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Wine Monitoring

Business value for developing a wine monitoring product
TMKT82

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Abstract

When determining the value of developing a product, several factors must be considered. This thesis explores the business value of developing a specific monitoring product with new technology under the fermentation stage in wine making. This was done by analysing competitors, examining macro factors and patent trends in the industry as well as visiting and observing potential users—winemakers. The study revealed both supportive and opposing factors for the product's value. There are established competitors offering both cheaper, simpler and more expensive options. Since both the product and technology are not near a finished state in their development, it is challenging to determine where this solution would position itself among competitors. Owning the specific product will not eliminate the need for further measurements, keeping users dependent on additional options. However, the need for monitoring and controlling the wine making process is increasing due to new EU laws and regulations, climate change impacting wine quality, and an overall technological transformation of the industry. Conversely, inflation, economic instability, and global conflicts negatively impact the wine industry and potential users, leading to less willingness to invest in new, expensive equipment. Observations from visiting winemakers in Sweden and Italy revealed that most use simple, inexpensive tools and send samples to nearby labs for crucial testing. Patent searches for relevant classification codes indicate that the market for liquid monitoring is thriving, suggesting a demand in this area.

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1 Introduction

In this chapter, a background to the project, and study is given. Thereafter, the purpose of the thesis and its research questions are presented, followed by the goal and constraints.

1.1 Objective

The project's objective is to conduct comprehensive research about the wine making processes, taking into account both traditional methods characterised by rituals as well as modern technological advancements. This holistic approach aims to give an extensive understanding of the production journey from start to finish. The ultimate goal is to identify suitable areas for implementations of one or both of the technologies provided by the client ATTRACT by designing a monitoring product for the wine industry.

1.2 Wine making process

The wine making process is a fairly simple process that has been used for over 6000 years. Different kinds of wine have slight differences in the production process. Identifying potential errors in their process can be made evident by mapping the production processes for red and white wine.[1]

1.2.1 Red wine making

In this section the steps of red wine making is described and illustrated in figure1.

[1]This chapter is taken and slightly modified from the larger project [Berg et al., 2024]

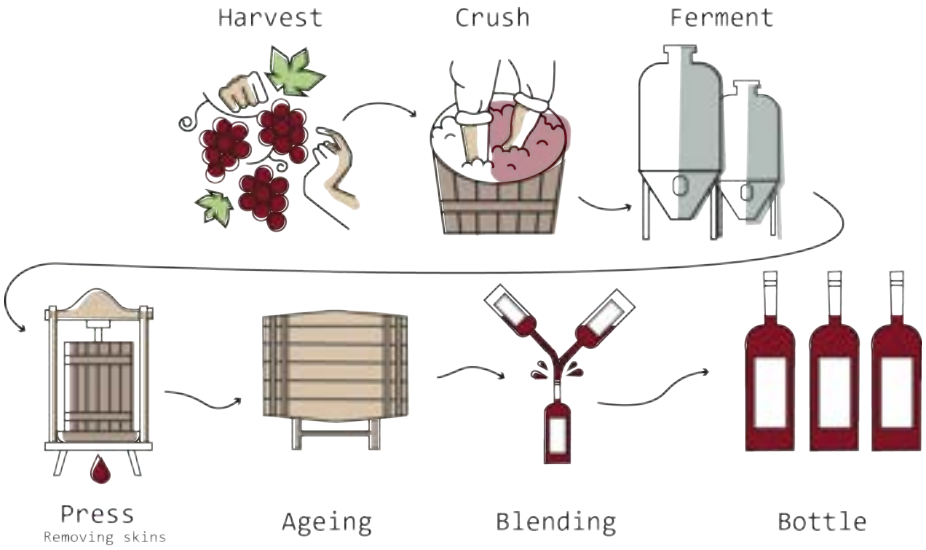


Figure 1: Steps of producing red wine

Harvesting and crushing
Red wine is made by first harvesting ripe grapes, either by hand or machine. Then the clusters of grapes go through a destemmer/crusher that removes whole grape berries from the stems and squeeze them to release the juices. This mixture of juice, skins and seeds is known as must. Sulphur dioxide is often added at this stage to kill unwanted microbes and preserve the must.

Alcoholic fermentation
After crushing, the must is fermented to convert sugars into alcohol. This can be done by adding commercial yeast or letting the native yeast that already occur on the grapes start the fermentation. Keeping the skin during the fermentation is what leads to the deep red colour. Depending on what kind of vessel that is used, different kinds of characteristics can be added to the wine. At the end of the alcoholic fermentation the wine is transferred to wine presses which separate the liquid from the skins and seeds.

Maturing
Red wine is then typically matured in oak barrels before being bottled. Usually a second fermentation, called malolactic fermentation, occurs during the maturing of the wine. What happens is that malic bacteria converts the wine's tart malic acid to softer lactic acid which creates a more pleasant feel to the wine.

Blending
Since wine making is a natural process, each barrel of wine will taste a bit different due to acidity and sugar levels. Therefore, blending is a crucial step to balance and harmonise the aromas of the different barrels. By selecting and

blending specific components, winemakers creates their own perfect wine.

Filtration/Clarification
Red wine undergoes clarification through racking, fining, and filtering during maturation. Sediments settle at the bottom, removed through racking. Fining, using substances like egg whites or clay, addresses tannins or haziness. Blending from various barrels and tanks enhances complexity and balance in red wine.

Bottle
Before bottling, a final adjustment involving sulphur dioxide takes place. Before filling, corking and labelling it is important that oxygen is removed from the empty bottle to prevent oxidation of the wine. [Jim Gordon, 2023b]

1.2.2 White wine making

In this section the steps of white making is described and illustrated in figure 2.

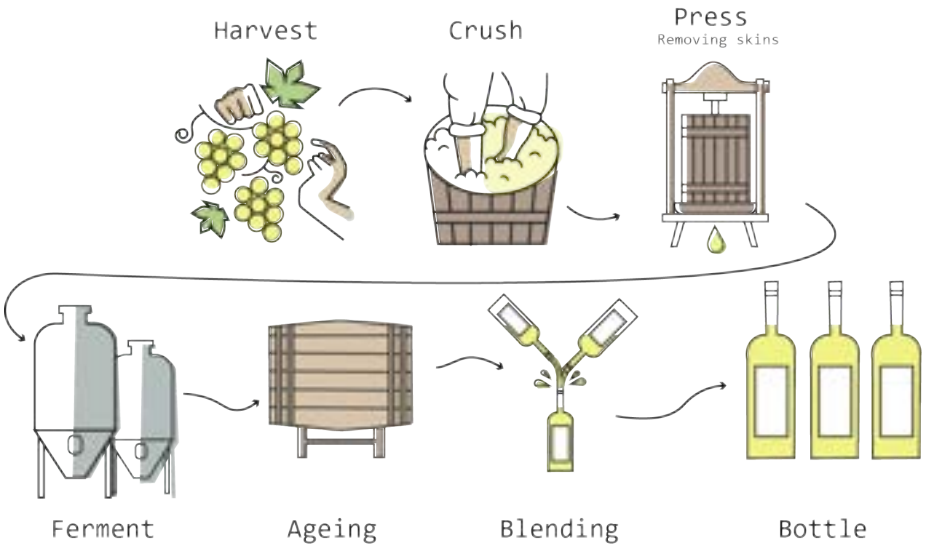


Figure 2: Steps of producing white wine

Harvesting and pressing
The grapes are harvested early in the morning at cool temperatures to keep freshness at optimal ripeness. The grapes are then pressed directly when they arrive to the winery. Wine presses extract juice from grapes. Winemakers may add sulfur dioxide or potassium metabisulfite to prevent spoilage and oxygen absorption. After separation from skins, the juice settles in a chilled tank, undergoes racking, and is ready for fermentation.

Alcoholic fermentation

Once yeast is added to grape juice, a biochemical process unfolds, converting sugar to alcohol, releasing carbon dioxide, and generating heat. Winemakers regulate this by manipulating temperature, stirring, aerating, and feeding the yeast. Various yeast strains are available for different wine styles. While commercial yeast is an option, native yeast present in vineyards and wineries can initiate fermentation. The majority of white wines ferment in stainless steel tanks, with some, like Chardonnay, fermenting in oak barrels.

Maturing
Malolactic fermentation is chosen for richness in Chardonnay or Viognier but avoided in crisp wines like Sauvignon Blanc. Maturation can range from four months for light whites to over two years for reserve-style white Burgundies.
Another choice is whether to keep white wine on lees, a layer of dead yeast at the bottom, adding aroma, protecting from oxidation, and contributing to a richer mouthfeel with periodic stirring.

Blending
Most winemakers are blending their batches in order to make the taste more to their flavour and create a more balanced wine. The blending is often made by hand and the composition determined by careful tasting and trying. This process heavily relies on the taste and preferences of the winemaker. [Sean P. Sullivan, 2023]

Filtering
During this phase, winemakers clarify wine through processes like racking (siphoning to remove sediment) and fining (using substances like egg whites). Commercially, membrane filtration eliminates microbes. Winemakers also adjust sulphur dioxide levels. [Jim Gordon, 2023a]

Bottling
When bottling still wine the wine is then ready for consumption immediately and no more ageing or fermentation is needed. TPO means Total Packaged Oxygen and is a measurement of the level of oxygen present in wine after bottling. The TPO has an effect on quality, stability and ageing potential. Thus, it is generally considered preferable to keep the TPO as low as possible. Higher TPO lends the risk of the wine ageing badly so that the wine in turn oxidises, losing flavour and colour.[Pete Brissenden, 2023]

1.2.3 Troubleshooting in wine

In some cases, the wine making process goes wrong somewhere, which can lead to the wine having an unpleasant smell or taste, spoil quickly or being completely undrinkable.

A few examples of what can go wrong is that the wine can smell like vinegar, rotten eggs or yeast. During fermentation, the fermentation may get stuck

or sluggish which has to be corrected in order to become wine.

A vinegary smell and taste means that the wine has been exposed to air, causing an interaction with acetobacter organisms. They convert ethanol to acetic acid in the presence of oxygen. This can be prevented by adding enough sulphides which inhibits the growth of unwanted organisms. But there is no way to correct this mistake once it occurs. The wine may still be drinkable if it is tolerable. Otherwise the batch may be turned into vinegar.[Northeast Winemaking, n.d.]

If the wine smells like rotten eggs it is likely due to an excessive use of sulphide or lack of nutrients. If the grape juice is lacking in nitrogen, hydrogen sulphide is released in to the wine by the yeast. This can also happen if the yeast is shocked by temperature changes. However, this fault can be corrected in most cases by simply racking the wine and then aerate. In more serious cases the wine can be treated with copper sulphate or activated carbon. [Northeast Winemaking, n.d.]

Smell of yeast is caused by the wine being in contact with lees for too long. Lees are deposits of dead yeast or residual yeast and other particles that precipitate to the bottom of a vat of wine after fermentation and ageing. When wine is left in contact with the lees for an extended period, autolysis of yeast cells can occur, releasing compounds that contribute to a yeasty or bready aroma. This process is intentional in some wine making styles, as it can add complexity and richness to the wine. However, if the wine has been in contact with the lees for too long or if the wine making process was not well-managed, it may result in off-putting aromas.[Northeast Winemaking, n.d.]

The fermentation can be stuck or sluggish due to many different factors. Stuck fermentation occurs when the yeast metabolises sugars to early, which results in a higher concentration of sugar than desired. Sluggish fermentations are defined as those that take an unusually long time to finish. It can take months instead of the ormal range of two to three weeks [Linda F. Bisson, 2005]. Possible causes for stuck or sluggish fermentation and solving actions are presented in table 1 below:

Table 1: Possible causes and solutions to stuck or sluggish fermentation

Possible causes	Solution
Temperature is too high or low	Adjust temperature
Sugar level is to high	Conduct a progressive fermentation
Alcohol level is too high	Use a strong fermenting yeast
Lack of oxygen	Aerate the must/wine
Lack of nutrients	Prepare and add nutrients
pH is too low	De-acidify and add fresh yeast
Volatile acidity (VA) is too high	Reduce VA and add fresh yeast
Low yeast count	Add fresh yeast

1.3 Technologies

The first technology was developed at the University of Twente, the Netherlands, and is currently in the possession of the company Unicorn DX. The technology can make quantitative measurements of up to 100 types of particles in the range of 10 to 100 nanometers at a time. The primary use for the technology lies within the medical industry, detecting pathogens and biomarkers such as viruses and proteins. However, getting approved for medical use on humans is a lengthy process and the company therefore runs the risk of facing bankruptcy before making it to the market.

The second technology was developed at the University of Padua, Italy, and is currently in the possession of the company Pipe4.0. Using Raman spectroscopy, the technology can measure gas compositions without direct contact with the gas. The intended use for the technology lies within biogas production and transportation of gas through pipelines.

Previous studies have come to the conclusion that a potential alternative use case for both these technologies could be found within the wine and beer making industries. Finding a suitable area of use for the technologies could provide a second source of income, enabling the survival of the two companies until each technology can be introduced to the market in the role they were intended for.

Thorough analysis of the technical aspects of wine and beer making will be conducted. By understanding underlying chemistry, microbiology and engineering principles, potential opportunities for technological implementations can be identified.

1.4 The concept

In the larger project [Berg et al., 2024], the wine production process has been analysed through excursions, that can be read about in section 4, to potential users and by studying the manufacturing process. With that knowledge, ideas for concepts were generated through various idea generation workshops that are described in [Berg et al., 2024]. This resulted in four different concepts which were then compared. The winning concept was *Pump on the tank* that was later developed to the final product *WineOT*.

1.4.1 Pump on the tank

The concept *Pump on the tank* is designed to be an attachable extension to the fermentation tanks outlet. Its main purpose is to monitor the fermentation process by continuously measuring sugar levels and other parameters such as pH and alcohol. The user would interact with the parameters through graphs and values presented in an app. The plan is to complement this simpler concept with the possibility of using Unicorn DX to detect yeast and bacteria in the

wine, which is found to be crucial in especially natural wine making. [Berg et al., 2024] A first sketch of the concept is presented in figure 3.

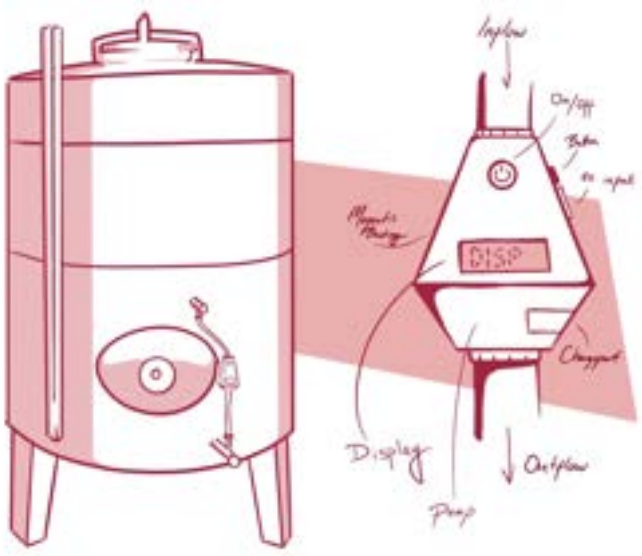


Figure 3: The concept: Pump on the Tank

1.4.2 WineOT

The final product that was created in the larger project [Berg et al., 2024] is called *WineOT*. It has the same main idea that the primary concept had, with a few exceptions. The assembly of the product was decided to be on the racking outlet of the tank. This is because it was decided that it was very important to make a product that is easy to implement for the user, without having to destroy their current fermentation equipment or buying new. It was also found to be crucial for the winemakers to still be able to use the smaller taps on the tank to taste their wine, since this is a meaningful part in the production for the user. The product has a small screen that can switch between modes to show the current temperature, pH, alcohol and sugar levels. A rendered image of the final product is shown in figure 4.

Figure 4: WineOT

The primary interface with the user is through an app. When opening up the app, the winemaker will be able to quickly scan the QR code on each specific tank to see the contents and the measured values and then be able to follow the fermentation without having to be on site all the time. Workshops and interviews with winemakers made by [Frostell et al., 2024] resulted in a prototype shown in figure 5. It was fould to be important for the winemaker not to feel like a lab worker and rather an artist which resulted in an app with focus on being simple and artistic [Frostell et al., 2024].

Figure 5: App prototype [Frostell et al., 2024]

1.5 Purpose

The purpose of this bachelor's thesis is to investigate and explore the value of developing a product containing Unicorn DX in the wine industry. The main perspectives are business and market, as well as viability for the users.

As wine making is a very traditional and personal process, many winemakers take pride in their work, therefore it is important to include the users wants and needs in the analysis when researching the viability and business acceptance of a possible product.

The essays research questions to answer are:

- What is the perceived value proposition of implementing WineOT with Unicorn DX among wine makers, and how does it compare to existing measurement methods in terms of accuracy, efficiency, and cost-effectiveness?
- What are the potential market dynamics, including demand, competition, macro and micro factors that could affect the adoption and commercial success of WineOT and Unicorn DX in the wine production industry?

1.6 Goal

The overarching goal is to identify what products/services are out in the market, what these products contain and why they contain them. Understanding different types of users needs, since there are different circumstances for varying scales of production or tradition is a goal as well. In other words complete an

in-depth market and user analysis on all types of accessories within wine production. This to, in turn, identify or breach a certain space within the market where the possible product can "shine".

The outcome objective of the research will then also provide the group with valuable insights in what type of product would be feasible to create, and produce a certain framework to navigate in.

1.7 Scope

Since this thesis is wide and goal seeking, it is important to have a defined scope. Firstly there is a clear time limit since the project has to be done and handed in by 10th of June.

Due to the detection of lower technical complexity and ability to make meaningful corrections midst fermentation during excursions in the larger project [Berg et al., 2024], beer brewing is disregarded in favour of wine production. Beer producers are, however, kept in mind as a secondary user group. If only minor changes are needed to adapt a concept originally intended for wine production to the beer brewing process these will be considered.

Because of the limited time frame of this project and the importance of conducting user studies, a geographical limit is set to the EU market.

It is decided to compare the concept with relevant competitors that winemakers from the excursions have been using or talked about in the context that the concept is aiming for.

1.8 Expected result

The expected result is to come to a conclusion about business value regarding of WineOT and Unicorn DX and to decide whether or not the creation of a concept, prototype and/or product is desirable in the current market, either for direct use and adaptation, or in the near future.

1.9 Connection to the larger project

During the pilot study, it was observed that the acceptability to new technologies in the wine industry differs between types of production scales. Traditional vineyards, in particular, seem to be quite critical to change their way of wine making, while newer vineyards to some degree have already adopted technologies.

Additionally, smaller wine and beer producers face resource constraints and cannot afford to invest heavily in individual measuring tools. Therefore, the

economical aspect of producing a new product using the technologies is quite important.

2 Theory, Methodology and frame of reference

This chapter discusses the theory that will be utilised in the work in order to understand the area and problem.

2.1 Theoretical foundation

In this thesis the theory used is mainly be based on previous studies in business and market analysis, literature as well as prior knowledge in the subject from university studies. The main literature on marketing analysis will be *"Foundations of Marketing"* [Fahy and Jobber, 2022]. Literature will also exist of scientific articles, reports and user studies. Furthermore, continuous research is done on both wine making and technology in the wine industry. To find relevant literature, databases and search tools found on Linköping University online library are used, other external websites like ResearchGate and browsers like Google Scholar are utilised well. Some key words when doing the research are listed in table 2.

Table 2: Keywords

Keywords
Market analysis
wine making technologies
Wine monitoring
Technology acceptance
Technology trends
Wine industry trends

As this project is part of an earlier ongoing project, the access to a lot of reports on early tech exploration which will be beneficial when the technologies are studied parallel to the patent search phase.

2.2 Use of AI

AI in the form of ChatGPT have mostly been used as an aid in wording and translation. It was also used in order to summarise and extract information from larger text sources, that then have been double checked in the original source to ensure that the information is correct.

2.3 Methodology

Various market analysis methods were employed throughout the project to yield results. These methods, sourced from the marketing book [Fahy and Jobber, 2022], encompassed the 4Ps-, SWOT-, PESTEL-, and trend analysis, in other terms, benchmarking. Furthermore, an ongoing three-year tenure studying design and product development would hopefully equip us with the necessary

expertise to achieve a formidable result. In addition to these methods, a thorough examination of current market products through patent searches will be conducted, prioritizing a construction and design perspective.

Moreover, collaboration within the broader project group was proven beneficial. As they further refined their final product, it was easier for this thesis to focus and narrow its scope even though, in theory, the projects are not codependent.

2.3.1 Market analysis

In order to get a relevant result for this thesis on business acceptability and viability a few theories were be applied. It was vital to understand both the market perspective as well as user experience and needs. Therefore, market theories such as market analysis consisting of SWOT-analysis, 4ps and a trend analysis. However, this essay did not come up with design concepts, it did just cover the first steps as in understanding the potential user and their needs.

4ps: To understand the target market it was necessary to break it down in smaller elements. Utilising the 4Ps framework for market analysis provided a comprehensive approach. It involved evaluating Products, Prices, Places, and Promotions. This includes assessing product features, pricing strategies relative to competitors, distribution channels, and promotional efforts. By analysing these elements, insights were gained to refine marketing strategies and effectively engage target demographics. [Fahy and Jobber, 2022]

PESTEL: The PESTEL analysis is a tool that identifies macro factors that influence an organisation. The five factors are political, economic, sociological, technological, legal and environmental. With the help of a PESTEL analysis, surveying the external factors can detect and aid the understanding of expansive, long-term trends. There are several situations in business planning this can be of good help. [Michelle Battista, 2024] For example:

- Strategic business planning
- Workforce planning
- Marketing planning
- Product development
- Reports and projects

SWOT: A SWOT analysis is a framework commonly used by businesses to evaluate their competitive position and with it develop a strategic business plan. The components of a SWOT, which makes up the acronym is strengths, weaknesses, opportunities and threats [Will Kenton, 2023]. To increase awareness when making a business decision internal and external environments are analysed as well as factors that can have an impact on the viability of a decision or

strategy. A strength with the SWOT analysis is that it can identify a market niche where a business or project has an advantage [Stephen J. Bigelow, 2023].

In order to provide a detailed picture on the market and supply a correct analysis on whether or not a product is viable in the current or future market, using these methods together is beneficial [Martin Dermawan et al, 2023]. Integrating the SWOT with both the marketing mix and PESTLE is great to organize factors and understand how all factors affect each other and which ones have the largest impact [Saba Hinrichs-Krapels et al, 2019]. According to [Research Optimus, 2021] some of the most notable benefits of using SWOT and PESTLE together are:

- It creates a method to find new opportunities
- Using both methods together produces a comprehensive evaluation of a project
- It can be applied to a range of large as well as small projects to identify factors that may affect success
- It encourages users to adopt a strategic thinking mindset at every stage of the planning and implementation process

2.3.2 User Studies

Several excursions to wineries were done during this project. The trips were to Sätshöga, Östergötland, Skåne, Sweden and Padova, Italy. At the wineries the main objective is to interview and observe the winemakers. In smaller and medium sized wineries, the individual winemaker has their own preferences, thought processes and ways to create the wine they want. This will be observed during visits to get a better understanding of winemakers, their work and different wants and needs depending on the size of their business and individuality. Semi-structured and unstructured interviews will be held with the winemaker for more specific topics like pricing and costs. The information gained from the excursions will be presented and taken into account for the result. Online interviews and questionnaires will be conducted and are important to gather information from several users, not only the winemakers visited.

2.3.3 Patent searching

When creating a product with different technologies in specific fields there are numerous reasons to do a patent search. Understanding what existing parts, materials and designs can or cannot be used in a new product is important for production and avoiding infringement, but there are many more benefits to a patent search. Unique technical information is a great reason for doing a patent search, according to Robyn Rosenberg [2024] 70-90 percent of technical information can be found only in patents. You can also learn how others have

dealt with design problems, explore state-of-the-art technology and avoid duplicating research efforts. Robyn Rosenberg [2024] also mentions the benefits of patent searching for market researching, possible licensing opportunities can be identified and tracking intellectual property as well as learning what companies or competitors have in their so called pipeline and understanding the next big trend.

Patent searching will be done using Espacenet. By finding the competitors patents, relevant Cooperative Patent Classification (CPC) codes can be found for the topic. The Cooperative Patent Classification initiative is a collaborative effort between the United States Patent and Trademark Office (USPTO) and the European Patent Office (EPO). The CPC system is hierarchical, consisting of:

- Sections
- Classes
- Subclasses
- Groups
- Subgroups

Each level provides increasingly specific categorisation. [USPTO, n.d]

2.4 Advantages of the methods combined

Combining a broad market analysis, user studies and the patent searching will allow a wide understanding of what products and technology is available on the wine market and many different factors surrounding the wine industry and wine making process to have in mind when designing a product.

Information acquired from user studies will also be of great importance both in understanding wants and needs, but also understanding what vision winemakers have on their industry and what affects it the most.

With the patent search, trends on a specific industry can be analysed and seeing how one can identify patterns and anticipate future market trends, enabling companies to innovate and adapt their product offerings to meet evolving consumer demands. These three methods used together should help to gather the needed information and analysing this hopefully helps reaching a result to answer the thesis research questions.

3 Market analysis

As mentioned in chapter 2, the market analysis will be conducted using the 4Ps framework to mainly assess competitors. Additionally, a macro analysis comprising a PESTEL analysis to evaluate external factors influencing the market landscape will be performed. These findings will then be summarised in a SWOT analysis, which will consider both micro and macro factors related to the concept. This holistic approach will provide a comprehensive understanding of the market dynamics and help identify strategic opportunities and potential challenges for the product.

3.1 Competitors mapping

This section will outline the primary competitors identified through excursions in the main project [Berg et al., 2024], focusing on product, price, place and promotion. Initially three brands that offers products similar to the concept, followed by service options where the winemakers sends samples to a lab that measures for them will be discussed. The competitors are then approximately compared in figure 11.

3.1.1 Winegrid

Product: Winegrid offers a variety of products in the category of wine making. The one in focus in this thesis is the "wineplus WP1110" which measures density, temperature and liquid levels. This to entirely replace manual testing and to make the process digital and automatic via an app or computer program [Winegrid, n.d]. The product does satisfy a certain demand for larger scale vineyards, where it is most often used. The switch from manual testing and adjustments to a more automatic form via controllable apps and programs is beneficial in all aspects of the process.

Figure 6: Wineplus WP1110 [Winegrid, n.d]

Price: WineGrid utilises a dynamic pricing strategy, wherein the prices of its products are not publicly listed but are instead adjusted based on various market dynamics and specific buyer circumstances. This approach allows WineGrid to remain flexible and responsive to changes in the market environment and competitive landscape. Utilising second-hand prices, such as resale or estimates, can provide valuable insights into the market value of WineGrid products, especially when official pricing information is not readily available. For instance, an eBay sales ad offering a WP1100, an earlier model of the WP1110, for 1250€ provides a benchmark for understanding the potential market value.

Place: Winegrid is headquartered in Portugal. This location offers a direct connection to many of the larger vineyards in Europe, particularly those situated in the southern regions. Given the favorable climate conditions in the south, this proximity presents a significant advantage for Winegrid in serving its target market.

Promotion: The promotion of Winegrid is highly dynamic, characterised by a personalised approach in its advertising efforts and a genuine connection with its customers. With a presence on social media platforms, Winegrid actively engages with its audience and cultivates a strong online community. The company also places a significant emphasis on optimising its website and overall advertising strategies to enhance user experience and embrace the latest technological advancements. This effort aims to make their products more accessible and user-friendly in today's tech landscape. It is also important to keep in mind that this market, the wine producing industry, is a relatively niche market. There is no broader advertisements to daily consumers, instead it is targeted to people or operations that produce wine on a larger scale.

3.1.2 Anton Paar

Product: Anton Paar's featured product is called "EasyDens." The technology aims to measure sugar levels during fermentation and then in turn calculate alcohol levels. This is done through a manual sampling of the wine from the fermentation tank into the product itself. The values are then communicated through an app to your smartphone. The process does satisfy demand but as mentioned it is a manual process which does take some time and effort. It would not be suitable for larger scale vineyards with many tanks.

Figure 7: Easydens by Anton Paar from study trip

Price: The price of Easydens is 5574kr or 6195kr with care.

Place: The company Anton Paar is headquartered in Malmö, Sweden but has locations all across Europe. Traditionally Nordic countries are not the most dominant when it comes to wine producing, but trends tend to indicate a upswing in production overall. The existing vineyards in these countries are predominantly small to mid-scale operations. Given EasyDens low price point and simple technology, it is appropriately targeted towards vineyard owners of this size.

Promotion: Due to EasyDens low price point and simple technology, it is targeted towards consumers with vineyards of a smaller size, namely a general consumer market. EasyDens also targets its marketing towards home brewers.

3.1.3 FOSS

Product: Foss's featured product is called WineScan. There are two different variations of this product: WineScan 3 and WineScan 3SO2, where the later also measures sulfur content. These two technologies aim to measure sev-

eral parameters during the fermentation process, including alcohol content, pH level, sugars, tartaric acid, malic acid, and many more [FOSS, n.d]. Like Anton Paar's EasyDens, this process involves manual sampling, where a sample of the wine is analysed through the technology and then displayed through a computer program. The product effectively meets a demand and holds an advantage in analysing a wider range of parameters. Despite the manual sampling process, the automated analysis has demonstrated efficacy, even for larger-scale vineyards.

Figure 8: Winescan 3 [FOSS, n.d]

Price: Just like Winegrid, FOSS also employs a dynamic pricing approach for its products. Known for its established reputation and commitment to excellence across various ventures, FOSS products often come with a premium price tag. This higher pricing is attributed to the perceived value and reliability associated with the FOSS brand. Through communication with FOSS sellers, an approximate pricing structure has been established for Winescan and Winescan S02. Winescan is priced at approximately 70,000€, while Winescan S02 is priced at around 90,000€.

Place: FOSS is headquartered in Denmark and operates in a total of 28 different countries. Its location in Denmark offers a central strategic standpoint for not only wine-producing analytics but also agriculture at large.

Promotion: FOSS is considering to be the market leader within agriculture and wine analytics. Due to it vast influence over the market in the agricultural world vineyard owners trust that FOSS provides reliable and innovative solutions to meet their analytical needs, ensuring the quality and consistency of their products.

3.1.4 Lab service

Product: The lab service option is that, instead of owning a monitoring device, samples of 100 ml are sent to a lab that does the tests for you. In this case, Brattås Winegarden that most Swedish winemakers use will act as an example. The owner claims to have around 70 customers that are all Swedish except from one Norwegian. For reference, there is around 150 vineyards in Sweden, including hobby makers. It is assumed that most labs works the same way and are in the same price range. An example from the visit to Särthöga vineyard, which uses Brattås Winegarden's service, is shown in figure 9. The basic testing gives 15 different parameters, and sulphur can also be analysed for an extra cost.

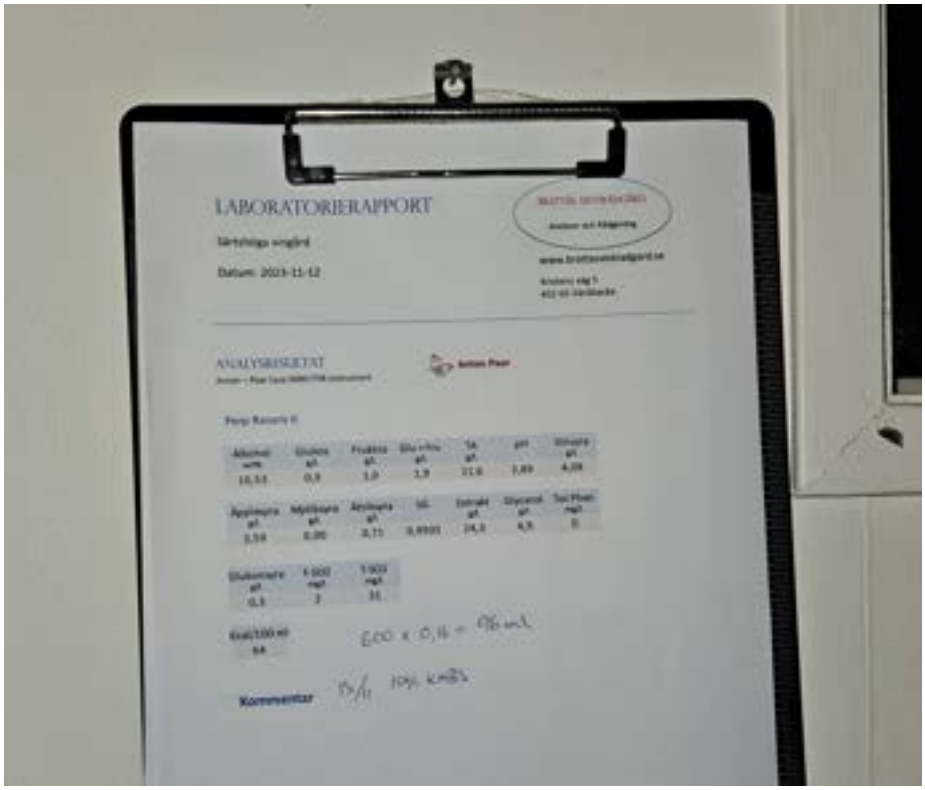


Figure 9: Values given from winelab analysis

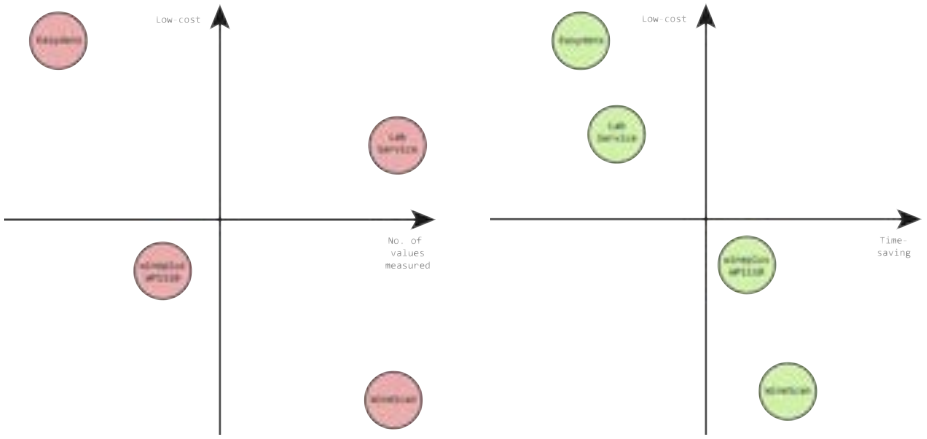
Price: Base price is 375 sek per test. Additional cost for sulphur analysis is 62,5 sek. Another test for protein stability done once per batch before bottling costs 270 sek. The customer is also responsible for shipping costs.

Place: Brattås Winegarden is located in Varberg, Sweden. Its location is advantageous for the Swedish winemakers, since it is in the south of Sweden where most Swedish wineries are. Since the tests are sent to the lab via post, it is crucial to not be too far away, because the wine should be tested fresh in order to get accurate values.

Promotion: Brattås Winegarden promotes itself mostly trough being active the Swedish wine community. On their website they say that they follow your wine from harvest to bottling and do the important analyses along the way, and gives you advice on appropriate measures to steer towards a successful wine[Brattås Vinträdgård, 2015]. Thus, it appears they aim to be more like a supportive friend than a typical business.

3.2 Comparison of competitors

These competitors are quite different from each other on points such as measuring values, marketing and especially price. This is illustrated in figure 10. One important thing to know is that if someone is using for example an easy-dense to measure during fermentation, it is still needed to send tests to a lab in order to gain the information you need. This is because of laws that can be read about in 3.3.6. Same thing with WineGrid's Wineplus WP1110, since it is also not giving all the values needed to label and sell wine. However, a product such as winescan can make someone independent and not in need of further service.



(a) Positioning map cost/values (b) Positioning map cost/time save

Figure 10: Positioning maps

An estimated price comparison is presented in figure 11. Since exact prices was unable to be found it is quite approximated. Further product service costs are not taken into account. But it still illustrates the fact that in order to be worth it to buy a product such as WineScan instead of choosing the local lab is quite a lot of tests.

Figure 11: Approximate price comparison of competitors

The graph assumes the use of five fermentation tanks, as each tank requires one unit of WinePlus WP1110, and the prices for the remaining competitors are the same regardless of the number of tanks. It is important to note that service costs and the lifetime of the products are not taken into account due to insufficient information. Therefore, while the lines for everything except service costs appear horizontal, this may not reflect the reality.

3.3 Macro analysis

This section analyse the wine industry in Europe on a macro level. This was be done using a PESTEL-analysis in order to cover many aspects on the wine industry that may affect the business value of the concept *Pump on the tank*.

3.3.1 Political aspects

The EU wine sector is regulated in numerous aspects of wine making. The key legislation in the sector is the Common Market Organisation (CMO) Regulation. These regulations administer product definitions, labelling and presentation, geographical indications and oenological practices among many other things. The common agricultural policy (CAP) also has plenty of regulations and implementing acts that apply to the EU wine policy, which is just as old as the CAP [Šajn, 2023].

Control systems and monitoring of wine is a very important part of this policy, as all wine sector products, required by the CMO, need an official authorisation, an 'accompanying document'. Additionally, processors, producers, bottlers, and merchants are required to keep inward and outward registers [Šajn, 2023]. Giving winemakers a possibility to do this on their own during their work process, and making sure all information needed for regulations, is a good opportunity for a monitoring product. Nonetheless, most winemakers send a sample to a third party lab to be sure that the analysis of the wine is correct.

The wine industry is remarkably affected by changed conditions due to the war in Ukraine. Inflation, fluctuating prices and exchange rates have created a heavy increase in costs for everything in between manure, bottles, corks and transport [Ngo, 2023]. 24.2 and 16.2 million euros worth of wine was exported from Spain to Russia respectively Ukraine. In 2022 Pau Roca, Director General of the OIV (the International Organization of Vine and Wine), told Oré [2022] the total would fall to almost zero. However, Roca said the wine industry is suffering more from the energy crisis triggered by the war.

3.3.2 Economical aspects

Wine in Europe is around a 70b euro business with over 3.2 million hectares of land in Europe alone[Insights, 2023]. Implementing a more effective wine monitoring system holds the potential to revolutionise operational efficiency within the wine industry. By harnessing advanced technology and data analytics, wineries can gain real-time insights into production processes, inventory management, and quality control. This increased efficacy not only streamlines operations but also minimises waste by promptly identifying and addressing issues. Consequently, wineries can optimise production levels, reduce spoilage, and ensure efficient resource utilisation. Ultimately, these improvements lead to cost savings throughout the value chain, from production to distribution, benefiting both producers and consumers.

The trajectory of the wine industry, particularly in Europe, has generally been on an upward trend for a considerable period. Europe boasts a rich heritage and expertise in wine making, contributing to its prominence as a leading wine-producing region globally. However, in recent years, this upward trajectory has been somewhat impacted by various factors discussed earlier in the report. [Šajn, 2023]

Challenges such as climate change have introduced new complexities to wine production, influencing growing conditions and harvest outcomes across European vineyards. Shifts in weather patterns, including heatwaves, droughts, and erratic rainfall, have posed challenges to traditional viticultural practices, requiring adaptation strategies from wine producers to maintain quality and yield.

Additionally, evolving consumer preferences and market dynamics have influenced the trajectory of the wine industry in Europe. Changes in consumption patterns, including the growing demand for organic, sustainable, and low-intervention wines, have prompted winemakers to adjust their offerings to meet shifting market trends. Furthermore, increased competition from emerging wine regions both within and outside Europe has heightened market competition, challenging established players to innovate and differentiate their products.

Inflationary pressures exert significant influence on consumer and investor behaviour within the wine industry. As inflation erodes purchasing power, consumers may become more price-sensitive, potentially favouring lower-priced wine options. This shift in consumer preferences can impact demand patterns and revenue streams for wineries, especially those producing premium wines. Moreover, inflation can instill uncertainty and risk aversion among investors, affecting investment sentiment within the industry. Consequently, wineries may encounter challenges in securing financing for expansion or capital-intensive projects, thereby impeding long-term growth prospects.

3.3.3 Social aspects

Today all wine produced can be sorted in two very broad categories; Old World Wines and New World Wines. Defining these are important to understand how they are made and what is important in the process from vine to wine.

Old World Wines: The Old World wines originate from Europe and are proof of wine making traditions that are centuries old. They are connected to the geographical location and exhibit a cultural narrative passed on for generations.

New World Wines: New World Wines are emerging from regions like Australia and the Americas and doesn't follow older protocol, but focuses on innovation and possibilities that modern wine making affords.

During the study visit to Särtshöga Vineyard in Linköping, the winemaker told us that there might be some stigma towards use of technology at traditional and family owned vineyards. However, in an interview with a wine making consultant and previous vineyard owner, points to this as a prejudice. He says there are of course traditionalists that opposes technological advances but these are often winemakers oriented toward nature wines and/or ancient methods. He also mentions that another reason for not modernising is unawareness and ignorance. According to Cellars [N/A] Old World regions are increasingly incorporating innovative wine making techniques. With this in mind, younger generations taking over old family vineyards or wineries working with older techniques, are a segment where technologies have the possibilty of being implemented.

Consumer behavior plays an important role for winemakers ability to sell their wine. When purchasing wine, consumers first come in contact with characteristics consisting of: labeling, awards, price, country of origin and alcohol percentage [Brata et al., 2022]. Higgins et al. [2014] states that "Wine is an experiential good that can not be fully experienced until it is consumed, thus in the absence of tastings or prior experience with the wine, the purchase decision is challenging for many wine consumers". With many consumers showing a growing interest in wine [Boroli, 2023], winemakers should benefit from informing consumers about their transparency and storytelling. With the new legislation, detailed in 3.3.6 winemakers can benefit by having technology that helps them produce the required information.

3.3.4 Technical aspects

As the rest of the world, the wine industry has gone trough a technical transformation in the last few years. Wineries worldwide takes advantages of new technologies to enhance every step in the business, such as production, marketing and distribution [Vinetur, 2023]. A clear consequence by timesaving and quality boosts is increased sales and profit.

Distribution: Distribution of products from wineries has been revolutionized by technology. Geographical limits have been broken down trough online platforms and streamlinging logistics with inventory management systems [Vinetur, 2023]. Wineries are now able to reach global consumers through e-commerce and are therefore not fully dependent on resellers.

Marketing: In line with the globalisation and streamline of distrobution, the marketing aspects of wineries has also been influenced by technology. With social media platforms and websites, reaching out to costumers and engaging with them has become more accessible and effective than ever before. Digital marketing tactics such as targeted segmentation and personalized messaging are notably effective in boosting brand visibility and nurturing customer loyalty [Vinetur, 2023]. By utilizing technology, wineries can engage consumers via

social media, employ data analytics to pinpoint potential customers, and customize marketing campaigns accordingly. New technology is also used to create a new experience of wine labels [Bernard Marr, 2022]. Through QR codes and augmented reality (AR), buyers can access detailed information about the wine they're purchasing, including production processes and conditions.

Production: New technology has been developed to help wineries in all stages of production, from planting to bottling. For instance, a robot called TED by Naio Technologies specialised on crop management and weed removal on wine plantations[Bernard Marr, 2022]. The robot is able to work fully automated for 8 hours per day, this saves a lot of time for the growers and also may reduce the need of using potentially harmful herbicides in the soil. Robots can overall be used to perform the most repetitive tasks, such as harvesting and bottling[Vinetur, 2023].

Sensors and software enable wineries to monitor weather patterns, ensuring optimal grape growth conditions[Vinetur, 2023]. There are projects that utilize satellite imagery and AI to monitor crop health and irregation effectiveness[Bernard Marr, 2022]. This type of services offers early alerts of potential threats, giving the growers a chance to act before any harm is done. Additionally systems using automated drones longside satellite imagery, ground sensors, and local weather data, all processed by AI algorithms can provide actionable insights in real-time[Bernard Marr, 2022].

In fermentation, several technologies on different complexity levels can be used to monitor the process. The shift from traditional laboratory analysis to real-time process analysis is driven by the need for rapid process control information, compliance with safety and environmental regulations and cost efficiency [Daniel Cozzolino, 2016]. Traditionally, density meters have been utilised to measure fermentation progress manually, typically once daily. With technologies that monitor the fermentation real-time instead, with more advanced and precise sensors, wineries are able to ensure a more consistent product [Vinetur, 2023]. One promising approach involves the integration of Infrared (IR) sensors with Multivariate Analysis (MVA) techniques shows promise for monitoring beer and wine fermentation, offering advantages such as reduced time and cost, faster analytical results, and ease of use in routine operations with minimal sample preparation [Daniel Cozzolino, 2016]. Challenges remain, including the need for affordable instruments, comprehensive understanding of the technology, validation of calibration models, and standardisation of sampling protocols for on-line analysis. The lack of formal education in related fields pose a significant barrier to widespread adoption of these methodologies in fermentation monitoring [Daniel Cozzolino, 2016].

3.3.5 Environmental aspects

Climate change has a growing impact on the wine industry. According to van Leeuwen et al. [2024] a significant risk of unsuitability for 49-70% of current wine regions, depending on the extent of global warming. Conversely, 11-25% of existing wine regions could see improved production due to higher temperatures, while new suitable areas may emerge at higher latitudes and altitudes.

Europe, particularly regions south of approximately 50°N, is a major producer of premium wine globally, with Spain, France, Italy, and Germany contributing significantly to half of the world's wine production[van Leeuwen et al., 2024]. Climate change is projected to shift suitable wine-growing regions towards higher latitudes and altitudes. Traditional wine-making areas are predicted to not be under threat as long as the levels of global warming remains low (under 2°C),but the combination of higher temperature and reduced rainfall suggests that some areas may face serious water shortages, making it difficult to continue using a lot of water to help the vines grow[van Leeuwen et al., 2024]. Overall, the suitable surface area for traditional wine-producing regions may decline by 20–70% by the end of the century, while new wine regions are projected to expand northward, particularly along the Atlantic sector. However, this expansion is theoretical and does not account for factors such as soil quality and land use[van Leeuwen et al., 2024].

Wine quality is highly affected by temperature during grape ripening. When it is colder than preferred, the wine ends up acidic and lighter colour, while too much heat leads to higher alcohol levels and cooked fruit aromas. In order to balance this out, grape varieties suited to the local climate can be chosen. However, climate change has caused grapes to ripe earlier due to higher temperatures. This shift affects wine quality in warmer regions. Additionally, high temperatures reduce phenolic compounds in grapes, impacting the wine's structure and color. The wine attributes affected by climate change is illustrated in figure 12. These changes make it challenging for winemakers to make harvest decisions. [van Leeuwen et al., 2024]

Figure 12: Wine attributes affected by climate change, redrawn from [van Leeuwen et al., 2024]

Another environmental aspect on the wine industry is its own carbon footprint. According to da Silva and da Silva [2022], the main contributor to CO_2 emissions in wine making and bottling is by far the packaging (58.1%-71.0%). The packaging is often producing more emissions than grape cultivation and wine making combined [Maxwell, 2023].

3.3.6 Legal aspects

New law on labelling wine forces winemakers to keep track of the nutrients and ingredients in their wine. On the 8th of December 2023, new rules on how to label ingredients and nutritional values on wines entered into effect in the EU. These new rules would apply to all products of wine that will be obtained from the 2024 harvest. Leaving out, falsifying or burying the information will be considered consumer fraud.

Labels can be chosen to either act as a physical label, or a QR code or other electronic mean. The requirement for these electronic labels is that information

provided online should be as clear and accessible to the consumer as if they were reading the label of the bottle. Consumers need to be able to identify the word 'ingredient' easily and should in no way be able to confuse it with other means containing marketing messages. The physical label will continue to present allergenic substances as it has, as will be the case for the energy value. [Directorate-General for Agriculture and Rural Development, 2023]

Other alcoholic beverages has been required to provide this information, as well as all other food products, for years and this change will close the gap that has existed between labeling of wine, and labeling of everything else.

On all wines sold in the EU, with these new labels, consumers will have access to at least the following information:

- The name of the bottler or the name of the producer or vendor
- The list of ingredients
- The term 'protected designation of origin' (PDO) or 'protected geographical indication' (PGI), and its name, for wines registered as geographical indications
- The designation of the category of grapevine product
- The minimum date of durability for grapevine products which have undergone a de-alcoholisation treatment.

[Directorate-General for Agriculture and Rural Development, 2023]

This is only part of a longer list of comprehensive information that will guarantee consumers clarity when purchasing wine.

This new labeling system will demand more from wineproducers. What is measured and information needs to be precise in order to legally be able to sell their wine. Therefore, many winemakers might soon have a great need for new equipment that can perform these measurements and tests, at a larger rate and scale. Sending in capsules for analysis at a third party might no longer be an option to attain correct levels. This opens up potential for a product that is easy to handle, use and maintain, even for the non tech-gurus.

4 Excursions

The chapter will present information gathered from field trips at winery's as well as conducted interviews. The first four is from field trips in Sweden. The last two are from a field trip in Padua, Italy.[2]

4.1 Vineyard in Östergötland

Size: 3 hectares
To gain an early understanding of how a vineyard operates, a study visit was conducted to a vineyard in Östergötland, Sweden. There, the group had the opportunity to meet the wine maker and observe and learn about the wine making process, the tools and instruments used. Given the group's relatively low level of knowledge at the time of the visit, the main goal was to obtain an overview and identify any clear problems and needs. At the vineyard, the owner showed a smaller device that was used to measure alcohol level, but all analysing of the wine was outsourced to Brattås Winegarden. Other than this, the owner had a device to measure pressure in the wine after bottling, an afrometer. This device pierced the bottle which means that the sampled bottle is "destroyed". This was something that caught attention early on and was further researched.

After the wine maker had gone through his work process and technologies, the group asked questions to gain knowledge and information. It was to the groups understanding that they were rather happy with his situation, and since his vineyard wasn't very large, funds for a highly technological device was not the main focus.

However, they said that if they were able to monitor the fermentation without manual testing, it could be interesting. They had looked into products such as Winescan, but said that it would take them 100 years to come to the break even point in comparison to using Brattås Winegarden's services. Price was definitely their main concern in investing in products.

4.2 First vineyard in Skåne

Size: 1 hectar
Located in eastern Skåne. This vineyard operates as a collective, with its primary focus not being profit but rather serving as a recreational pursuit. It stands as one of the oldest and largest vineyards in Sweden. The group had the opportunity to meet the winemaker who is a retiree and formerly an agronomist. Their prior professional experience includes a role as a marketing manager at a company. They predominantly oversees the vineyard for the communal enjoyment it offers and as a fulfilling pastime. As earlier mentioned, the vineyard worked as a collective in the way that individuals that had interest, pay for rows of vines and decide what grape they want to work with. When the time comes

[2]This section is taken and slightly modified from the larger project [Berg et al., 2024]

for managing the vines and harvesting, all members that had their vine rows joined and helped with the harvest.

The owners, a married couple, didn't buy the land first hand to run a vineyard, the previous owner was selling and the land was leased. They thought it would be a shame if the vineyard and capital were to be destroyed if no one purchased the land, so it was a very spontaneous happening. Because of this, there wasn't much knowledge about wine making and they had to learn on the go. In the winery, no advanced technologies are used. In the steel tanks they measured pressure only. Just like the previous wine maker, this wine maker also outsourced all her analysing of wine to Brattås Winegarden, who they spoke very highly of. They mentioned that there was absolutely more to learn from analysing the wine on their own, but then you need to be able to act on this, and neither of the owners were into the analytic part of wine making. They also mentioned that the contact and relationship with Sveneric, the owner of Brattås Winegarden, is meaningful and is more important than being able to do her own analysis.

4.3 Second vineyard in Skåne

Size: 11 hectares
Located right by the sea on the western side of Skåne the group met two younger-generation winemakers from France. Both individuals had backgrounds in the wine making industry and had studied wine making at master level in France. They had a positive attitude towards technology and used several instruments and technologies that the group had not seen during the previous visits. Their main scanning device was from FOSS which gave them almost all needed values. When purchasing this particular scanner, the customer is able to choose which functions should be included. One of these functions, is a sulphate analyser. However, since the accuracy of the sulphate scanner is not precise enough for their needs, it was deemed not economically worth it for them. In order to analyse sulphate, they use manual process called the Ripper method. According to them, the process is easy but time consuming. Another new aspect discovered in the wine making process was the usage of microscopes. At this vineyard, microscopes were used to inspect smaller test batches during fermentation, with the purpose of analysing the yeast in the must. The goal of the method is to identify both wanted and unwanted yeasts as soon as possible. This information sparked ideas for what issue the concept could aim to solve.

4.4 Third vineyard in Skåne

Size: 1 hectare
Located in the south-western part of Bjäre peninsula, the group met another wine maker, a former architect with a love for wine making as an art form. Their view on wine making was as mentioned focused on art and letting nature, weather and soil be the important factors. They were not advanced in using

technologies and had ties to Georgian wine making, using Qvevri wells buried in the ground to age the wine.

They were not interested in the concept or barely any technologies, however he was very committed in political questions. They wanted to break the Swedish alcohol monopoly, which would result in them being able to sell their wine on their own. That would make them able to gain a much higher profit from his products, and it was important to them to be in direct contact with his customers. When asked about the new law from EU that forces winemakers to put ingredients on their labels, they answered that they thought it was a very good thing. This was because they did not use any additives what so ever, except a little sulphur, so they would just look good in comparison to others. When asked about how they would gather information on the values of their wine in order to complete their labels, they said that they would probably send it of to a lab instead of buying a measuring product themselves.

4.5 First vineyard in Padova

Size: 25 hectares
Located in the Euganean Hills south of Padova, the vineyard is a family owned, organic vineyard with 25 hectares of vines. The group met the winemaker who together with their family and seasonal employees ran the vineyard. Today the winemaker used a manual hydrometer to measure density, calculate sugar as well as alcohol levels in his wine. For further analysis of the wine they sent samples to a local laboratory. The winemaker described that they were in the thought process of purchasing a microscope for analysis in the winery in order to detect *Saccharomyces* (a type of yeast that is used in wine making) and *acetobacter* (bacteria used to convert malic acid into lactic acid). Since they created their wine by not adding any yeast, it was important to know if the right cultures were present in the must. After similar dialogue as the other visits, they said that a product of the concept's nature would be worth four times the price of a microscope, which was in the 1500€ range, as long as it was easy to use, didn't need regulating and measured values precisely and accurate. When asked about if there had been any problems related to climate change the answer was given: "If the grass is yellow in the end of the summer, you know that there is going to be problem with the fermentation." This due to the environmental aspects presented in 3.3.5.

4.6 Second vineyard in Padova

Size: 20 hectares
Located at the bottom of the Euganean Hills, this vineyard is also a family owned vineyard with over 70 000 vines. In the winery, the family used the same kind of simple manual density meter as the previous vineyard. They seemed rather pleased with their current situation, and their main concern for a product was as the other winemakers, pricing. However, they had noticed the impact

of warmer weather. They discussed about how their latest wines had a lot of residual sugars left after fermentation, that the pH was too high and that their wine that is supposed to be around 12% alcohol instead came all the way up to 15%. This, in their opinion, contributed to a less enjoyable drinking experience.

5 SWOT analysis

In this SWOT analysis, information from the competitors mapping, PESTEL, Study trips and Patent searching will be tied together. The product *WineOT* will be in focus and discussed on micro and macro level. Strengths and weaknesses is on micro level, and opportunities and threats are on macro level.

5.1 Strengths

The main strength with the concept is that it would be able to detect bacteria and yeast thanks to the implementation of Unicorn DX. None of the competitors products measures yeast. From the study trips it was found that those who make natural wines (not adding commercial yeast) either guesses that they have the right type of yeast by monitoring the fermentation or uses a microscope to manually look for the right type of cells. The concept would therefore be time saving and helpful, especially for those that make natural wines.

There are also not many other continuous fermentation monitoring products on the market, and those that was found are very expensive. Therefore, the product could shine by being the cheaper option.

The concept is also made to be modular, so it can be used by all winemakers. This is done be having the option to buy the Unicorn extension or just the fermentation monitor. The fermentation monitors are made to fit a standardised fermentation tank. The competitors options for continuous fermentation monitoring requires drilling holes in the tanks, destroying them, in order to attach the product, which is a huge commitment and eventually a waste if the customer is not happy. By eliminating this destructive step, users of the product will have the possibility to resell their tanks, which creates a longer lifespan for the tanks and therefore making the product more environmental friendly than competitors.

5.2 Weaknesses

The main weakness of the concept, is that it is unclear how Unicorn DX actually works. The technology is not yet fully developed and there is an uncertainty of its potentials. Because of this, it is also unclear what the price point of the fully developed product would end up as. As a result of this, it is difficult to estimate how the product would be able to differentiate itself from the competitors.

The concept is also much more technologically advanced than the technology used by winemakers that have been visited. This could be a weakness in comparison to simpler products that costs a fraction of the price of the final product.

5.3 Opportunities

As described in section 3.3.6, a new EU law on wine labelling has been implemented affecting all wines and wine products obtained from 2024. This means, that all wine producers need to keep track of ingredients and nutritional values of their wines along with presenting them on their labels. Therefore, the demand for monitoring devices may rise among winemakers in order to monitor and measure wine during all stages of wine making and keeping these steps in house, instead of sending to a third party. One could also think that since all ingredients are going to be presented from now on, wine makers would want to reduce the amounts of unnecessary additives and keep their wine as "natural" as possible. Consequently, the need to monitor the wine making process more frequently might increase, in order to achieve the best possible product instead of adding additives to prevent faults, which could negatively affect their product with these labels.

As described in 3.3.5, the wine industry is greatly affected by the climate change. Warmer climate in the north, combined with new types of fungus resistant grape varieties, creates new opportunities for more northerly lands to grow grapes and produce wine. This creates new generations of winemakers that does not have any traditions or family knowledge in how to create wine which contributes to a potential clientele for developing a wine monitoring device.

Shown from both 3.3.5 and from the study trips in Italy, warmer climate is also affecting the traditional vineyards and their old methods do not work as they used to. By having advanced monitoring devices, the winemaker can understand the new circumstances conveniently and this consequently enables better control of their production, simplifying their process of creating a wine they can be proud of.

5.4 Threats

The most obvious threat to developing a new, advanced product today is the inflation and economical situation in the world. Developing and establishing something is more expensive than ever. Additionally, the consumers are less likely to invest in something new and expensive, especially when their current methods are working. Both the inflation combined with the war in Ukraine has created much higher costs in production for winemakers. As one of the winemakers in Italy said; The prices of bottles and energy has increased significantly the last few years.

There is an obvious mix in attitude towards implementing technologies in wine making. As described in 3.3.3 there might be a majority of negative attitude towards products as the concept, especially in Europe where the Old World Wines comes from. From the excursions it were found that most winemakers used very simple tools themselves, and there was not really a need for more

advanced products. If more advanced testing had to be done, samples were sent to a lab. As the owner of Särtshöga said, they would have to make wine for over 100 years in order to make up for the costs of investing in a WineScan instead of using the lab service, which is illustrated in figure 11.

6 Patent search

This section will delve into patents from the competitors presented in 3.1 that are in the same area as WineOT. By finding the classification codes in the area, an analysis of the most frequent used codes over time is then made to see where the industry is heading. The absence of a patent could indicate a less favourable business position for the product, which will subsequently be analysed in greater detail in the discussion.

6.1 Data gathering

The patent search was conducted through Espacenet, a website for patent searching. The three competitors from 3.1 were searched in the data base together with keywords such as: wine, monitoring, measure, density etc. This resulted in the information given in Table 3.

Table 3: Competitors' patents

Title	**DOP**	**CPC**
Winegrid (Watgrid)		
Level and/or density sensor device for liquid vessels	2024-03-19	C12M41/44; G01F23/14; G01F23/168; G01F23/18; G01N9/26; C12M41/44;
Fermentation Monitoring System	2024-04-04	C12G1/02; C12G3/02; C12L11/00; G01N1/12; G01N33/146; G01N2001/1037;
FOSS		
Determination of Components of Liquids	2007-10-03	G01N21/3504; G01N33/0042; G01N33/14; G01N33/146; G01N2021/3595;
Determination of Sulphur Dioxide In a Liquid	2012-06-07	G01N21/3504; G01N21/59; G01N33/0042; G01N33/146; Y02A50/20;
Anton Paar		
Method and instrument for measuring the density of fluid media	2019-12-31	G01D11/245; G01N9/002; G01N2009/006;
Method and Device for Determining an Alcohol Content of Liquids	2008-09-11	G01J3/02; G01J3/0272; G01J3/10; G01J3/42; G01N21/05; G01N21/314; G01N21/3577; G01N21/359; G01N33/146;

6.2 Classification code analysis

The most frequent CPC codes from the found patents of the competitors in Table 3 are presented and described in Table 4. The trends on each of those four CPC codes on the time span 2000-2024 is then illustrated in figure 13.

Table 4: Most frequent patents

CPC	Meaning [USPTO, n.d]	Current no. of patents [Espacenet]
G01N33/146	Investigating or analysing materials by determining their chemical or physical properties; Investigating or analysing materials by specific methods not covered by groups G01N 1/00 - G01N 31/00; Containing alcohol	2135
G01N33/0042	Investigating or analysing materials by determining their chemical or physical properties; Investigating or analysing materials by specific methods not covered by groups G01N 1/00 - G01N 31/00; SO_2 or SO_3	1340
G01N21/3504	Investigating or analysing materials by determining their chemical or physical properties; Investigating or analysing materials by the use of optical means, i.e. using sub-millimetre waves, infrared, visible or ultraviolet light; For analysing gases, e.g. multigas analysis	18218
C12M41/44	Apparatus for enzymology or microbiology; Means for regulation, monitoring, measurement or control, e.g. flow regulation; Of volume or liquid level	3646

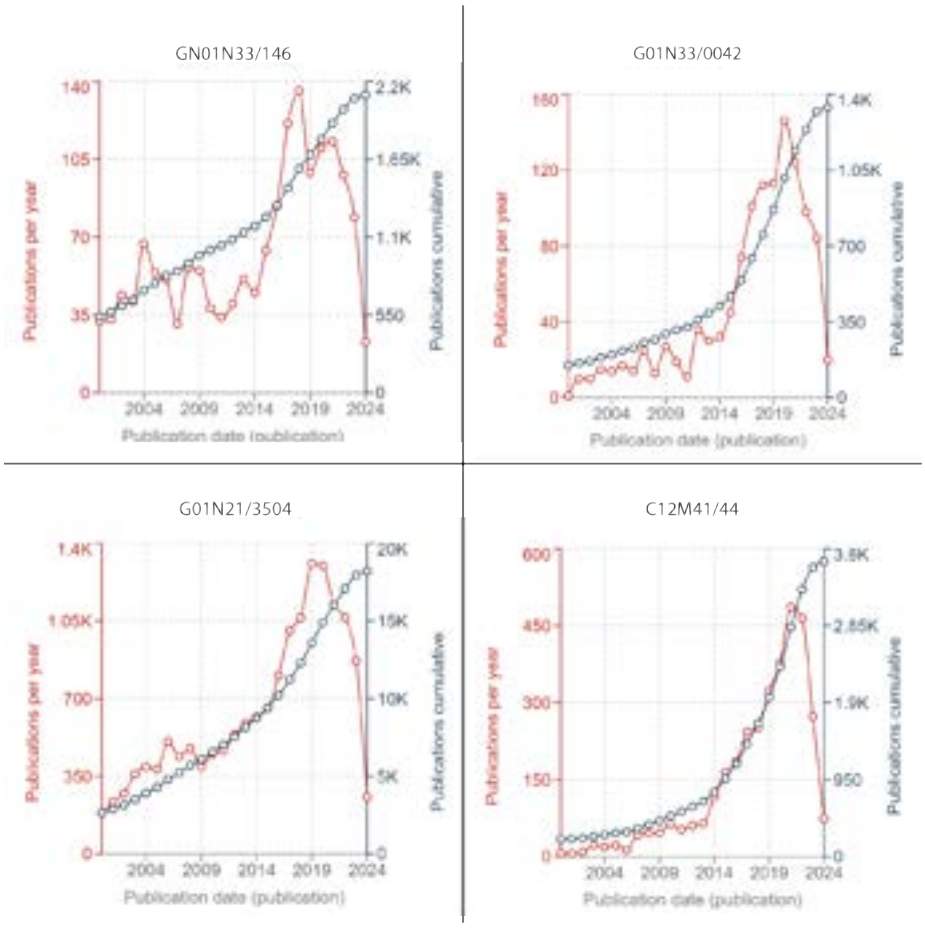


Figure 13: Graph of patents 2000-2024 [Espacenet]

As seen in figure 13, the numbers of publicised patents per year in all of the four categories have increased significantly since the year 2000. However, all have a dip around 2020 that has not yet recovered.

7 Result

This chapter will conclude and summarise the results from the market analysis and patent chapter as well as give insights to answering the study questions presented in the introduction. Further reasoning will be in the discussion chapter.

7.1 Results from 4ps

The result from the 4p's method is concluded in table 5

Table 5: Comparison of Competitors

Brand	**Product**	**Price**	**Place**	**Promotion**
Winegrid	Wineplus WP1110	Dynamic pricing around 1250€	Portugal	Personalized advertising, social media engagement
Anton Paar	EasyDens	488€ (539€ with care)	Sweden	General consumer market, home brewers
FOSS	WineScan , WineScan SO2	70,000€ , 90,000€	Denmark	Market leader, reliable solutions

An analysis using the 4Ps method (Price, Promotion, Product, and Place) provided the group with a foundational starting point. The most significant takeaway from this analysis has been the insights into the different price points and product characteristics. As the table indicates, and as earlier research confirms, there is a considerable range of prices depending on the extent of measurement and monitoring desired during fermentation.

Winescan, the most expensive product, measures everything in-house, eliminating the need to send samples to established laboratories. EasyDens, on the other hand, only measures density during fermentation and is a manual device that requires the winemaker to test samples themselves, EasyDens is also the cheapest of the specific products. Wineplus, which falls in the mid-range price category of the three examined, conducts automatic testing directly on the tank but measures fewer parameters than Winescan. WineOT is theoretically priced similarly to Wineplus but offers more extensive parameter measurement without requiring modifications to fermentation tanks.

7.2 Results From User Studies

From the study trips, several key insights have been concluded about the operations and challenges of vineyards in Sweden and Italy.
First, it was observed that most vineyards, regardless of their location, tend to rely heavily on outsourcing wine analysis to specialised labs such as Brattås Winegarden. This practice is primarily driven by cost considerations, as investing in high-tech devices is often not feasible for smaller operations. Manual testing remains prevalent, though there is a clear interest in automated solutions to monitor fermentation, provided they are affordable.

In terms of operational focus, many vineyards prioritise recreational or artistic goals over purely profit-driven motives. This is evident in the collective and family-owned vineyards visited, where members or family members actively participate in vine management and harvesting. This communal approach emphasises the importance of community involvement in vineyard operations.

One of the significant challenges identified is the high cost and long break-even point for advanced technologies. Additionally, environmental factors such as climate change are impacting wine quality, leading to issues like residual sugars and high pH levels. There is a pressing need for accurate, easy-to-use, and affordable tools to monitor various wine production variables, including yeast presence and fermentation metrics.

Regulatory and market factors also play a crucial role. Some winemakers are focused on overcoming regulatory barriers, such as the Swedish alcohol monopoly, to improve profitability through direct sales. Compliance with new regulations, like the EU's ingredient labeling requirements, is generally viewed positively, especially by those using minimal additives, as it enhances transparency and market competitiveness.

Finally, the cultural and educational backgrounds of winemakers are diverse. Many come from different professional fields, blending traditional practices with modern techniques. Educational backgrounds in wine making, particularly from regions like France, contribute to a more technology-forward approach in some vineyards.

7.3 Results From Patent Search

The competitors patents fluctuated in CPC codes indicating a complexity in categorisation. Looking at the most frequent codes showed an upward trend in developing and establishing patents within this specific area, but was downsized around 2020.

7.4 Results From SWOT

A SWOT matrix compiles the main results from the analysis illustrated in figure 14.

Figure 14: SWOT Matrix

8 Discussion

This chapter will with help from the result conclude and answer the research questions in depth.

8.1 Answers to research questions

1. What is the perceived value proposition of implementing WineOT with Unicorn DX among wine makers, and how does it compare to existing measurement methods in terms of accuracy, efficiency, and cost-effectiveness?

2. What are the potential market dynamics, including demand, competition, macro and micro factors that could affect the adoption and commercial success of WineOT and Unicorn DX in the wine production industry?

The perceived value proposition of WineOT with Unicorn DX is substantial due to the growing demand for advanced technology among winemakers. Our concept offers the ability to measure several more parameters than existing products like Winegrid or Easydens, potentially providing winemakers with a more comprehensive understanding of their wine's characteristics.
From an accuracy standpoint, WineOT with Unicorn DX focuses on providing precise measurements to enhance the wine making process. It offers detailed insights that go beyond basic density and alcohol content. While WineOT may not measure as comprehensively as Winescan, its significantly lower price makes it a relevant and valuable tool for winemakers.
When talking about efficiency, consolidating multiple measurements into one device, our concept can streamline the monitoring process, saving time and reducing the need for multiple tools.

To answer the overarching question of this report, "Does the concept have its place in the market?", the short answer is yes, to a certain extent. As discussed, it has been essential not only to analyse different price points but, more crucially, to understand the purpose and positioning of our competitors. By focusing on small to medium-sized vineyards within Europe, more clearly established the wants and needs of our target market with consideration to current products could be found. This understanding, combined with new EU regulations, has pushed more traditional vineyards toward adopting technological approaches, albeit with smaller budgets.

Based on the information provided, vineyards that fit within certain size constraints tend to outsource technological analyses to established laboratories. These analyses are crucial for monitoring the fermentation process and obtaining various metrics and values necessary for producing quality wine. However, these vineyards typically manage simple density measurements in-house, either using a test tube or a product like Easydens in combination with laboratory tests. These tools allow winemakers to establish alcohol content in real time.

However, if other issues arise, the winemaker would most likely be unable to identify or remedy the problem without external assistance. This is a problem our concept would solve, being able to monitor relevant parameters in-house directly.

WineOT fits into the market only to a certain extent because of it's price point. However, various studies have shown that WineOT may be reasonably priced for vineyards of medium size in comparison to others, depending on how the development of Unicorn DX turns out.

The patent analysis showed an increasing amount of published patents per year in the last few years. A growing amount of patents may reflect an increased interest and investment, a more competitive landscape and that there is significant innovation and technological development occurring in that particular field. However, all have a dip around 2020 that has not yet recovered. This is most likely due to the COVID-19 pandemic and economical situation, or a delay in updates. The patents from the competitors fluctuated widely in CPC-codes, indicating that this area is quite complex. Therefore, it was not very giving to look at the combinations of the codes which could have given a more complex market analysis if the codes were more consistent.

8.2 Methodology evaluation

The research methods and data were generally sufficient to answer the research questions. However, the vastness of the wine industry means there is always more information that could enhance the precision. The chosen target group and geographical focus within the EU provided valuable insights within the project's scope and time constraints. A more detailed methodology section could discuss specific limitations, such as sample size and data collection methods.

The combination of methods used have worked well. All methods have played an equally important role in gathering information to accurately answer the research questions. Mapping of competitors and PESTEL analysis allowed us to understand the current market, climate in the wine industry as well as current trends. To really understand winemakers wants and needs, online research was not enough and the excursions to several vineyards was paramount to understand this. These methods allowed us to create a well grounded SWOT for the WineOT concept. The hardest part has been the patent search, as none of the group members have done anything similar prior to this project. The beginning of the patent search was very difficult as we were unsure on what it would result in and what to interpret from the findings, but the final turnout helped us in the result and in answering the research questions. Altogether, the goals of this thesis were reached and the chosen methodology granted us the needed results.

8.3 Remaining questions

In this project, research and studies made have been done on small to medium sized vineyards. Most of these vineyards are limited by their budget and all have posed the same question: Is an investment of advanced equipment worth? To further understand the true value of the WineOT concept, it would be ideal to also look at large and mass scale production of wine. These producers could be very interesting to look into and understand how their production works, since they do have the budget for investing in technology and most likely the need as most mass production brand wines aim for similar taste and experience each year. However, these producers might not be as interested in yeast or bacteria but the question still stands if the concept has potential in the larger market.

A major question is of course about Unicorn DX. The goal of the project was to implement either Unicorn or PiPe, and without knowledge of the final turn out of Unicorn, it is impossible to come up with an exact value proposition of WineOT. There are still unresolved questions regarding the long-term adoption and integration of WineOT with Unicorn DX across different market segments. Future research should explore these aspects in greater depth, considering factors like technological compatibility, training needs for winemakers, and long-term cost-benefit analysis.

9 Conclusion

In the current scenario, there would indeed be a perceived value in further developing WineOT, which can measure several more parameters compared to, for example, Winegrid's product, while may maintaining a lower cost. However, determining the feasibility of this development would be challenging at this stage. It would require careful analysis of factors such as market demand, production costs, scalability, and the willingness of vineyards to adopt new technologies. Additionally, conducting market research and gathering feedback from potential customers would be essential to gauge the viability and potential success of WineOT in the market.

The concept cannot eliminate the need of using a lab to help with the last values such as SO_2 and total acid etc. Therefore it should be far lower in price than WineScan in order to be attractive to consumers. With Unicorn DX it offers a new possibility to be able to detect yeast and bacteria, which none of the competitors can. The concept is however, apart from the Unicorn DX implementation, quite similar to WineGrid's WinePlus WP1110. Therefore should it be different by making a cheaper monitoring product with another approach in order to make it more appealing.

It is important to note that WineOT is currently only a theoretical concept, and Unicorn DX is still in the prototype stage. If the technology owners are committed to exploring the full potential of the product, it's worth considering its value beyond just business applications. The end product of Unicorn Dx will hopefully detect biomarkers with great accuracy and precision, to further develop and improve the product, the tech owners should consider testing and using future prototypes in wine applications to understand what factors matter for improvement and learn different parameters the technology can detect. If this method proves useful to advancing the final Unicorn product, it could help in marketing the product to winemakers and work as a gateway to enter the wine market.

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