



# Digital technologies as a competitive advantage in the wine business

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## **Abstract**

The purpose of this dissertation is to investigate how wine companies can use technologies to create value and competitive advantages for their businesses. I also seek to study how luxury wines, with their distinctive characteristics, can be affected by these technologies. To answer my research question, I conducted a case study with three companies: Placido Volpone, Cartuxa, and Sogrape. The findings indicate that, first, technologies undoubtedly have an enormous weight in the management of the entire wine company, and, secondly, it is the level of integration of these technologies that will define the company's competitiveness.

Keywords: digital technologies; wine; wine business; competitive advantage; Cartuxa; Sogrape; Placido Volpone; innovation, integration

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## **Resumo**

O objetivo desta dissertação é investigar como é que as empresas de vitivinicultura podem utilizar as tecnologias de modo a criar valor e vantagens competitivas para as mesmas. Procuo também estudar como é que os vinhos de luxo, com as suas características distintivas, podem ser afetados por estas tecnologias. De forma a responder à minha pergunta de investigação conduzi um caso de estudo com três empresas: Placido Volpone, Cartuxa e Sogrape. Os resultados demonstram que, em primeiro lugar, as tecnologias têm sem dúvida um peso enorme na gestão de toda a empresa vitivinicultura e, em segundo lugar, é o nível de integração destas mesmas tecnologias que vai definir a competitividade da empresa.

Palavras-chave: tecnologias digitais; vinho; negócio do vinho; vantagem competitiva; Cartuxa; Sogrape; Placido Volpone; inovação, integração

As tecnologias digitais como uma vantagem competitiva no negócio do vinho

Margarida Neves

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**List of acronyms and abbreviations**

- OIV – International Organisation of Vine and Wine
- SEO - Search Engine Optimization
- AI – Artificial Intelligence
- IoT – Internet-of-Things
- CTO – Chief Technology Officer
- FEA – Fundação Eugénio de Almeida
- R&D - Research and Development
- N/A – Not applicable

## 1. Introduction

For thousands of years, no one has heard of digital technologies. The truth is that they have emerged and are here to stay. The agri-food sector has been one of the slowest to embrace this new reality and understand what its advantages to the business (OIV, 2021). Fortunately, nowadays, many solutions have arisen, but how should they be used to sustain a competitive advantage?

Digital technology is the application of advanced information and communications technologies to collect, store, analyse, and exchange physical and market information along the value chain, providing critical technological support for innovation in a variety of sectors (Yu et al., 2022). According to Verhoef et al. (2019), digital technologies are one of the three major external factors driving the need for digital transformation, a topic to which there has been little attention. Furthermore, the company's capacity to leverage its unique resources, such as digital technologies, to generate offers that outperform its competitors in terms of distinct products, market awareness, customers, and competitor responsiveness, is what defines its competitive advantage (Ramaswami et al., 2009). Some articles focus on the use of digital technologies in the wine sector ( e.g. Maraš et al., 2020; Prencipe, 2020). However, most of them concentrate solely on one specific digital technology, while how wine companies can use different digital technologies remains a blind spot. Therefore, I propose to answer the following research question: "How can wine producers use digital technologies to sustain a competitive advantage?"

This dissertation's topic is especially meaningful for managers since they can identify which technologies add the most value to their business and discover how to integrate them for process optimization and competitiveness. From the standpoint of society, this study will be relevant, not just to educate people on the reality of some technologies, but also to motivate the agri-food sector to embrace these new opportunities more actively. Concerning the academic relevance, besides contributing to filling the gaps regarding digital transformation and the luxury wine sector, it will also provide an overview of the latest digital technologies used in the agri-food sector.

To address my research question, I used a qualitative approach (Birkinshaw et al., 2011; Graebner et al., 2012) and conducted a multiple case study (Esser & Vliegenthart, 2017; Yin,

2009) on an Italian winery, Placido Volpone, and two Portuguese companies, Cartuxa and Sogrape.

In the literature review chapter, I studied articles focused on the two topics of digital transformation and wine industry, and then narrowed them down to digital technologies and potential wine segments.

In the methodology chapter, I explain my research design as well as the process of data collection and subsequent data analysis, using the coding method.

In the empirical chapter, the three companies are described regarding their history, environment, products, prices, distinctions, and latest technological projects. Apart from the fact that the companies are completely different in size, Placido Volpone being a small family business and Sogrape a multinational, their distinctions in terms of technology are also notable.

The findings chapter is split into four strategies and explains how the diverse digital technologies, associated with each strategy, enable the company's competitive advantages. It is also possible to observe how integrating digital technologies adds unique value to the wineries.

Following that, the discussion chapter connects the findings chapters with the previous literature review, highlighting the significance of these discoveries for managers and how they complement the literature review. It also tackles several constraints and obstacles to the evolution of the agri-food sector, in addition to providing clarifications on the luxury wine sector.

## **2. Literature Review**

This literature review shows that there is a necessity for research in the wine business and the need to adapt to new technologies. Given its distinct qualities, the luxury wine sector has an even greater need to use them; nonetheless, it is critical to figure out how to do so while maintaining the originality and mystery of luxury brands.

We start by looking into the wine industry before moving on to a more detailed analysis of the market's segmentation to understand its differences. Next, we cover how digital technology is being used both generally and in the wine industry.

### **2.1. The wine world and its specificities**

To begin, it is essential to have an overview of the wine business and its different segments. The luxury segment is highlighted since these wines do not have the same characteristics or are managed in the same way.

#### **2.1.1. Wine sector: an overview**

According to the European Commission-Agri-food Data Portal (n.d) the wine industry is a subset of the agri-food sector, that began to expand as an academic field of study with the foundation of the Journal of Wine Research, following global patterns of rapidly increasing wine production and consumption (Bonn et al., 2017). In the comprehensive study conducted by Bonn et al. (2017) regarding wine research between 1990 and 2015, the following wine research areas were identified: oenology, viticulture, education, marketing, business, tourism, and hospitality (Bonn et al., 2017).

An increasing number of studies have also been focused on climate and its effects on wine production (Seccia et al., 2016). Climate change and environmental challenges such as water scarcity crises and regulating the use of fertilisers, pesticides, and herbicides have emphasized the importance of better understanding how sustainability initiatives must be integrated into viticulture, which will remain a prominent wine study topic in the future, as well as the examination of concerns linked to organic wines (Bonn et al., 2017).

Ultimately, marketing and tourism have also been researched topics within the wine industry, thus wineries must be thoroughly analysed from the consumer's perspective (Bonn et al., 2017). Understanding generational habits and consumption patterns as younger customers obtain the opportunity to buy wine, particularly online, is also a growing topic of interest and critical for the future of wine research and business (Bonn et al., 2017; Lockshin & Corsi, 2012).

The supply chain is another important wine research issue that deserves attention (Bonn et al., 2017). The wine industry is characterized by high added value, which means that the quality of the final product is the result of the right combination of many variables, which involve the choice of suitable wine grape varieties to conditions of location, soil, and climate, together with the right entrepreneurial decisions from the vineyard to the retailer (Seccia et al., 2016).

The Covid-19 pandemic had a devastating effect on the global wine market, forcing down the global wine market growth by 9,2% in 2020 (*MarketLine Industry Profile Global Wine, 2022*). Wineries were forced to react to this reality by changing their sources of income away from tasting rooms and restaurants and toward online and retail store sales (Coyne, 2020). The global wine market, which includes the sale of still wine, sparkling wine, and fortified wine, has recovered, growing 2.7% in 2021 to a market value of \$320,778.7 million (*MarketLine Industry Profile Global Wine, 2022*). Market growth will likely quicken throughout the forecast period (2021-2026), driving the market to a value of \$438,801.4 million. Still wine was the market's most profitable sector in 2021, accounting for 82.1% of the total market value.

One significant component of the wine business is that wine production may be generically classified as Old World (Europe) or New World (Australia, New Zealand, South Africa, South America, and the United States). A new categorization, "NewNew World," which is neither New nor Old World, encompasses the rise of wine-growing regions such as China (Lawrence, 2016). However, the Old World currently has the largest share of the wine market, accounting for 56.7% of the overall value of the global wine industry (*MarketLine Industry Profile Global Wine, 2022*).

Additionally, both *MarketLine Industry Profile Global Wine (2022)* and Lockshin & Corsi (2012) highlighted that the luxury wine industry was one of the most in need of research. As a result, this study believes it is critical to emphasise luxury wine owing to its distinct qualities,

strong link to the old world (which will be the wine sector under investigation), and differences in production and management processes.

### **2.1.2. Wine segmentation**

Wine, in addition to being a very complex product, has an unusually broad segmentation possibilities (Samardzija et al., 2017). Besides the demographic division already stated by Lawrence (2016), another option explored by Cholette & Castaldi (2005) would be to segment the wine market by price. The three “super” segments analysed were: everyday, premium and luxury, which are further subdivided into three more:

- Everyday Super Segment (up to 7\$)
  - Jug Wine (wine sold in 3L jugs or 5L boxes): below 3\$
  - Extreme Value: below 3\$
  - Fighting Varietals: 3\$ up to 7\$
- Premium Super Segment (7\$ to 25\$)
  - Popular Premium (7\$ to 10\$)
  - Mid-Premium (10\$ to 14\$)
  - Ultra Premium (14\$ to 25\$)
- Luxury Super Segment (over 25\$)
  - Luxury (25\$ to 50\$)
  - Super Luxury (50\$ to 100\$)
  - Icon (over 100\$)

Although in economic terms, luxury items are those with the best price/quality ratio on the market, there is still some ambiguity around the notions of luxury and luxury brands (Kapferer, 1997). Several approaches have already been taken to define the idea of luxury and none of them provided a problem-free solution. Hence, luxury is described not as a category, but as the extreme limit on a set of traits, none of which (for example, high price) would be enough to define luxury on their own (Kapferer & Bastien, 2009). Thus, to understand what luxury wines are, we should not limit ourselves to the price, contrary to what may happen with other wines.

Luxury wines, such as the concept of luxury or luxury brands, have no industry definition (M. B. Beverland, 2004; Le Fur & Outreville, 2019). However, “Icon wines exhibit many of the characteristics of a luxury product.” (M. B. Beverland, 2004, p. 16). As a result, we shall analyse

luxury wines using several concepts that characterize luxury. For this purpose, we will relate the luxury criteria of Ko et al (2019) and M. B. Beverland (2005) attributes for the vital progress of a luxury wine brand.

Luxury Criteria (Ko et al., 2019)	Luxury Wine Brand Attributes (M. B. Beverland, 2005)
<p>Quality</p> <p>The winery's status was elevated further with the adoption of a standardized quality classification system. Besides that, to increase quality, wineries check their vineyards regularly and replant with superior clones. Luxury wineries are distinguished by constant attention to detail ("We do not pick by the bunch, we pick by the grape") and a knowledge of how these details come together to form the product and the brand (M. B. Beverland, 2005).</p>	<ul style="list-style-type: none"> <li>• The role of formal and informal classification</li> <li>• Real commitment to quality</li> </ul>
<p>Authenticity</p> <p>The connection to location and traditions strengthened a point of differentiation, lending authenticity to the product and story sincerity (M. B. Beverland, 2005). This view of authenticity was expressed in the commitment to terroir (M. B. Beverland, 2005). Terroir ensures a product's origin from a certain place, but it may also impact the components and some production aspects. Terroir is directly linked to authenticity since it clearly indicates a dedication to heritage and the place of origin (Heine et al., 2016).</p>	<ul style="list-style-type: none"> <li>• Usage of traditional productions methods</li> <li>• Location as a referent</li> </ul>
<p>Prestigious Image</p> <p>Wineries acknowledge the challenge of adjusting to changing customer tastes while keeping faithful to past styles (brand and region.). They also recognize that the absence of that style results in a loss of prestige because wine's essential traits were built over time and required a long-term, secretive commitment by the winemaker. This way, wineries need to preserve authenticity through the slow evolution of wine style to retain a link to the past and maintain the mystique (M. B. Beverland, 2005).</p>	<ul style="list-style-type: none"> <li>• Stylistic Reference/Consistency</li> </ul>
<p>Commands Premium Price</p>	<ul style="list-style-type: none"> <li>• Ability to demonstrate historical quality and price performance</li> </ul>

It is considered crucial for the winery status protection to establish a genuine continuous product quality (including the capacity to age) and the presence of price premiums (M. B. Beverland, 2005). For instance, “consumers and distributors often identified the audacity of many wine producers who ‘felt they could charge high prices for wines with little track record, from young vines, with no story and little pedigree” (M. B. Beverland, 2005, p. 1017) .

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Resonance

- Appear above commercial consideration

Although the producers have a comprehensive grasp of marketing techniques, they are unquestionably opposed to image-based advertising (M. Beverland, 2006). The wineries downplayed their true scientific and marketing capability and adhered to the accepted standards of artisan production, handcrafted processes, intuitive expertise, historical continuity, and a conservative attitude toward change (M. B. Beverland, 2005).

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Age

- History and Culture

Wineries emphasize that the wines proven capacity to age is evidence of status. In addition, using historical linkages and connecting to cultural events is another way to ensure authenticity (M. B. Beverland, 2005). One quote from Baroness Philippine de Rothschild may be the greatest summary of the significance of age in fine wines.: ‘It is fairly easy to create an icon wine, except for the first 200 years.’ (Heijbroek, 2003)

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In conclusion, “We can estimate that the term fine wine is reserved for exceptional wines from the world’s best vineyards, the highest quality grapes and the most acclaimed winemakers” (Le Fur e Outreville, 2019, p. 1). Moreover, “luxury wines have an established track record of consistent quality and aging ability” (M. B. Beverland, 2004, p. 22) with deep connection to terroir and traditions (M. B. Beverland, 2005).

According to a recent bibliometric analysis of luxury brands conducted by Verhoef et al. (2019), one of the seven central themes was the counterfeiting of luxury brands. In line with this, Mr. Roca, OIV (International Organisation of Vine and Wine) director, stated that some of the challenges that the wine sector is facing are sustainability issues, climate change, traceability, fraud prevention, and resilience therefore, it is crucial to understand how some of these issues can be addressed by technology.

Once more, there is a general lack of material available from a management standpoint, presenting an opportunity to better understand luxury brands (Husain et al., 2021). As mentioned, both Verhoef et al. (2019) and OIV, identify counterfeiting/fraud prevention are major concerns in both the luxury and wine sectors, consequently we shall examine them using digital technology.

## **2.2. Digital technologies application**

Digital technologies are driving our society's most creative evolution, in our lives and the economy. We have reached a stage in history where man has produced new capacities and has even been able to transmit these human capacities to computers, allowing artificial intelligence to become a reality. In some cases, the vitivinicultural sector may be vulnerable to significant disruption as it adapts at a different pace and stage. Furthermore, in a changing environment, the sector's reactions may be apprehensive and hence conservative. However it is crucial to remember that new technologies will provide great possibilities, analytical and forecast tools, and accelerate all procedures (OIV, 2021).

### **2.2.1. Overview of digital transformation**

Over the last three decades, the exponential acceleration of technical progress has marked the shift to a digital world in which practically everyone is surrounded by components of virtual reality: this profound change is commonly referred to as digital transformation (Quacquarelli, 2019).

Beyond digitization or digitalization, digital transformation provides a new business model by introducing a new business logic to create and capture value (Filho et al., 2022; Verhoef et al., 2019). According to Verhoef et al. (2019), there are three major external factors driving the need for digital transformation: digital technology, digital competition and digital customer behaviour.

Firstly, digital transformation makes use of digital technology to facilitate cross-border interactions with suppliers, consumers, and competitors (Singh & Hess, 2017). A rising number of supporting technologies (e.g. internet, Web 2.0, SEO, cloud computing, speech recognition, online payment systems, and cryptocurrencies) have emerged, bolstering the growth of e-

commerce. Furthermore, the pervasiveness of big data and the emergence of new digital technologies such as artificial intelligence (AI), blockchain, internet-of-things (IoT), and robots are expected to have far-reaching implications for business and its cost structure. The widespread use of new digital technologies plainly indicates the necessity for businesses to digitally adapt (Verhoef et al., 2019). However, making the best use of these new digital technologies and integrating them through the supply chain is one of the major challenges businesses confront today as it is intrinsically related to significant business model modifications (Sebastian et al., 2017). Secondly, competition is shifting substantially due to these new digital technologies, becoming more intense and global (Verhoef et al., 2019). Lastly, because of the digital revolution, customer behaviour is also changing. Consumers are migrating their purchases to online businesses, and digital connections play an essential part in the customer experience, influencing both online and offline sales (Verhoef et al., 2019).

Despite the visible impact of digital transformation, the academic literature has paid surprisingly little attention to these developments, only recently beginning to address topics such as digitization, digitalization, and digital transformation (Verhoef et al., 2019).

Continuous technological progress threatens traditional company models and presents an opportunity for new and innovative service offerings. As a result, leading companies must attempt to control the progress of technical applications to their benefit (Quacquarelli, 2019). Implementing new digital technologies requires organizations constantly challenge their status quo and think outside the box, as well as respond to changing conditions to adapt and prosper (OIV, 2021).

### **2.2.2. Digital technologies innovation in wine sector**

As previously stated, digital transformation is based on the use of various digital technologies to change how organisations connect and generate value for their consumers (Cakic et al., 2021; Verhoef et al., 2019). This transition is occurring across many sectors of business, including the agri-food sector (Cakic et al., 2021).

Inside the broad context of digital technologies, it is important to define three sorts of digital technology applications in the agri-food sector (Campos, 2021):

- Precision Agriculture: “application of modern information technologies to provide, process and analyze multisource data (...) for decision making and operations in the management of crop production” (National Research Council, 1997, p. 2). It includes field sensors, satellite imaging, drones, and robots for converting data into real-time farm management guidance (Fuglie, 2016). The concepts embodied in precision agriculture “offer the promise of increasing productivity while decreasing production costs and minimizing environmental impacts” (National Research Council, 1997, p. 1).
- Big data analytics: capacity to gather exceptionally huge amounts of data to give probabilistically based insights to better decision making (e.g. weather forecasting).
- Communication and social media:
  - “The use of social media to communicate with personal and business contacts.
  - The use of telecommunication-based wireless, WIFI, and the Internet: to transfer production-related data captured from sensors to devices where that data can be stored/analysed and to transfer findings to the farmer and/or instructions directly to machines as activities that should be conducted” (Campos, 2021, p. 212).

Nowadays, blockchain technology is also a new theme related to digital technologies that is gaining traction in this industry because it can be used to provide traceability, transparency, and efficiency throughout the whole supply chain, enabling the delivery of high-quality goods while minimising social and environmental repercussions (Agnusdei et al., 2022). “Traceability of wine can be defined as a method through which anybody in the wine supply chain can be able to verify the origin and composition of each batch of wines, its conditions of storage, and all the products that were in contact with the wine after the production” (Palade & Popa, 2014, p. 226). Wine traceability is critical for proving its authenticity, for better control of all representative events that may occur along this chain, from grape cultivation to wine sale (Palade & Popa, 2014) and fraud prevention (OIV, 2021). A transparent system seeks interest of multiple stakeholders, primarily customers, by providing them with access to all relevant product information. The benefits of accurate information are also numerous for manufacturers, suppliers, and retailers (Adamashvili et al., 2021).

Summing up, a set of technologies is now available that enables grape farmers and wine makers to collect and use precise data and information about their vineyards as a foundation for making the right decisions about keeping productive while also remaining ecologically and financially

sustainable. However, fast and reliable data analysis necessitates cooperation and management at both the vineyard and winery levels (Tardaguila et al., 2021).

With this in mind, and even though digital technologies such as sensors, drones, weather station, and blockchain have been mentioned in separate articles, the processes in the vineyard and the winery are not independent but rather interconnected, resulting in a lack of integration of these digital technologies and how they can sustain a competitive advantage. Moreover, this integration of digital technologies is related to the complex phenomena of digital transformation, which have received little attention (Verhoef et al., 2019).

The emphasis on luxury wines is appropriate since it is an industry area with a higher risk of counterfeiting, making it a priority to invest in technology that specifically increase data gathering and traceability. “The complexity of the counterfeit phenomena validates the need for further studies in this field and the establishment of corporation steps for combating brand piracy” (Staake et al., 2009, as cited in Husain et al., 2021, p. 595). Luxury brands, and those seeking to develop legendary credentials, incorporate their heritage into their brand, as luxury wines do. The problem is to optimize digital tools without jeopardizing heritage (Quacquarelli, 2019).

In conclusion, I propose to answer the following research question: “How can wine producers use digital technologies to sustain a competitive advantage? In this new digital age, it has become crystal clear that only companies that can adapt to digital innovation have a high probability of success, if not survival (Filho et al., 2022). Thus, it is extremely crucial that managers acknowledge how those technologies can bring value to their businesses. Moreover, I intend to clarify the impact of this digital technologies on luxury wines.

### **3. Methodology**

In this chapter, I explain why I chose a qualitative approach to address my research question (3.1) and detail how I chose my cases and collected primary and secondary data (3.2). Ultimately, I describe the process of data analysis using the coding method (3.3).

#### **3.1. Research design**

I chose to employ a qualitative approach for several reasons. The fundamental benefit of qualitative data is its open-endedness, which implies that researchers do not need to predetermine particular notions and measurements in order to gather qualitative data (Graebner et al., 2012). As a result, the qualitative approach is the most appropriate given the limited literature on digital technologies and the wine industry, especially when it comes to luxury wines (Graebner et al., 2012). Moreover, due to the scarcity of studies, I intend to propose a more in-depth understanding of those (Birkinshaw et al., 2011). This research design is also excellent when investigating a dynamic phenomenon such as digital technology (Birkinshaw et al., 2011).

I decided to conduct a multiple case study to have more compelling evidence and a more robust overall study (Yin, 2009). Comparing the different strategies that the companies undertake while using digital technologies is important to understand their similarities and differences, resulting in distinct outcomes and alternative solutions for similar matters, which is critical given the complexity of the competitive environment (Esser & Vliegenthart, 2017).

To select the cases, I used the following criteria: located in Europe, producing luxury wines within their portfolio, and employing disruptive digital technologies. I contacted 18 companies in total, either via email, LinkedIn for employees, or directly through the company website. I have not received any answer from Chateau Ste. Michelle Winery, Domaine de la Romanée-Conti, Ruffino, Château Thieuley, Château Mouton Rothschild, Château Lafite Rothschild, Château la Mission Haut-Brion, Chateau Beychevelle, Chateau Cos d'Estournel, M. Chapoutier. Unfortunately, Les Domaines Barons Rothschild, Domaine Bonneau du Martray, Château Margaux, and Murgatheira answered saying that they were in a very busy period. I also suggested sending the interview questions by email, but they still refused. Symington sent my email to the management secretary, but no one else returned. Concluding, I was able to

interview employees or people associated with three wineries: Placido Volpone, Cartuxa, and Sogrape, whom I first contacted through email. The investigation of these three cases was crucial to answer my research question since they all met my criteria and were even pioneers in developing of some digital technology. Furthermore, the fact that Placido Volpone is a small family firm, Cartuxa is a medium company, and Sogrape is a large market leader, contributes to a better understanding of the wine industry's reality.

### **3.2. Data collection**

To address my research topic, I relied on both primary and secondary data sources (Table 2 and 3), contributing to the primary data (Table 2) a total of 10 semi-structured interviews with 11 people.

For Placido Volpone I conducted 4 interviews, 2 of them with the CTO, Gerardo Volpone and other 2 with employees of EZ Lab and Ernst and Young, to triangulate data regarding their blockchain project. Unfortunately, I could not contact anyone else from the company since they only spoke Italian. Regarding Cartuxa, I interviewed 2 people: João Teixeira, the head of sales & marketing of Fundação Eugenio de Almeida and Duarte Lopes, an enologist. Since my meeting with Duarte lasted 1 hour and 45 min, I was able to obtain a great deal of information regarding all the processes and technologies used both on the winery and the vineyard, as well as his opinion on these matters and other future technologies that could be developed, and as a result, no further interviews with Cartuxa were conducted. Finally, unlike what happened with Cartuxa, Sogrape has a more structured organization, which led me to do more interviews, having conducted a total of 4 interviews with 5 people.

The main themes explored during the interviews were history, company assets (e.g. vines), wine processes, supply chain, impact of Covid, digital technologies (sensors, mechanical harvesting, drones, weather station, optical sorting table, e-label, authentication seal, management software and blockchain) and their managerial and sustainable impact, when applied to each case (Table 7). Lastly, I have discussed the theme of luxury wines, and their relationship with digital technologies, as well as future strategic plans.

As secondary data, (Table 3) I gathered data from websites, including the company website, their social media (Instagram, Facebook, and LinkedIn, when applied), newspapers and

magazines. I also considered important to gather information from international organization related with the sector, such as, International Organisation of Vine and Wine (OIV), that although not directly related to the cases, developed reports and conducted interviews with industry experts regarding digital technologies, which helped me have a more in-depth understanding of the topic and the industry necessities.

### **3.3. Data analysis**

After conducting the interviews, I proceeded to transcribe all of them (a total of 54 727 words), which was essential to better understand the organizational context and then, analyze the data through a coding method (Auerbach & Silverstein, 2003).

I started by labelling the quotations, creating the first order codes, which are associated with each technology (Table 4). I subsequently went back through the literature review and related these technologies (and consequently the first-order codes) into broader conceptual categories and then into aggregate dimensions, creating the coding tree (Table 5) that ultimately answered my research question.

For instance, the following quotation “It is also associated with quality assurance (...) and allow us to take corrective or preventive actions” (Interview João Teixeira – Head of Sales & Marketing of FEA), allowed me to create the first order code “improve product quality” and “immediate corrective or preventive actions” which led me to the digital technology sensors and consequently the conceptual category “Employing Precision Agriculture Techniques through Sensors, Mechanical Harvesting, Optical Sorting Tables and Drones”. Another example is, “transparency”, retrieved from the literature review and related with the technology blockchain, included in the conceptual category “Optimizing Data Integration through Blockchain or Management Software’s” enabled me to generate the first order codes “improve performance”, “less efficiency/waste” and “qualitative gains” that finally led me to “Optical Sorting Table” to which the following quotation was linked (Table 4): “we identified food sector like one that would benefit most from blockchain because of immutability, transparency so there was tangible benefit from moment T0 (..)”(Interview Gerardo Volpone – CTO of Placido Volpone)

Finally, in table 6, I have schematized the coding information to demonstrate the link between the literature review information and the findings. In table 7, I related the cases to the digital technologies that they were using to have a broader perspective on the findings.

## 4. Empirical Setting

To answer this dissertation's research question, I selected three wineries, one Italian (4.1. Placido Volpone) and two Portuguese (4.2. Cartuxa and 4.3. Sogrape). In this chapter the three companies are described regarding their history, environment, products, prices, distinctions, and latest technological projects.

### 4.1. Placido Volpone

Placido Volpone is the culmination of the union of two families, Placido and Volpone, with affinity and devotion to their land, Puglia, Italy (*Placido Volpone*, n.d.).

The Volpone family has been producing wine since the late 19<sup>th</sup> century and created Cantina Volpone in 2009, meaning that they have more than 100 years of agricultural heritage. (Interview Gerardo Volpone - Chief Technology Officer of Placido Volpone). On the other hand, the Placido family, although having nothing to do with agriculture, is one of Italy's most famous family of actors. These families, friends since 1974, agreed to invest in Puglia, establishing Cantina Placido Volpone in 2017 (Interview Gerardo Volpone - Chief Technology Officer of Placido Volpone).

For Placido Volpone, the wine, product of generations of farmers, is the result of vinification using both old and cutting-edge procedures, which makes tradition and ongoing innovation, the paths that Placido Volpone pursues to deliver the best wines to their customers. Their wine selection is composed of *Il Rosso e il Nero*, *Calve Viva*, *Rosantica*, *Rosane*, *Cinque Figli*, *Faragola*, *Altomare*, *Beniamino* and *Mimi* (*Placido Volpone*, n.d.).

Placido Volpone is nowadays a small family-owned company, that owns the entire supply chain and 19 hectares of vineyard. All their wines come from their own vineyards, and they produced in 2021, 148 000 kg of grapes, which generated 108 000 l of wine, and almost 150 000 bottles. This resulted in a turnover of 136 411€, with 5% coming from international sales, and is expected to expand by 20% by 2022 ( Interview Gerardo Volpone - Chief Technology Officer of Placido Volpone).

Placido Volpone is known to be the first winery in the world to certify its wine supply chain using blockchain technology (Figure 1). In 2016, a collaborative initiative with Ernst & Young EZ Lab and Cantina Placido Volpone certified the first wine in the world at "km 0 virtual." Consumers can verify the entire agricultural and industrial chain of Placido Volpone wine by bringing their smartphone close to the QR code on the label: from the field where it was grown, to the seeds used, from the treatments carried out, to the steps in the chain, including the number of 'kilometers' travelled from the field to the shop shelves. This is additional evidence of the winery's desire to share transparency with its clients, regarding the quality of its grapes and the winemaking process (*Placido Volpone, n.d.*).

## 4.2. Cartuxa

The Eugénio de Almeida family is the driving force behind Adega Cartuxa. The history of the Cartuxa winery dates to 1869, when the great-grandfather of the Foundation's founder, José Maria Eugénio de Almeida, purchased Quinta de Valbom, in Évora. After his death, his son, Carlos Maria Eugénio de Almeida, planted the vineyards that now supply some of the foundation's wines (*Cartuxa, n.d.*). In 1963, Vasco Maria, founded Fundação Eugénio de Almeida (FEA), revitalised the winegrowing business and invested in establishing a wide tract of olive, which, along with what Carlos had previously established, resulted in the wines and olive oils produced to this day (*Cartuxa, n.d.*).

The Foundation's vineyards, Herdade de Pinheiros, Casito, Álamo de Cima, Álamo da Horta and Quinta de Valbom, are all in Évora (*Cartuxa, n.d.*). Cartuxa has about 600 hectares of owned vineyard, and 400 hectares of rented vineyard (Interview João Teixeira-Head of Sales & Marketing of Fundação Eugénio de Almeida).

The Cartuxa Winery produces around 6 million bottles of white, rosé, and red wine under the Monte de Pinheiros, EA, Foral de Évora, Cartuxa, Scala Coeli, and Pêra-Manca labels, with the respected prices in table 8. The Cartuxa Winery processed 6211 tonnes of grapes in the 2021 harvest, generating 4 390 000 liters of wine (*Fundação Eugénio de Almeida, n.d.*).

The year 2021 was the strongest so far in terms of sales of bottled wines and olive oils, with the foreign market contributing 47% and the national market 53%, resulting in total sales of approximately 20 million euros (*Fundação Eugénio de Almeida, n.d.*).

The Cartuxa winery is known for producing one of the most famous and exclusive national wines, Pêra Manca (Matriz, 2021) becoming a temptation for those engaged in the counterfeiting and forgery of luxury wines (Matriz, 2021). To address this issue, the Cartuxa winery pioneered the creation of a stamp of authenticity for Pêra Manca 2015, harvest 2011, in partnership with the *Imprensa Nacional Casa da Moeda* (Interview João Teixeira-Head of Sales & Marketing of Fundação Eugénio de Almeida).

Quality certification in wine and olive oil production is structural in FEA's policy, as it ensures the use of appropriate technical means and qualified human resources, promoting improvements in innovation processes and, as a result, product quality and consumer satisfaction (*Cartuxa*, n.d.). Duarte Lopes also clarifies that, when it comes to digital technologies, Adega Cartuxa's goal will always be to produce traditional wines, with traditional grape varieties, but to use the available digital technologies to be able to produce them in the best possible way and in a more sustainable manner.

### **4.3. Sogrape**

Sogrape was founded in Gaia, by Fernando van Zeller Guedes (Público, 2019) in 1942, with the creation of *Mateus Rosé* (*Sogrape*, n.d.). The success of Mateus Rosé, which is now Sogrape's best-selling wine and the best-selling Portuguese wine in Portugal and the world, ended up acting as an impulse for the growth of the company, beginning to invest in the acquisition of other brands such as *Azevedo*, *Gazela*, *Casa Ferreirinha*, *Offley* and *Herdade do Peso* (Interview Inês Carola- Innovation Specialist of Sogrape) Following its consolidation as the largest wine production and distribution company in Portugal, it began investing in the international market in 2000 with the acquisition of Finca Flichman in Argentina (Interview Jorge Machado - Digital Transformation Lead of Sogrape; Público, 2019).

Nowadays, Sogrape is a family-owned global wine company with a strong international presence in over 120 markets. The year 2021 was exceptional for Sogrape, beginning with numerous sales records smashed, followed by high profitability which resulted in a turnover of EUR 309.9 million. It generated 12 million kg of grapes, which resulted in 30 million liters of wine and 7 million 9-liter boxes sold (*Sogrape*, n.d.).

Sogrape Vinhos, which will be our focus from now on, is the leading wine company in Portugal and owner of the 12 brands in Portugal (wine prices in table 8). It has 18 properties in 6 wine regions: Alentejo, Bairrada, Bucelas, Dão, Douro and Vinhos Verdes, 980ha, over 600 employees and 61 grape varieties planted (*Sogrape*, n.d.).

The ongoing commitment to scientific research has enabled Sogrape Vinhos to develop solutions that increase the innovation, efficiency, and effectiveness of the organization in its production and commercial processes. Sogrape Vinhos believes that digital technologies are essential to create knowledge and enable them to lead in the areas in which it identifies its main business opportunities (*Sogrape*, n.d.). Projects such as NOVATERRA, i-GRAPE, MED-GOLD, and WINE GRID allow to respond to market challenges, obtain resilience by managing variability, adapt to climatic risk, and streamline production management (Interview Jorge Machado - Digital Transformation Lead of Sogrape; *Sogrape*, n.d.).

Sogrape was also the first Portuguese wine company to join the digital electronic label platform, U-Label, with the goal of increasing consumer information transparency and encouraging more responsible consumption, and Mateus was chosen as the pilot brand. (*Sogrape*, n.d.).

Finally, Sogrape Vinhos, such as Cartuxa, added in 2021 the authenticity seal (Figure 5) to Barca-Velha, harvest 2011, in collaboration with *Imprensa Nacional Casa da Moeda*. (Interview Paulo Medina - Brand Lead Casa Ferreirinha; *Sogrape*, n.d.).

## 5. Findings

With the aim of answering my research question and based on the information of the cases, I was able to aggregate the findings in four strategies: employ precision agriculture techniques (5.1), leverage big data (5.2), develop new communication solutions (5.3) and optimize data integration (5.4). In each section I analyse the respective technologies and how they are used to sustain a competitive advantage.

### 5.1. Employing precision agriculture techniques

The results show that the first strategy to sustain a competitive advantage in the agricultural sector, using digital technologies, is to use precision agricultural techniques such as sensors, both in the vineyard and in the winery, mechanical harvesting, optical sorting table and drones. Precision agriculture, as we saw in the literature review, promises to increase productivity while lowering production costs and reducing environmental impact (National Research Council, 1997), therefore, we must analyze how each of these technologies contributes to this purpose.

#### 5.1.1. Sensors

The findings show that the main objective of using sensors in the winery is to reduce risks during harvesting while in the vineyard is to control all the essential parameters for a correct wine-making process. These two goals are connected to ensure and improve the final **product quality**. In Sogrape, this idea is followed in the vineyard:

*“Igrape, (...) are sensors to monitor the parameters of interest in grape maturation, which reflect its quality and which in turn determine the date of the grape harvest. It is based on sugars, pH, and total acidity, among others, that the time for the grape harvest is determined, and this is a key moment for the sector because it will determine the quality of the wine itself”.* (Interview Natacha Fontes – R&D Manager of Sogrape)

This idea can also be found in the winery, both in Cartuxa and Sogrape:

*“these wine grid sensors (...) measure the density which allows us in real time to monitor the fermentation, understand if nutrition is needed, (...) if it has any deviation, if it is necessary to intervene etc, (...) Based on the various parameters that are being measured in the fermentation tank, we can understand when that fermentation is going to finish and anticipate any problem”* (Interview Natacha Fontes – R&D Manager of Sogrape)

*“It is also associated with quality assurance because it is much more unreliable to be dependent on evidence or reports that sometimes are not immediate, than sensors that trigger alerts immediately and allow us to take corrective or preventive actions, to take that decision immediately, and that helps a lot, especially in areas as extensive as the ones we have in the vineyard.” (Interview João Teixeira – Head of Sales & Marketing of FEA)*

With this in mind, we could see that sensors technologies are also used to **increase productivity** through the optimization of processes and subsequently *“take corrective or preventive actions”* as João Teixeira mentioned. The enologist Duarte Lopes, also corroborated with this:

*‘It is direct so that we can improve in terms of performance (...) from a management point of view, because they are tools that help us understand where we are failing and help us optimize the processes.’ (Interview Duarte Lopes – Enologist of Cartuxa)*

Furthermore, João argued that sensors are employed to **lower production costs** by reducing the workforce typically required to oversee both the vineyard and the winery. He highlights that, although this technology requires a significant investment, it pays off over time, either financially or in higher quality wines.

*“the humidity sensors, the irrigation sensors, the nutrient variation sensors in the soil, (...) allow us to reduce the need for man hours (...) it does not mean that we will not be monitoring the vineyard, but maybe it is not necessary to do it so often (...)this allows us to manage almost 600 hectares of our own vineyard with much less human costs (...) When an investment is made, obviously it is based on this financial plan to know how long it will be amortized and that there will be a return(...).Many times, the return may not be (...) exclusively financial, but may also be a qualitative one for what is the quality of the wines from the Cartuxa Winery. (Interview João Teixeira – Head of Sales & Marketing of FEA)*

Natacha pointed up that most sensors used in vineyards also focus on climatic issues, such as monitoring soil and water conditions for optimal water usage and irrigation management, and hence have a great component of **sustainability**:

*“We know that in the current context of climate changes (..)water is a finite natural resource, and that increasingly there will be less available (...) even though the vine is a rain fed plant, i.e., it does not need water, but in the extreme conditions that we are, (...) irrigation is already a necessity, but that irrigation must be done in a very precise way, the idea is to give the plant exactly the minimum amount of water it needs to maintain its survival and to guarantee a certain level of quality, (...) and what we do at the moment is exactly that, we determine which is the hydric state of the plant to irrigate, it happens that there is no way of doing it like we are doing (...) with igrape” (Interview Natacha Fontes – R&D Manager of Sogrape)*

Finally, another major benefit of using sensors, which is directly related to product quality, is **security**. Duarte explained that wine is a transformed product in which the grapes are constantly in contact with the external environment of possible pests and fungi in the vineyard and the

fermentations and temperature in the winery must be under strict control to avoid the production of biogenic amines <sup>1</sup> or even carcinogenic products. This is even more important in luxury wines made in *talhas*, where wines evolve differently, and the need arises to adapt and control with sensors:

*“How can we have biogenic amines? How can we have the production of some carcinogenic by-products that are not so good for us? So, by controlling fermentation (...), we install inside the talhas a cold system with a temperature sensor (...) many of these products appear when there are large temperature oscillations (...) the technology used in this way goes in the direction of safety and of having products that are effectively better, while still being the traditional raw material that ferments, it is the grape that ferments and is put into the bottle and this ends up being what is important to pass on.”* (Interview Duarte Lopes – Enologist of Cartuxa)

In this scenario, Duarte added that it is critical to emphasize that the employment of technology has no bearing on the authenticity or heritage of luxury wines. From his point of view, digital technologies just serve as guidelines and assist in the development of a higher-quality product.

*“What we do continues to be quite attached to tradition, what we have are tools to do it in a better way, and this is what has to be communicated, in fact what we do is nothing far from tradition, what is important is the vine (...) what all these technologies allow us to do is, taking grapes, old vines, without intervention, with an organic production method, and for us the organic production method is nothing more than a less interventionist way, (...) and it continues to be a product in a quite traditional way. The technologies are not used to change the product itself, they are used to help produce a wine in the best possible way, and in a safer way and with more quality because in the old days great wines were made, but the truth is that oscillations between great wine and bad wine were big.”* (Interview Duarte Lopes – Enologist of Cartuxa)

As observable, the usage of sensors dramatically impacts the production process of all types of wines and is essential for the final product, not only regarding quality but also security. Proper management of the information provided by this technology is critical and can lead to increased productivity, reduction of production costs and environmental impact, as expected from a precision agriculture technique.

### **5.1.2. Mechanical Harvesting and Optical Sorting Table**

Results have demonstrated that mechanical harvesting and optical sorting tables are two more precision agricultural techniques that have three common characteristics: first, they both aim to **increase productivity and minimize labor costs**; second, they are essential during harvesting

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<sup>1</sup> Biogenic amines are deamination products of amino acids and have been associated with physiological effects such as migraine (Crozier & Hurst, 2014).

season; and third, they are not used in luxury wines. These first two characteristics are confirmed by Cartuxa:

*“The optical sorting table is basically an aspect that improves our performance and qualitative performance. It does not make us more efficient because we end up losing a little more that is rejected, but (...) is an equipment that makes a real time reading of the grape, passes on a mat and (...) rejects everything that does not have the shape within the interval that we want and the colour within the colour standards that we want and the dimensions.”*(Interview Duarte Lopes – Enologist of Cartuxa)

*“is a table that allows us to work 24 hours a day, not having the fatigue of the human (...)and we have two optical sorting tables that allow us at harvest time to make a much more careful and qualitative selection of all the grapes that enter the winery (...) guaranteeing quality as the optical sorting tables manage to do a much better job than any person or any shift of people who are there selecting grapes.”* (Interview João Teixeira – Head of Sales & Marketing of FEA)

Duarte explained that these technologies could not be employed in luxury wines since the grapes often originate from older vines that do not support such type of technology and require more maintenance, thus firms choose to sort these grapes by hand.

*“these two wines (Pêra Manca and Cartuxa Reserva) come from very good vineyards, extremely qualitative, they had an extremely high level of field work (...) normally the vineyards that produce the Pêra Manca wine are a little bit older vineyards and the older vineyards do not allow so much mobilization with machines, they need more care in terms of manual work of pruning, cleaning of the vineyards, treatment of the vines, they are older vineyards, they need some extra care (...) are vineyards that are treated in a slightly different way because they are qualitatively better, sometimes are not even used for Pêra Manca but they are quality vineyards that are always used to make top-range wines.”*( Interview Duarte Lopes – Enologist of Cartuxa)

Natacha also highlighted that Sogrape “handpick at the tables for the top of the range wines, it doesn’t get any better than that.”

### 5.1.3. Drone

The results show that drones have become a key device for measuring a wide range of information and indicator such as vegetation density, which allows for an optimization of pesticide application and fertilizer distribution. For Gerardo, such enables more precise and efficient operations on wider fields, and the data may subsequently be utilized to apply other precision agricultural techniques to **maximize productivity**:

*“we also did a test with a drone (...) to provide us the information about the vegetation, this kind of information help address the agricultural operation, so you do not waste water for example in places that there is more vegetation, you do not waste organic activities on that.”* (Interview Gerardo Volpone – CTO Placido Volpone)

João Teixeira also explained that drones are used to assess irrigation and soil moisture, allowing management of the water in the vineyard, and therefore becoming vital for **minimizing environmental impact**:

*“this mapping is done by the operator to verify immediately, in a vast area, (..)how the plants are developing, the level of water resources or even thermal resources because in times when we reach 40 degrees during the day it is very important (..) that the night cooling occurs, if we have consecutive nights without cooling, these drones, through thermal sensors, can detect the temperature of the leaves and vines, obviously we can also take corrective measures”* (Interview João Teixeira – Head of Sales & Marketing of FEA)

We conclude that the data gathered from these four technologies support the development of valuable strategies that can lead to an enhancement in wine quality. It is also important to highlight that these technologies, by being effectively of precision, have a significant effect on the reduction of environmental impact, since we only use the resources that are truly necessary for that purpose, thus reducing waste. This fact also leads to cost reduction which is essential for top management and consequently to sustain competitive advantages. Given that the harvest is seasonal, these technologies become critical for increasing production at times of high demand for workforce, which is extremely scarce in the agricultural sector. Finally, we must remember that the use of these disruptive technologies is also required for the day-to-day administration of the vineyard and winery, thus becoming work tools that allow performing a better job.

## **5.2. Leveraging big data**

As we saw in the literature review, big data analytics is the collection of huge volumes of data to provide probabilistically based insights for improved decision-making, which is precisely what weather stations do.

### **5.2.1. Weather Stations**

Even though everyone nowadays can check the weather on their phones, in Sogrape, the use of weather stations in agriculture is for far more purposes:

*“we have weather stations installed in our vineyards and (...) based on the weather conditions we can predict that a certain disease has conditions to develop which means that we only intervene at that moment,(..) we have a weather forecast system for our properties and we only treat if it is not going to rain, because if it rains the treatment is washed away and there is a waste, not only economically but also environmentally.”* (Interview Natacha Fontes – R&D Manager of Sogrape)

As evidenced by Natacha, this technology that leverages big data anticipates if a given plague will emerge depending on meteorological conditions and manages the administration of treatment, all of which ultimately leads to **increased productivity** and **reduced environmental impact**. Furthermore, Duarte mentioned that other elements such as humidity and wind might be measured, which is critical since they influence the soil nutrients, which in turn affect the vine and, lastly, the **quality of the grapes**.

### **5.3. Creating new communication solution**

Communication is an essential part of any business since it helps provide specific product characteristics in addition to presenting a company's image, making a statement to potential buyers, and establishing a brand with which they can associate. In the case of wine, this communication is done through the label. Results have shown that it is possible to adopt two new digital technologies that enable wine brands' communication: e-label and Authenticity Seal.

#### **5.3.1. E-label**

In recent years, countries, regulatory agencies, and local governments have moved to force manufacturers to disclose an increasing quantity of information on product labels. Such information might range from warnings and cautions about the materials used to clinical data, which must subsequently be translated into other languages. (OIV, 2021). Inês Carola, explained that it is getting extremely challenging to manage the label manufacturing, and According to Regulation (EU) 2021/2117 released on December 2<sup>nd</sup> 2021 modifying the labelling requirements for wines, it will be mandatory to indicate the list of ingredients and the nutrition declaration on the label of wines beginning on December 8<sup>th</sup> 2023, an especially difficult request in a market dominated by micro and small businesses, and for items that are not manufactured according to a set formula. Conscious of this EU legislators decided to allow corporations to transmit such information electronically using digital labels.

OIV described that electronic labelling (e-labelling) is an alternative for manufacturers to deliver more information electronically than on a physical label and can also connect to videos of experiences with that exact bottle and grape. Results show that its simple access via QR codes provides a compelling alternative to traditional means of presenting all relevant product information required by regulatory agencies while ensuring security and reliability:

*“bottles are already overloaded with information, both on the label and on the back label, they already have lots of stamps and then each country has its own legislation and then they have to have different things, (...) so these associations launched the challenge of putting the QR code on the bottles so that when you read (...) you can see the nutritional tables (...) the translation of the label yes, it is a way of standardising the labels and then each country has different languages”* (Interview Inês Carola – Innovation Specialist of Sogrape)

This means that, besides increasing brand transparency to consumers, this solution is highly helpful since it allows for **product design innovation** while also **minimizing environmental impact** and protecting natural resources. It eliminates excessive paper consumption and waste generated during the production and update of physical labels.

### 5.3.2. Authenticity Seal

OIV highlighted that labels have also become a key element in product traceability and fraud protection. The employment of specific authentication certifications, such as the authenticity seal, to prevent illegal product alteration or tampering is becoming increasingly important in the wine business. This aspect is especially relevant for luxury wines, which are constantly targeted for counterfeiting due to their added value, as indicated in the literature review.

The results show that, through the authenticity seal, Cartuxa and Sogrape intend to ensure the consumer that he is not acquiring a counterfeit product, by guaranteeing its authenticity, while also protecting their own reputation:

*“The authenticity seal allowed the consumer to guarantee that he was buying an authentic product, i.e. not only did the seal itself guarantee the bottles’ inviolability, i.e. if someone broke the capsule to modify the product in any way, it was impossible to put that seal back on, i.e. the seal would be irretrievably broken, but it was also possible to verify the authenticity of the bottle through an alphanumeric code on our website, using a unique code (...) with this innovative technology, we had immense coverage, immense visibility and it gave the brand a very good notoriety, and confidence because some cases had appeared in the market with premium wines (...) Then it placed the Cartuxa winery as an innovative company. (...) Appearing in a highly traditional market with a solution like this in partnership with the national mint institute (...) gave (...) immense interest to the market about this technology (...) nowadays we always continue with this seal of authenticity to be a pretext, every*

*time we launch a new vintage to have this argument and this source of communication or communication plus which is this seal of authenticity so I would say that at the marketing level it was very important” (Interview João Teixeira – Head of Sales & Marketing of FEA)*

In conclusion, both communication technologies are seen as **differentiation and enhancement product strategies**, which are also a form of competitive advantage. These technologies contribute to increase brand competitiveness through marketing and product value, while also making available a new **contact channel** with the client. In the case of luxury wines, where communication is fundamental, João, Paulo and Duarte explained that the development of these digital technologies helps the customer feel important and makes the product more unique and distinctive by incorporating charisma, history, and text into the wine.

#### **5.4. Optimizing data integration**

Data integration is the method of merging data from several sources into a single and comprehensive perspective for effective data management, intuitive understanding, and workable information.

As we just saw, wine is a processed product with several production processes that rely on multiple technologies and require continuous management and supervision. Since the supply chain can be enormous, data is constantly growing in volume, arriving in various formats, and becoming more distributed than ever. However, the three cases explained that, for this data to be meaningful, it must be accessible for analysis in real-time:

*“These products that are then transformed end up having a different impact here, and a bit of subjectivity comes in, the need to have something that goes beyond a simple data analysis (...) the challenge is to take all the information that is spread across all the platforms and present the information as friendly and easy to consult as possible” (Interview Duarte Lopes – Enologist of Cartuxa)*

As a result, the greatest form of competitive advantage is precisely in developing solutions that permit integrate all the information available from the technologies I have mentioned and many others, allowing for daily process optimization and, consequently, greater supply chain efficiency. This idea is shared by all cases via different solutions such as blockchain and management software (SAP HANA).

### 5.4.1. Management Software

Cartuxa and Sogrape both employ SAP HANA management software to integrate all data received from multiple technologies and other management tools. The findings show that this is a superior approach to manage a business more **efficiently and decrease costs** by making better use of existing resources:

*“It was basically an entire process of digitalization of the viticulture and oenology processes; everything is integrated into a single system. What has changed between the old solutions and this one? First, it was a solution available in any kind of device much more user friendly (...), one of the great advantages is that it can be connected to any place, all you need is a door to enter, what I mean by this is, when they are consuming a phytopharmaceutical with a herbicide, for us they are going to SAP to see if the product exists, if the lot exists, and if the validity of the lot is valid, (...) everything is registered and the consumption, both per cent and the quantity, comes out of the system” (Interview António Pereira – Leader of Custom & Web Development Software Team of Sogrape*

Jorge also described how this system allowed Sogrape employees to capture value from the data, i.e. collect critical data from wherever it may be in order to **support organizational reporting and business operations.**

*“made a software that goes from the vineyard to the bottle, i.e.,(...) manages the vineyard, manages the grape delivery to the winery, manages the whole wine ageing process (...) you define the vineyards, which grapes are there, how long the vineyards have been there, when are they going to leave, the maturation states, etc, then you go to the reception of these wines at the winery, it means, you do the harvest, when the trucks come with the grapes, the quantity of grapes, this makes all the management, which is connected to the sensors that are in the wine vats and barrels, and our oenologists will, through this application which is connected to those sensors, understand what they have to do with that specific lot of wine” (Interview Jorge Machado – Digital Transformation Lead of Sogrape*

Natacha also explained that this solution allowed the traceability of all Sogrape products, the fact that “everything is controlled in detail and from vat X it can be traced to the plot of land from which it originated”, prevents or **solves any problems with greater accuracy and at lower cost.**

### 5.4.2. Blockchain

Elia Paggi explained that, while in a typical database, data is stored on cloud services, blockchain does not store the data; it registers hashes, which are a fingerprint of the digital data. Consequently, the data becomes immutable, meaning that once it is validated, it cannot be

changed or deleted by any user on the network. These qualities of blockchain technology enable **data transparency and traceability**, bringing benefits to the wine industry:

*“We identified food sector like one that would benefit most from blockchain because of immutability and transparency so there was tangible benefit from moment T0 (..) wine sector could benefit because it is a high value product where the consumer loose time to know where it comes from and likes to know more about the product”* (Interview Gerardo Volpone – CTO of Placido Volpone)

As mentioned by Gerardo and further noted by Ellia, wine consumers like to know the origin and process of creating wine. This becomes even more important in luxury wines, as demonstrated in the literature review. Findings show that blockchain is particularly important for luxury wines as a solution to demonstrate product heritage while **preventing counterfeiting**:

*“wine it is something that it is perceived as some sort of product that needs some anti-counterfeiting, needs some possibility to see what is the actual process of creating it, because a lot of the value that wine has derives from the process of creating it and also the materials that you use (...) the steps of the wine supply chain are all notarized and all the data that is related to these steps (...) cannot change from that time on. So, this is why it is thought as something for anti-counterfeiting because you cannot say that this bottle of wine comes from a specific territory when (...) the data is saying that the grapes come from another territory.”* (Interview Ellia Paggi – Digital & Emerging Consulting Intern of Ernst & Young)

Gerardo explained that although early blockchain projects aimed to profit from the buzzword and produce marketing content, he now views it as an **enterprise resource planning** tool and, as a result, a strategy to **lower costs and obtain a competitive advantage**.

*“early projects based on blockchain were made to take advantage of the hype of blockchain (...) Cantina Volpone, took advantage of that hype, but now there is no more any hype (..) blockchain has some value beyond that marketing value and in my opinion the value is, in, notarization, tokenization and automation with smart contract. You can take advantage of tokenization, for example, for anti-counterfeiting, so if you give a number to any bottle, with the token, you can guarantee immutability and authenticity of any peace (...)so you can monitor and have the guarantee that your material that you purchase is unique, is a good quality, (...) the last one is automation, (...) blockchain will be for network of companies like ERP was for a single company, so connect the different function in a single company, connect the different companies in a supply chain, once these companies are connected, you can leverage on automation. There is an order from the end customer automatically there could be triggered an order produce more material (...) and sell to the customer (...) this is the cost reduction in terms of time to create this order back to your supplier, time to create the reconciliation in terms of finance activities (..) is not a differentiation but who does not have it stays behind and who has it is at the same level, has to leverage blockchain for a cost reduction to have a competitive advantage”*  
(Interview Gerardo Volpone – CTO of Placido Volpone)

Furthermore, Edoardo clarified that while ensuring transparency to all stakeholders, blockchain also guarantees **product quality and sustainability**:

*“I think there is a real value for the company because it is about their reputation, it is about doing everything that you can do to guarantee the quality of your wine and if you have nothing to hide in the supply chain, with the blockchain, (...) everything is tracking. Of course, you can decide the borders of the tracking process and you can decide if you want to skip something specific because maybe it is a secret of the company, but you also know that all the rest that you are putting will always be visible in the future for the market, the consumers, and your competitors. So, it is a guarantee that you have nothing to hide, and this gives a real value to the product (...) because there is a different value, (...) an incremental value for products and for companies. (...) Generally, the things related to sustainability are self-declaration that you put inside the website so you can change the stuff, you do not have to prove this data are just the self-declaration. By using the blockchain you are turning self-declaration into data that you cannot change”* (Interview Edoardo Erlini – Sales & Special Project Manager of EZ Lab)

On the other hand, this transparency might bring certain restrictions to the firm:

*“the limits that blockchain gives to the company, is not about the software or the implementation but the fact that you start producing it inside a factory made of glass so it is transparent”* (Interview Edoardo Erlini – Sales & Special Project Manager of EZ Lab)

Natacha’s view is that the blockchain project requires all parties to have access to all information, indicating the complexity of its implementation in terms of regulations and consensus.

*“Implementing Blockchain is very interesting but very difficult (...) a Blockchain foresees that information can be consulted by all stakeholders, so it is a megalomaniac project and very complicated, if we take the issue of regulation and think that it takes consensus to approve certain information at certain times”* (Interview Natacha Fontes – R&D Manager of Sogrape)

Moreover, Edoardo referred that one of the challenges of blockchain is the “knowledge transfer” to the clients. In line with this, Elia explained that, when he mentions blockchain “everyone is tempted to think about just Bitcoin and speculation so a lot of education about what is actually the utility of blockchain for corporations” needs to be done. Therefore, in his opinion:

*“adopting blockchain right now it is probably a long-term play, rather than a short-term play because you do not see the value immediately but you if you understand and see what the potential behind it is very good to adopt it right now instead of following the others in the long term”.*

### **5.4.3. Artificial Intelligence**

An extra layer of integration that although not currently used by any of the cases, is signaled by all three as the future is artificial intelligence.

*“When I talk about artificial intelligence, we are talking about a tool that allows us to analyse and make a decision that is not ours, I think that is what we are getting at, (..)it adapts to different circumstances and different production goals. The use of artificial intelligence will be very useful to be really more efficient and we can produce even better” (Interview Duarte Lopes – Enologist of Cartuxa)*

Moreover, if companies were willing to accept this automated decision, many mistakes could be avoided, and resources saved:

*“we are not machines and we have some failures and it ends up being quite complicated, with some dimension, to not have failures, to have a readiness, to not have one mistake in an analysis. It ends up being a very easy way to eliminate these failures, (...) a good filter and it is an excellent help, if the decision making is almost not the technicians’, it is only a simple validation, (...) the next step will be a little bit like this, we accept or not this decision making, of course the resistance at the beginning will be great, but all these technologies end up having to be modulated, (...) to what the production objectives are and everything may be adjusted” (Interview Duarte Lopes – Enologist of Cartuxa)*

In conclusion, all three technologies are a great solution for optimizing data integration, giving companies the capacity to leverage their resources and processes with increased efficiency, leading to a competitive advantage.

Based on all these findings, I can now answer my research question, “How can wine producers use digital technologies to sustain a competitive advantage?”. The overall conclusion is that all these disruptive technologies have certain characteristics that allow managers to achieve a competitive advantage. However, in a constantly changing world, those technologies must respond with such readiness, and the best way to do so is to encapsulate all the information offered by digital technologies in a single management platform. Moreover, companies may take it a step further by including artificial intelligence. As a result, the optimal form of competitive advantage is a combination of strategies and technologies.

In the wine industry, a processed product with several production processes that require continuous management and supervision and a supply chain that can be huge, the competitive advantage is precisely in creating solutions that allow for improved management of the entire supply chain. The solutions that integrate all the information available to all actors in the value chain, from suppliers, to producers, distributors, and resellers, allow a daily optimization of processes, greater efficiency, and a better quality of the products.

<b>Technologies</b>	<b>Main three contributions</b>		
<b>Sensors</b>	Ensure and improve product quality	Increase productivity	Lower production costs
<b>Mechanical Harvesting and Optical Sorting Table</b>	Increase productivity	Lower production costs	Assist harvesting season
<b>Drones</b>	Ensure and improve product quality	Increase productivity	Minimize environmental impact
<b>Weather Station</b>	Ensure and improve product quality	Increase productivity	Minimize environmental impact
<b>E-Label</b>	Marketing	Comply with legal requirements	Minimize environmental impact
<b>Authenticity Seal</b>	Marketing	Product Value	Anti-Counterfeiting
<b>Management Software</b>	Support organizational reporting and business operations	Efficiency	Lower costs
<b>Blockchain</b>	Enterprise resource planning	Lower costs	Anti-Counterfeiting
<b>Artificial Intelligence</b>	Total efficiency	Lower costs	Avoid failures

*Table 1 - Technologies main contributions*

The author

## 6. Discussion

According to previous studies, precision agriculture includes field sensors, satellite imaging, drones, and robots for converting data into real-time farm management guidance (Fuglie, 2016). The concepts embodied in precision agriculture “offer the promise of increasing productivity while decreasing production costs and minimizing environmental impacts” (National Research Council, 1997, p. 1).

My findings show that, besides contributing to all this, it has a major impact on improving the quality of the final product. In fact, when it comes to sensors, this will be one of their primary purposes since they provide several parameters and indexes that must be monitored to produce a higher-quality wine. Without these sensors, it would be more difficult to assess nutrients in the soil, humidity, temperatures in the vats, and grape ripening, among others, because laboratory analysis would be required, which would be far more time-consuming. Consequently, it is imperative to underline that the readiness with which these sensors lead us to obtain the results, is also a key component for the final product. When it comes to wine, if we discover a pest too late or a temperature level outside the desired parameters, there may be no final product at all, which will then have a great impact on the competitiveness of the company. Finally, it is also critical to remember that, associated with product quality, these sensors are essential to produce a safer product.

Big data analytics, according to Campos (2021), is the capacity to gather exceptionally huge amounts of data to give probabilistically based insights for better decision-making. Moreover, as proven by the findings, the weather stations, it is also related to increased productivity, reduced environmental impact, and improved grape quality. However, I may conclude that all these aspects derive from good decision-making based on the weather station data.

Finally, the third application of digital technologies to the agri-food sector is communication, which includes social media and telecommunication-based wireless, WIFI, and Internet. My findings show that communication is much more than that and must be regarded as a differentiation and enhancement product strategy. Besides contributing to increased brand competitiveness through marketing and product value, it also provides a new contact channel with the client, none of which is related to social media, as demonstrated by the e-label and authentication seal. On the other hand, I must say that telecommunications-based wireless,

WIFI, and Internet are indeed a big part of communication. Natacha and António explained that all the benefits and optimizations that we can take from these solutions need to be available to everyone to be useful, and that can only happen through communication.

Furthermore, the agri-food sector traditionalism is directly tied to this communication dependence. The reality is that many of the vineyard locations are not yet equipped with communication infrastructures that will allow them to adopt digital technologies in the future, which is a big barrier to the evolution of the sector.

Concerning the fact that making the best use of these new digital technologies and integrating them through the supply chain is one of the major challenges businesses confront today as it is intrinsically related to significant business model modifications (Sebastian et al., 2017), in the case of these three wineries, it becomes evident that is not entirely true. Both the Blockchain and management system mentioned are indeed challenging to implement, especially through all the supply chain. However, none of these integration strategies requires changes to the company's business model, they are only elements that contribute to its realisation and success. However, it is true that fast and reliable data analysis necessitates cooperation and management at both the vineyard and winery levels (Tardaguila et al., 2021).

According to previous studies, the term "luxury wine" was reserved for exceptional wines from the world's best vineyards, the highest quality grapes and the most acclaimed winemakers (Le Fur e Outreville, 2019, p. 1) with an established track record of consistent quality and ageing ability (M. B. Beverland, 2004) and a deep connection to terroir and traditions (M. B. Beverland, 2005). Furthermore, terroir guarantees a product's origin from a specific location, but it may also influence the components and some production aspects, particularly the use of traditional production methods.

The findings show that luxury wines do have these characteristics, however, they are not necessarily related to traditional techniques. As mentioned about sensors, these wines require the use of digital technologies to ensure their quality. In addition, digital technologies such as the seal of authenticity or blockchain, can help decrease a major problem related to luxury wines, counterfeiting. On the other hand, it is true that, because these wines originate from older vineyards, certain technologies such as mechanical harvesting and optical sorting tables are not used, and more traditional production methods should be applied.

Furthermore, the literature review reveals that the challenge of relating digital technologies to luxury wines would be to optimize them without jeopardizing heritage. (Quacquarelli, 2019). The findings undoubtedly demonstrate that technologies in no way diminish the characteristics of luxury wines, including heritage, and that it is only necessary to adapt them to the production conditions of these wines.

When interviewing the Head of Sales & Marketing of FEA, João Teixeira, he stated that when they launched the seal of authenticity, they had immense coverage and visibility, which provided Cartuxa Winery great positioning and visibility. In this way, contrary to what M. B. Beverland (2005) has shown in the literature, wineries do not downplay their true scientific and marketing capabilities or adhere to the accepted standards of artisan production.

Last but not least, Peter Drucker once said that “You cannot manage what you do not measure!” and that is precisely why digital technologies are required in the wine sector. The link between measurement and the capacity to make better decisions is vital for achieving a competitive advantage. In line with this, Natacha mentioned that:

*“for any business, any company, the goal is to generate value and in the process that we currently have, and we have several threats, we have to ensure the sustainability of the business, and the way that we are looking for, is exactly manage in the best way all the information we have but for that, we need sensors to collect it”*

Finally, I would like to reinforce that, in relation to technologies, the world is constantly evolving, and although the ones I mentioned are the most disruptive and generate the most value for the company, there is always room to evolve, and wineries corroborate with this idea:

*“With this, I would like to pass on the following message: there is still a lot of work to do.” (Interview Natacha Fontes – R&D Manager of Sogrape)*

*“The only thing that should be clear is that this is not the final solution and never will be, no solution will be the final solution.” (Interview Paulo Medina – Brand Lead Casa Ferreirinha of Sogrape)*

## **7. Conclusion**

The purpose of this dissertation, guided by the research question “How can wine producers use digital technologies to sustain a competitive advantage?”, was to help fill the identified research gap on the lack of studies about digital transformation and provide the integration of the technologies that was missing in the literature. Moreover, it contributes to help fill the gap on luxury wines by explaining how to unite them with digital technologies.

The results of this study show that technologies can help achieve competitive advantage by reducing cost, improving productivity, minimizing environmental impact, and helping create better quality products. Furthermore, communication technologies are critical for developing customer relationships and product design. Finally, the stronger the integration of these technologies along the supply chain, the greater the benefits that may be realised.

The main limitation of this dissertation has to do with the geographical focus of the cases selection. Although these three wineries were able to provide a lot of information to answer my research question, they all belong to the old world. New World countries, such as the United States and New Zealand, can have different approaches or even solutions in the world of digital technologies to sustain a competitive advantage.

In line with this, this study may open doors to future investigation related to the topic in other countries, such as the “New World” or “NewNew World”. Future researchers could also investigate how these technologies could integrate suppliers and distributors. Other great options would be to investigate the other two external factors of digital transformation (digital competition and digital customer behaviour) in the agri-food sector.

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## 9. Appendices

Table 2 - Primary Data

Case	Type of data	Name of the Interviewee	Organization	Position in the Organization	Date of The Interview	Length of the Interview	Transcription Pages	Transcription Words
Placido Volpone	Interview	Gerardo Volpone	Placido Volpone	Chief Technology Officer	15/10/22	50 min	8	4341
Placido Volpone	Interview	Elia Paggi	EY	Digital & Emerging Consulting Intern - Blockchain Hub Med	08/11/22	47:16 min	10	4610
Placido Volpone	Interview	Edoardo Erlini	EZ Lab Blockchain Solutions	Sales & Special Project Manager	11/11/22	54:16 min	14	6512
Placido Volpone	Interview	Gerardo Volpone	Placido Volpone	Chief Technology Officer	12/11/22	42:44 min	9	3743
Cartuxa	Interview	João Teixeira	Fundação Eugénio de Almeida	Head of Sales & Marketing	02/11/22	56:09 min	10	6620
Cartuxa	Interview	Duarte Lopes	Cartuxa	Enologist	04/11/22	1:45:52 h	24	12 178
Sogrape	Interview	Jorge Machado	Sogrape	Digital Transformation Lead	21/11/22	54:57 min	8	4462
Sogrape	Interview	Inês Carola	Sogrape	Innovation Specialist	24/11/22	44:44 min	8	4274
Sogrape	Interview	Paulo Medina	Sogrape	Brand Lead Casa Ferreirinha	28/11/22	27:16 min	6	2947
Sogrape	Interview	Natacha Fontes	Sogrape	R&D Manager	29/11/22	56:21 min	10	5040
		António Pereira	Sogrape	Leader of Custom & Web Development software Team				

The author

Table 3 - Secondary Data

Case	Type of Data	Title of the document	Name of the author	Name of his/her organization	Date of publication
Placido Volpone	Website	Placido Volpone	Cantina Placido Volpone	Placido Volpone	2019
	Website	EZ Lab	EZ Lab	EZ Lab	2018
	Instagram	placidovolpone	Placido Volpone	Placido Volpone	5/17
	Facebook	Placido Volpone	Placido Volpone	Placido Volpone	05/04/17

	Excel	Business Case Blockchain	Gerardo Volpone	Placido Volpone	N/A
	Photo	Blockchain Example	N/A	N/A	N/A
	Powerpoint Presentation	Overview del Blockchain HUB MED di EY	Giuseppe Perrone	Ernst & Young	04/07/19
	Powerpoint Presentation	EY OpsChain Traceability	Giuseppe Perrone	Ernst & Young	2019
	News Video	È di Ortona la prima cantina cantina al mondo ad utilizzare la tecnologia blockchain	Antonella D'Avola	Antenna SUD	10/5/22
	Magazine Article	2020 Was A Great Year For Wines	Jeanette Hurt	Forbes	1/4/21
	Magazine Article	La Cantina Placido Volpone si affida a Metaverso e NFT per un'esperienza immersiva	N/A	Agrifood.Tech	14/4/22
	Magazine Article	Blockchain: melhorar uma indústria ineficiente	Alexandra Costa	iAlimentar	31/01/22
	Article	EY partner digitale della cantina Placido Volpone: il mondo del vino sbarca nel Metaverso	Giuseppe Perrone	Ernst & Young	12/04/22
<b>Cartuxa</b>	Website	Cartuxa	N/A	Cartuxa	N/A
	Instagram	adegacartuxa	Cartuxa	Cartuxa	5/14
	Facebook	Adega Cartuxa	Adega Cartuxa	Cartuxa	13/09/10
	Linkedin	Cartuxa - Fundação Eugénio de Almeida	Cartuxa	Cartuxa	N/A
	Website	Clube Pêra Manca	Fundação Eugénio Almeida	Fundação Eugénio Almeida	N/A
	Website	Fundação Eugénio Almeida	N/A	Fundação Eugénio Almeida	N/A
	Website	Relatório Contas FEA	N/A	Fundação Eugénio Almeida	N/A
	Newspaper Article	Cartuxa, Malhadinha, Blog, Leo d'Honor e Boeira são os vencedores dos prémios Design Awards 2022	J.M.A	Sapo	8/11/22
	Newspaper Article	Adega Cartuxa teve em 2021 o melhor ano de sempre com vendas de 20 milhões	Ilídia Pinto	Dinheiro Vivo	6/3/22
	Newspaper Article	Falsificação Pêra-Manca. Adega Cartuxa mostra a diferença	N/A	Dinheiro Vivo	6/7/16
<b>Sogrape</b>	Website	Sogrape	N/A	Sogrape	N/A

	Instagram	Sogrape	N/A	Sogrape	5/20
	Linkedin	Sogrape	N/A	Sogrape	N/A
	Website	Mateus	N/A	Mateus	N/A
	Newspaper Article	O futuro do vinho em Portugal depende de uma revolução silenciosa, já em curso	Ana Isabel Pereira	Público	25/11/2022
	Newspaper Article	Novo Barca-Velha chega acima de 400 euros e com selo antifalsificação	António Larguesa	Negócios	11/09/2020
	Newspaper Article	Sogrape integra projeto pioneiro a nível europeu para disponibilizar rótulos eletrónicos	N/A	Sogrape	N/A
<b>Industry Information</b>	Youtube	OIV Last Press Conference	OIV	International Organisation of Vine and Wine	27/04/22
	Document	OIV Last Press Conference	OIV	International Organisation of Vine and Wine	28/04/22
	Presentation	OIV Last Press Conference	OIV	International Organisation of Vine and Wine	29/04/22
	Presentation Video	State of the world vine and wine sector	Pau Roca	International Organisation of Vine and Wine	06/12/2021
	Report	Digital trends applied to the vine and wine sector	OIV	International Organisation of Vine and Wine	11/21
	Presentation	Digital trends applied to the vine and wine sector A comprehensive report on the digitalisation of the sector	Giorgio Delgrosso	International Organisation of Vine and Wine	24/11/21
	Presentation	Digital Transformation Observatory Hub	OIV	International Organisation of Vine and Wine	N/A
	Interview	[EN] In depth Interview Adrian Oleofse. Smart Vineyards	OIV	International Organisation of Vine and Wine	06/12/21
	Interview/Discussion	EN OIV Symposium on the Digitalisation of the Vine and Wine Sector – Round Table	OIV	International Organisation of Vine and Wine	07/12/2021

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Table 4 - Data Structure/ Coding

Technologies	Interviews Quotations
Sensors	<p>“In the case of igrape, they are sensors to monitor the parameters of interest in grape maturation, which reflect its quality and which in turn determine the date of the grape harvest. It is based on sugars, pH, and total acidity, among others, that the time is determined for the grape harvest, and this is a key moment for the sector because it will determine the quality of the wine itself”. (Interview Natacha Fontes – R&amp;D Manager of Sogrape)</p>
	<p>“these wine grid sensors (...) measure the density which allows us in real time to monitor the fermentation, understand if nutrition is needed, if it is finishing, if it has any deviation, if it is necessary to intervene etc, (...) Based on the various parameters that are being measured in the fermentation tank, we can understand when that fermentation is going to finish and anticipate any problem, this is very interesting. (Interview Natacha Fontes – R&amp;D Manager of Sogrape)</p>
	<p>“It is also associated with quality assurance because it is much more unreliable to be dependent on evidence or reports that sometimes are not immediate, than sensors that trigger alerts immediately and allow us to take corrective or preventive actions, to take that decision immediately, and that helps a lot, especially in areas as extensive as the ones we have in the vineyard.” (Interview João Teixeira – Head of Sales &amp; Marketing of FEA)</p>
	<p>“It is direct so that we can improve in terms of performance here, (...) from a management point of view, because they are tools that help us understand where we are failing and help us optimize the processes” (Interview Duarte Lopes – Enologist of Cartuxa)</p>
	<p>“the humidity sensors, the irrigation sensors, the nutrient variation sensors in the soil, (...) allow us to reduce the need for man hours, in other words, the need for manpower, which is huge, it is significant, because if before we walked around at different times of the day, different periods of the year, per hectare (...) it does not mean that we will not be monitoring the vineyard, but maybe it is not necessary to do it so often (...) this allows us to manage almost 600 hectares of our own vineyard with much less human costs (...) When an investment is made, obviously it is based on this financial plan to know how long it will be amortized and that there will be a return (...). Many times, the return may not be (...) exclusively financial but may also be a qualitative one for what is the quality of the wines from the Cartuxa Winery. (Interview João Teixeira – Head of Sales &amp; Marketing of FEA)</p>
	<p>“We know that in the current context of climate changes (..)water is a finite natural resource, and that increasingly there will be less available (...) even though the vine is a rain fed plant, ie, it does not need water, but in the extreme conditions that we are, (...) irrigation is already a necessity, but that irrigation must be done in a very precise way, the idea is to give the plant exactly the minimum amount of water it needs to maintain its survival and to guarantee a certain level of quality, (...) and what we do at the moment is exactly that, we determine which is the hydric state of the plant to irrigate, it happens that there is no way of doing it like we are doing (...) with igrape” (Interview Natacha Fontes – R&amp;D Manager of Sogrape)</p>
	<p>“How can we have biogenic amines? How can we have the production of some carcinogenic by-products that are not so good for us? So, by controlling fermentation (...), we install inside the <i>talhas</i> a cold system with a temperature sensor (...) many of these products appear when there are large temperature oscillations (...) the technology used in this way goes in the direction of safety and of having products that are effectively better, while still being the traditional raw material that ferments, it is the grape that ferments and is put into the bottle and this ends up being what is important to pass on.” (Interview Duarte Lopes – Enologist of Cartuxa)</p>
	<p>“What we do continues to be quite attached to tradition, what we have are tools to do it in a better way, and this is what has to be communicated, in fact what we do is nothing far from tradition, what is important is the vine (...) what all these technologies allow us to do is, taking grapes, old vines, without intervention, with an organic production method, and for us the organic production method is nothing more than a less interventionist way, (...) and it continues to be a product in a quite traditional way. The technologies are not used to change the product itself, they are used to help produce a wine in the best possible way, and in a safer way and with more quality because in the old days great wines were made, but the truth is that the oscillations between great wine and bad wine were big.” (Interview Duarte Lopes – Enologist of Cartuxa)</p>

<b>Mechanical Harvesting</b>	<p>“Now, these two wines (Pêra Manca and Cartuxa Reserva) come from very good vineyards, extremely qualitative, they had an extremely high level of field work (...) normally the vineyards that produce the Pêra Manca wine are a little bit older vineyards and the older vineyards do not allow so much mobilization with machines, they need more care in terms of manual work of pruning, cleaning of the vineyards, treatment of the vines, they are older vineyards, they need some extra care (...) are vineyards that are treated in a slightly different way because they are qualitatively better, sometimes are not even used for Pêra Manca but they are quality vineyards that are always used to make top-range wines.”( Interview Duarte Lopes – Enologist of Cartuxa)</p> <p>“We do handpick at the tables for the top of the range wines, it does not get any better than that.” (Interview Natacha Fontes – R&amp;D Manager of Sogrape)</p>
<b>Optical Sorting Table</b>	<p>“The optical sorting table is basically an aspect that improves our performance and qualitative performance. It does not make us more efficient because we end up losing a little more that is rejected, but (...) is an equipment that makes a real time reading of the grape, passes on a mat and (...) rejects everything that does not have the shape within the interval that we want and the colour within the colour standards that we want and the dimensions. (...) This is a very good technology that (...) were very big qualitative gains.” (Interview Duarte Lopes – Enologist of Cartuxa)</p> <p>“with an enormous advantage that is a table that allows us to work 24 hours a day, not having the fatigue of the human eye at the end of a few minutes, at the end of a few hours, when a lot of resources are needed, to exchange people, which is highly fantastic, and we have two optical sorting tables that allow us at harvest time to make a much more careful and qualitative selection of all the grapes that enter the winery (...) guaranteeing quality as the optical sorting tables manage to do a much better job than any person or any shift of people who are there selecting grapes.” (Interview João Teixeira – Head of Sales &amp; Marketing of FEA)</p>
<b>Drone</b>	<p>“we also did a test with that drone (...) to provide us the information about the vegetation, this kind of information help address the agricultural operation, so you do not waste water for example in places that there is more vegetation, you do not waste organic activities on that.” (Interview Gerardo Volpone – CTO Placido Volpone)</p> <p>“We have this technology being used in the vineyard (...) they do this mapping and do this water and thermal control of the vines (...) this mapping is done by the operator to verify immediately, in a vast area, (...) how the plants are developing, the level of water resources or even thermal resources because in times when we reach 40 degrees during the day it is very important (...) that the night cooling occurs, if we have consecutive nights without cooling, these drones, through thermal sensors, can detect the temperature of the leaves and vines, obviously we can also take corrective measures” (Interview João Teixeira – Head of Sales &amp; Marketing of FEA)</p>
<b>Weather Stations</b>	<p>“we have weather stations installed in our vineyards and (...) based on the weather conditions we can predict that a certain disease has conditions to develop which means that we only intervene at that moment,(...) we have a weather forecast system for our properties and we only treat if it is not going to rain, because if it rains the treatment is washed away and there is a waste, not only economically but also environmentally.” (Interview Natacha Fontes – R&amp;D Manager of Sogrape)</p>
<b>E-label</b>	<p>“bottles are already overloaded with information, both on the label and on the back label, they already have lots of stamps and then each country has its own legislation and then they have to have different things, (...) so these associations launched the challenge of putting the QR code on the bottles so that when you read (...) you can see the nutritional tables (...) the translation of the label yes, it is a way of standardising the labels and then each country has different languages” (Interview Inês Carola – Innovation Specialist of Sogrape)</p>
<b>Authenticity Seal</b>	<p>“The authenticity seal allowed the consumer to guarantee that he was buying an authentic product, i.e. not only did the seal itself guarantee the bottles’ inviolability, i.e. if someone broke the capsule to modify the product in any way, it was impossible to put that seal back on, i.e. the seal would be irretrievably broken, but it was also possible to verify the authenticity of the bottle through an alphanumeric code on our website, using a unique code (...) with this innovative technology, we had immense coverage, immense visibility and it gave the brand a very good notoriety, and confidence because some cases had appeared in the market with premium wines (...) Then it placed the Cartuxa winery as an innovative company. (...)Appearing in a highly traditional market with a solution like this in partnership with the national mint institute (...) gave (...) immense interest to the market about this technology (...) nowadays we always continue with this seal of authenticity to be a pretext, every time we launch a new vintage to have this argument and this source of communication or communication plus which is this seal of authenticity so I would say that at the marketing level it was very important” (Interview João Teixeira – Head of Sales &amp; Marketing of FEA)</p>

<b>Management Software</b>	<p>“These products that are then transformed end up having a different impact here, and a bit of subjectivity comes in, the need to have something that goes beyond a simple data analysis (...) the challenge is to take all the information that is spread across all the platforms and present the information as friendly and easy to consult as possible” (Interview Duarte Lopes – Enologist of Cartuxa)</p>
	<p>“It was basically an entire process of digitalization of the viticulture and oenology processes; everything is integrated into a single system. What has changed between the old solutions and this one? First, it was a solution available in any kind of device much more user friendly (...), one of the great advantages is that it can be connected to any place, all you need is a door to enter, what I mean by this, when they are consuming a phytopharmaceutical with a herbicide for us, they are going to SAP to see if the product exists, if the lot exists, and if the validity of the lot is valid, (...) everything is registered and the consumption, both per cent and the quantity, comes out of the system” (Interview António Pereira – Leader of Custom &amp; Web Development software Team of Sogrape)</p>
	<p>“made a software that goes from the vineyard to the bottle, i.e.,(...) manages the vineyard, manages the grape delivery to the winery, manages the whole wine ageing process (...) you define the vineyards, which grapes are there, how long the vineyards have been there, when are they going to leave, the maturation states, etc, then you go to the reception of these wines at the winery, it means, you do the harvest, when the trucks come with the grapes, the quantity of grapes, this makes all the management, which is connected to the sensors that are in the wine vats and barrels, and our oenologists will, through this application which is connected to those sensors, understand what they have to do with that specific lot of wine” (Interview Jorge Machado – Digital Transformation Lead of Sogrape)</p>
<b>Blockchain</b>	<p>“we identified food sector like one that would benefit most from blockchain because of immutability and transparency so there was tangible benefit from moment T0 (..) wine sector could benefit because it is a high value product where the consumer loose time to know where it comes from and likes to know more about the product” (Interview Gerardo Volpone – CTO of Placido Volpone)</p>
	<p>“wine it is something that it is perceived as some sort of product that needs some anti-counterfeiting, needs some possibility to see what is the actual process of creating it, because a lot of the value that wine has derives from the process of creating it and also the materials that you use (...) the steps of the wine supply chain are all notarized and all the data that is related to these steps (...) cannot change from that time on. So, this is why it is thought as something for anti-counterfeiting because you cannot say that this bottle of wine comes from a specific territory when (...) the data is saying that the grapes come from another territory.” (Interview Ellia Paggi – Digital &amp; Emerging Consulting Intern of Ernst &amp; Young)</p>
	<p>“early projects based on blockchain were made to take advantage of the hype of blockchain (...) Cantina Volpone, took advantage of that hype, but now there is no more any hype (..) blockchain has some value beyond that marketing value and in my opinion the value is, in, notarization, tokenization and automation with smart contract. You can take advantage of tokenization, for example, for anti-counterfeiting, so if you give a number to any bottle, with the token, you can guarantee immutability and authenticity of any peace (...)so you can monitor and have the guarantee that your material that you purchase is unique, is a good quality, (...) the last one is automation, (...) blockchain will be for network of companies like ERP was for a single company, so connect the different function in a single company, connect the different companies in a supply chain, once these companies are connected, you can leverage on automation. There is an order from the end customer automatically there could be triggered an order produce more material (...) and sell to the customer (...) this is the cost reduction in terms of time to create this order back to your supplier, time to create the reconciliation in terms of finance activities (..) is not a differentiation but who does not have it stays behind and who has it is at the same level, has to leverage blockchain for a cost reduction to have a competitive advantage” (Interview Gerardo Volpone – CTO of Placido Volpone)</p>
	<p>“I think there is a real value for the company because it is about their reputation, it is about doing everything that you can do to guarantee the quality of your wine and if you have nothing to hide in the supply chain, with the blockchain, (...) everything is tracking. Of course, you can decide the borders of the tracking process and you can decide if you want to skip something specific because maybe it is a secret of the company, but you also know that all the rest that you are putting will always be visible in the future for the market, the consumers, and your competitors. So, it is a guarantee that you have nothing to hide, and this gives a real value to the product (...) because there is a different value, (...) an incremental value for products and for companies. (...) Generally, the things related to sustainability are self-declaration that you put inside the website so you can change the stuff, you do not have to prove this data are just the self-declaration. By using the blockchain you are turning self-declaration into data that you cannot change” (Interview Edoardo Erlini – Sales &amp; Special Project Manager of EZ Lab)</p>

	<p>“the limits that blockchain gives to the company, is not about the software or the implementation but the fact that you start producing it inside a factory made of glass so it's transparent” (Interview Edoardo Erlini – Sales &amp; Special Project Manager of EZ Lab)</p>
	<p>“Implementing Blockchain is very interesting but very difficult (...) a Blockchain foresees that information can be consulted by all stakeholders, so it is a megalomaniac project and very complicated. If we take the issue of regulation and think that it takes consensus to approve certain information at certain times” (Interview Natacha Fontes – R&amp;D Manager of Sogrape)</p>
<b>Artificial Intelligence</b>	<p>“When I talk about artificial intelligence, we are talking about a tool that allows us to analyze and make a decision that is not ours, I think that is what we are getting at, (...)it adapts to different circumstances and different production goals. The use of artificial intelligence will be very useful to be more efficient and we can produce even better” (Interview Duarte Lopes – Enologist of Cartuxa)</p>
	<p>“we are not machines and we have some failures and it ends up being quite complicated, with some dimension, to not have failures, to have a readiness, to not have one mistake in an analysis. It ends up being a very easy way to eliminate these failures, (...) a good filter and it is an excellent help, if the decision making is almost not the technician's, it is only a simple validation, (...) the next step will be a little bit like this, we accept or not this decision making, of course the resistance at the beginning will be great, but all these technologies end up having to be modulated, (...) to what the production objectives are and everything may be adjusted” (Interview Duarte Lopes – Enologist of Cartuxa)</p>

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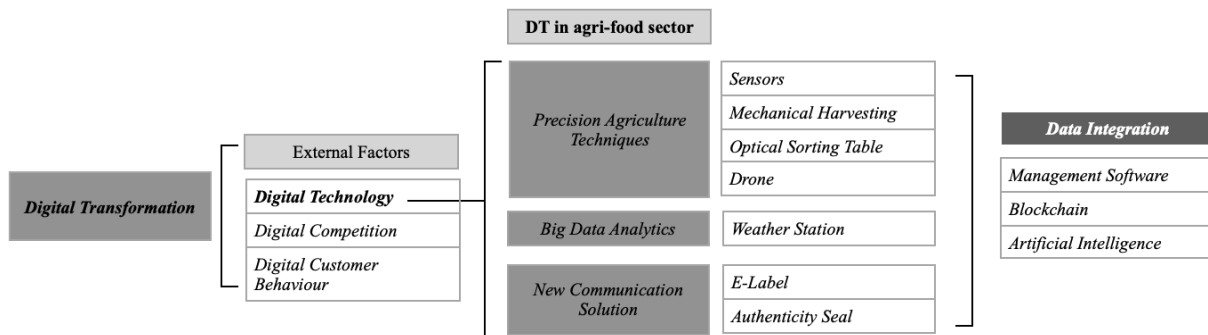
Table 5 – Coding Tree

First Order Codes	Conceptual Categories	Aggregate Dimension
Improve/ guarantee product quality	<p><i>Employing Precision Agriculture Techniques through Sensors, Mechanical Harvesting, Optical Sorting Tables and Drones</i></p>	<p><i>Strategies using technologies individually</i></p>
Otimization of processes		
Health security		
Sustainability/ Less Waste		
Workforce reduction		
Immediate corrective or preventive actions		
Assist/improve production		
Efficiency		
Adress necessities		
Improve performance		
Investment		
Real Time/ 24 hours/day		
Careful and qualitative selection		
Qualitative gains		
Harvest season		
Gathers data	<p><i>Leveraging Big Data through Weather Station</i></p>	
Disease and pest management		
Predict		
Decision-making		
Information		

EU legislation	<i>Developing New Communication Solutions (E-Label and Authenticity Seal)</i>	
Uniformization		
Cluttered information		
Less paper/ sustainability		
Forgeries		
Authenticity		
Truth		
Guarantee		
Marketing		
Anti- Counterfeiting		
Counter-check	<i>Optimizing Data Integration through Blockchain or Management Softwares</i>	<i>Strategy that relies on interconnected technologies</i>
Transparency		
Certification		
Anti-Counterfeiting		
Tangible benefits		
Reputational risk		
Enterprise resource planning		
Authenticity		
Supply chain		
Long-term		
Guarantee		
Sustainability		
Optimization		
Decision-making		
Reduction of failures		
Prompt		
Future		
Efficiency		
User-friendly		
Integrate		
Details		
Traceability		
Cost management		
Supply chain		
Connectivity		

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Table 6 - Findings Association with Literature Review



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Table 7 - Digital Technology per case

Digital Technology	Placido Volpone	Cartuxa	Sogrape
Sensors	Y	Y	Y
Drone	Y (Test)	Y	Y
Optical Sorting Table	N	Y	N
Mechanical Harvesting	Y	Y	Y
Weather Station	Y	Y	Y
E-Label	Y (Through Blockchain)	N	Y (Mateus Wine)
Authenticity Seal	Y (Through Blockchain)	Y (Pêra Manca Wine)	Y (Barca-Velha Wine)
Blockchain	Y	N	N
Management Software	Y (Through Blockchain)	Y (SAP HANA)	Y (SAP HANA)
Artificial Intelligence	N	N	N

Y – The company use this technology

N – The company does not use this technology

The author

Table 8 – Wine Prices

	Placido Volpone	Year	Prices	Cartuxa	Year	Prices	Sogrape Vinhos	Year	Price
<b>Everyday Segment</b>				Monte de Pinheiros	2019/2021	3,68 €	Gazela	2021	3,79 €
				EA red/white/rose	2019/2021	5,99 €	Azevedo	2021	4,99€ - 6,99€
							Mateus	2021	4,29 €
<b>Premium Segment (+6.6€)</b>	Calve Viva	2021	12,00 €	EA Reserva/Biologic	2018/2019/2021	9,49 €	Papa Figos Casa Ferreirinha	2021	7,49 €
	Rosantica	2021	12,00 €	Foral de Évora red/white	2018/2020	12,98 €	Q. Carvalhais	2021	8,99 €
	Il Rosso e il Nero	2021	14,00 €	Foral Évora Colheita Tardia white	2016	22,98 €	Silk and Spice	2021	11,00 €
	Cinque Figli	2021	14,00 €	Cartuxa white/red	2018/2021	16,99€ - 19,99 €	Callabriga Casa Ferreirinha	2020	18,49 €
	Faragola	2021	14,00 €						
	Rosane	2021	18,00 €						
	Altomare	2021	18,00 €						
	Beniamino	2021	20,00 €						
<b>Luxury Segment (+23,7)</b>	Mimi	2021	30,00 €	Cartuxa Reserva/ Colheita Tardia	2012/2017/2018	44,99€ - 59,03€	Q. Carvalhais Reserva/ Especial	9 201/202	25,00€ - 27,00€
				Vinho de Talha Cartuxa		44,99€	Q. Carvalhais Especial	Sem data	50,00 €
				Scala Coeli	2017/2019	79,99€ - 99,99€	Herdade do Peso Ícone	2014	80,00 €
				Pêra Manca	2015	449,90 €	Q. Carvalhais Único	2017	100,00 €
				Pêra Manca	1991	1150,00 €	Barca Velha	2011	899,90 €
							Barca Velha	1991	1049,00 €

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Notes:

Segment according to the literature review

Conversion in accordance with the rate in force on 12/12/2022

Prices variations could be because of red/white/rose or Age

For Sogrape Vinhos I only considered the brands of rose/white/ red/ green wine

For Cartuxa and Sogrape, not all wines are on the list

Figure 1 – Blockchain Project



EZ Lab

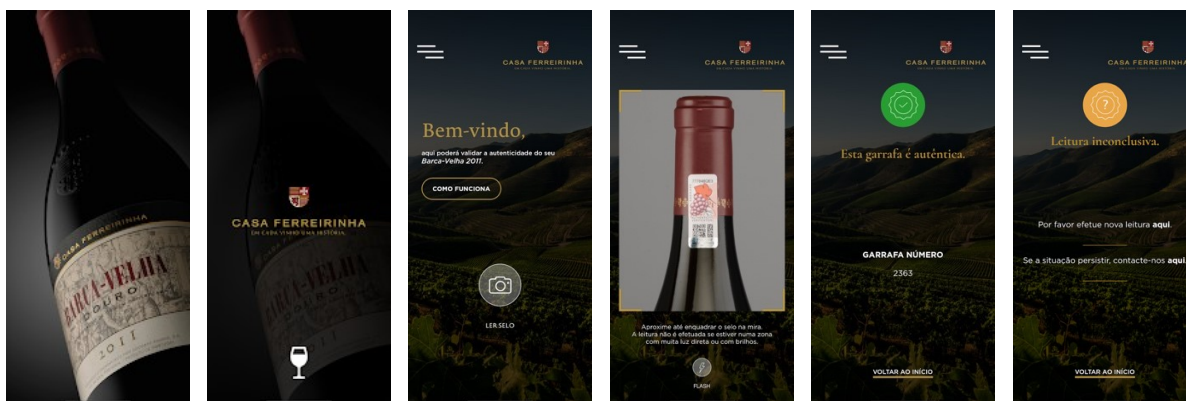
Figure 2 – Sogrape Companies



Figure 3 – E-label Mateus



Figure 4 – Barca Velha (Sogrape) Authentication Seal



AuthenticBV App- Imprensa Nacional – Casa da Moeda