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The circular economy : Analysis of the transformation of a sector of activity to make it more circular

The barriers to the circular economy in the wine sector

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Academic year 2023-2024
Dissertation for the Master of Business Engineering

Acknowledgement

First of all, I would like to thank the academic staff who made this project possible. First, Mr Yves de Rongé for agreeing to supervise this thesis. Then Mr Josep Oriol Izquierdo Montfort, for his availability, advices and guidance throughout the writing process.

Secondly, I would like to thank my parents for giving me the opportunity to study and for their support throughout the different stages of my university journey. I would also like to thank them for their help in constructing this thesis and for their various proofreading.

And finally I would like to thank the various participants in this thesis, whether for taking the time to complete my survey, or those with whom I had the chance to exchange views on the subject.

Declaration

During the writing of this thesis, different digital and AI tools were used for different purposes. The tools and parts affected are listed in the table below.

Tool	**Usage**	**Affected parts**
DeepL	Translations	All
Grammarly	Spell check	All
Scribbr	Citation generator	References
EndNote 21	Reference Manager	References
Google Forms	Survey	Empirical part
ChatGPT	Theme identification in literature	Literature review
	Survey and questions improvement	Data collection: survey construction
	Code improvement (RStudio)	Results
	Language improvements	All

Figure 1: Digital tools used

After using these tools, the content has been carefully checked and edited. I take full responsibility for the content in this thesis. I declare that I have read and adhere to the Code of Ethics for students concerning borrowing, quoting and the use of various sources and that I am aware that plagiarism is a serious offence. This master thesis reflects the fruit of my work, enhanced by the use of digital tools.

Table of contents

Table of Figures

List of Abbreviation

CE – Circular Economy

EU – European Union

Mhl – Million hectoliters

OIV – Organisation Internationale de la Vigne et du Vin

SD – Sustainable Development

SDG – Sustainable Development Goals

SMEs – Small and Medium-sized Enterprises

Introduction

Seven percent. This is the percentage of circularity in the world in 2023, and a strong reminder that most of the resources are still consumed in a linear model. Even more alarming, instead of increasing, this number is decreasing compared to previous years (Circle Economy Foundation, 2024). At a time when the depletion of natural resources and climate change are at the heart of a number of issues, this new model, the circular economy (CE), has emerged as a viable alternative to the way we consume, produce and a possible response to the significant challenges posed by the human activity on our planet. One of its leading advocates is the Ellen MacArthur Foundation, and defines CE as follows (2023, pp.1): *"The circular economy is a system where materials never become waste and nature is regenerated. In a circular economy, products and materials are kept in circulation through processes like maintenance, reuse, refurbishment, remanufacture, recycling, and composting. The circular economy tackles climate change and other global challenges, like biodiversity loss, waste, and pollution, by decoupling economic activity from the consumption of finite resources"*. If the circular economy is the cure for our world's ills and looks so promising, then how do we explain the fact that the world has become less and less circular in recent years?

To address this question, it is crucial to understand the barriers preventing the widespread adoption of CE practices. This thesis focuses on these barriers within a specific context: the wine sector. This sector is worth around 36 billion euros, and produces over 20 billion litres a year (OIV, 2024). However, due to its agricultural origins, the wine sector is at the forefront of the issues posed by climate change and biodiversity loss, which have a major impact on its business. Topics such as sustainable development and the search for more responsible production practices have therefore become highly relevant for them (Costa et al., 2022). To explore these issues, a quantitative-method approach was adopted, combining a comprehensive literature review with a survey distributed to vineyards in France, Spain, and Italy (empirical study). The survey was designed based on a survey commissioned by the European Commission, the Flash Eurobarometer Survey number 441 (European Commission, 2016), which studies the activities of European small and medium enterprises with regard to circular economy. The purpose of this was to capture both the extent of CE practice adoption and the specific barriers encountered by vineyards. This approach also allows for comparisons between the wine industry and other sectors, highlighted by the work of Garcés-Ayerbe et al. (2019).

Therefore, the study will be structured around the following research question: "*What are the main barriers to implementing circular economy practices in the wine industry"*, with the sub-question *"how do overcoming these barriers contribute to achieving sustainable development objectives?"*.

The primary objectives of this are to identify the main barriers to implementing circular economy practices in the wine industry, compare these barriers with those in other sectors, and propose strategies to overcome these obstacles. The findings are expected to contribute to the theoretical understanding of CE barriers within the wine sector and offer research leads for stakeholders seeking to adopt more sustainable practices.

This master thesis aimed to provide a thorough understanding of these issues and its structure is as follows: it begins with a literature review, laying the theoretical foundation by discussing global sustainability challenges, CE principles, and the specific context of the wine industry. Following this, the empirical analysis presents the methodology, survey results, and an analysis of the barriers to CE adoption in the wine sector. The discussion section reviews the findings, compares them with existing literature, and offers insights into the unique challenges and opportunities for the wine industry. The final chapter summarizes the key findings, discusses the theoretical and managerial implications, and provides recommendations for future research and practical implementation.

1 Part I : Literature Review

The purpose of this section is to lay the theoretical foundations on which this thesis will be based. To do this, the literature review starts with an outlook of the global environmental situation, followed by the definition of the CE, its core principles and explain how these principles contrast with the traditional linear economy. And eventually, elaborate on the specific sustainability challenges within the wine industry which include environmental, economic and social aspects.

1.1 THEORETICAL FRAMEWORK

1.1.1 Global environmental context

The focus of this section is on the global environmental context in which we find ourselves today. The world is experiencing significant changes, driven largely by human activities. These changes have significant implications for our environment, societies, and economies. The study will examine key aspects of this transformation, focusing on the role of human activity in altering our planet's climate and ecosystems. This overview aims to provide a foundation for understanding the complex, interconnected challenges we face.

1.1.1.1 Impact of human activity

A pivotal source that informs our understanding in this area is the Intergovernmental Panel on Climate Change (IPCC) report. The IPCC report, written by an objective and scientific body, provides detailed assessments of the state of scientific, technical and socio-economic knowledge on climate change, its causes, the potential impacts and coping strategies. According to the IPCC (2023), human activities have caused global warming through greenhouse gas emissions, with global surface temperatures rising to 1.1°C above pre-industrial levels by 2011–2020. Emissions continued to increase from 2010 to 2019 due to unsustainable energy use, land use changes, and consumption patterns. This climate change is already affecting weather extremes worldwide, leading to adverse impacts on food and water security, human health, economies, and ecosystems (United Nations, 2023a). Vulnerable communities, which have historically contributed the least to climate change, are disproportionately affected (IPCC, 2023).

This underscores the unequivocal influence of human activities on global warming, highlighting the increased emissions of greenhouse gases as a principal factor. Changes caused

by human activity are already observable, as widespread and rapid changes in the atmosphere, ocean, cryosphere and biosphere (IPCC, 2023). Moreover, these climate-related changes are not isolated events; they interact with other social, economic, and environmental factors. In their report, the IPCC (2023) highlights the urgency of a rapid respond to address the multifaceted challenges posed by climate change.

Another alarm bell has been rung by the Stockholm Resilience Center (Stockholm Resilience Center, 2023). They have identified nine planetary limits within which humanity can continue to develop and resources can be sustained for future generations. According to the latest study (Richardson et al., 2023) six of these limits have already been crossed: Climate change, Novel entities, Freshwater change, Land system change, Biogeochemical flows, Biosphere integrity.

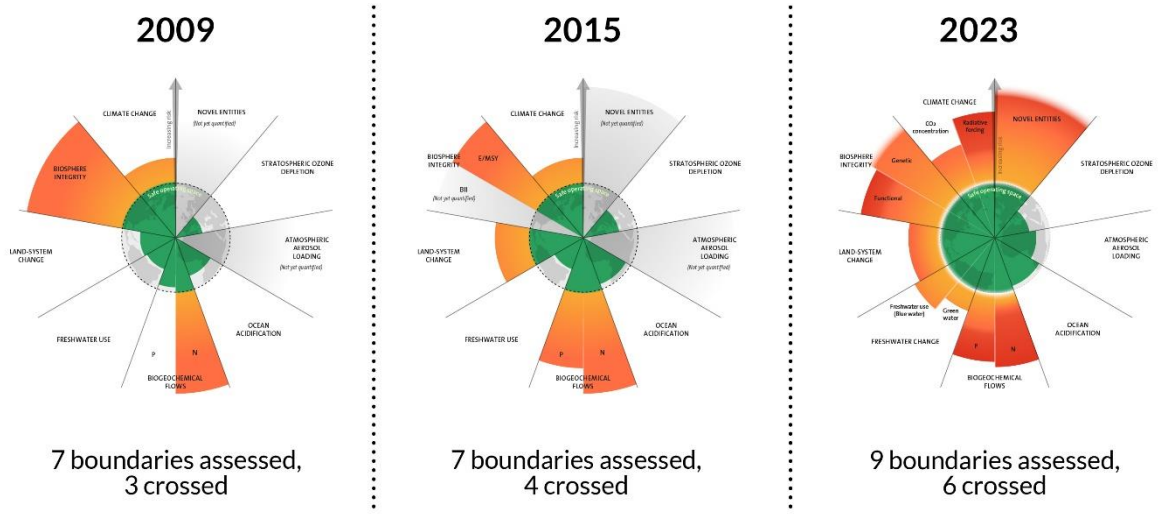

Figure 2: Planetary Boundaries (Source: Azote for Stockholm Resilience Centre, based on analysis in Richardson et al 2023)

Crossing boundaries increases the chances of causing big, possibly irreversible changes to the environment (Richardson et al., 2023). These changes might not happen all at once (as shown in *figure 2*), but these boundaries show critical points where risks to people and ecosystems become higher. Boundaries involve different processes in the Earth system that are connected. Just focusing on climate change is not enough for sustainability. We need to understand how different boundaries, like climate change and biodiversity loss, interact for better science and action (Richardson et al., 2023).

1.1.1.2 Resource consumption

Building on the discussion of the global environmental context, a critical aspect to consider is the concept of sustainable consumption and production patterns, as highlighted in the 12th Goal of the United Nations Sustainable Development Goals (United Nations, 2023b):

"Our planet is running out of resources, but populations are continuing to grow. If the global population reaches 9.8 billion by 2050, the equivalent of almost three planets will be required to provide the natural resources needed to sustain current lifestyles."

Our economic system takes place in a finite world with a limited quantity of natural resources that can be regenerated with a limited capacity. As explained above, although these resources regenerate, our current consumption exceeds the regenerative capacity of our planet earth (Aurez et al., 2019).

This emphasizes the importance of establishing consumption and production practices that can support the livelihoods of both present and future generations. Indeed, as cited by the United Nations (SDG 12; 2023), over the past century, environmental degradation has accompanied economic and social progress, but enhancements in resource efficiency, considering the full economic life cycle, and proactive participation in multilateral environmental agreements are necessary for a successful transition.

The impact of our consumption is not only environmental, but also social and economic: in recent times, many companies are recognizing that the linear economic model exposes them to various risks, particularly the increasing prices of resources (Gebhardt et al., 2022). Additionally, price volatility for metals, food, and agricultural output surged in the first decade of the 21st century, surpassing levels seen in the entire 20th century (Ellen MacArthur Foundation, 2013). These trends are expected to continue due to population growth, urbanization, resource extraction becoming more challenging, and rising environmental costs associated with depleting natural capital (Ellen MacArthur Foundation, 2013).

1.1.2 The circular economy (CE)

In response to the significant challenges posed by human activity on the planet, particularly those from our current consumption model, it is crucial to explore new solutions. These

solutions are essential to safeguard the future for coming generations. One promising approach is the adoption of a new economic model, known as the **circular economy**.

1.1.2.1 From linear to circular: rethinking resource management

Defining the circular economy can be challenging due to the variety of existing definitions and that the concept is still evolving (Ghisellini, Cialani, & Ulgiati, 2016; Kirchherr, Reike, & Hekkert, 2017). Despite these complexities, the essence of the circular economy represents a transformative shift in how we think about and manage resources (European Commission, 2023).

The European Policy Center defines the CE as *"an economic system which aims to maintain the value of products and materials for as long as possible, and minimize resource use and waste by increasing the repair, recovery, reuse and recycling of materials and products. Novel business models and responsible consumers enable it."* (Hedberg & Šipka, March 2020)(pp.7).

One of the pioneers and main advocates of this concept is the Ellen MacArthur Foundation. Their work involves research, education, and collaboration with businesses, governments, and academia to accelerate the transition to a circular economy, and is an enriching source for this thesis. Their definition of CE is as follows: *"The circular economy is a system where materials never become waste and nature is regenerated. In a circular economy, products and materials are kept in circulation through processes like maintenance, reuse, refurbishment, remanufacture, recycling, and composting. The circular economy tackles climate change and other global challenges, like biodiversity loss, waste, and pollution, by decoupling economic activity from the consumption of finite resources."* (Ellen MacArthur Foundation, 2023) (pp.1).

While both definitions share common themes of resource efficiency and waste reduction with a cycle approach, they differ slightly in emphasis and scope. The European Policy Centre's definition leans towards economic aspects, emphasizing novel business models and responsible consumer behaviour, while The Ellen MacArthur Foundation's definition takes a broader ecological perspective, highlighting the regeneration of nature and the decoupling of economic activity from resource consumption.

Another way to define it is through the 'negative,' in the manner of Vincent Aurez & Laurent Georgeault (2019), as the opposite of the linear economy. The linear economy is a system in which the product follows an "take-make-dispose" pattern, and continually increases its

demands of scarce natural resources (European Commission, 2023a). This characteristic has remain unchanged throughout the evolution and diversification of our industrial economy : companies extract materials, utilize energy and labour to manufacture goods, and sell them to consumers, who eventually discard them when they are no longer needed (Ellen MacArthur Foundation, 2013). Despite improvements in resource efficiency, a system built on consumption rather than the sustainable use of resources incurs significant losses across the value chain.

It is necessary to move beyond the traditional, linear, economy in which we are currently evolving for two key reasons (Aurez et al., 2019):

1) Our current economic activities are harming the natural world in a widespread way due to their increasing environmental impacts.
2) The reality is that our planet has limited resources. These resources have a set amount and can only renew themselves at a certain rate. If we use them too quickly and exceed a critical limit, this can cause lasting damage to their ability to replenish.

To achieve these transition goals, governments and institutions are implementing policies and plans to promote the CE, such as the green deal and the circular economy action plan in Europe, or the circular economy plan in China (Collard, 2020; Ghisellini, Cialani, & Ulgiati, 2016). The aim of this action plan, in the case of Europe, is to reduce pressure on natural resources, promote sustainable economic development and create employment opportunities by introducing policies to encourage good practices and eventually achieve carbon neutrality by 2050 (European Commission, 2020). Having policies in place is crucial for successfully transitioning to a circular economy as they provide a clear roadmap and framework for businesses, industries, and governments to follow, ensuring alignment and coordination towards common goals (Ellen MacArthur Foundation, 2013). While some laws may hinder or delay the transition as we will see when analysing the barriers, the European Commission has designated the CE as a policy priority since 2015. This prioritization suggests that significant efforts have been made to address the most pressing regulatory barriers to advancing the CE (Brändström, Jazairy, & Roos Lindgreen, 2024). Other studies have also explored the impact of regulatory pressures: on one side, regulatory initiatives compel organizations to adhere to new environmental standards, while on the other side, they serve as external signals that draw attention to underlying environmental concerns and prompt managerial responses (Gusmerotti et al., 2019).

1.1.2.2 Principles & Strategies of the CE

While CE is intrinsically linked to sustainability, it is not synonymous with it (Geissdoerfer et al., 2017). The three principles on which CE rests are preserving natural resources, maximizing resource use through circulation, and enhancing system efficiency by eliminating negative impacts (Ellen MacArthur Foundation, 2013). This concept overlaps with sustainability, which aims to meet present needs without compromising the ability of future generations to meet their own (Geissdoerfer et al., 2017). Sustainability encompasses environmental, economic, and social dimensions, whereas CE specifically targets the transformation of waste into resources through restorative and regenerative processes (Geisendorf & Pietrulla, 2018).

From these principles and goals, various strategies have been developed and encapsulated in frameworks commonly referred as the R frameworks. In the growing literature on the CE (Lieder & Rashid, 2016), there exist plenty of frameworks (3R, 4R, 10R,…), each distinguished by the number of 'R's it incorporates (Reike, Vermeulen, & Witjes, 2018). For example, the European Union advocates for a 4Rs model, which includes Reduce, Reuse, Recycle and Recover as strategies (see appendix 1, *figure 9 : The 4R framework*). Regardless of the specific number of "R", the fundamental principle remains constant across all R framework variations. What ties them together is a hierarchical approach, where the first 'R' takes priority over the second, and so on (Kirchherr, Reike, & Hekkert, 2017). This hierarchy underscores the importance of prioritizing certain actions to maximize their positive impact on sustainability. You will note that recycling should be seen as the second less circular alternative, yet it is often chosen as the first (Reike, Vermeulen, & Witjes, 2018). The positive effects on circularity and sustainability are actually greater at the start of the material value chain, where strategies are fewer and waste loops are shorter, such as for "reduce" (Malooly & Daphne, 2023; Potting et al., 2017).

Given the multitude of existing frameworks which can lead to confusion, and the difficulty in choosing the appropriate framework as the literature does not agree on one in particular (Kirchherr, Reike, & Hekkert, 2017; Reike, Vermeulen, & Witjes, 2018), this thesis will adopt a different approach. Rather than focusing solely on a 'R' framework, we will explore how the circular economy can be operationalized through five key CE activities identified by Garcés-Ayerbe et al. (2019) for SMEs in Europe:

(1) **Re-planning Water Usage:** Minimizing water consumption and maximizing re-use.

(2) **Utilization of Renewable Energy Sources:** Transitioning to renewable energy to reduce dependency on fossil fuels.

(3) **Re-planning Energy Usage:** Optimizing energy consumption to enhance efficiency.

(4) **Waste Minimization:** Implementing recycling, reusing, or selling waste to other companies to minimize waste.

(5) **Product and Service Redesign:** Innovating product designs to reduce material usage or incorporate recycled materials.

By focusing on these activities, the study aligns with contemporary practices in the European context and provides a comprehensive framework for analysing the circular economy in the wine industry.

1.1.2.3 Barriers to the circular transition

Much of the current enthusiasm regarding the CE is fuelled by its benefits for sustainable development. For instance, the CE could potentially reduce CO2 emissions by 48%, create a net economic benefit of 1.8 trillion euros, and generate two million additional jobs until 2030 in the European Union (EU) (McKinsey & Company, 2015). But while many people in business and politics have declared their support for CE, its implementation is still in its early stages (Kirchherr et al., 2018). Indeed, the effectiveness of this is open to question when considering the findings of the Circular Economy Gap Report 2024, which indicates that the world was only 7.2% circular in 2023, a decrease from 9.1% in 2018, signifying a concerning trend away from circularity (Circle Economy Foundation, 2024).

This decline in circularity raises an important question: if the circular economy is such a trending topic everywhere, why is the world becoming less circular? This gap highlights the necessity of studying the barriers hindering its progress. Various publications have identified several barriers hindering the implementation of the circular economy by firms (see Araujo Galvão et al., 2018; Brändström, Jazairy, & Roos Lindgreen, 2024; Garcés-Ayerbe et al., 2019), but in the first large-N-study on the barriers to CE implementation in the EU, Kirchnerr et al. (2018) find 4 types of barriers:

- **Cultural:** cultural barriers including limited consumer acceptance and corporate cultures not integrating CE principles, are significant obstacles to CE implementation. While less discussed in academic literature, recent research highlights their crucial role and the gap between academic understanding and real-world experiences (Kirchherr et al., 2018).
- **Market**: the market hinders the transition to the CE due to low prices for new materials and high costs for CE business models. These low prices make it difficult for circular products to compete, reducing consumer interest and company adoption. High upfront costs make it difficult for businesses to invest in new CE models, often requiring financial support for economic viability. Additionally, this reluctance may be influenced by corporate culture (Kirchherr et al., 2018).
- **Regulatory**: the literature highlights regulatory barriers to adopting CE principles, particularly the absence of supportive policies. While academics prioritize these barriers, it seems that businesses and policymakers view them as less critical. In the EU, where CE is a priority, these barriers seems less prominent. (Kirchherr et al., 2018).
- **Technological**: while it is certainly important to have the necessary technology for transitioning to a CE, they don't emerge as core barriers in reality, although it is common to find studies that identify technology obstacles such as lacking detailed technical knowledge, data, design complexities among others (Kirchherr et al., 2018).

Garcés-Ayerbe et al. (2019) offer valuable insights regarding the barriers to implementing CE principles in the EU, focusing on Small and Medium Enterprises (SMEs), which comprise a significant majority of businesses in the EU (99% of the businesses) (European Commission, 2023b). Their findings present a nuanced perspective on the challenges faced. While Kirchherr et al. identify cultural, market, regulatory, and technological barriers, Garcés-Ayerbe et al. (2019) highlight additional complexities related to SMEs:

- **Lack of Human Resources:** SMEs often struggle with limited personnel, hindering their capacity to adopt and implement CE practices effectively.
- **Lack of Expertise to implement these activities:** the absence of specialized knowledge and skills necessary for CE implementation poses a significant challenge for SMEs.
- **No clear idea about cost benefits or improved work:** not sufficiently aware of what can be done, and of the impact (financial or efficiency) this can have on their activities.

- **No clear idea about investment required:** no clear idea of how much to invest and the minimum amounts required.
- **Complex Administrative or Legal Procedures:** SMEs encounter difficulties navigating intricate bureaucratic processes and complying with regulatory frameworks, further impeding their transition to CE.
- **Cost of Compliance:** meeting regulatory standards and requirements comes with financial burdens, adding to the already challenging economic landscape for SMEs.
- **Financial Accessibility:** SMEs face obstacles in accessing the necessary capital and financial resources to invest in CE initiatives, preventing their ability to initiate sustainable practices.

They have summarized their findings (based on the Flash Eurobarometer Survey number 441 commissioned by the European commission in 2016) in the following figure, which gives a good understanding of the state of the circular economy for SMEs in different industries in Europe, as well as the main barriers encountered. It shows the percentage of SMEs by industry that have implemented at least one circular economy practice (referred as in-going firms). Conversely, those that have not implemented any practices are named no-going firms. The arrows indicate the barriers encountered by each category of firm, with the most significant barriers listed at the top. In addition, the percentage associated with the barrier represents the proportion of firms in this category that faced the barrier.

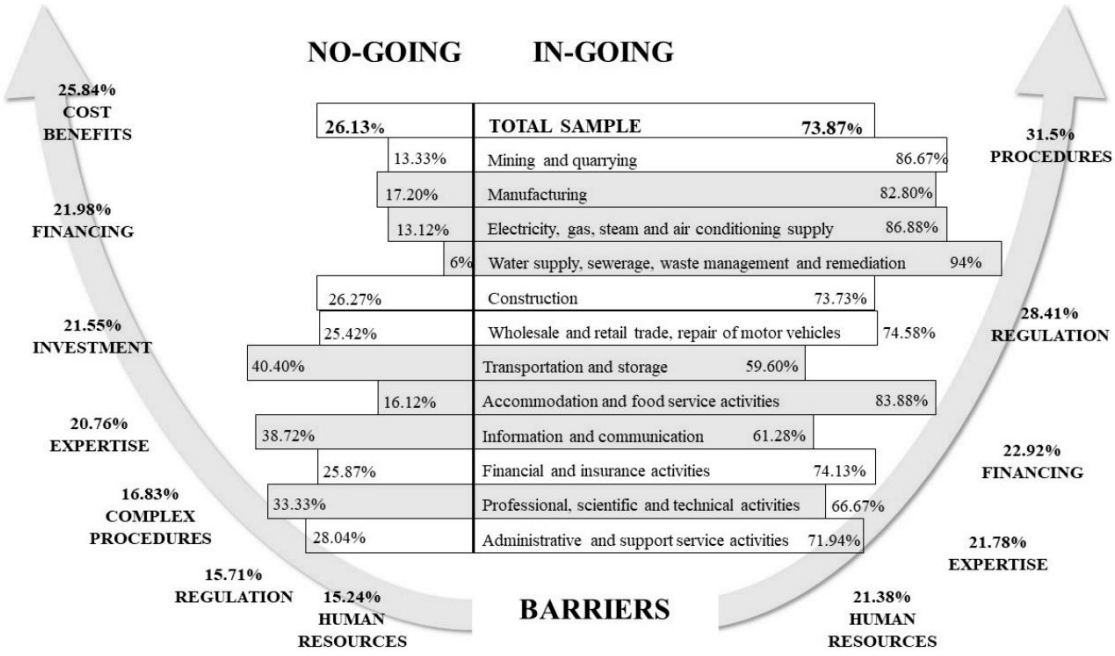

Figure 3: Circular economy implementation and barriers within SMEs (Source: Garcés-Ayerbe et al., 2019)

Some barriers resonate with the more general challenges identified by Kirchherr et al. (2018), providing a better understanding of the barriers faced by SMEs: for example, the lack of human resources and expertise overlaps with the cultural and business barriers, as SMEs may struggle to align their organisational culture with CE principles and compete in markets dominated by traditional linear models. But what is interesting about this study is that the results are different depending on the industries studied, both in terms of the circular economy initiatives implemented, as well as the barriers encountered. Hence, when studying barriers to CE implementation, considering the specificities of each industry is essential. Currently there is no prior literature analysing the implementation of CE practices and the barriers face by companies in the wine industry, which is interesting to know and helps us to justify the reasons for wanting to develop into this sector.

1.1.3 The wine industry and sustainability

This gap in research highlights the importance of exploring the wine sector further. Although this is a little-explored sector in terms of the circular economy, the concept is not unfamiliar for the sector as vineyards are also concerned by the issue that the circular economy is addressing. As reported by Flores (2018), the wine sector is concerned by the issue of sustainability in two ways: firstly because the activity obviously has its own impact on the problem. And secondly, because it is threatened by the resulting consequences of sustainability issues: climate change, water and energy use, chemicals among others. In a recent study, Costa et al., (2022, pp8) states: *"Recently, and related to the circular economy approach, the concept of regenerative wineries is gaining relevance. Regenerative practices in wineries guarantee efficient use of resources but also regenerate resources by recovering value from grape and wine by-products and wastewater"* which highlights the potential role of the CE in the wine sector.

1.1.3.1 The wine sector : overview

Given the size of the sector, it is important to understand its scope through key figures reported by the OIV for 2023 (International Organisation of Vine and Wine, 2024). The vineyard surface area stands at 7.2 million hectares, representing a fall of 0.5% from the previous year, continuing the downward trend that began in the early 2000s. Wine production is at its lowest level in 20 years, with 237 million hectolitres produced, reflecting a nearly 10% reduction compared to 2022. Wine consumption has also decreased to 221 million hectolitres, influenced by energy crises and disruptions in the global supply chain, which have increased production

and distribution costs and led to higher prices for consumers, resulting in a 2.6% decline in demand. The international trade in wine saw a global export volume of 99 million hectolitres, with a 6.3% decline. However, this decline was offset by substantial export value, reaching 36 billion euros.

Despite the downward trend, the wine industry remains significant in size and importance, especially in traditionally wine-producing countries such as France, Italy, and Spain. This makes the wine sector an intriguing subject for studying the implementation of CE practices. Detailed regional information, including specific data for Europe, the USA, and South America, is available in Appendix 2 for further reference.

1.1.3.2 Trends towards sustainability and innovation

There is a strong trend towards sustainability in this sector, as shown by a significant increase in academic research in this area in recent years: publications covering topics such as sustainability, viticulture, wine production, and climate change have multiplied nearly tenfold, from less than 50 publications a year in 2010 to almost 400 released in 2020 (Costa et al., 2022).

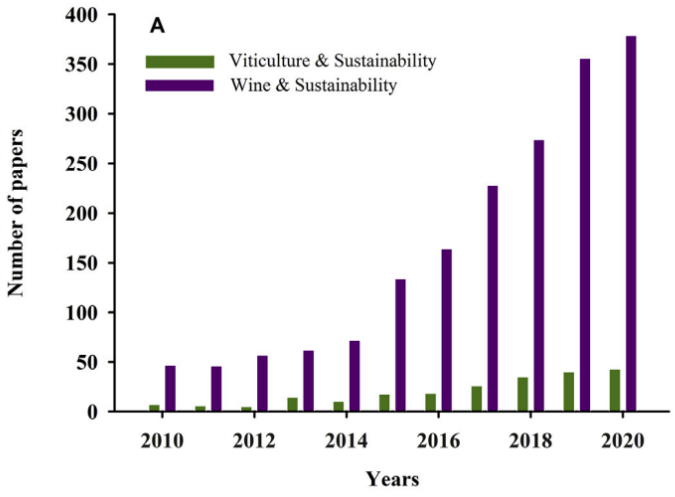

Figure 4: Publications about Wine and Sustainability (Source: Costa et al., 2022)

The wine industry cares about sustainability, and the International Organization of Vine and Wine (OIV) has set official rules about it. They first defined sustainable winegrowing in 2004 as a way to make grapes and wine while also looking after the environment and making sure workers are treated well. They improved this definition in 2008 with guidelines on topics like picking good locations for vineyards, managing waste, and using resources like water and energy wisely (Flores, 2018). More particularly, this translates to sustainable vineyards striving

to utilize organic products, and it also involves minimizing water and energy usage in both vineyard and cellar operations, often requiring upfront investments with a long-term return (Costa et al., 2022). While a significant portion of wine consumers may not yet demand eco-labelled wines (Pomarici & Vecchio, 2014), many in the global wine industry proactively pursue sustainability strategies (Flores, 2018). Some are driven by "philosophical" beliefs in environmental preservation and ensuring a sustainable business for future generations, while others prioritize wine quality and the associated business benefits (Gilinsky, Newton, & Vega, 2016).

The increasing complexity of environmental issues presents opportunities for businesses to innovate sustainable processes and products, aiming for a competitive edge. Research suggests that such innovations can enhance business performance (Costa et al., 2022; Deloitte, 2019). Factors like business age, size, and ownership influence investments in sustainable systems (Drempetic, Klein, & Zwergel, 2020; Gilinsky, Newton, & Vega, 2016). Established companies may hesitate to invest due to concerns about impacting existing product lines, focusing primarily on regulatory compliance and in contrast, younger, entrepreneurial agricultural businesses tend to embrace innovation, often setting new standards for sustainability (Gilinsky, Newton, & Vega, 2016). In addition, other trends have emerged in the industry in recent years, as adopting more sustainable agricultural practices such as organic, biodynamic or integrated farming, which limit the use of chemicals and encourage biodiversity (Pink, 2015).

The literature on biodynamic viticulture is not very abundant but the work and research of Castellini, Mauracher, & Troiano (2017) is very insightful on this subject and allows us to have a better understanding of it. Organic and biodynamic approaches share a close connection, yet they diverge significantly in their regulatory frameworks. While organic viticulture adheres to official regulations, biodynamic practices rely primarily on voluntary adherence without public intervention (Pink, 2015). Biodynamic agriculture is challenging to define due to its reliance on abstract concepts such as the inherent energy in objects and their resonance. However, the central idea for the vineyards, as emphasized by R. Steiner the founder of biodynamic agriculture, is : *"The farm must become a self-sustaining organism, ie, a closed system producing all the necessary stuffs for vineyards, winery and the life of the farmer–winemaker"* (Castellini, Mauracher, & Troiano, 2017). In biodynamic agriculture, growers utilize special natural preparations, referred to as biodynamic preparations, instead of synthetic substances and these preparations are distributed according to natural rhythms (Pink, 2015). Additionally,

planting, harvesting, and other agricultural activities are guided by a unique calendar aligned with lunar and planetary cycles (Castellini, Mauracher, & Troiano, 2017). From this perspective of natural rhythms, regenerative cycle and self-sufficiency, biodynamic practices are perhaps closest to the concept of eco-circularity regarding wine practices.

On the other hand, as explained, organic wines differ from biodynamic wines in that they are regulated by rules (EU Council Regulation EC No 834/2007 and EC Reg No 203/2012) and subject to certification that prioritize environmental sustainability and natural methods. In addition, it is good to note that most of the producers that use biodynamic practices are also organically certified (Castellini, Mauracher, & Troiano, 2017). However, even if a trend is emerging for these practices, it is worth noting that the surface area of organically cultivated vineyards only represented around 2.5% of the total surface area in 2007 (Gilinsky, Newton, & Vega, 2016). This represented around 95,000 hectares (ha), 85,000 of which were in Europe. In 2019, according to the OIV report, this certified organic wine-growing area has grown and is estimated at 454,000 ha, i.e. 6.2% of the world's total wine-growing area, with most of it still concentrated in Europe. The area under certified organic vines has increased by an average of 13% a year (2005-2019), while the area under non-organic vines has fallen by an average of 0.4% a year over the same period (International Organisation of Vine and Wine, 2021). To connect this growth with the earlier observation regarding academic publications on wine and sustainability, it is worth noting that this subject has only recently started to attract interest and gain popularity among both academics and practitioners, but remains a trend that has not yet been fully developed on an industry-wide scale.

According to Costa et al. (2022), wineries will also undergo technological advancements aimed at reducing energy and water usage, minimizing additives, and lowering waste production. Some of these have already been adopted, often quite recently, such as AI (machines and sensors to evaluate water requirements and soil conditions for grape cultivation), automation (mostly in the warehouses), real time data (for the production stage), geospatial intelligence (such as GIS, which employ satellite imagery to map wineries), etc. (Forbes, De Silva, & Gilinsky, 2020). This will involve constructing more efficient and intelligent infrastructures and adopting innovative and more sustainable practices. Often larger companies lead in adopting innovation and digital tools, with smaller ones following (Costa et al., 2022; Deloitte, 2019).

1.1.3.3 Sustainability challenges and limits

Kirchherr, Reike, and Hekkert (2017) suggest that the CE is a practical approach for businesses to implement sustainable development. Therefore it is interesting to examine the challenges that sustainable development poses to the sector. Sustainability encompasses three dimensions: environmental, economic, and social. Challenges faced will be analysed through these three dimensions, which are detailed below.

Environmental: One of the main challenges for global viticulture is adapting to climate change. Although some effects of climate change on wine are hard to assess, it will impact factors in grape development and wine production such as soil composition, water and energy supply, temperature, levels of carbon dioxide in the atmosphere (Costa et al., 2022; Gilinsky, Newton, & Vega, 2016). Climate change and sustainability are intimately intertwined since more brutal and more extreme weather will negatively affect yield, berry composition (e.g., higher sugars content, lower organic acids, higher pH,…), vine health, and wine quality in the end, which will ultimately disrupt the business and job security in the industry (Costa et al., 2022; van Leeuwen et al., 2024).

Water management is expected to become a major issue for the agriculture industry (and thus the wine industry) (Ellen MacArthur Foundation, 2013). The escalating demand for food, activity with high water requirements, coupled with diminishing water resources will intensify pressure on all agricultural activities, which presently consumes about 70% of the planet's freshwater reserves (Schultz, 2016). Moreover, water shortage stands out as a prominent environmental challenge within the wine industry, with grapevines frequently experiencing drought stress even in moderate temperate climates. According to Costa (2022), producing 1L of wine requires between 1 and 14L of water depending on factors like winery size, technologies employed, and the type of wine. Therefore, efficient wastewater management is key to minimize the environmental impact of the wine production and water conservation (Musee, Lorenzen, & Aldrich, 2007). Schultz (2016) additionally notes that global warming is projected to increase the water-holding capacity of the atmosphere in the future, along with plant and soil evapotranspiration, thereby significantly altering the whole water cycle.

The worldwide scope of the wine industry and its extensive production, positions it as a significant consumer of energy and emitter of greenhouse gases (Navarro et al., 2017). In wineries, managing temperatures is crucial, and it is very energy demanding. Cooling grapes,

managing temperatures during fermentation and aging, bottling, and storing wine all require a lot of energy (Costa et al., 2022). This is an issue that vineyards need to keep a close eye on, given the rise in energy prices in recent years, and the environmental impact of their energy source (Zacharof, 2017). For example, energy reduction can be achieved by optimizing building characteristics (i.e. *Jess S. Jackson Sustainable Winery Building*), but such optimizations often require significant investment which can limit the innovations that can be implemented (Szolnoki, 2013).

Economic: In today's dynamic business landscape, the pursuit of growth remains a strategic imperative for many organisations. The increasing expenses in production and distribution driven by inflation over the last few years resulted in higher wine prices for consumers who were already facing reduced purchasing power, and resulting in decreased wine consumption by 2.6% compared to the already low figures of 2022 (International Organisation of Vine and Wine, 2024). The challenge lies in linking the growth of the business to the objectives of sustainability and profitability, however these different objectives do not always go hand in hand, or even prevent others from being achieved (Gilinsky, Newton, & Vega, 2016). The challenge is to balance sustainability, profitability, and social responsibility within the vineyard. In the competitive wine industry, executives are pressured to prioritize cost-cutting and maintaining consistent quality (Signori, Flint, & Golicic, 2017). This focus turns them away from investing in costly sustainability initiatives and innovation projects. Therefore, apart from the financial demands of environmental sustainability projects, the need to survive discourages pursuing costly innovation projects (Signori, Flint, & Golicic, 2017).

On top of that, European viticulture commonly referred as "Old World" and including France, Italy, Spain, Portugal faces increasing competition from "New World" wine-producing countries such as the United States, Australia, Argentina, South Africa,… who have increased their scale, quality, and branding expertise (Costa et al., 2022). In addition, diversified markets and increase in competitiveness are further facilitated by the development of online marketing and e-commerce (Costa et al., 2022). To remain competitive in the wine market, European winemakers must enhance the quality of their wine while reducing costs and ensuring sustainable production. Which stresses the primary problem of economic viability, as price is the primary factor in consumer choice (Schäufele & Hamm, 2017): indeed, growing in quality and turning to sustainable and innovative production come at a price, as well as investments to differentiate from competitors. It has been estimated, for example, that the cost of producing a

bottle of biodynamic wine is around 50% higher, for a very limited premium in the end (Castellini, Mauracher, & Troiano, 2017). The rise in the costs results from higher operational and labour costs, as well as increased workload associated with biodynamic techniques. Additionally, lower yields further contribute to the overall increase in costs associated with biodynamic methods (Castellini, Mauracher, & Troiano, 2017).

There is also a great need to adapt skills and resources : *"Resources in this context included financial resources, access to markets, wine production and marketing experience, land, and experimentation facilities. Capabilities included experimentation knowledge, operational knowledge, supply chain management knowledge, relationship building skills, wine production, and visionary thinking"* (Signori, Flint, & Golicic, 2017) (pp.81). The same authors report that in today's rapidly changing environment, the wine industry needs to adapt its resources, capabilities and reskill the workforce. However, these efforts are limited by constraints such as costs, limited access to materials, shortage of capable employees, and the absence of an innovation culture (Garcés-Ayerbe et al., 2019).

Social: This aspect is the least addressed in the literature on wine sustainability, yet as reported by Costa et al. (2022): *"The wine industry relies heavily on manual labour inputs. Therefore, the social component of sustainability is highly relevant".* The sector needs to account for a number of socioeconomic issues, including the quality of life of its workforce, wages, health, education and training, social benefits, and ethics (Forbes, De Silva, & Gilinsky, 2020; OIV, 2016). It is difficult to quantify the social effects of wine production because there are many players and stakeholders involved, as well as various stages of the production process (Costa et al., 2022). While this dimension is frequently undervalued by businesses compared to other aspects of sustainable development, it holds significant importance as the wine sector is rich in tradition, heritage, and people with social aspects forming its core (Flores, 2018). However, initiatives under this dimension are often limited to donating to charities and sharing resources with other wineries, and train employees in the area of sustainability (Forbes, De Silva, & Gilinsky, 2020).

It is imperative to invest in the socioeconomic development of regions and local communities for wineries (OIV, 2016). These communities include vineyard labourers, potentially exposed to prolonged contact with chemicals like fertilizers and pesticides. Nearby residents also have special interests, with concerns ranging from unpleasant odours to increased noise and traffic.

Furthermore, downstream communities may suffer the consequences of wineries discharging wastewater into rivers, which adversely affects water quality and ecosystems (Gilinsky, Newton, & Vega, 2016).

Consumers want to know where their products come from, and de facto, another key point to which wineries will have to adapt is traceability (Process2Wine, 2020). As environmental concerns grow, consumers' ethical priorities are shifting, leading them to seek out wine production methods that prioritize sustainability and environmental respect (Schäufele & Hamm, 2017). The presence of multiple "green" categories in the market, each with its own logos and claims such as natural, organic, biodynamic, and sustainable wine, has led to confusion among consumers (Moscovici & Reed, 2018). Many consumers lack sufficient information about these product specifications, leading to increased uncertainty and influencing their purchasing decisions (Costa et al., 2022). Improving the traceability within the wine supply chain will help as the geographical origin of wine adds valuable information and serves as an assurance of quality and authenticity and allows producers to be held accountable for their actions and impact on the different dimensions (Costa et al., 2022).

1.1.4 Conclusion and research question

In the initial segment of this thesis, the transition from a linear to a circular economy was underscored as crucial. This shift, advocated by institutions and governments, aims to address contemporary challenges such as resource depletion, climate change, population growth, economic strain, and social issues through a more sustainable approach. However, the implementation of this concept faces several challenges across economic, environmental and social dimensions.

In conclusion and guided by Kirchherr, Reike, & Hekkert (2017, pp221), who stated that *"CE is frequently viewed as an operationalization for businesses to implement the much debated concept of sustainable development"*, this research will explore how vineyards can utilize CE principles to advance sustainable practices. However, this study demonstrated that these circular practices face multiple barriers, and as reported by the Circularity Gap Report of 2024, **the world is less and less circular** (Circle Economy Foundation, 2024)). This disparity prompts to question: if the circular economy is such a trending topic everywhere, why is the world less circular now than before? This question underscores the **necessity of studying the barriers hindering the transition towards a more circular model** in sectors that are less explored,

such as the wine industry. The research question for the thesis will therefore be: ***"What are the main barriers to implementing circular economy practices in the wine industry?"***, and as a sub-question ***"How do overcoming these barriers contribute to achieving sustainable development objectives?"***

1.2 PROPOSITIONS DEVELOPMENT

1.2.1 Propositions related to CE practices

The concept of CE is gaining momentum among businesses, with an increasing number of companies implementing its practices (Muller, Delai, & Alcantara, 2022). Recent research highlights the growing relevance of regenerative practices in wineries, which align with CE principles by ensuring efficient resource use and regenerating resources from by-products and wastewater (Costa et al., 2022). Facing significant sustainability challenges, the sector needs to adopt such innovative practices (Flores, 2018). This necessity is reflected by the growing popularity of practices such as biodynamics and organic viticulture (Castellini, Mauracher, & Troiano, 2017; International Organisation of Vine and Wine, 2021). Thus, the primary proposition of this thesis explores the integration of the CE practices within the wine sector and is formulated as follows:

P1: *The circular economy is being introduced and implemented in the wine industry*

Additionally, research has found different levels of implementation of the CE in different industries (Garcés-Ayerbe et al., 2019). However, the wine industry might be slower to adopt CE due to traditional practices and less pressure from regulatory bodies compared to more industrialized sectors (Costa et al., 2022; Flores, 2018). To further explore these differences, the following proposition will be tested:

P2: *The rate of adoption of circular economy practices is lower in the wine industry compared to other sectors.*

The literature highlights cultural resistance and limited acceptance in adopting circular economy principles (Kirchherr et al., 2018). This is supported by the study conducted by Garcés-Ayerbe et al. (2019), which indicates that one of the significant brakes when implementing CE practices in SMEs is the lack of a clear understanding of the benefits or improved work, as faced by 25.84% of the no-going firms. Increased familiarity and awareness of the CE practices can drive wineries to adopt them, overcoming cultural resistance and

highlighting the importance of sustainable development (Kirchherr et al., 2018; Costa et al., 2022). Education towards the circular economy therefore plays a key role in adopting it. The following proposition therefore arises:

P3: *There is a lack of familiarity and awareness within wineries regarding circular economy practices*

Other factors, such size and resources influence the adoption of innovative practices, for example larger firms typically have more resources and capabilities to invest in sustainable practices and innovation (Drempetic, Klein, & Zwergel, 2020; Gilinsky, Newton, & Vega, 2016). Additionally, larger wineries often lead in adopting innovative practices, setting industry standards that smaller wineries subsequently follow (Costa et al., 2022; Deloitte, 2019). The study will test whether this is also the case for CE-related practices in this sector:

P4: *Larger wineries are more likely to adopt circular economy practices compared to smaller wineries.*

1.2.2 Propositions related to CE barriers

The literature review showed that many barriers could prevent this new model (CE) from being implemented within a sector. The literature suggests that high upfront costs and lack of financial incentives are major obstacles for businesses adopting CE practices (Kirchherr et al., 2018). This is supported by the survey figures from Garcés-Ayerbe et al. (2019), which indicate that 21.98% of the no-going firms faced financial barriers, making it the second most dominant obstacle in the study. Thus, considering the information just presented above, the following research proposition is formulated:

P5: *Wineries face significant financial barriers that hinder the adoption of circular economy practices.*

The OIV established rules for sustainable winegrowing, which include managing waste and using resources wisely (Flores, 2018; OIV, 2016). For vineyards that have already adopted CE practices, ongoing compliance with these evolving guidelines can be a significant barrier (Garcés-Ayerbe et al., 2019). In contrast, economic viability often remains a critical issue for vineyards that have not adopted CE practices and seems to be a major barrier, as the costs of sustainable production often outweigh the immediate benefits (Gilinsky, Newton, & Vega,

2016). Additionally, in-going vineyards must continuously innovate to maintain a competitive edge whereas no-going may not yet perceive the market benefits, affecting their motivation to invest in CE practices (Signori, Flint, & Golicic, 2017). A disparity can then appear between those who have already implemented CE and those who have not, and raises the assumption:

P6: *The most significant barriers to implementing circular economy practices differ between wineries that have already adopted these practices and those that have not.*

Furthermore, understanding the barriers specific to the wine industry requires comparing these challenges to those faced by other sectors. Studies indicate that common barriers such as financial, regulatory, and cultural challenges are prevalent across various sectors (Garcés-Ayerbe et al., 2019; Kirchherr et al., 2018). However, the wine industry may face unique challenges related to its agricultural nature, such as climate dependency and water usage, which might not be as significant in other sectors (Schultz, 2016). This leads to this proposition:

P7: *Certain barriers are more pronounced in the wine industry compared to other sectors.*

1.2.3 Proposition related to sustainable development

The final proposition will explore the impact of the CE within the wine sector, with a particular emphasis on sustainability. Indeed, Kirchherr et al. (2018) suggest that CE is a tool to operationalize sustainable development, as CE practices are designed to enhance resource efficiency and minimize waste, leading to measurable improvements in environmental sustainability (Ellen MacArthur Foundation, 2013; Costa et al., 2022). However, other aspects of sustainable development, such as the social dimension, are also very relevant. The wine sector is rich in tradition, heritage, and the social aspects form its core (Flores, 2018). Investing in the socioeconomic growth of regions and local communities is essential for wineries given that the industry relies heavily on manual labour (OIV, 2016; Costa et al., 2022). Therefore, the final proposition will test whether CE practices have a particularly significant impact on the environmental pillar of sustainable development rather than the others (economic and social).

P8: *The implementation of circular economy practices in wineries impact particularly the first pillar of sustainable development, namely the environment.*

2 Part II : Empirical Part

After establishing the various propositions based on the literature and the research question, this second part will aim to test and verify the established propositions. Therefore, this part will be devoted to the study and analysis of observations gathered within the wine industry through a quantitative survey carried out online and distributed to various vineyards.

2.1 METHODOLOGY

2.1.1 Choice of methodology : Survey-Based Approach

The aim of the thesis is to understand the current state of the circular economy in the wine sector (mainly in France, Spain & Italy), analyse the existing barriers to circularity and identify how these practices can be a vehicle for vineyards to achieve sustainable development goals. The research is therefore descriptive in nature. Consequently, in order to provide a relevant answer to my research questions, I have used a quantitative research methodology, which is the type of methodology used in an descriptive approach (McCombes, 2023).

To investigate the adoption CE practices and barriers in the wine industry, this master thesis employs a survey-based approach. Surveys are particularly useful for quantitative research, as they enable statistical analysis of responses, which can identify trends, patterns, and correlations (Fowler Jr, 2013). The surveys also allow to collect large amount of data from a significant number of respondents, providing a comprehensive overview of the subject (Groves et al., 2011; Pinsonneault & Kraemer, 1993) while ensuring a certain level of consistency and reliability in the data collected by asking all respondents the same set of questions (Groves et al., 2011; Hinkin, 1995).

Given the limited data on CE in this sector, the primary aim was to collect substantial data to describe trends within it, achievable through surveys rather than interviews (Bryman, 2016; Groves et al., 2011). While the interviews can provide in-depth responses, they have the disadvantage of being better suited for small-scale studies, are subject to various types of bias (interviewers often seek answers to support their preconceived notions; might misinterpret what the interviewee is conveying; and interviewees might misunderstand the questions being asked), and are not fully anonymous, potentially leading to less honest answers (Alshenqeeti, 2014; Fowler Jr, 2013).

In addition, the use of surveys in similar studies underscores their appropriateness for this research. For instance, the use of surveys can be found in studies on the CE barriers faced by SMEs in Europe (Garcés-Ayerbe et al., 2019; Kirchherr et al., 2018), for examining sustainability and CE practices within specific industry contexts (Garcés-Ayerbe et al., 2019; Masi et al., 2018), or that explore attitudes towards sustainable wine production (Pomarici & Vecchio, 2014; Schäufele & Hamm, 2017; Sinha & Akoorie, 2010).

2.1.2 Data collection : survey construction and distribution

The survey used is adapted from a survey commissioned by the European Commission : The **Flash Eurobarometer Survey number 441** (European Commission, 2016), which studies the activities of European small and medium enterprises with regard to circular economy (10618 companies surveyed in different sectors through 172 variables and 24 questions). It has been simplified and adapted to suit the wine sector and companies such as wineries. The survey was in the end a Google Form with a total of 11 questions, but this may vary depending on whether or not the winery has taken action regarding the CE. The survey was open from May 18 2024 to June 8 2024 (during three weeks). The respondents were contacted by email, and of the 1,500 wineries contacted, **167 responded to the survey**. This quantitative study primarily focused on **vineyards in Spain, France, and Italy** as they are the main actors in this sector in the world and in Europe (they represent about 80% of the EU total wine-production in 2023 (114 on 144mhl) (International Organisation of Vine and Wine, 2024)).

The survey was first pre-tested with four wineries to ensure that all questions were clear and smooth to answer. After feedback, readjustments were made including a question on the number of bottles produced per year, and redefining a little more the 5 categories of CE practices that can be implemented. An open-ended question at the end was also added in case the respondent wanted to add a remark, analysis or additional relevant information (as the questionnaire was mainly based on pre-defined answers). These questions and the final survey distributed can be found in the appendix 3.

The survey was organized into two parts, each containing a given number of questions. The first part consists in gathering information on the vineyards: their location, their annual production (number of bottles produced per year) and the annual turnover range in which they are situated.

The second part focuses on the circular economy within vineyards. First, based on a Likert scale, respondents were asked how familiar they felt with the concept of circular economy on a scale of 1 to 7 (not at all familiar to very familiar). This choice has been made as a 7-point scale enhances the quality and interpretability of the findings by offering a more nuanced measure of the attitudes and perceptions of the respondents (Joshi et al., 2015). Then it was asked whether they had implemented any practices relating to CE (Yes or No). Here we have two cases:

- If yes: They were asked in which categories the implemented practices fall (5 possible categories of practices). And then, for each category what were the main barriers encountered during implementation or in taking action in the categories. Finally, they were asked which pillar(s) of sustainable development had been impacted by the implementation of these initiatives.

- If not: what barriers had they encountered preventing them from implementing circular economy practices (7 categories of barriers available). They were also given the opportunity to develop their answers through an open-ended question (optional).

2.1.3 Data analysis : analyse the survey results

To analyse the survey data collected from vineyards, this master thesis employs statistical analysis in R, descriptive analysis, and comparison with other studies.

The first method for analysing our data is a statistical analysis in R. R provides a comprehensive toolset for statistical analysis, including functions for hypothesis testing, regression analysis among others (Chambers, 2008; Worsley, 2023). Its reproducibility and flexibility make it suitable for this study (Chambers, 2008; Gandrud, 2018). In the context of the master thesis, I used the statistical software RStudio to determine the significance of various factors affecting the transition to CE practices (i.e. tested whether there was a link between the fact that vineyards had implemented circular economy activities, and their familiarity score with CE). A common method is the T-test Student, which compares whether the means of two groups differ significantly and impact the dependent variable (Wackerly, Mendenhall, & Scheaffer, 2008). Therefore, I compared the mean familiarity scores between vineyards that had and had not implemented CE practices (in-going and no-going vineyards). Additionally, a generalized linear model (GLM) tested which other characteristics (turnover, size, location) might have an

influence on whether the firm adopted certain practices relating to this model. A GLM is a flexible generalization of ordinary linear regression that allows for the dependent variable to have a non-normal distribution (R Documentation, 2024b).

Then, I used a descriptive analysis and compared the data with results from other studies. Descriptive analysis provides clear and simple summaries of the data, making it easier to understand and interpret (Creswell & Creswell, 2017; Lawless et al., 2010). This also ensures transparency and reliability of data, as the descriptive method does not control or manipulate any of the variables, but only observes and measures them (McCombes, 2023). In the case of this thesis, it is relevant for highlighting the most frequently reported CE barriers and practices in the sector, providing a snapshot of the sample characteristics, and comparing them with results obtained in other studies to identify similarities and differences. Descriptive analysis in this study includes summarizing the key metrics (frequencies and percentage of survey responses), visualizing data (use of charts, graph and table to report the results), identifying the patterns and the trends for each group.

The results are then compared with those obtained by Garcés-Ayerbe et al. (2019) in their study *"Is it possible to change from a linear to a circular economy? An overview of opportunities and barriers for European SMEs"*, where the authors based their research on a quantitative study involving various SMEs and industries across Europe inquiring whether they had implemented CE initiatives, and if not, what were the barriers encountered. This offers a broader contextual understanding of the findings, by situating them within the existing body of knowledge, and increasing the reliability and robustness of the conclusions drawn (Bryman, 2016; Yin, 2009).

2.2 RESULTS

The following section will share the empirical findings coming from the survey, including the description of the sample, whether or not CE practices are being implemented in the wine sector, and the barriers to the CE transition in this sector.

2.2.1 Sample description

Over half of the respondents (59.28%) are located in France, followed by Spain (19.76%) and then Italy (18.56%). A further 2.40% of the sample contacted for pre-testing the survey are Belgian wineries, and are included in the "other" category.

Of the 167 wineries responding, 151 (90.42%) said they had implemented at least one of the five CE initiatives proposed: namely (1) re-planning of the way water is used to minimize usage and maximize re-usage; (2) use of renewable energy; (3) re-planning energy usage to minimize consumption; (4) minimizing waste by recycling and reusing waste or selling it to another company; (5) redesigning products and services to minimize the use of materials or use recycled materials (Garcés-Ayerbe et al., 2019). And to echo the analysis made by Garcés-Ayerbe et al. (2019), the term used to call these vineyards will be the In-Going firms (or vineyards). On the other hand, those who have not implemented any CE-related practices, the No-Going vineyards, account for 16 (9.58%) of the vineyards who took part in the survey. The various possible barriers encountered by those vineyards have also been asked, and will be developed in the next section.

In terms of annual turnover of the vineyards surveyed, the majority of them have annual turnover of less than 2 million (M) (in €), i.e. 66.47% of the respondents. This is then completed by the other wineries with their turnover between 2M and 10M, representing 21.56% of respondents, followed by 4.79% of respondents with a turnover between 10M and 50M, and finally 2.40% of the vineyards with a turnover over 50M. Note that 4.79% of respondents were unable to provide this information. In total, 92.81% of these check the first SME criterion, i.e. annual turnover of less than 50M (European Commission, 2023b) (including 88% of the sample with an annual turnover of less than 10M).

The **Table 1** below reports the main results of the survey sent to vineyards.

Table 1 - *Sample's descriptive information*

Variables	Categories	N	%*
Location	*France*	99	59.28
	Spain	33	19.76
	Italy	31	18.56
	Others	4	2.4
Turnover	*Less than 2M (million)*	111	66.47
	Between 2M and 10M	36	21.56
	Between 10M and 50M	8	4.79
	More than 50M	4	2.4
	NA	8	4.79
Familiarity with CE	*1 (not at all familiar)*	7	4.19
	2	6	3.59
	3	14	8.38
	4	19	11.38
	5	48	28.74
	6	42	25.15
	7 (very familiar)	31	18.56
CE Activities Implementation	*YES (In-Going)*	151	90.42
	NO (No-Going)	16	9.58
CE Activities (In-Going) (N=151)	*Water*	97	64.24
	Renewable Energy	66	43.71
	Energy Consumption	75	49.67
	Recycle/Reuse	124	82.12
	Redesign	59	39.07
Pillars of Sustainability (N=151)	*Environment*	137	90.73
	Economic	101	66.89
	Social	52	34.44
	None	8	5.30
Barriers to CE (No-Going) (N=16)	*Lack of human resources*	5	31.25
	Lack of expertise	8	50.00
	No clear idea about benefits	6	37.50
	No clear idea about investment required	7	43.75
	Complex administrative or legal procedures	5	31.25
	Cost of meeting regulations or standards	2	12.50
	Difficulties in accessing finance	6	37.50

N (Survey) = 167

** ∑ ≠ 100%; The percentage is calculated with the respective N*

The survey also asked in-going vineyards about the issues they had encountered when undertaking CE initiatives. The results are shown in **Table 2**, with the main barriers encountered for each category of CE activities highlighted in bold.

Table 2 - *In-Going Vineyards: Barriers of the initiatives implemented*

Variables	Categories	N	%*
Barriers to Recycle/Reuse initiatives (N=124)	*Lack of human resources*	24	19.35
	Lack of expertise	36	29.03
	Complex administrative or legal procedures	28	22.58
	Cost of meeting regulations or standards	20	16.13
	Difficulties in accessing finance	12	9.68
	None	**38**	**30.65**
Barriers to Water initiatives (N=97)	*Lack of human resources*	19	19.59
	Lack of expertise	36	37.11
	Complex administrative or legal procedures	37	38.14
	Cost of meeting regulations or standards	**44**	**45.36**
	Difficulties in accessing finance	24	24.74
	None	22	22.68
Barriers to Energy Consumption initiatives (N=75)	*Lack of human resources*	15	20.00
	Lack of expertise	**48**	**64.00**
	Complex administrative or legal procedures	23	30.67
	Cost of meeting regulations or standards	43	57.33
	Difficulties in accessing finance	34	45.33
	None	24	32.00
Barriers to Renewable Energy initiatives (N=66)	*Lack of human resources*	12	18.18
	Lack of expertise	34	51.52
	Complex administrative or legal procedures	44	66.67
	Cost of meeting regulations or standards	**52**	**78.79**
	Difficulties in accessing finance	51	77.27
	None	18	27.27
Barriers to Redesign initiatives (N=59)	*Lack of human resources*	28	47.46
	Lack of expertise	**42**	**71.19**
	Complex administrative or legal procedures	16	27.12
	Cost of meeting regulations or standards	24	40.68
	Difficulties in accessing finance	19	32.20
	None	27	45.76

N (In-Going) = 151

** ∑ ≠ 100%; The percentage is calculated with the respective N*

2.2.2 CE practices & CE barriers in the wine sector

The first proposition of this study aims to determine whether CE principles have been introduced in the wine industry. According to the survey results (Table 1), 90.42% of vineyards in the sample have implemented at least one CE-related initiative (in-going firms), while 9.58% have not (no-going firms). These findings suggest that the circular economy is present within the sector and that it has begun transitioning towards this new model. The most widely implemented CE activity is recycling and reusing waste, adopted by 82.12% of the in-going vineyards. Therefore, **P1 is verified for our sample**.

Our second proposition regarding CE was P2: *The rate of adoption of circular economy practices is lower in the wine industry compared to other sectors*. The circular economy adoption rate within the wine sector is high at 90.42%; it is slightly below the water supply sector (94%) but practically 10% higher than sectors such as manufacturing and food services which were already considered high by previous studies (Garcés-Ayerbe et al., 2019; Gusmerotti et al., 2019). In addition, using the framework suggested in the theoretical section, i.e. analysing the implementation of CE practices across the five key categories of activity identified by Garcés-Ayerbe et al. (2019), the results for the wine industry compared to the average of other sectors are shown in *figure 5*:

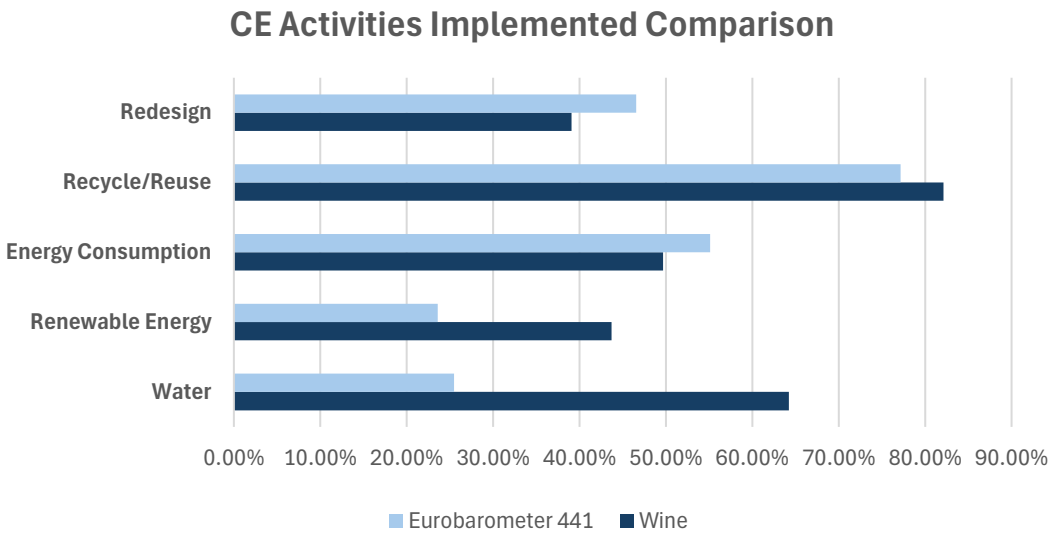

Figure 5: CE activities implemented : industries comparison (Source: Garcés-Ayerbe et al.(2019) & Survey Results (2024))

The results show a much higher adoption rate for water and renewable energies initiatives in the wine sector (almost 64% and 43%). In the other three categories, the wine sector matches the average adoption rate of other sectors. **P2 is therefore rejected**. A general comparison of CE adoption rates for different sectors can be found in the appendix 4 (in-going vs no-going percentage for different industries). The results of the Flash Eurobarometer Survey number 441 regarding the five key CE initiatives in appendix 5.

Then, the third proposition stated: P3: *There is a lack of familiarity and awareness within wineries regarding circular economy practices*. According to the T-test student performed in R, the average familiarity score for the "no-going" vineyards is 3.4, and that for the "in-going" vineyards is 5.2 (on 7). The p-value of the test is 0.001143, well below p=0.05 (which is equivalent to a 95% confidence threshold). This means that there is a statistically significant

difference between the familiarity scores of the two groups and this awareness could influence vineyard in implementing CE activities (Beers, 2024; R Documentation, 2024a). The average for the entire sample was 5.06 out of 7 (7 being very familiar with the circular economy). **This leads us to not verify P3.**

Regarding the proposition P4: *Larger wineries are more likely to adopt circular economy practices compared to smaller wineries*, the GLM was used to test the proposition. Table 3 shows the results of the statistical test and determine whether other characteristics of the vineyard, such as its location, size or annual turnover can also influence the adoption of CE practices.

Table 3 - RStudio GLM Output : Factors potentially influencing CE adoption

Coefficient	Estimate	Std. Error	z value	Pr(>|z|)
(Intercept)	-13.92	4612.0	-0.003	0.998
Size Vineyard	-5.638e-07	1.415e-06	-0.398	0.69
LocationFrance	15.19	4612.0	0.003	0.997
LocationItaly	16.35	4612.0	0.004	0.997
LocationSpain	16.28	4612.0	0.004	0.997
LocationOther	-3.288	6392.0	-0.001	1.0
TurnoverSmall	-1.161	1.057	-1.098	0.272
TurnoverMedium	-14.86	1830.0	-0.008	0.994
TurnoverLarge	-14.13	2359.0	-0.006	0.995
Familiar	-7.714e-01	0.1891	-4.08	4.51e-05***

Following this statistical model, the results show that the other variables (vineyard size, location, and turnover) are not significantly related to the adoption of circular economy initiatives according to this model for our sample (their p-value being greater than 0.05). Only the familiarity with the CE is a significant determining factor in the adoption of CE initiatives (which reinforces proposition 3). As a result, we can therefore **reject the proposition p4**.

With regard to the fifth proposition, which stated that wineries face significant financial barriers hindering the adoption of CE practices (P5), observations from the no-going vineyards in the sample reveal that "difficulty in accessing finance" ranks third, with 37.5% of vineyards encountering this barrier. This barrier is tied with the "no clear idea about the benefits of CE" and follows closely behind the "no idea of investment required" barrier, which ranks second. The results concerning the barriers faced by in-going and no-going vineyards are illustrated in *Figure 6* below.

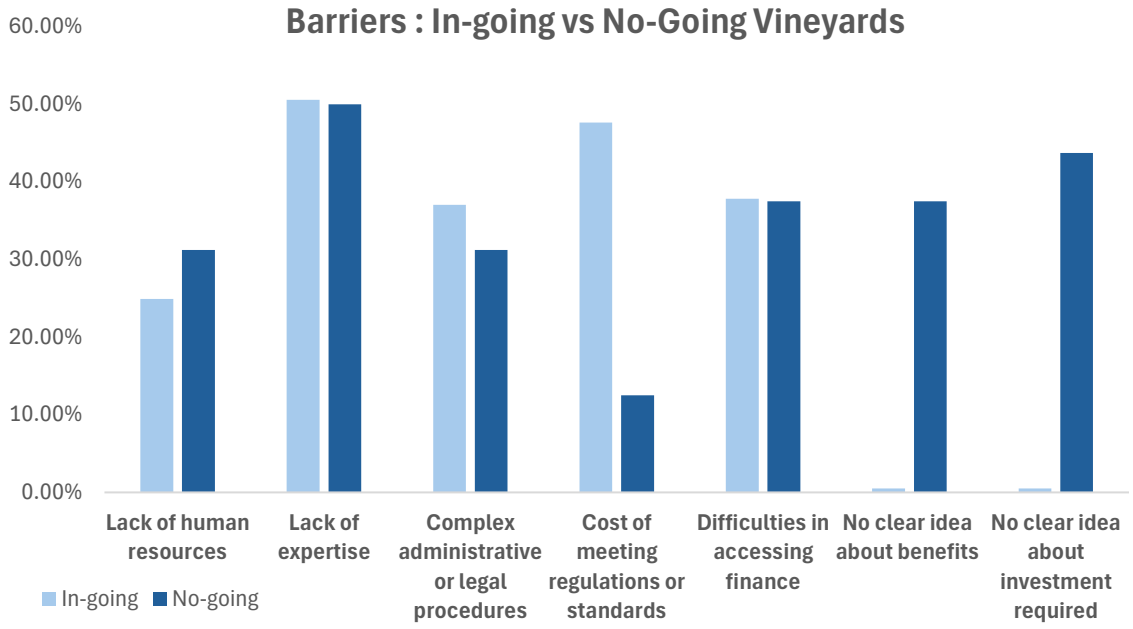

Figure 6: Barriers comparison In-going vs No-going (Wine) (Source: Survey Results (2024))

The graph shows that the predominant barrier encountered by the sector is a lack of expertise for implementing the practices, with 50% of vineyards facing this issue. This is also evident for in-going vineyards (Table 2), where lack of expertise was the main barrier for two of the five categories of CE initiatives: managing energy use and redesigning products, with respectively 64% and 71% of firms encountering this barrier. On average, slightly more than 50% of firms implementing one of the five CE initiatives faced this challenge. In addition, for in-going vineyards, the difficulty of accessing finance often ranks third or fourth among the five possible barriers for the selected categories of initiatives. However to mitigate this, the "cost of meeting regulations or standards" barrier is predominant for two activities, namely water and renewable energy initiatives, at 45.36% and 78.79%, respectively. This reflects a cost-related financial burden that could potentially lead to financial collapse. We would claim however, that it is **not possible to satisfy proposition P5.**

The *figure 6* shows the differences regarding the dominance of the barriers encountered by vineyards, depending on whether or not they had implemented certain practices. Proposition 6 suggests that : *The most significant barriers to implementing circular economy practices differ between wineries that have already adopted these practices and those that have not*. As seen for proposition 5, the major barrier for in-going and no-going vineyards is the lack of expertise. However, one notable observation is the difference in the "cost of meeting regulation and standards" barrier. This barrier is three to four times higher in wineries having implemented CE activities than in no-going firms. For the other barriers, we do not see any significant difference

(apart from the fact that no-going vineyards faced two additional barriers, the lack of idea of the investment required and the potential benefits of the CE). **P6 is partially supported.**

Another proposition considered on the basis of the literature explored was P7: *Certain barriers are more pronounced in the wine industry compared to other sectors.* To assess this, the scores for each barrier encountered in the wine industry and other industries (averaged based on Garcés-Ayerbe et al., 2019) have been summarized in the graphs below for comparison. The first graph represents the barriers for no-going firms, while the second represents those for in-going firms.

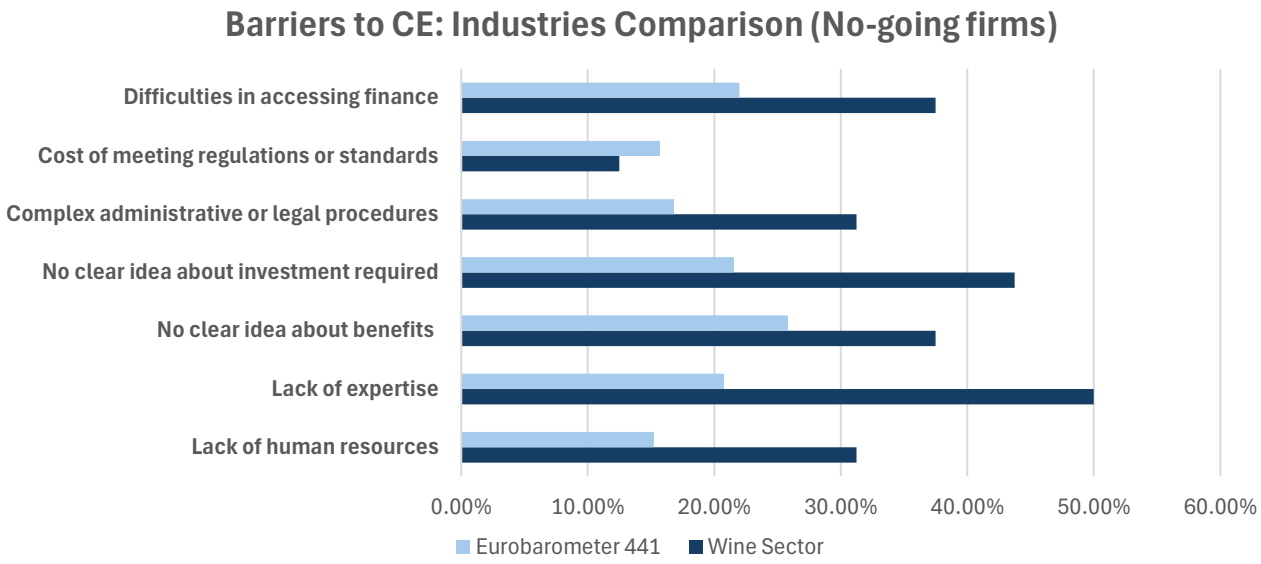

Figure 7: No-going firms barriers comparison (Source: Garcés-Ayerbe et al.(2019) & Survey Results (2024))

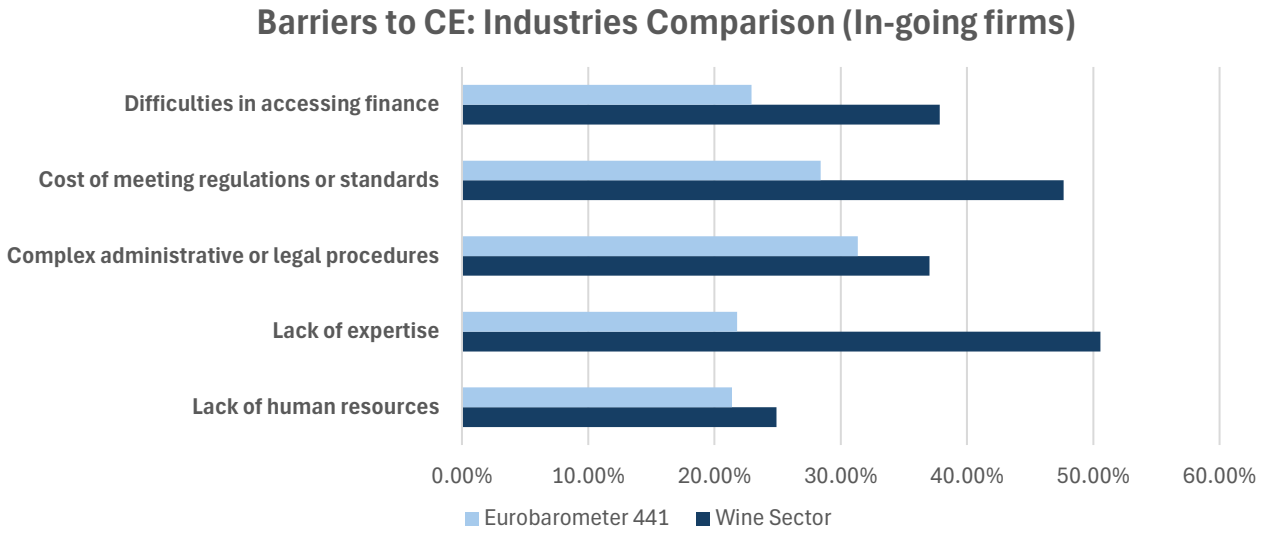

Figure 8: In-going firms barriers comparison (Source: Garcés-Ayerbe et al.(2019) & Survey Results (2024))

One striking point emerges: the lack of expertise seems to be prevalent for vineyards (both no-going and in-going), and is far more pronounced than for other industries (over two times more). More generally speaking, the same is true for each of the barriers to CE: they are more pronounced for the wine sector than for the other industries. Two additional notable differences for no-going vineyards, compared to no-going firms in other industries, appear in two barrier categories: the lack of human resources, where the score doubles compared to the average, and the lack of knowledge about the investment required to implement these practices, which exceeds 40% in the sample (versus 21.55% for Eurobarometer 441). We conclude that **P7 is supported**.

The final proposition of this thesis concerned the impact of CE practices on sustainable development. We therefore used the survey to analyse which pillar or pillars of sustainable development were most impacted when they had implemented one of the 5 practices identified by Garcés-Ayerbe et al. (2019), and the result is clear across the sample: 90.73% of in-going vineyards report that these practices primarily impact the environmental pillar. Regarding the economic pillar, 66.89% perceive an impact, while only 34.44% believe there is a social impact. It's worth noting that 5.30% thought it had no impact at all. Therefore **P8 is verified**: *The implementation of circular economy practices in wineries impact particularly the first pillar of sustainable development, namely the environment.*

Table 4 shown a summary of the propositions and the outcome of the empirical results.

Table 4 - *Summary of propositions & results*

Propositions	**Outcome**	**Justification**
P1: The CE is being introduced and implemented in the wine industry	*Supported*	Over 90% of the vineyards in the sample has implemented CE practice
P2: The rate of adoption of CE practices is lower in the wine industry compared to other sectors.	*Rejected*	The adoption rate of CE and the five key initiatives in the wine sector are high and comparable to other sectors
P3: There is a lack of familiarity and awareness within wineries regarding CE practices	*Rejected*	T-test student result: average familiarity score was 5.06 out of 7 for the sample, indicating sufficient awareness
P4: Larger wineries are more likely to adopt CE practices compared to smaller wineries.	*Rejected*	GLM result: No significant relationship between vineyard size and CE adoption
P5: Wineries face significant financial barriers that hinder the adoption of CE practices.	*Rejected*	Financial barriers are not the most significant barrier to CE adoption, the lack of expertise rank first for in-going & no-going vineyards

P6: The most significant barriers to implementing CE practices differ between in-going and no-going wineries	*Partially supported*	Significant difference observed only in "cost of meeting regulations and standards" barrier, but not for other barriers
P7: Certain barriers are more pronounced in the wine industry compared to other sectors.	*Supported*	All barriers are encountered to a greater extent in the wine sector than in other sectors
P8: The implementation of CE practices in wineries impact particularly the first pillar of SD, namely the environment.	*Supported*	CE practices positively impact sustainable development in the wine industry (more than 90% of winegrowers say it has had an impact)

2.3 DISCUSSION & INTERPRETATION OF RESULTS

This section discusses and compares the results obtained in this study and compares them with the theoretical framework for discussion. The survey also included an open-ended response option at the end, allowing respondents to share their perspectives on the matter. This provided valuable insights for discussion and a new approach to our observations.

Firstly, our results show that the circular economy is currently present in the wine sector, with the majority of vineyards having implemented circular economy practices. This result supports what several authors or institutions have observed, such as Flores (2018), the OIV (2021) and Costa et al. (2022), a trend is emerging towards sustainable practices and the concept of regenerative vineyards and CE is gaining in relevance within the sector. Although the literature suggested that factors such as the size or age of the business were important factors in the adoption of such practices (Costa et al., 2022; Gilinsky, Newton, & Vega, 2016), the survey reports that, above all, one of the determining factors is simply the familiarity or awareness of the vineyard and its people to the circular economy. This has also been confirmed in other sectors such as manufacturing, where awareness as been identified as one of the main drivers of CE adoption (Liakos et al., 2019; Masi et al., 2018).

Regarding the most common practices in the sector, studies (Kirchherr, Reike, & Hekkert, 2017) suggested that most policies in recent years have encouraged recycling, which is why it is not surprising to find it also as the most implemented initiative within the wine sector. However, one notable difference with other sectors concerns the water initiatives. The wine sector has a much higher adoption rate in this category than the Flash Eurobarometer 441 average. A possible explanation for this is, as pointed out by the Ellen MacArthur Foundation (2013), water management will become (and already is) a key challenge for agricultural activities, and this is

echoed by Costa et al. (2022) and Flores (2018) for the wine industry, as it is very water demanding to produce wine, underlining the necessity of efficient water management.

The first thing to note about CE barriers in the wine sector is that they seem to be much more pronounced than in other sectors, for both in-going and no-go firms. This aligns with the literature highlighting that agricultural sectors are heavily affected by issues such as climate dependency and water usage (Ellen MacArthur Foundation, 2013), and involves complex challenges hard to overcome (Schultz, 2016). Concerning the various barriers:

Lack of human resources; The results of our survey for the in-going vineyards, as well as for no-going, also reveal that this barrier is more pronounced than the average for other industries. To explain this difference, the results agree with Costa et al. (2022) who suggested that the wine industry relies heavily on human input and work, mainly manual, which may be a reason why this shortage is more easily felt in the industry.

Lack of expertise to implement these activities; This was revealed as the most dominant barrier within the wine sector by our sample. Signori, Flint, & Golicic (2017) highlighted the importance and great need to adapt skills and resources within vineyards, even more in today's rapidly changing environment. This often goes hand in hand with the technological barrier identified by Kirchnerr et al. (2018), and as one respondent testifies: *"Among other things, the drone eliminates fossil fuel consumption, greenhouse gas emissions and water consumption. To pilot a drone of this size, we needed a pilot's license, and probably a few skills upgrades"*. (France, in-going)

No clear idea about cost benefits or improved work processes & No clear idea about investment required; These two barriers are specific to no-going firms. As our sample has shown, awareness of the circular economy and its benefits is an important factor in the transition. Many businesses are unaware of the potential cost savings and efficiency gains associated with CE practices. This barrier is often linked to a broader lack of education and dissemination of information regarding the benefits of CE (Kirchherr et al., 2018). Moreover, quantifying these benefits can be an arduous task, and the consequences of certain effects, such as the impact on the environment, are not directly observable (Ellen MacArthur Foundation, 2013).

Complex administrative or legal procedures & Cost of meeting regulations or standards; The open-ended answers left by survey respondents shed some light about this barrier for the sector.

In fact, one answer that came back was the AOC (Appellation d'Origine Contrôlée) or AOP (Appellation d'Origine Protégée) specifications. These regulatory commissions ensure that producers wishing to use a certain name for their wine (Champagne, for example) comply with a certain number of rules when developing their product, and implementing new practices, such as CE practices, while remaining within these standards entails a cost (Alonso Ugaglia, Cardebat, & Jiao, 2019).

Difficulties in accessing finance; The survey results highlighted that many vineyards find it challenging to obtain financial support, aligning with the literature that emphasizes the need for financial incentives, subsidies, and targeted funding programs to facilitate the transition to a circular economy (Garcés-Ayerbe et al., 2019; Kirchherr et al., 2018). It was this barrier that received the most open responses, even though it was not the first in terms of "score". Some of the answers point to the origins of these difficulties: *"We need further support as farmers; nowadays cost are the critical point to make a better circular economy practice. The price paid to wineries regarding the costs is under price; so no profit, no wine or no food at the end; not with standing any implementation of circular economy practices"* (Spain, in-going)

"The use of water is important for winemaking, and possible materials for using less water are not financed by subsidies." (France, in-going)

"all the cost of recycling falls on our shoulders and I think it should be distributed among more agents involved as our suppliers, citizens etc. or as is done in other countries reward citizens for recycling and pass on the cost to those who do not." (Spain, in-going)

One of the respondents also gives us another clue to understanding the barriers within the wine sector: Time. Although this barrier has been mentioned in the context of sustainability implementation (Szolnoki, 2013), prior studies on CE in the wine industry have not extensively addressed it. The wine industry, like any other agricultural business, is extremely demanding and labour-intensive, leaving very little time for other, unrelated activities. From this, the respondent (France, in-going) explains that the result is a lack of time for training, acquiring the necessary expertise, inform yourself about the solutions and benefits of the CE. These new model practices also require more work and therefore more staff, which is often complicated by cost pressures within the sector and the result is a lack of human resources (Costa et al., 2022).

3 Part III : Conclusion

3.1 Brief summary of the study

This study explores the adoption of circular CE practices within the wine sector, focusing on identifying the main barriers to implementation and comparing them to those in other industries. The research, conducted through a survey of vineyards in France, Spain, and Italy, reveals a high adoption rate of CE practices among the respondents, particularly in recycling and water management. However, significant barriers persist, including a lack of expertise, unclear benefits, and uncertain investment requirements under cost pressure. These barriers are more pronounced in the wine sector compared to others, underscoring the need for targeted education, financial incentives, and standardized metrics to facilitate the transition to sustainable practices.

3.2 Contributions from the study

Regarding the theoretical contributions of the research, the study shows that despite limited literature on wine and CE, the wine sector has already embarked on the transition to the CE, with a majority of vineyards having already adopted some initiatives. Building on the work of Garcés-Ayerbe et al. (2019), we have extended their study of barriers to this additional sector. The thesis provided a detailed understanding of the specific barriers to CE adoption in the sector by highlighting the unique challenges faced by agricultural industries compared to more industrialized sectors, and the outcome is that the barriers to CE are much more pronounced in this sector. This was particularly noticeable regarding the "lack of expertise" barrier. Another contribution of the study is the identification of time as a barrier to CE adoption, a factor not clearly mentioned in prior literature for this sector. The time-demanding nature of agricultural activities leaves little opportunity for stakeholders to explore and engage with new models like the CE.

From a managerial perspective: vineyards with greater familiarity with the circular economy are more likely to adopt these practices, which could be a focus point for policymakers. If they want to increase the rate of CE adoption they need to focus on education and training, to increase the level of familiarity regarding CE. Secondly, as we have seen, the lack of possibilities is also a major obstacle to CE, the idea here is to encourage collaboration between vineyards through associations or wine institutions, and to share best practices, successful case studies or the innovative solutions found between practitioners. Additionally, although financial barriers were not the most significant issue, it was the one that drew the most responses to the

open-ended questions, underlining the importance of costs for the wine industry. It could be interesting for policymakers to develop and promote financial incentives, such as subsidies, grants, and low-interest loans, specifically targeted at vineyards to support their transition to CE practices.

3.3 Limitations and future research leads

This research is not without limitations. To begin, the first thing to consider is the sample representation. The survey's sample size, while significant, may not fully represent the diversity of the entire wine sector across different regions and scales of operation. The focus on vineyards in France, Spain, and Italy, though dominant in Europe, may limit the generalizability of the findings to other wine-producing regions, such as the USA or South America, which have been growing in importance in recent years (OIV, 2024). In addition, there are several thousand vineyards in Europe, and obtaining a larger number of respondents would have enabled more accurate data. The external validity should be tested on a more representative sample of the wine sector. For example, the thesis established in the literature review that factors such as business age, size and turnover influence business transition to sustainability (Gilinsky, Newton, & Vega, 2016), but this was not true for our sample. Further research could re-test these hypotheses in different institutional contexts, such as the US, where there is currently no national Circular Economy policy, to see if the results hold with different samples.

Secondly, we were able to observe a limitation related to the composition of the survey. The survey design was based on Flash Eurobarometer 441, commissioned by the European Commission; however, it was necessary to simplify and adapt it to facilitate responses from winegrowers. The adaptation of the Flash Eurobarometer Survey for the wine sector may have led to the omission of sector-specific barriers or practices not captured by the original survey. As we have seen, the wine sector is rich in tradition, heritage and social aspects are at its heart (Flores, 2018; Forbes, De Silva, & Gilinsky, 2020), it is possible that certain wine-related dimensions are set aside (such as technological limitations specific to the wine industry or unique cultural barriers within certain regions). Investigate the sector-specific barriers in greater detail could be a potential future research lead. In addition, there is a possible self-reporting bias error from the vineyard. Respondents may overstate their familiarity with CE practices or underreport barriers due to social desirability bias or misunderstanding of the survey questions. This study was quantitative, but the qualitative methods such as interviews and case studies could provide deeper insights on the matter. Another bias that affects the results

of our study is non-response bias. This occurs when the survey primarily attracts firms already implementing CE practices, potentially leading to an overrepresentation of the in-going firms and underrepresentation of the no-going (it is possible that the wineries that did not respond the survey are companies that do not implement the CE). These limitations should be considered when interpreting the study's findings, and be careful with the conclusions drawn.

Another limit to mention is the temporal limit of the study. In fact, it is capturing data at a single point in time. This limits the ability to observe changes over time or the long-term impacts of CE practices. As we know, the circular economy is still a topic in stage, both in theory and in practice. The evolving nature of CE practices and policies means that findings could quickly become outdated as new technologies and regulatory changes emerge.

Finally, stemming from the data collected from one of the respondents that said : *"Of all the agricultural sectors, wine is the one with the fewest proposed solutions"* (France, no-going). It is true that, based on the Flash Eurobarometer 441 canvas and Garcés-Ayerbe et al. (2019), the survey has remained fairly general about possible circular economy initiatives within the wine industry (by categorizing them under 5 areas of activity, but without going into the details of what may have been implemented specifically). Future research could benefit from focusing specifically on the CE initiatives within the wine sector, identifying and developing particular activities. Some of these activities might be more effective, encounter fewer implementation barriers (compared to the others in the same category), and result in a more significant impact on vineyards.

3.4 A final word

First of all, this thesis enabled me to develop a better vision of the circular economy, but also to gain a foothold in a sector with which I was less familiar. I realized the relevance of the question when I started distributing my survey. As the number of responses grew, I received emails from winegrowers encouraging me in my research, and more than half the respondents told me they wanted to know the results of the survey or have access to my thesis. This was an additional motivation, and as I exchanged emails with the winemakers, they really wanted to find out more about the possibilities. Once again, I would like to thank all the winemakers with whom I had the pleasure of talking, and who helped me in the realization of this work.

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Abstract :

The implementation of circular economy (CE) practices in the wine sector presents unique challenges and opportunities for sustainability. This thesis investigates the primary barriers to adopting CE principles in the wine industry and examines how overcoming these obstacles can contribute to a more sustainable industry. Drawing on a comprehensive literature review, the study identifies key theoretical frameworks and categorizes barriers into various groups. An empirical analysis is conducted through a survey targeting wine industry professionals, designed to capture their perceptions and experiences related to CE practices. The results reveal that the transition to CE in this sector is progressing compared to other industries. However, significant barriers, including lack of expertise, difficulties in accessing finance, and unclear benefits, prevent the industry from fully embracing CE. Statistical analyses highlight the most pressing issues and suggest correlations between these barriers and the industry's reluctance to fully implement CE practices.

Key words: : Circular economy, Wine industry, Barriers, Sustainability, Transition

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