers. (Haaff, 2014)

4.3 Conclusion

After analyzing why road maps are important for any business and discussing which road maps are used in the field. The author can conclude that to answer the thesis question, the strategic roadmap will be the preferred method of use. The main reason why the strategic roadmap is the best fit is that it describes what the current situation is and what can be done to create change. As AI is still a fairly new topic within the beer brewing industry it can be matched to existing problems and try to solve them. By making use of the strategic roadmap the author can specifically explain what the current “pain points” are in the industry and what type of AI exists that can resolve these points.

5 Empirical part

The fifth chapter of this paper will discuss the methodology as well as the results of the research. The author will justify his course of action with theoretical references to other papers and academic studies. The results of the interviews with both brewers and an AI expert will influence the end product in chapter four.

5.1 Methodology

This chapter is a continuation of the theoretical part of the thesis. By first gathering extensive knowledge on both the beer brewing process and Artificial Intelligence, the author is prepared to describe certain themes from the results and link them to the knowledge gained in the theoretical part. In order to research certain meanings and concepts, the research had to be performed by gathering qual data. This type of data explores information and is categorized based upon either properties, attributes, labels, and other identifiers. (C. Pope, 2000) As a result of performing qualitative research. The sample size was limited to five six. There have been many studies on what the right sample size may be for qualitative research. According to (Morse, 2021), the recommended guidance is anywhere between 5 to 50 participants. The main reasons behind these numbers are to guarantee the quality of the research. Any number above 50 is more related to quantitative research and most of the time not performed by performing interviews. The second reason is to limit the scope of the research. (Charmaz, 2021) In this case, the scope of the study has been limited to micro and medium breweries in Finland. These factors are academically based and have therefore resulted in the choice of having Five Finnish Breweries be included in the research. Another factor that has resulted in the participant amount of 5 interviews is the limited time in which the thesis had to be conducted. As the author is a Double Degree student from The Netherlands, the thesis semester started end of March and therefore resulted in only a two-month period of doing research. Another external factor is the willingness and time of breweries to conduct interviews, especially since the corona situation also reduces the possibility to visit the breweries.

As the end product of the thesis will be to create a roadmap for micro and medium breweries to integrate their production process with certain AI technologies. The research had to be conducted with different breweries in different stages. From the five Finnish breweries interviewed, one was still beginning and did not even start the brewery yet (Masis brewery), two breweries can be categorized as micro-breweries (Person and Kiiski Brewery) and two can be categorized as medium breweries (Salama Beer brewing Company and Fat Lizard Brewery). Every interview participant was either the head brewer or the CEO/founder of the

brewery. By interviewing these specific participants the quality and trustworthiness are guaranteed. Furthermore, these five Finnish brewers gave the author key insights on certain topics and problems breweries have at their respective stages, these will be discussed further in the thesis.

5.2 Target of Semi structured interview

The empirical part was performed via the gathering of qual data employing primary and secondary methods. The primary method used was the interview, which a semi-structured interview. The reason behind opting for a semi-structured interview is as following:
- A semi-structured interview discussed selected topics that are based on the theoretical framework, in this case, based on both Artificial Intelligence theory as well as beer brewing theory. Furthermore, the interviews are based on a list of themes and questions and there is room for flexibility. This allowed for additional questioned being asked and the order of questions being changed throughout the interview.

- To ensure that the semi-structured interviews yield enough data to be analyzed, the questions asked were planned and the same questions have been asked to all the interview participants.

Appendix 3 displays the questions asked to the brewery interviewees. To have a clear structure of what needs to be discussed during the interview, the questions were divided into 3 segments. Before the questions were asked there was a short introduction in which the interviewer introduced himself and asked for recording permission. This was followed by the first segment of introduction questions. The first three questions in the segment helped determine the size of the brewery as well as the position it is in as of now. The second segment introduced the main themes of the brewing process, AI, quality control, and customer feedback. By asking these 7 questions, the interviewer wanted to discover any problems there might be in each respective theme. At last, the third segment concluded with 4 ending questions in which themes were explored as a future vision, personal wishes, and recommendations of other possible interviewees. The ending of the interview concluded with a thank you note and the possibility to ask the interviewer some questions.

Appendix 4 displays the questions asked to the AI specialist. The same concept as used for the brewery interviews applied for this particular interview. The difference can be found in the questions asked and the themes explored. The first segment with the first three questions needed to establish if the AI specialist is qualified and reliable for the interview. The second segment with nine questions explored AI in general and the problems breweries are currently facing. At last, the third segment with two questions explored the suggestions and

future vision of the AI specialist. Once again the interview concluded with a thank you note and permission to use the name and data from the interviewee.

Some key figures about the interviews that have been conducted to guarantee the quality of the data that has been gathered. The interviews have been conducted over 3 weeks starting on the 12th of April with Fat Lizard brewery and Salama brewing company. the final interview was with the AI specialist on the 7th of May. These interviews have been conducted via Zoom of which were three interviews, email of which was one, and the last one in person. The average length of the interviews was 19 minutes. However, the 19 minutes is only the recorded part of the interviews. Some interviews carried on longer due to visiting the brewery and asking questions along the way or shorter due to an email correspondence

5.3 Coding Qualitative data methodology

After conducting the semi-structured interviews, the interviewer had to process the raw data received. This has been carried out by coding the qualitative data. Coding in this sense means “labeling and organizing qualitative data to identify different themes and the relationship between them” (Medelyan, 2021). Moreover, these themes will appear through thematic analysis. The author will focus on a more broader aspect while going over the qualitative data and therefore, the author was able to make sense of certain meanings and experiences from the ones being interviewed. (Braun, V & Clarke, V. 2012) As the participant group consisted of just 6, there was no need to automate the coding process. Therefore, the choice was made to conduct a manual coding process. Manual coding offers the choice to either perform deductive coding or inductive coding. When using the deductive coding method the researcher already establishes a set of codes that will be linked to the newly gathered qualitative data. Inductive coding does not depend on a pre-set code list, the codes are generated by the newly gathered qualitative data. The author has chosen to adopt the inductive coding data as the interview sample size of 6 did not require a setlist of codes. If the interview sample size would have been bigger the choice would have changed to inductive coding.

After establishing the codes the next step is deciding which type of coding frame will be most suitable. There is the Flat Coding Frame which gives each code equal importance. Then there is the Hierarchical Coding Frame which organizes codes based on how they relate to one another and divides them into levels of importance. This time the author has chosen the Flat Coding Frame as not one problem needs to be solved but several and for breweries in different stages. (Medelyan, 2021) The next chapter will discuss the codes and themes that were found from the qualitative data.

5.4 Results of Finnish brewery interviews

While coding the data from the beer brewery interviews the same 4 themes returned. The first theme that returned is the Beer brewery and capacity. By discussing the beer brewery and the capacity the author can establish in which category the beer brewery can be placed. The second theme discussed Quality. By reviewing the quality process for each brewery it gave the author new insights into a theme not yet explored. The third theme concerned AI and technology, which allowed new possible connections to be made between the brewing industry and AI. At last, the fourth theme discussed the “pain points” for every brewery and helped the author create a strategic plan in which “pain points” could be solved by AI. The results can be seen in Figures 6-8 below and will clarify the thought process of the author.

Figure 6. Theme 1 Establishing Beer Categories Figure (Geilings, 2021)

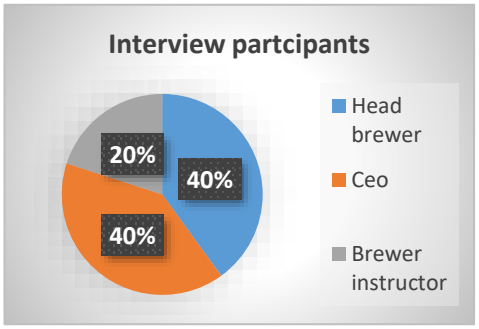


Figure 7.

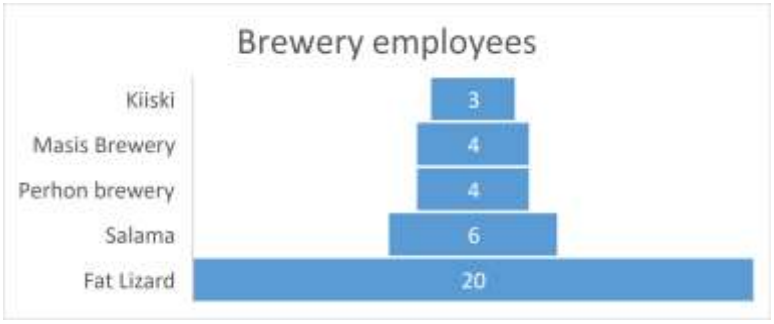
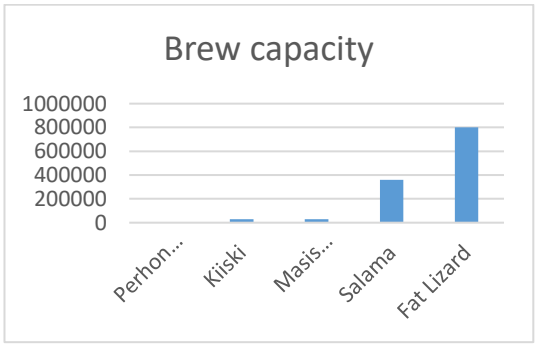


Figure 8.

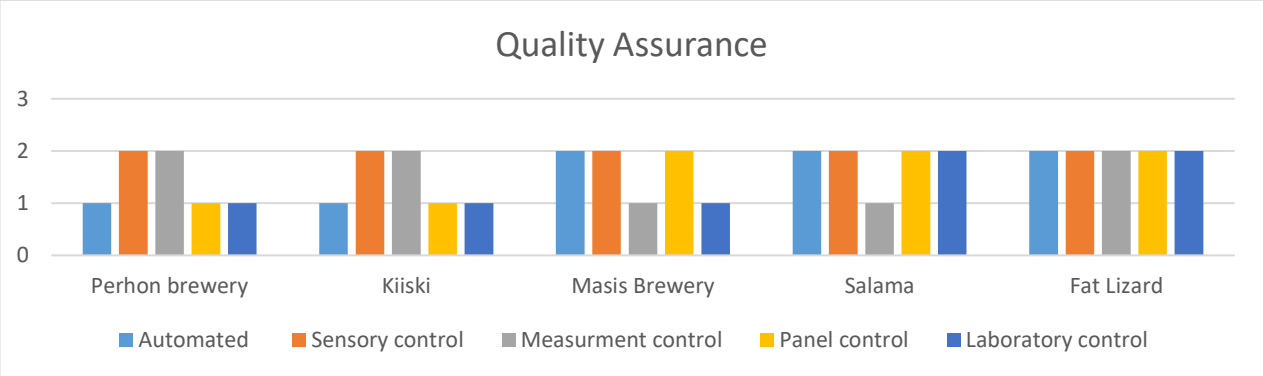


In order to establish the three brewery categories for the end product of the roadmap, the author had to establish criteria to justify the reasoning behind placing the interviewed breweries in their respective category. The author has opted for two criteria, being the employee size and the brewing capacity. As seen in illustrations 7 and 8 above. The first category of starting a brewery is been created for Masis Brewery. What makes Masis Brewery a starting brewery is a fact that they are in the midst of finishing their own brewery. During the interview, the interviewee stated that “This month we will get the equipment for the brewery and we aim to get our first beer out mid-June” (Palo, 2021) Therefore, Masis Brewery has been placed in the first category of Starting breweries. The second category is a microbrewery,

where Perhon and Kiiski brewery has been placed. Both breweries have less than five employees and as seen in the brewing capacity they produce a marginal amount of beer per year. During the interview, both breweries stated “it is a very manual process” (Sinsalo, 2021) Therefore, they have been placed in the second category of a microbrewery. At last, the third category is Medium breweries. In this category, the breweries of Salama and Fat Lizard have been placed. The main reasons are a larger employee base of more than 5 and the brewing capacity of more than 50.000 liters a year. Therefore, these two breweries have been placed in the Medium brewery category.

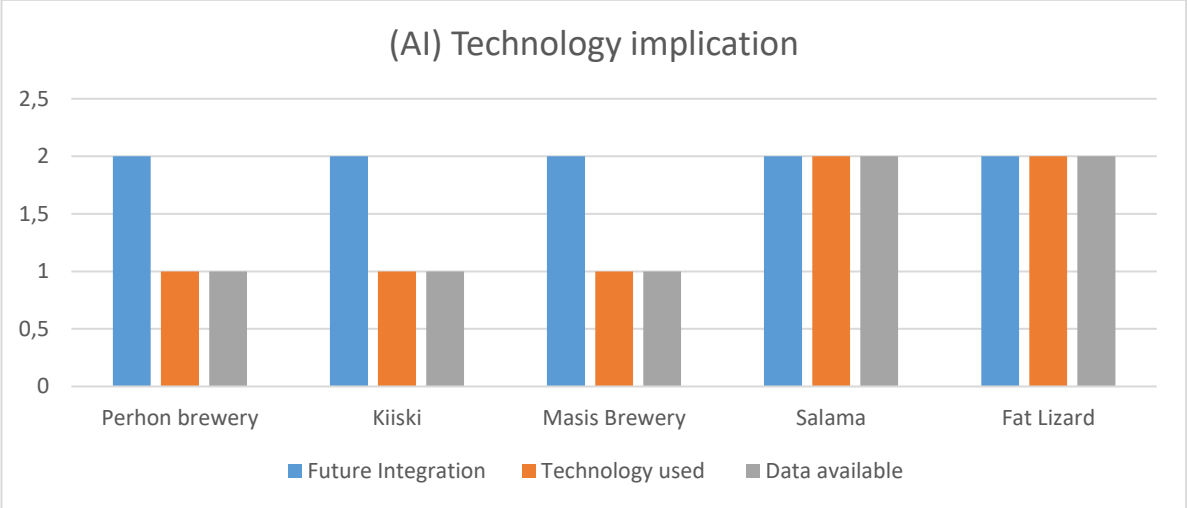
At last, the author needed to ensure the quality of the interviews. Therefore, as seen in illustration 6 the interviewees were either high-placed company officials or brewers who are directly involved in the brewing process. By interviewing these participants, the author has a piece of gathered information from reliable sources.

Figure 9. Theme 2 Quality assurance (Geilings, 2021)



The graphical illustration above has been created by measuring five different quality controls. The reasoning behind the use of numbers one and two is because the data was not numerical but alphabetical. Therefore, number one stands for no, and number to stands for yes. The questions are therefore formulated as; is there any automation in the brewery? Or does the brewery make use of sensory control? As seen in the graphical illustration above, the first two category breweries tend to have at least two of five quality controls as compared to medium breweries that have four or more quality controls in place. There are however some quality control issues for smaller breweries as they only focus on “Sensory controls, of course, every beer we smell, taste, visual control” in the case of Perhon Brewery. However, due to their primary function of being an educational institute and the fast turnover for the beers they produce, this should not be worried to much about. Larger breweries tend to make more use of laboratory control, such as Salama Brewing who “We currently send it to Tallin, to do the basic testing about the alcohol and the hygiene” (Holmlund, 2021)

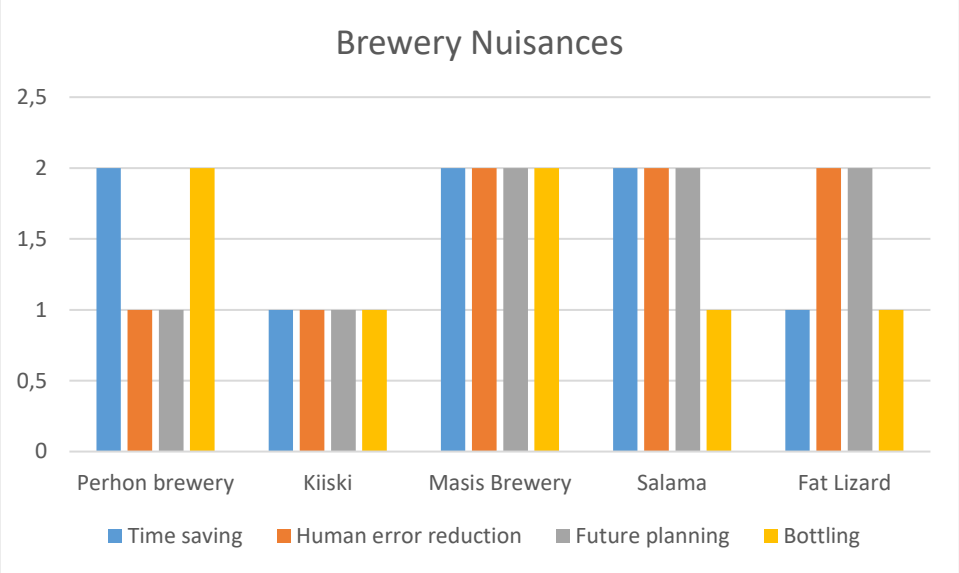
Figure 10. Theme 3 (AI) technology implication, (Geilings, 2021)



Note* The graphical illustration above has been created by measuring three different technological implications. The reasoning behind the use of numbers one and two is because the data was not numerical but alphabetical. Therefore, number one stands for no, and number to stands for yes.

The third theme explored by the author regarded the current AI implication in the breweries from each category. As seen in the graphic illustration of 10, the technology implication has been divided into three categories. The first category focussed on the opinion, of all the interview participants, if AI or other forms of technology will be integrated into the brewing process in the future. The second category established if breweries were already using any form of AI or beer brewing-related technologies. At last, the third category explored the possibility of data being available. As mentioned throughout the empirical part, AI runs on data and without data, it will simply not be useful. Every brewery recognizes the future integration of AI in the beer brewing process and speak positively about this integration. Janne Palo from Masis Brewery has stated the following; “I think AI will be a big factor in the brewing future. and I am looking forward to it as it can take out a human error aspect of it.” (Palo, 2021) As for technology or AI being used, that is much lower. Only the larger breweries make use of it as of now. An example of what is being used is; “the app which is called brewplanner. It is a US program that helps to keep track on the tanks and what is coming out when” (Holmlund, 2021). Fat Lizard also created their own system that keeps track of the mashing time. It is called the brewing apparatus system; “it means that the first system that was built by ourselves had a way to automate the mashing procedure” (Ylinen, 2021).

Figure 11. Theme 4 Brewery Nuisances, (Geilings, 2021)



Note* The graphical illustration above has been created by measuring four different brewery nuisances. The reasoning behind the use of numbers one and two is because the data was not numerical but alphabetical. Therefore, number one stands for no, and number to stands for yes.

At last, in each interview, the questions were asked what the main nuisances are for the breweries and how this could be solved by AI. From the five breweries, the themes seen in the graphical illustration above reoccurred. Of course, the starting brewery is facing all the common problems such as how to best plan their time, how they can reduce human error in the brewing process, etc. Overall the most reoccurring nuisance is future planning. During the interviews, breweries have stated that they would like to minimize the amount of time the tanks are empty or plan more accurately the brewing time so they can make better planning for the personnel. A statement from Salama CEO; “I think it will be to get the whole process more efficient from start to finish and see like when a tank is going to be empty” (Holmlund, 2021) This clearly states the desire of having a more precise planning system. This is also the case for Fat Lizard Brewing; “One thing for our brewery is to be able how to predict the schedule of finishing an individual batch. We would benefit from knowing how long the fermentation is going to take beforehand” (Ylinen, 2021).

5.5 Result of Artificial Intelligent expert interview

After coding and discussing the data from the beer brewery interviews the author presented the findings to the AI specialist. Presenting the findings occurred via a semi structured interview and resulted in the following coding of themes. The first theme discussed

questions to establish the expertise and status of the AI expert, the second theme discussed AI in general and from the AI expert's view. The third theme focussed on the brewery nuances and how AI could solve these. At last, the fourth theme involves suggestions to anyone who is thinking of integrating AI into their business.

Theme 1, AI expertise

The main reasons for interviewing the AI specialist Victor Correa Gandia is his work experience and his specialization. He has over six years of experience in the AI field and is specialized in the neural network; "I am specialized in the neural network, I am most specialized in image recognition" (Gandia, 2021) Furthermore, he is an MIT researcher and currently researching in the breast cancer subject. As mentioned before, questions one to three were specifically asked to guarantee the reliability of the AI expert. In the author's opinion, the credibility of the AI expert is non-questionable and the interview could be continued.

Theme 2 AI general questions

The interview continued with questions four to eight where the interviewer attempted to gather the perspective on AI from the expert. The main reason for gathering this perspective is to match the theoretical research with the reality of an expert working in the field. Examples of the questions asked and the received answers are: How would describe AI to a non-technical person? On which the expert replied, "I can say that AI is the future of computer science. The big point that we are trying to achieve is that a computer is thinking like a human person" (Gandia, 2021). But also "You have some input and the algorithm gives to you a response/ output. That can be a problem. You never know what the algorithm is going to give you". (Gandia, 2021). Both these answers confirmed that the author's pre-existing knowledge matched with the expert's point of view. AI is a very complex process that eventually would like to match all human capabilities, however, some obstacles need to be overcome. Another, aspect that has given the author a new perspective on AI is the cost area. According to the AI expert: "Cost about money, it is hard to say. It depends a lot on the business that you have. It depends on how much money you want to invest. You can do AI by using just API, Application Programming Interface, a set of tools for AI software (Choudhury, 2019), or Amazon, Google, Microsoft services, and you can say that you are doing AI, but you are not doing AI, you are using the company services" (Gandia, 2021). The author did not think of this aspect of AI and how businesses can incorporate it. However, now it will be taken into account when the strategic roadmap is created.

Theme 3 Brewery nuances

During the interviews with the breweries, four main nuances came to light. Questions nine to twelve in the interview talked about these problems. Again, the AI expert gave new perspectives on what AI is and whatnot. For example, Masis brewery is looking for a technology that can assist them in filling out the paperwork for Valvira, as this is time-consuming. However, that is not AI that is automation; “Actually for this thing that you are saying you do not need AI, you only need a software that automates this task” (Gandia, 2021). This was one of the areas that the AI that clarified specifically what is AI and what it is not. Another example is in the feedback process. How breweries have a lot of data about customer feedback but there is no extensive use for it, as of now. However, This is more a big data thing; “because you have a big data set and with certain probabilities/ odds you have this expected result. it is not AI as your algorithm is learning nothing” (Gandia, 2021). The areas in which AI can be used are quality control and future planning/ predictions. For generating constant quality “It is something you can do with AI, the first thing you need is a big data set, the first thing for AI implication is a big data set because you need it to teach your AI” (Gandia, 2021) At this moment only two breweries have the capability to generate the best results. These are Salama Brewing Co and Fat Lizard Brewery, as they have a vast amount of data available and over a larger amount of time. As for future planning and predictions “Is the most basic case for AI, when you have historic data/ old data and that data gives you specific results, the AI is learning from that data” (Gandia, 2021). Yet again, this can be best accomplished by the medium breweries. However, smaller breweries could also make use of this whenever they start collecting data and adding it into the AI algorithm.

Theme 4 Future suggestions

At last, questions 13 and 14 discussed suggestions for anyone who thinks about integrating AI in their business and what the future of AI is according to the AI expert. The most important finding from the first question is the investment of time and money; “be ready to spend a lot of money. Actually, it is a golden rule, if you want something cheaper/good and fast. It is not possible. You need time, invest much money and then you will have good results with it” (Gandia, 2021). Currently, it is not possible to get fast and cheaper AI results as it a complex technology and needs experts working on it. The latter question regarding the future of AI is according to Gandia the following; “Probably in 5 years it is still not enough time to make a big step. We are now making small steps because we are limited to the hardware, the physical aspect”. To conclude, the machines and materials that now are being used are not sufficient to support a major change in AI. Therefore, the discussed applicability for the breweries will probably stay the same for the coming five years.

6 The Product: “Strategic roadmap”

The strategic roadmap can be found in full in the appendices, specifically appendix 5. To get a better understanding of the Strategic roadmap. It has been structured in the following matter. On the left side, there are the three categories which have been the pre-defined scope of the research, the first category is the Brewery starters of which in this case has been directly influenced by Masis Brewery. The second category consists of microbreweries Perhon Brewery and Kiiski Brewery. The final and third categories consist of Medium Breweries Salama Brewery and Fat Lizard Brewery Company.

Each slide will discuss one element that will be later integrated into the total overview of the Strategic roadmap. These elements will all have their own color and are highlighted in the Legenda at the end of the appendix. As mentioned in the introduction, the strategic roadmap will follow six steps. These six steps will cover the five elements that will be discussed below. The sixth step will be the total overview in which all of the elements will come together.

Step 1. Problem
This theme will discuss the obstacles breweries in their respective categories face and why it limits them to obtaining their strategic vision. I.e. becoming larger and reaching their targeted amount of brewing per year, preserve the quality of their products, manage time schedules.

Step 2. Technology
The technology theme will discuss what can be achieved with AI and how it can solve the problems of starting, micro and medium breweries. Each AI technology will be clearly linked back to each problem discussed in the first theme by positioning it right next to it.

Step 3. Company capabilities
The theme will cover what type of investments need to be made to resolve the problems and make the brewers continue their journey into obtaining their own strategic goals. Also, the investments will be marked with either Low (L), Medium (M), and High (H) level of investment required. Adding these markers will highlight what is most important at the moment for each respective category.

Step 4. Cost
Knowing which problems can be resolved by which technologies and by who is the first step of making change. Now by looking at the cost of each technology and its implementation. It

will become clearer for each brewery in its category what the price will be for the change it is willing to make.

Step 5.Time frame

At last, each problem and its solution will take time to be implemented into the company. Some solutions need a longer time to be fully operational than others. Therefore, looking at each solution and estimating what time it will take, the Overview will be more clearer.

The total overview will incorporate the five elements discussed previously into a single summary. Furthermore, the time frame will be two years from now. The author has chosen to keep the time frame of two years as it both incorporates technology and the manufacturing industry. Research has shown that the length of the roadmap depends on the industry it is based upon. The technology and software industry tend to have the shortest time frame as technologies and software evolve quite rapidly. On the other hand, the manufacturing industry has one of the longest time frames as they are producing physical products and that takes time. Figure 4 shows the average time frame for different industries. By taking both the manufacturing and technology industry into account the author has chosen to take an average of 3-4 months for software and 1-3 years for manufacturing. Therefore the suggestions will be placed in the timeframe of two years.

Figure 12. Timeframe per industry, (Productplan, 2021)

The last page of the strategic roadmap consists of the Legend and displays the colors used to differentiate each element as well as the figures used to clarify certain objectives.

7 Discussion

This paper has revolved around the question: “Using AI to positively impact the beer brewing process”. The author’s interest in both the beer brewing industry and the technological field of AI has led to the research in both these aspects. Eventually, the end product of the roadmap would bring these industries together and clearly display solutions to problems.

The structure of the thesis consisted of six chapters in which three chapters discussed the theoretical framework of the Beer Brewing Process, AI, and the Roadmap. The first chapter of the introduction served its purpose to inform the reader in general of what would be discussed throughout the paper. At last, each particular information discussed in each chapter has been collected from sources such as books, academic articles, journals, etc.
The fifth chapter of the thesis, the empirical part, went over the methodology of the research and the results of it. At last, the sixth chapter outlined the end product of the strategic roadmap. Note, that the outline should be read together with appendix five, to get a clearer understanding of how the roadmap was developed.

During the process of collecting trustworthy information of the Beer Brewing Process, the line of thought behind it was to answer the question “How can brewers at different stages make use of Artificial Intelligence?”. The line of thought behind the research in the fourth chapter of the empirical part, was to answer the question “How do brewers see AI?”.

As discussed in chapter five, the author has chosen to carry out a qualitative research. The main reasons behind gathering qual data were the amount of time, which unfortunately was limited, and the number of participants that could be targeted. Furthermore, the author intentionally wanted to have a limited sample size, both to guarantee the best possible quality of the research and have the possibility to explore other themes during the interviews. The interview structure was therefore semi-structured and the questions, see appendix three and four, were based on knowledge gained from the theoretical part of Beer Brewing and AI. However, during the interviews, as expected, the outcomes would vary and new themes would come up. An example, Valvira’s reoccurring strict paperwork regarding alcohol production. Whenever new themes would be discussed with the interview participants, the author would afterward research these themes and include them in the theoretical framework. This would only further strengthen the end product and justify the results.

At last, before discussing the results of the research, the author has had two different interview participants. All the knowledge for the end product’s first part of knowing what prob-

lems circle in the brewing process was gained by interviewing qualified people of five breweries. The second part of the end product's solutions to the problems has been gained from presenting the problems to an AI expert. Therefore, in chapter five there are two separate chapters of results.

The results of the Finnish brewery interviews have provided insights into the brewing operation of the three categories (Starting brewery, Micro-brewery, and Medium-brewery). First, the quality assurance of the beer is more invested in the bigger the brewery gets. For example, the smaller breweries rely more on sensory controls and measurement controls. This is acceptable, as there are many instrumentations available that can ensure the quality of the beer is consistent and according to Parker (2020) every brewery must at least have those two quality control measurements.
Also, while discussing the technology implication in the beer breweries. All of the interview participants recognize the future integration of AI in the beer brewing process. The interview participants welcome this technology as they see potential in getting better quality or remove manual work, to focus their resources on other areas. This is further supported by the possibilities of AI, such as managing quality control with camera sensors or product optimization where AI uses historic data to alter future outcomes.
At last, the most important part for the end product, are the problems that breweries are facing and how AI could solve them. Four main nuisance themes surfaced during the interview, time-saving, human error reduction, future planning, and bottling.

After discussing the results of the Finnish brewery interviews with the AI expert, the following interesting outcomes came up. The cost of creating AI is high as you need a lot of manpower. However, you can state you are using AI, but that simply means you are making use of AI software produced by others, such as Google, Microsoft, or Amazon. Another interesting point made by the AI expert is the explanation of what AI could do and what it can not do. From the five problems, the breweries face currently, only two can be for sure solved by AI and one is still doubtful as it technically is not AI. Other problems can be related to automation, such as the bottling problem some breweries have or Big data problems about customer feedback analysis. The interview with the AI specialist has been valuable and pointed out some interesting points that would not have been learned from only theoretical research.

Throughout the research and development of this paper, the following limitations have been faced by the author:

- Time.

As stated before, the author is a Double Degree student from the Netherlands and has had a limited time frame in which the thesis could be written in. This limited amount has therefore resulted in narrowing down the scope of the thesis.

- Brewery contact.

Less than 50% of the breweries that have been contacted have replied to the request for an interview. This resulted in the bare minimum of only five interview participants. The Covid-19 situation has also played an influence on a smaller amount of interview participants as the author was could not visit breweries outside of the city of Helsinki.

- Academic research on the combination of AI and beer.

The individual research of the topics yielded enough information to understand the processes behind AI and Beer Brewing. However, finding specific implications of AI in the Beer industry was very limited.

- Finnish market.

The author had whished to compare the Finnish beer market with at least one other EU beer market. However, due to the limited time and little response from the Finnish breweries, this could not be realistically accomplished in the given timeframe.

7.1 Development and suggestion for further ideas

To conclude, AI has great potential in the beer industry with all its capabilities. The usage of AI in the smaller brewery industry is, as of now, very limited due to a lack of deep understanding or investment capabilities. Still, brewers from different categories recognize the potential and see a future of AI integration in the brewery. Together with the extensive knowledge of the beer brewing process and AI, it is safe to assume that AI can solve some problems the breweries are facing right now. However, time and money should not be forgotten. To answer the question on how AI could positively impact the beer brewing process, the answer lies in future planning. That is the particular part in which AI can impact the brewing process right now.

As for further ideas, the author would like to see more research be conducted on the fermentation process and how AI could predict this time exactly. Also, for future researchers, the focus should be more on what type of AI technologies exist and could be applied in the beer industry. Currently, ideas are being developed for many other industries, and the beer industry tends to fall behind.

8 Conclusion

The thesis process for the author consisted of three stages. The first stage revolved around gaining the knowledge needed on AI, Beer Brewing Process, and Roadmap. However, the research gained in the first part would be constantly updated. The second stage was all about gathering insights from reliable sources. The author would, therefore, like to thank all my interview participants for their hospitality and the time was taken to sit down with me. Especially, Salama Brewing Company who invited me to their brewery in Espoo. Also, the AI expert has helped me tremendously in making the current assumptions of what exactly can be classified as AI. This really has strengthened the research in the author's opinion. The third and final stage of the thesis consisted of building the final end product of a strategic roadmap. Constantly updating the information was kind of nuance but it contributed to the paper's layout. However, next time the author will opt for another approach instead of writing parts and carrying on without double-checking. The author can say that he has learned a lot from the thesis subjects as well as managing time more efficiently and refining his research skills. Overall, the thesis has been tough to write as the time period was much shorter than usually is given. Also, the current Corona pandemic affected the opportunity to visit breweries. But, as mentioned before, the process itself has given the author valuable skills and some of these will be applied in the future.

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Appendices

Appendix 1. Interview invitations

Request to interview you on the application of AI and Beer Brewing

Dear Sir/Madam,

I am a fourth year hospitality exchange student at Haaga-Helia. I am currently writing my thesis on how Artificial Intelligence could positively impact the beer brewing process and I would love to interview you (preferably by the end of next week) as part of my research. Specifically, I am hoping you can comment on:

How the brewing process currently is being performed
If AI is already being used in the company/ beer brewing process
Whether or not AI would be used in the beer brewing process

The phone or (Zoom) interview will not exceed more than 15 minutes.
The thesis, once completed, publishes on the 1st of June. My goal from our interview: is to gain more in depth understanding on how AI is being perceived in the beer brewing industry.

Thank you for considering my request. I hope to hear your response either way by the end of this week.

Kind regards,

Brian Geilings

Appendix 2. Interview guideline

Interview Guideline

The interview protocol that will be followed for conducting the semi-structured interviews is based on (Oxfam International, 2019) guidelines. By following the set guidelines, the interview should generate valuable insights and useable qual data. Side note, only the most important suggestions from the Oxfam guideline will be taken into consideration for this guideline.
The guideline will consist of 4 chapters, some chapters will have a supporting document or external source/tool. This is the case for chapter 2 where the external tool used will be Zoom. At last, in chapter 3 the supporting document is an excel file in which the questions will be processed.

Chapter 1 Who will be interviewed?

The research questions that need to be answered are (1) How do beginning, micro, and medium brewers see AI. (2) How can brewers at different stages make use of AI?
Therefore, I will need to interview at least one of each group to discuss their opinions on the matter of AI. As the brewing part, for now, is the main focus, the questions need to be answered by brewers. They are familiar with the brewing process and could highlight certain problems.
It is important to keep in mind if the interviewee could introduce other members from the beer brewing community. This method is called the snowball technique. Using this technique could provide access to more interview candidates. (Oxfam International, 2019)

Currently, I have contacted the following breweries, see figure 1.1 below. There are three breweries that are interested in having an interview. These breweries are Fat Lizard, Salama and Fiskars. By the end of this week (Week 14) there have to be at least 6 interview candidates. Especially breweries that are medium and starting. The current interview candidates are two micro-breweries (Fat Lizard and Fiskars) and one medium brewery (Salama).

Apart from interviewing beer breweries/ brewers, there will also be an interview with an Artificial Intelligence expert, Dr. Victor Correa Gandia. He will be answering questions regarding the different Artificial Intelligence technologies and how they could be implemented by beer brewers.

Figure 13. Interview candidates (Geilings, 2021)

Interview contacts		
Email:	Company:	Telephone number:
jere@etko.beer	Etko Beer	358503206538
info@panimo.com	Soumelinanan Panimo	9668200
juha.sinisalo@perho.fi	Perhon Brewery	405090770
krista.lehtoranta@stadinpanimo.fi	Stadin Panimo	440270379
topi@fatlizard.beer	Fat lizard brewing	358456674838
ville@olarinpanimo.fi	Olarin Panimo	408401438
lumi@lumibrewing.com	Lumi brewing	358442438104
christian@salamabrewing.com	Saloma brewing	358405633860
kirsi@fiskarsinpanimo.fi	Fiskars brewery	358449789987
janne@panimokiiski.fi	Kiiski brewery	505098031

Chapter 2 Setting up the interview

Prior to the interview, I will create a Zoom link in which I will host the conversation. The Zoom link will be sent at least a week in advance. Due to the current restrictions the interview cannot be held face to face and has therefore been moved to an online environment. The e-mail send out to the breweries regarding the interview, states that the interview will take no longer than 15 minutes. Still, for each interview, a set time of 1 hour is planned. This 1-hour time-frame will hopefully include an interview longer than 15 minutes and time to reflect upon the interview afterwards. The suggested time table will be:

Friday 9th of April 2021

Timeslot 1: 14:00-15:00

Timeslot 2: 15:00-16:00

Timeslot 3: 16:00- 17:00

Tuesday 13th of April 2021

Timeslot 1: 14:00-15:00

Timeslot 2: 15:00-16:00

Timeslot 3: 16:00- 17:00

Monday 12th of April 2021

Timeslot 1: 14:00-15:00

Timeslot 2: 15:00-16:00

Timeslot 3: 16:00- 17:00

Wednesday 14th of April 2021

Timeslot 1: 14:00-15:00

Timeslot 2: 15:00-16:00

Timeslot 3: 16:00- 17:00

These dates are especially set in week 14 as the gathering of data needs to happen as soon as possible. The confirmations of the dates by the breweries still have to be received.

Chapter 3 Questioning

The beginning of the interview will start off with a small introduction of who I am, why I am interested in researching about the topics and ask the interviewee if they agree to being

recorded or their name used in the thesis. This will be followed by an introduction from the interviewees themselves.

The questions that will be asked are based on being:

- General (To start of the conversation)
- Open Probe (“WH” questions)
- Comparing and contrasting (Ask questions regarding a past situation and a current situation)
- Imagining (Ask questions in a what if scenario)
- Impact (Ask questions that on how certain aspect would impact the interviewee)

The questions that will be asked during the interview are displayed in the excel file “”. The excel file will be used to gather the data from all the interviewees and to create supporting visual figures.

Important side notes that will be kept in mind during the interviews will be to remain neutral in expressions, truly concentrate on what is being said and paraphrasing their points. (Oxfam International, 2019)

Chapter 4 Interview ending

The interview will end with spare time left so that the participants have the opportunity to ask questions. Also, in the end, the purpose of the interview will be repeated so that the interviewee exactly knows for what the data will be used and if they may be implicated in the research.

Lastly, after each interview, there will be time taken to reflect on the interview and the gathered data. By doing this directly after the interview, the most important findings will not be forgotten. Moreover, by reflecting on the interview process, certain adjustments could be made for the following interview.

The questions that will be asked during the interview are displayed in the excel file “”. The excel file will be used to gather the data from all the interviewees and to create supporting visual figures.

Important side notes that will be kept in mind during the interviews will be to remain neutral in expressions, truly concentrate on what is being said and paraphrasing their points. (Oxfam International, 2019)

Appendix 3. Interview questions for breweries

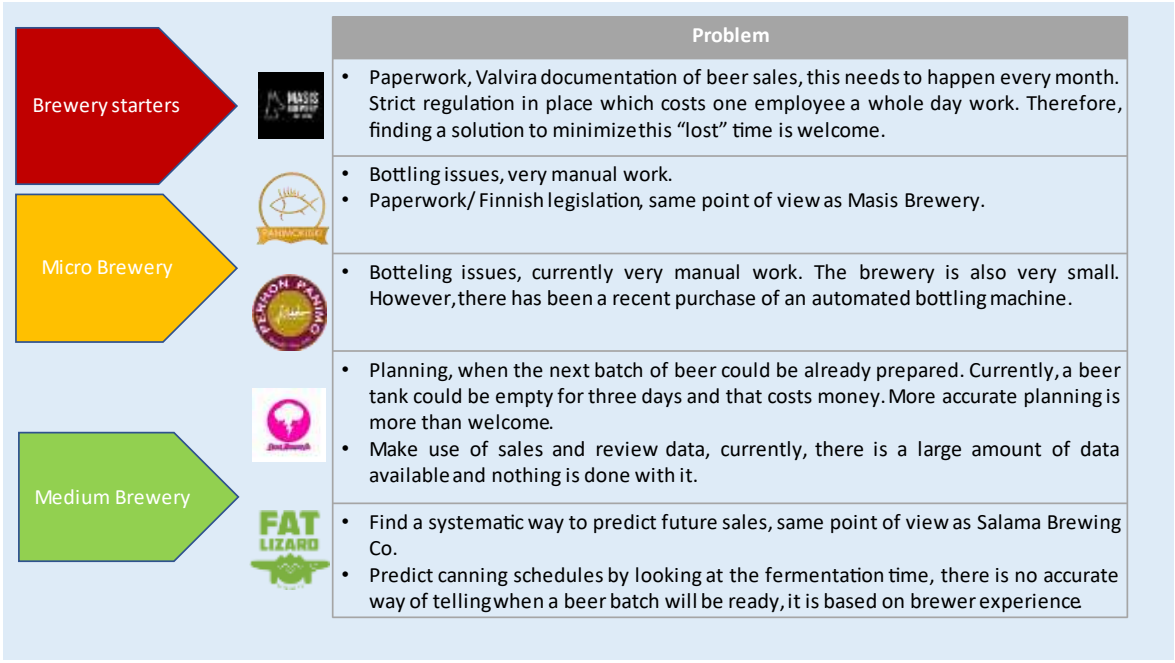
1. How long the company is operational?
2. How many people do you employ
3. How many beer do you produce?
1. How does your beer brewing process occur?
2. What are the challenges in each step?
3. Why do you have these challenges?
4. What kind of waste do beer breweries have (in general)
5. How do you make sure the quality of the beer is consistent?
6. Do you use any sort of AI in the beer brewery?
7. How do you implement customer feedback in the beer brewing process?
8. What kind of process would you like to implement , if anything is possible what would you like to have?
9. What is next for your brewery?
10. How do you see the future (5 years from now) of beer brewing evolve?
11. Do you know more people in your network that I could approach for my research?

Appendix 4. Interview questions for AI specialist

1. What type of AI technology segment are you specialized in?
2. How long do you have experience in the AI field?
3. What is your current job regarding AI?
4. How would you describe AI to a non-technical person?
5. What are some examples of AI in use?
6. In your opinion, how can AI impact the beer/ product manufacturing industry?
7. What are the challenges of AI?
8. What type of costs are linked to AI in businesses?
9. What type of AI can automate paperwork?
10. How can AI make sure the quality of beer/ a product is consistent?
11. How can AI implement customer feedback for the beer brewing process?
12. How can AI implement historic data and make future predictions?
13. What would you suggest to anyone who would like to make use of AI?
14. How do you see the future (5 years from now) of Artificial Intelligence evolve?

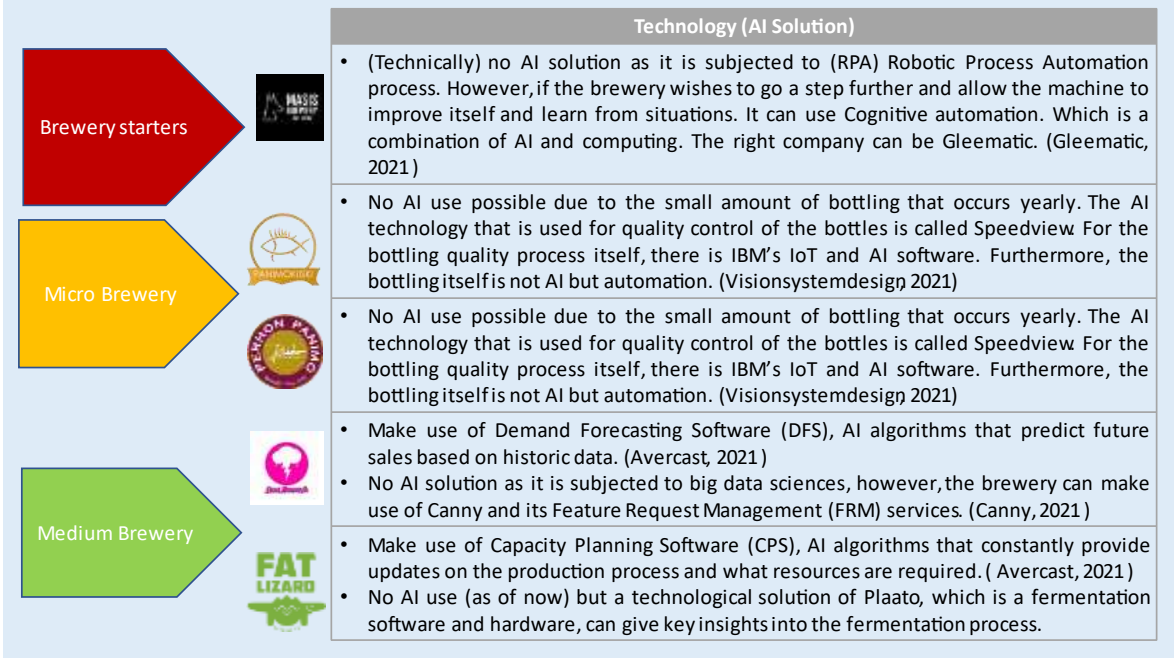
Appendix 5 The Strategic Roadmap

Figure 14. Brewery problem. (Geilings,2021)



Problem
• Paperwork, Valvira documentation of beer sales, this needs to happen every month. Strict regulation in place which costs one employee a whole day work. Therefore, finding a solution to minimize this "lost" time is welcome.
• Bottling issues, very manual work. • Paperwork/ Finnish legislation, same point of view as Masis Brewery.
• Botteling issues, currently very manual work. The brewery is also very small. However, there has been a recent purchase of an automated bottling machine.
• Planning, when the next batch of beer could be already prepared. Currently, a beer tank could be empty for three days and that costs money. More accurate planning is more than welcome. • Make use of sales and review data, currently, there is a large amount of data available and nothing is done with it.
• Find a systematic way to predict future sales, same point of view as Salama Brewing Co. • Predict canning schedules by looking at the fermentation time, there is no accurate way of telling when a beer batch will be ready, it is based on brewer experience

Figure 15. (AI) Technology Integration. (Geilings,2021)



Technology (AI Solution)
• (Technically) no AI solution as it is subjected to (RPA) Robotic Process Automation process. However, if the brewery wishes to go a step further and allow the machine to improve itself and learn from situations. It can use Cognitive automation. Which is a combination of AI and computing. The right company can be Gleematic. (Gleematic, 2021)
• No AI use possible due to the small amount of bottling that occurs yearly. The AI technology that is used for quality control of the bottles is called Speedview. For the bottling quality process itself, there is IBM's IoT and AI software. Furthermore, the bottling itself is not AI but automation. (Visionsystemdesign, 2021)
• No AI use possible due to the small amount of bottling that occurs yearly. The AI technology that is used for quality control of the bottles is called Speedview. For the bottling quality process itself, there is IBM's IoT and AI software. Furthermore, the bottling itself is not AI but automation. (Visionsystemdesign, 2021)
• Make use of Demand Forecasting Software (DFS), AI algorithms that predict future sales based on historic data. (Avercast, 2021) • No AI solution as it is subjected to big data sciences, however, the brewery can make use of Canny and its Feature Request Management (FRM) services. (Canny, 2021)
• Make use of Capacity Planning Software (CPS), AI algorithms that constantly provide updates on the production process and what resources are required. (Avercast, 2021) • No AI use (as of now) but a technological solution of Plaato, which is a fermentation software and hardware, can give key insights into the fermentation process.

Figure 16. Company investments. (Geilings,2021)

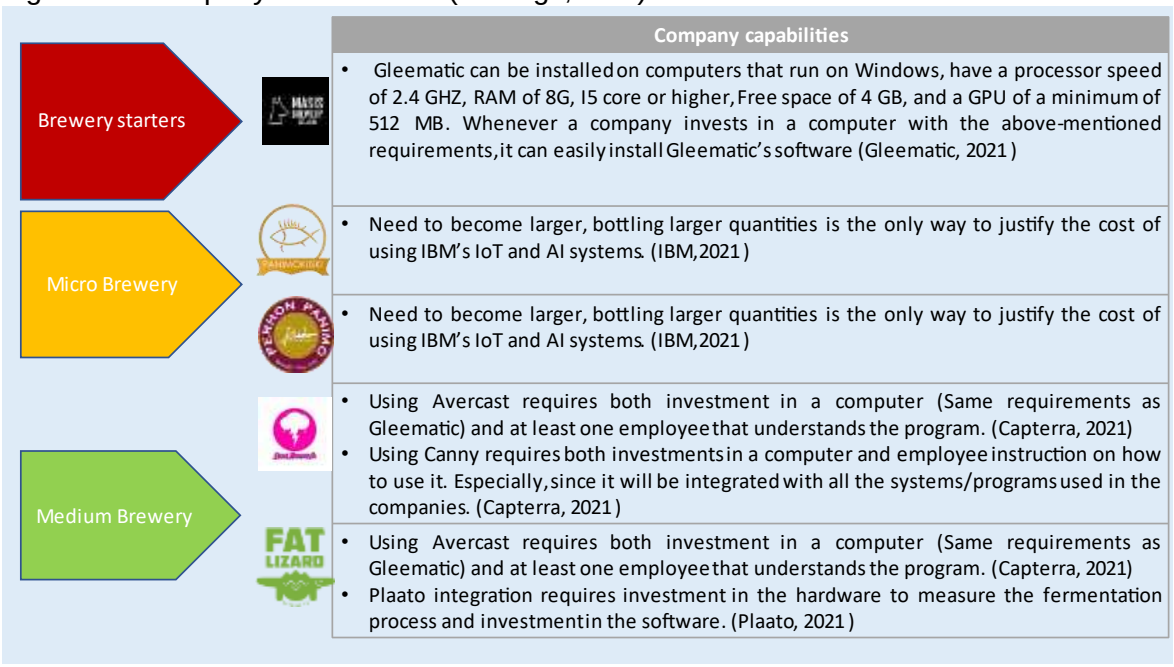


Figure 17. Cost for the Brewery. (Geilings,2021)

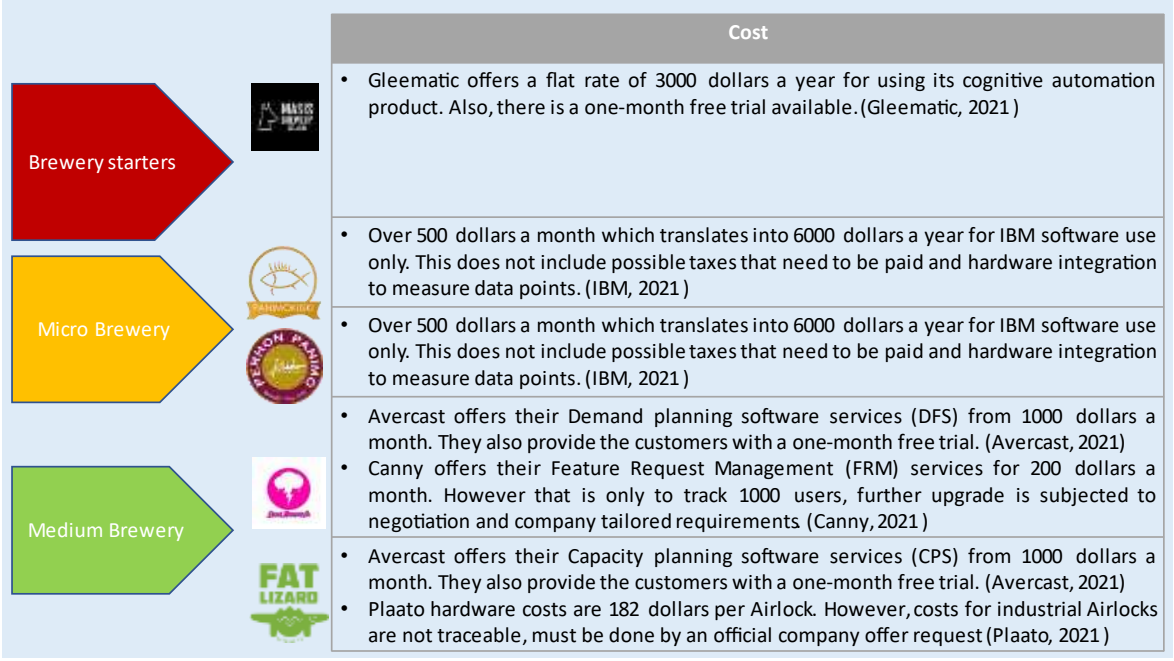


Figure 18. Time frame for solutions. (Geilings,2021)

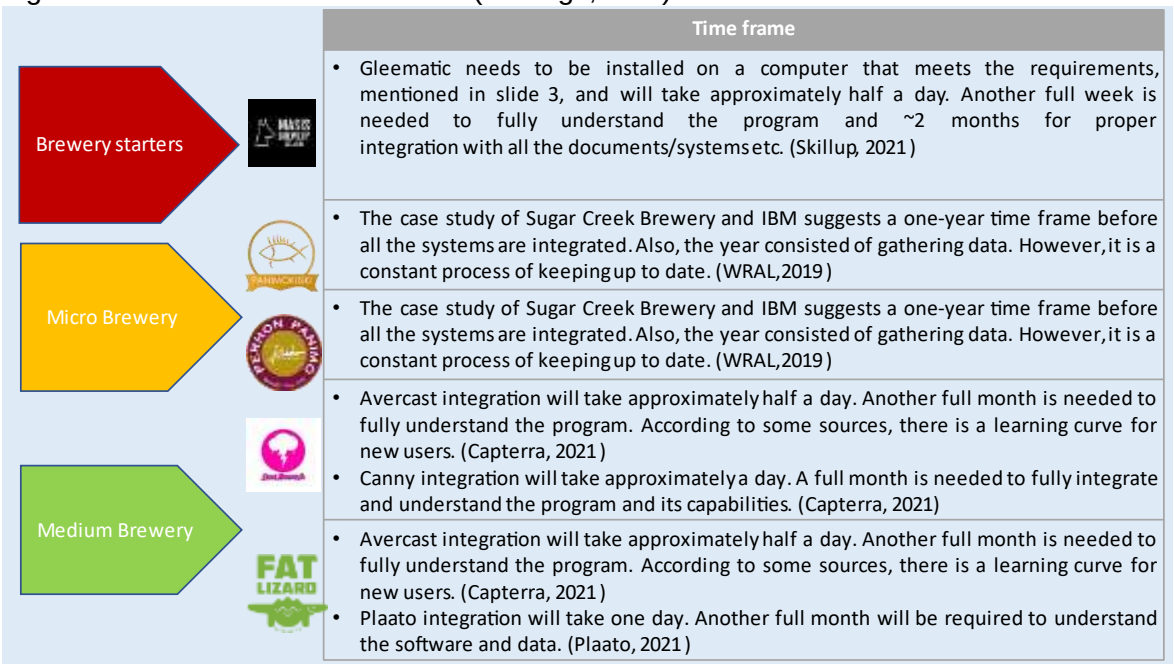


Figure 19. Final overview. (Geilings,2021)

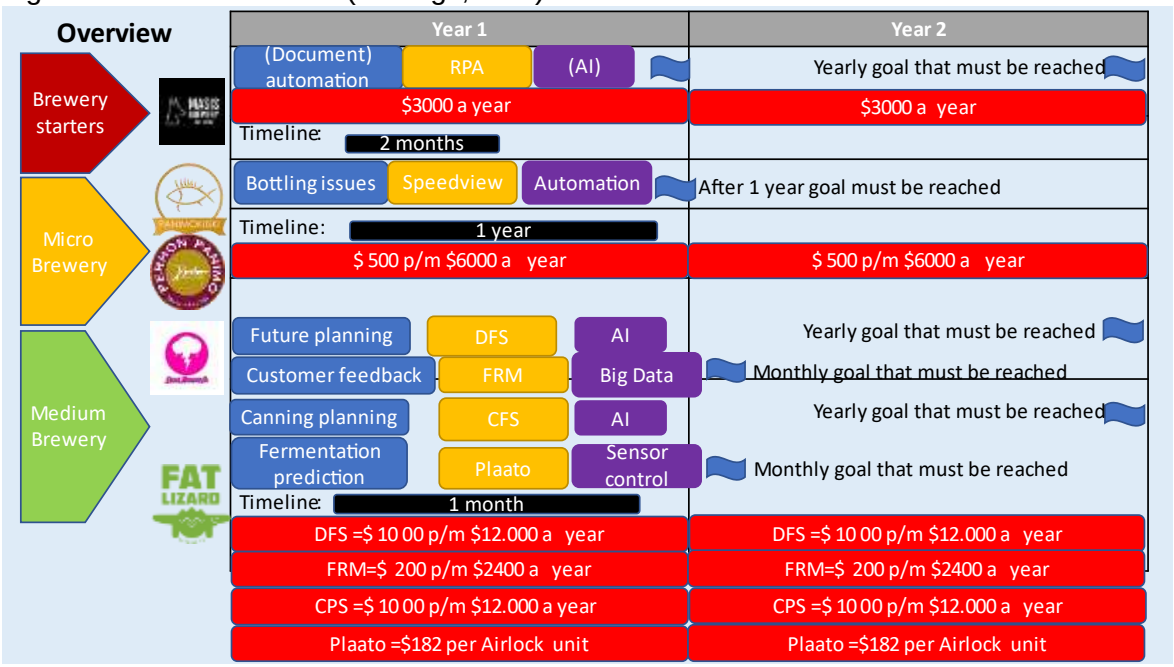


Figure 20. Legend. (Geilings,2021)