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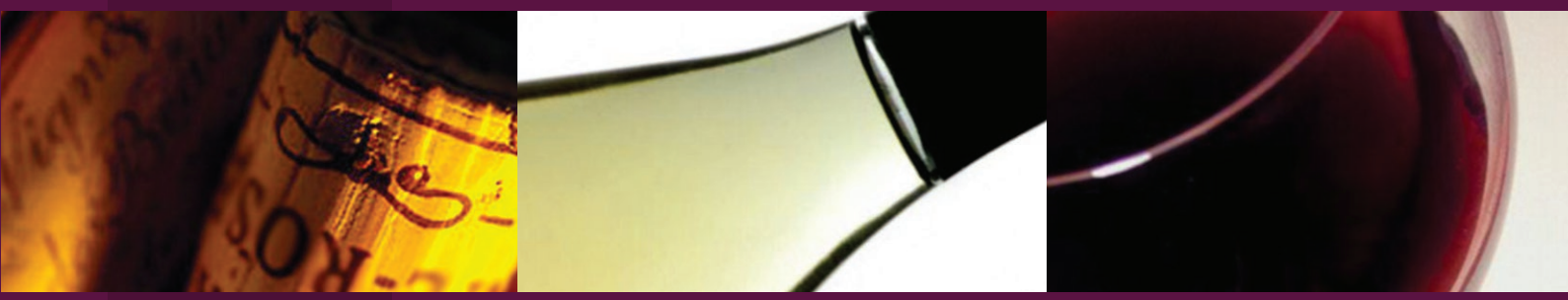

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State of the International Wine Markets in 2023. The wine market at a crossroads: Temporary or structural challenges?

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Abstract. The global wine trade experienced a decline in volume and value in 2023 due to reduced real incomes, post-pandemic overstocking, and shifting consumer preferences. Non-sparkling red wines were more affected than sparkling wines, white wines and wines in bag-in-box formats, with notable declines in non-sparkling bottled wine imports across major markets. Despite this, an exceptionally low wine harvest in 2023 prevented a global oversupply. Regionally, some countries and appellations face an imbalance where grape supply exceeds demand due to misalignment with current consumption trends. The critical question for the wine sector is whether these declines are due to temporary factors, structural changes, or a combination of both. Excessive inventories accumulated in the post-pandemic period suggest a temporary decline in trade. However, there are growing concerns about changing consumption habits, particularly among younger consumers in Europe and the US. The relative influence of these factors remains uncertain. Premium wines still enjoy demand among traditional aficionados, but there is a clear shift in consumer preferences towards more refreshing products, including white wines, sparkling wines, and low-alcohol wines. To address these challenges, the wine industry must innovate and adapt its regulatory framework to support consumer-oriented innovation and diversified portfolios. The global wine industry is at a pivotal transition point, requiring a strategic response to evolving consumer preferences to maintain its market position.

Keywords: global wine trade, wine consumption trends, industry strategies.

1. SCOPE AND OBJECTIVE OF THE DISCUSSION PAPER

The objective of this discussion paper is to bridge the gap between academic research and industry-relevant insights and trends in the global wine market. Building upon the foundational discussion by Del Rey and Loose [1], this paper offers a comprehensive analysis of the global wine trade's development in 2023, examining both volume and value across various product categories and key markets. In the second chapter, we provide an in-depth

analysis of these trends, highlighting significant shifts and emerging patterns. The third chapter delves into the underlying factors contributing to the current decline in global wine trade, exploring product trends and market polarisation. Finally, we discuss the implications of our findings and propose specific strategic recommendations for the industry to foster and sustain wine consumption across different product categories. This paper aims to provide actionable insights that can inform industry strategies.

2. WORLD WINE TRADE IN 2023

In 2023, the global wine trade experienced a notable decline. World wine exports decreased by 6.5% in volume, amounting to 98.3 million hectolitres, reflecting a loss of 12.9 million hectolitres over the past two years since the post-COVID peak in 2021 (Figure 1). In monetary terms, the trade recorded a negative growth rate of -4.6%, with total revenues falling by 1.8 billion euros to 36 billion euros from the previous year's peak of 37.8 billion euros (Figure 2). Given the significant international inflation rate of 6.8 percent in 2023 [2], the decline in real value terms was even more pronounced.

This decline in volume follows over 13 years of relative stability, contrasting with the growth observed during the first decade of the century. The unexpected decrease in trade value in 2023 disrupted a long-term premiumisation trend that had only been interrupted during the economic crises of 2009 and 2020 [1]. This cessation has raised concerns among professionals, companies, and institutions within the wine sector [3, 4]. The extent to which this decline is driven by temporary versus structural factors remains uncertain, necessitating further investigation into their respective influences. The third section of this paper will provide a detailed analysis of these factors.

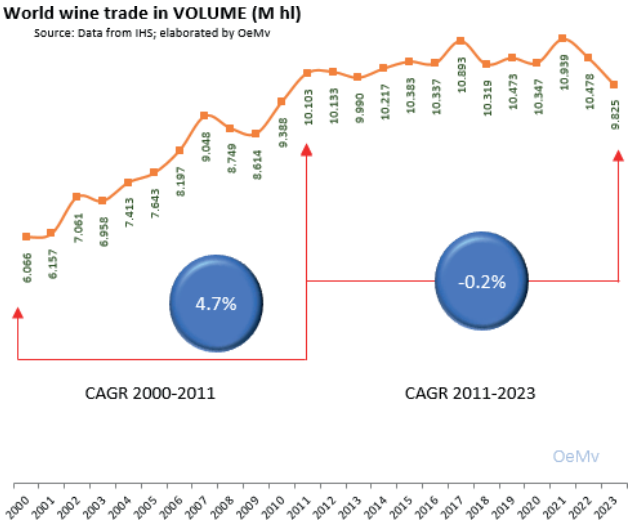

Figure 1. Development of word wine trade in volume 2000-2023, graphic based on data from [5], obtained from GTA/HIS).

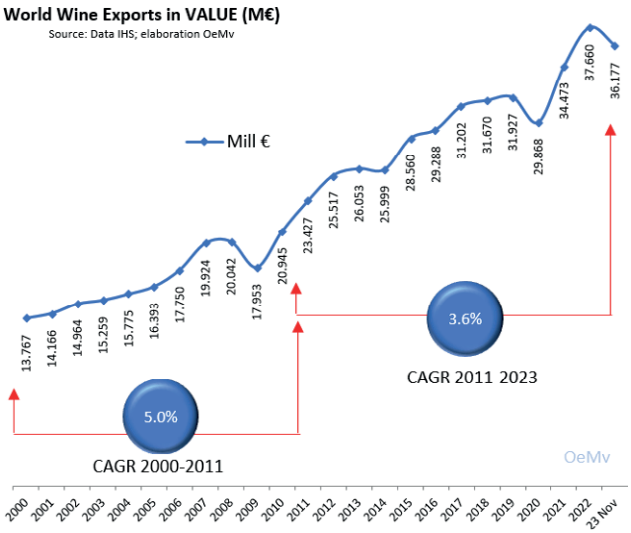

Figure 2. Development of word wine trade in value 2000-2023, graphic based on data from [5], obtained from GTA/HIS).

To gain a deeper understanding of the overall decline, an analysis of the evolution of various wine categories is essential. Subsequent sections will present the development trends of different wine categories, including sparkling wine, non-sparkling bottled wine, bag-in-box wine, and bulk wine. This categorical analysis may offer insights into the underlying causes of the observed downturn in the global wine trade.

2.1. Export of sparkling wine

Sparkling wine has been the dominant category in the global wine trade in recent years, a trend that persisted in 2023, albeit at a slower rate (Figure 3). Following the robust post-COVID recovery in 2021 and 2022, revenues from sparkling wine grew by 0.8% in 2023, reaching 8.9 billion euros, while volume declined by -4.0%, particularly in the second half of the year.

Export performance varied by origin (Figure 4). In 2023, Italian sparkling wine exports increased in value by 3.3%, whereas French and Spanish exports decreased by 1.1% and 0.9%, respectively. Notably, a substantial price increase of 10.2% for French sparkling wine led to a volume decline of 10.2%. The price elasticity for Italian sparkling wine, predominantly Prosecco (73%), was

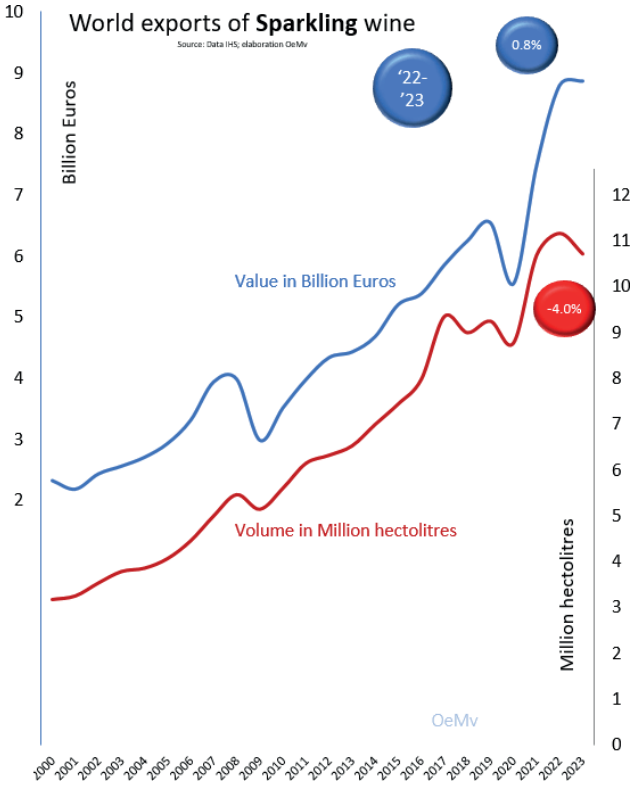

Figure 3. Global export of sparkling wine by value and volume 2000-2023, graphic based on data from [5], obtained from GTA/HIS).

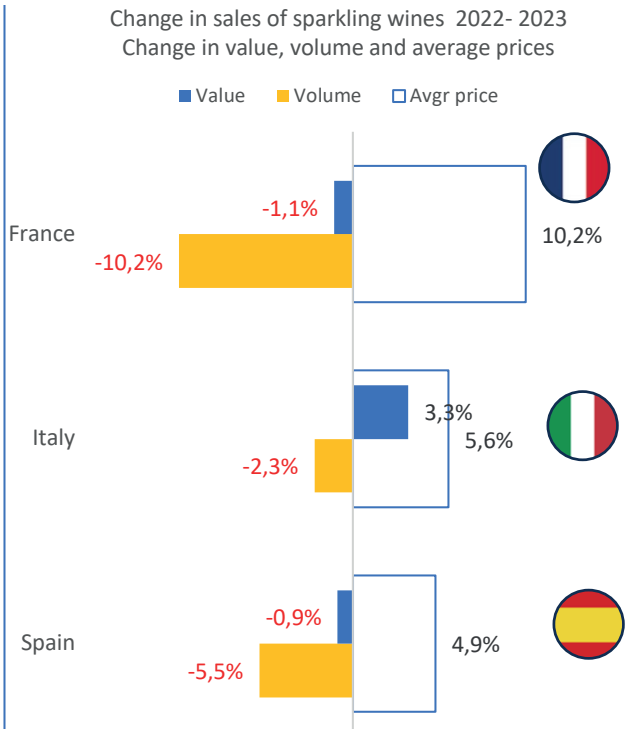

Figure 4. Sparkling wine: change in sales value, volume and average prices by country of origin, graphic based on data from [5], obtained from GTA/HIS).

weaker; a 5.6% price increase resulted in a 2.3% volume reduction. Spanish sparkling wine, mainly Cava (79%), experienced the strongest price elasticity, with a 4.9% price increase leading to a 5.5% volume loss.

Italy leads in sparkling wine exports by volume, while France, despite exporting less, commands higher prices. Champagne accounts for 91% of French export value but only 58% of the volume. Thus, although sparkling wine remains the most prominent category in the global wine trade, Italy emerges as the primary volume driver of this segment.

2.2. Non-sparkling bottled wine

The category of non-sparkling wine, encompassing still, fortified, and semi-sparkling wines, experienced a significant decline in 2023. Following a robust post-COVID recovery, the trade saw a decrease of 5.3% in value (1.4 billion euros) and 7.6% in volume (4 million hectolitres), resulting in a trade value of 24 billion euros and a volume of 51 million hectolitres (Figure 5). This marks the first interruption in the previously consistent increase in trade value, aside from the crises in 2009 and 2020.

Despite this, the trend of nominal price increases remained stable. The average value rose by 2.6% to a record 4.69 euros per litre, 12 cents above 2022 and 2 euros higher than 2009, mainly driven by rising production costs (inflation) [1]. However, the substantial volume decline led to an overall drop in trade value in 2023.

The significant decline in global exports in 2023 was primarily due to reduced imports across most markets (Figure 6). Among the top 23 import destinations, only Sweden, Singapore, Macao, and Ireland showed growth. In 19 of these markets, imports of non-sparkling bottled wines fell, with the largest declines seen in South Korea, China, Australia, India, and Canada.

2.3. Bag-in-Box wine

Wines in "bag-in-box" (BiB) represent a small but growing segment of the global wine trade, accounting for 2% of the total trade value and 3.8% of the total volume, compared to over two-thirds and 52% respectively for non-sparkling bottled wines. In 2023, BiB wine exports reached 3.7 million hectolitres, valued at 707 million euros. Despite a volume decrease of 2.4%, BiB export value grew by 0.9% due to a 3.5% increase in

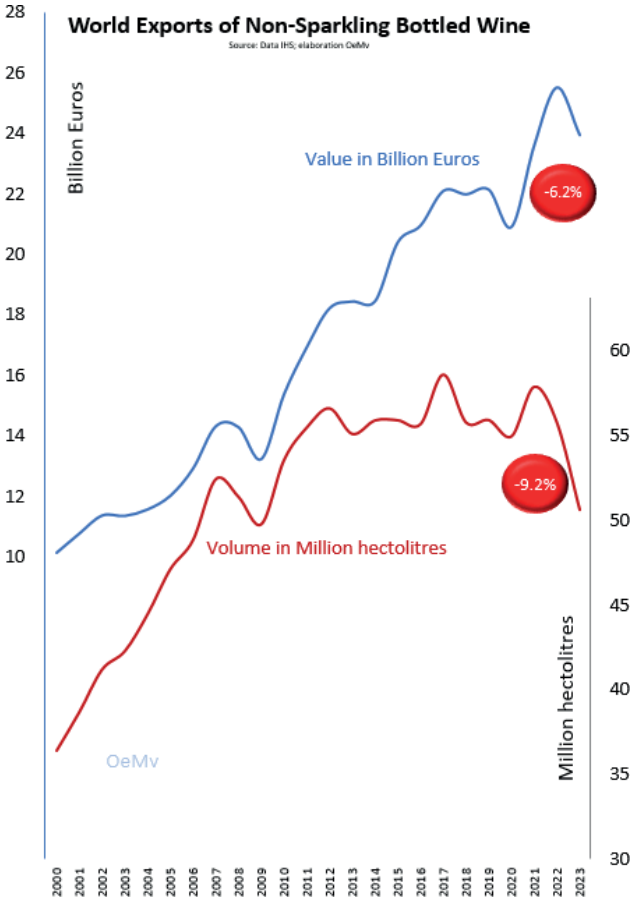

Figure 5. Global export of non-sparkling bottled wine by value and volume 2000-2023, graphic based on data from [5], obtained from GTA/HIS).

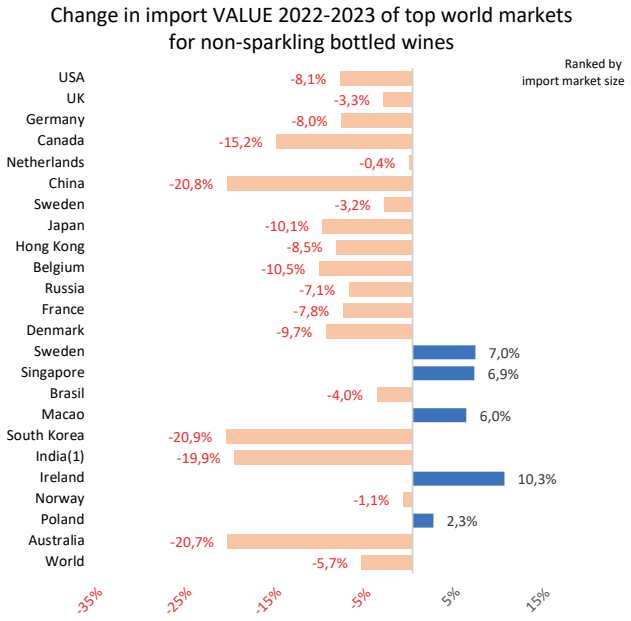

Figure 6. Change in import value of non-sparkling bottled wine 2023 vs. 2022 by import market, graphic based on data from[5], obtained from GTA/HIS). Official figures for wine imports in India indicate a striking increase of over 1,600% in 2023. However, this may be an error, and therefore, Indian imports are substituted in this graphic by declared exports of all countries to India.

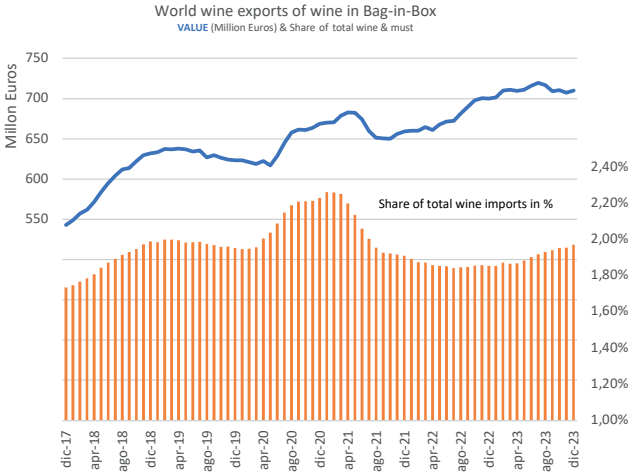

Figure 7. World wine exports of wine in Bag-in-Box, graphic based on data from [5], obtained from GTA/HIS.

average prices, reaching 1.89 €/l. Since its official recognition in 2017, BiB has first shown consistent growth in value, driven initially by increased home consumption during the pandemic, and then stabilized towards the end of 2022. Due to the decline in wine sales overall, the BiB's share increased in 2023.

BiB exports are highly concentrated, with three-quarters handled by six major exporters: France, Italy, Spain, Germany, Portugal, Denmark, and the USA. Similarly, 56% of BiB imports are concentrated in six key markets: Sweden, Norway, Germany, the United Kingdom, the Netherlands, Belgium, and Canada. Once seen as a niche for Nordic markets, BiB is expanding to other regions less focused on traditional wine consumption. Alongside trends in new packaging formats like cans and PET bottles [6], as well as shifts towards fresher and sweeter flavors and lighter wines, the evolution of BiB sales provides valuable insights into changing global wine consumption patterns.

2.4. Bulk wine

World trade of bulk wine represents roughly one-third of total wine trade by volume but only 6.6% by value, given its low average price of 0.73 euros per liter at the end of 2023. This price is significantly cheaper than

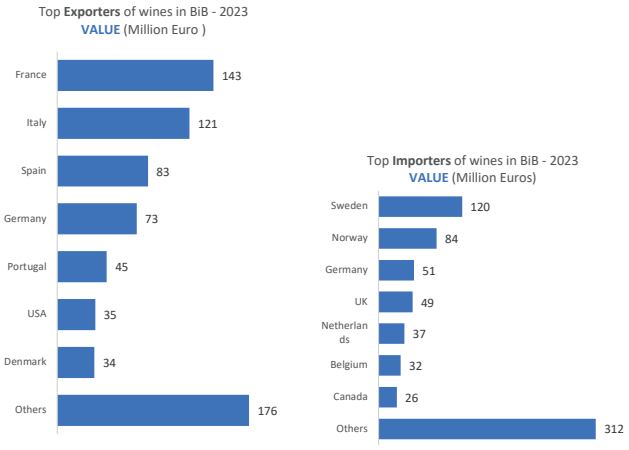

Figure 8. Top exporters and importers of wines in Bag-in-Box for 2023, graphic based on data from [5], obtained from GTA/HIS.

the average price for all wines (3.66 €/l), bottled wines (4.69 €/l), and Bag-in-Box wines (1.89 €/l).

The drivers for bulk wine trade differ from those for regular consumption. A significant portion of bulk wine trade occurs among producers to balance yearly crop variations or to replace domestic consumption in low-price segments. Countries like Italy, France, and Germany import large quantities of cheap bulk wine, especially when local production is low. These imports help supply popular domestic segments with lower-cost wine, allowing more expensive domestic production to be sold in more profitable markets abroad. The high imports of Spanish bulk wine during the low harvest in Italy or the high imports of Spanish bulk wine by French distributors are key examples of this type. This intra-producer trade, typically at low prices, depends on wine availability and crop levels, but could shift if lower-cost producers start shipping directly to final markets instead of through foreign distributors.

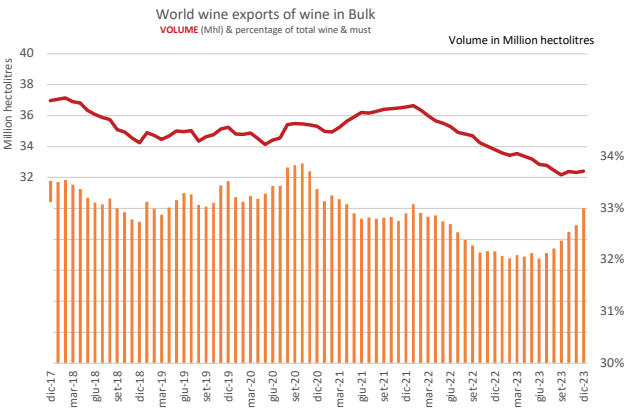

Figure 9. Development of word wine exports of bulk wine 2017-2023, graphic based on data from [5], obtained from GTA/HIS.

Conversely, there is a distinct segment of bulk wine trade characterized by different actors, higher prices, and different motivations. The reduction of transport costs over long distances and the reduction of carbon dioxide emissions are key factors here. New Zealand exemplifies this with high-quality bulk wine exports at an average price of 2.70 €/l, totaling over 1 million hectoliters. Major destinations include Australia (37%), the United Kingdom (28%), and the USA (25%), which collectively account for nearly 90% of New Zealand's bulk wine exports. Australia serves as an intermediate hub for shipments to the UK and USA. Efficient bottling facilities in the UK and USA provide competitive access to consumers and enhance sustainability.

France also exports a substantial amount of bulk wine (1.15 million hectoliters) at an average price of 1.54 €/l, more than double the world average. French bulk wine's top destinations are Germany (28%), Belgium (18%), and Switzerland (12.3%). These exports are likely driven by specific commercial relationships with local retail chains for direct distribution without further processing.

2.5. Long-term development of import markets

The long-term development of key global wine import markets was impacted variably by the 2023 downturn (Figures 7 and 8). The USA remains the most crucial import market for both sparkling and non-sparkling wines, driven by a significant increase in domestic consumption by value. However, the sharp recovery post-Covid-19 was abruptly halted in mid-2023 with a marked reduction in imports. This shift in US wine consumption could be attributed at least partially to overstocking by importers due to supply chain disruptions in 2021 and 2022 (Del Rey and Loose, 2023). The three-tier system in the US, where importers, wholesalers, and retailers maintain separate stocks, likely exacerbated this effect. McMillan [7] noted that significant stockpiles in US retail needed to be sold off before new orders could be placed. Additionally, younger US consumers are more responsive to health warnings about alcohol in the post-pandemic era and show a preference for other alcoholic beverages [7, 8]. By the final quarter of 2023, the value of US wine imports had fallen below the long-term trend, with new 2024 data needed to determine if this decline is temporary or indicative of a structural shift.

In contrast, the UK, the second-largest import market, experienced a more moderate recovery post-Covid-19 and a less severe decline in 2023. Germany, however, has shown a steady downward trend since 2021,

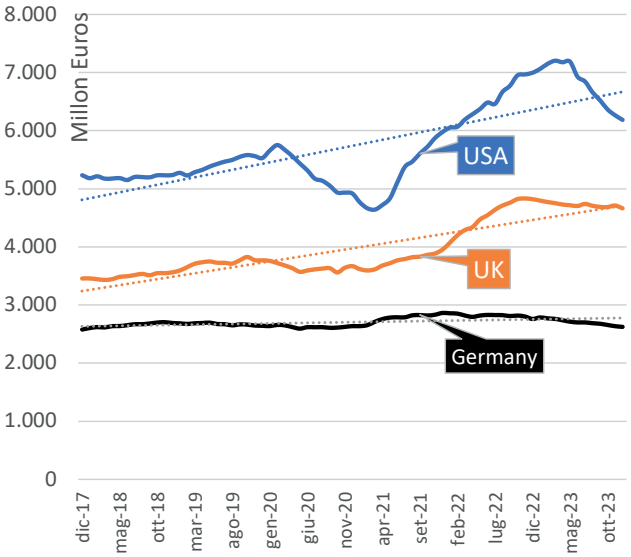

Figure 10. Top-3 import markets by import value in billion Euros – sparkling wine and non-sparkling wine, graphic based on data from [5], obtained from GTA/HIS.

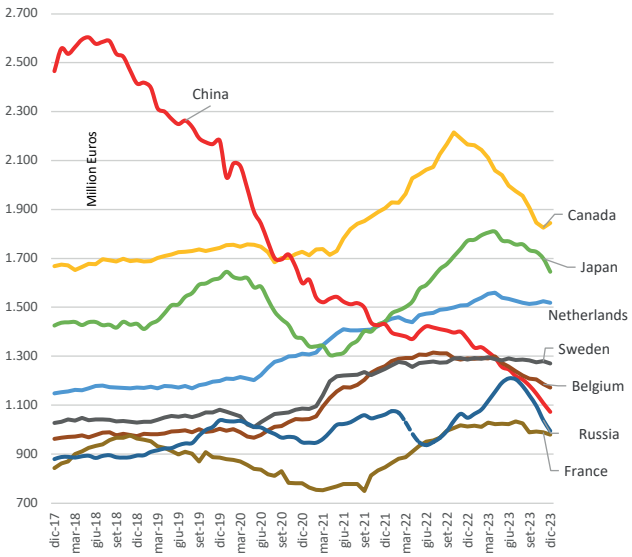

Figure 11. Other major import markets by import value in billion Euros sparkling wine and non-sparkling wine, graphic based on data from [5], obtained from GTA/HIS.

largely due to economic challenges from the Russian-Ukrainian conflict. Figure 8 highlights declines in wine imports from other major markets. Canada, Japan, Belgium, China, and Russia saw significant reductions in 2023, while the Netherlands, Sweden, and France remained more stable. In Canada, reduced real incomes due to high inflation and mortgage interest rates led to decreased discretionary spending, including on wine. The Netherlands' stability can be attributed to its strategic role as a distribution hub for Europe.

China's wine imports continued their decline throughout 2023, a trend detailed by Del Rey & Loose (2023). Since peaking in 2017 (2.5 billion euros and 7.5 million hectolitres), Chinese wine imports have decreased in both value and volume, hitting a new low of 1.4 billion euros and 5 million hectolitres—a loss of two-thirds in value and 56% in volume. Despite this, average prices increased to over 4 euros per litre last year. The decline is likely due to a combination of slower economic growth, the Covid-19 pandemic's impact, regulations on gifts to public officials, and waning interest in Western habits. A reversal of this trend appears unlikely. Following the relaxation of import restrictions on China, Australia faces a significantly altered market landscape.

2.6. Key exporters and summary

From the producers' perspective, all top 11 wine-producing countries, except Germany, saw reductions in exports in 2023. The most significant declines were in Chile (-23% in value), the USA (-20%), Argentina (-20.6%), and Australia (-13%). Less severe reductions occurred in France (-1.8%), Spain (-2.6%), New Zealand (-5%), and Portugal (-1.2%), while Italy remained almost unchanged (-0.5%). Chile's case is particularly notable, with a double-digit decrease in both value and volume (-23% and -18% respectively). Exports to its 15 most important markets all declined, with significant drops in China (-33%), the UK (-19%), the US (-29%), Japan, and Canada.

In conclusion, the global wine trade in 2023 reflects trends consistent with previous years, such as stable or gradually declining export volumes, rising average nominal prices, and better performance of sparkling wines compared to non-sparkling wines. The growth in the relative volume share of bag-in-box wines also continues. EU export data indicates white wines outperformed reds and rosés. However, 2023 also saw a decline in both export volume and value, with the increase in average prices losing momentum and even sparkling wines stabilizing. Overall, the outlook for this year is more negative, with most markets showing declines, some more severe than others.

3. CURRENT CHALLENGES AND SHIFT IN PREFERENCES

Post-pandemic, the wine sector continues to face economic challenges on the supply side, albeit to a lesser

extent. Concurrently, shifts in consumer preferences and reduced demand for wine have become evident, posing a risk of structural oversupply in the global wine market if strategic measures are not implemented.

3.1. Current challenges for the international wine sector

Each year, the ProWein business survey identifies the current challenges and threats perceived by the industry (Figure 12). Since 2022, the cost pressure on the industry has slightly declined while concerns about the profitability have increased. This is attributed to the inability to raise prices proportionally with rising costs, leading to decreased profitability. Additionally, concerns about declining wine consumption have intensified, with half of industry experts anticipating a significant impact. Lastly, supply chains have normalized following the disruptions caused by the pandemic.

3.2. Decline of World Wine Trade in 2023: Temporary or Structural Factors?

The decline in world wine trade in 2023 stems from a mix of temporary and structural factors. Understanding these is crucial for determining appropriate responses. Temporary issues, such as the uncertain global context, eroded purchasing power, and geopolitical tensions, may correct over time [9]. However, long-term trends indicate a structural decline in consumption and shifts in wine preferences. The decrease in US and Canadian wine imports in late 2023, along with stabilized UK imports and a decline in Russia, partly relate to post-pandemic overstocking and slower economic growth. If

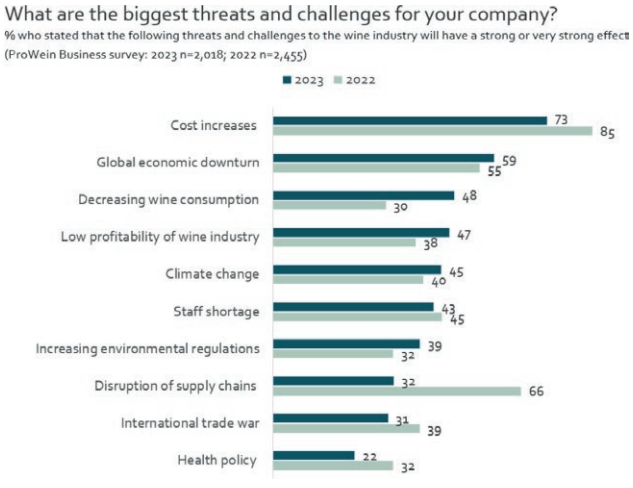

Figure 12. Threads and Challenges to the wine industry [9].

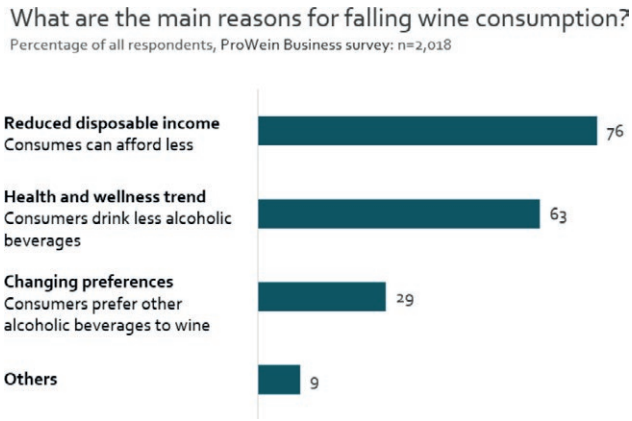

Figure 13. Reasons for falling wine consumption [9].

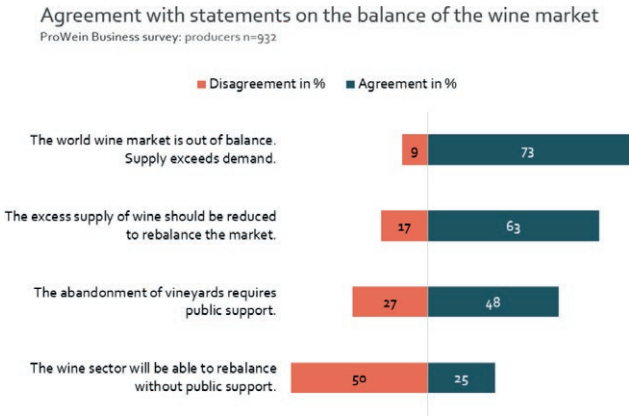

Figure 14. Producer perception of the balance of the wine market [9].

these are the main causes, companies might need to wait for new import needs to replenish inventories. In this case, measures like the EU Commission's crisis distillation and green harvest programs may suffice until economic conditions improve.

The European Wine Market Observatory [3] and industry experts [9] identify three primary factors contributing to the decline in wine consumption (Figure 13):

1. Inflation and Economic Downturn: Reduced disposable incomes have led to lower wine consumption. The impact of this factor may diminish with economic recovery.
2. Health Concerns and Societal Changes: Increased awareness of health issues has resulted in reduced alcohol consumption, expected to be a long-term trend.
3. Changing Preferences: Consumers are increasingly favouring other alcoholic beverages, such as beer and spirits, over wine.

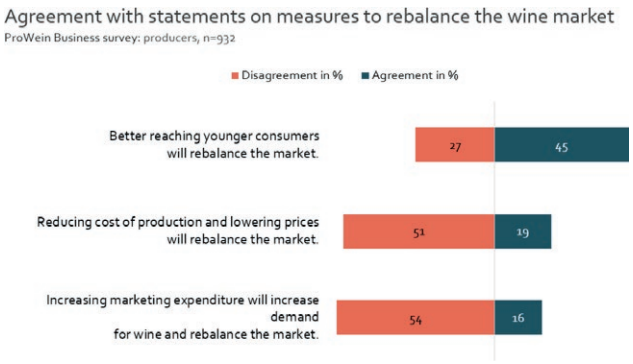

Figure 15. Measures to regain balance in the wine market [9].

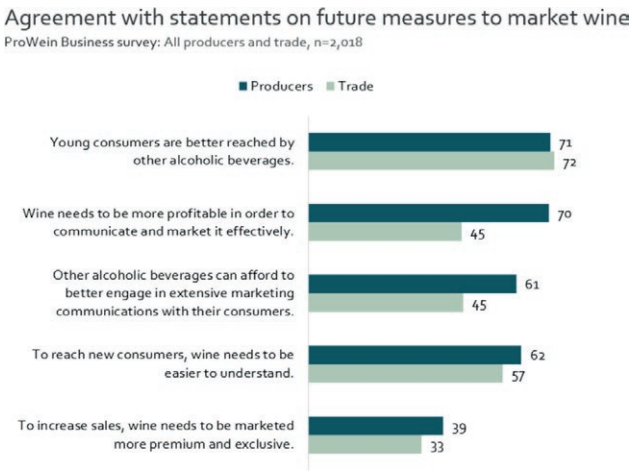

Figure 16. Producer and trade perceptions about future marketing strategies [9].

Consumer preferences are shifting towards beverages other than wine, heightening market competition. For instance, in France, beer's market share increased from 15% to 25%, while wine's share of total alcohol consumption declined from 49% to 41% between 2000 and 2022 [10]. Industry experts acknowledge the success of other alcoholic beverages in attracting young consumers with innovative offerings (Figures 15 and 16). While the total volume of pure alcohol consumed is declining in many countries, wine is losing disproportionately to beer and spirits. In this context of intensified competition, the pricing and substantial marketing investments by the beverage industry place wine at a competitive disadvantage (Figure 16).

3.3. How to restore the long-term market balance?

The decline in international wine consumption has been mitigated by a record low wine harvest of 237 million hectolitres in 2023, a 25 million hectolitre (9.6%) decrease from 2022 (OIV, 2024). This coincidence between reduced demand and supply prevented global oversupply, which would have led to sharp price declines for grapes and wines. However, industry experts warn of the risk of structural oversupply, with 73% of wine producers perceiving an imbalance in the market, where supply exceeds demand [9].

To restore market balance, the sector suggests reducing supply. Some industry experts advocate for public support to abandon vineyards for products with falling demand, such as red wine. Reductions in vineyards for traditional red wine production are already happening in Bordeaux, Australia, and California [11].

The wine industry has yet to fully recognize the necessity and potential of enhanced marketing strategies, especially those targeting younger consumers (Figure 15). Additionally, reducing production costs has not yet been seen as a significant opportunity by wine producers.

3.4. Future marketing of wine

In addition to reducing vineyards, companies may need to adapt their portfolios to better align with new consumer preferences, potentially requiring institutional support. Wine must become more accessible and attractive to consumers by closely following demand trends and identifying key elements appreciated by new consumers, such as freshness and sweetness. Simultaneously, there is potential for premium and exclusive marketing strategies targeting wealthy aficionados who enjoy famous traditional wines. The industry recognizes the need to better reach young consumers, who are more likely to be influenced by other alcoholic beverages (Figure 16).

3.5. Product trends

There is a clear trend towards more refreshing products, including white and sparkling wines. The performance of low- and no-alcohol wines is also expected to improve, albeit from a low absolute base [12]. Conversely, traditional red wines are anticipated to decline further in popularity (Figure 17). However, market data indicate a differentiation within red wines into two distinct categories: traditional red wines and fruity, strong red wines with residual sugar. Orange and natural wines remain limited to a niche market. Finally, wine-mix beverages are expected to experience a modest increase in popularity.

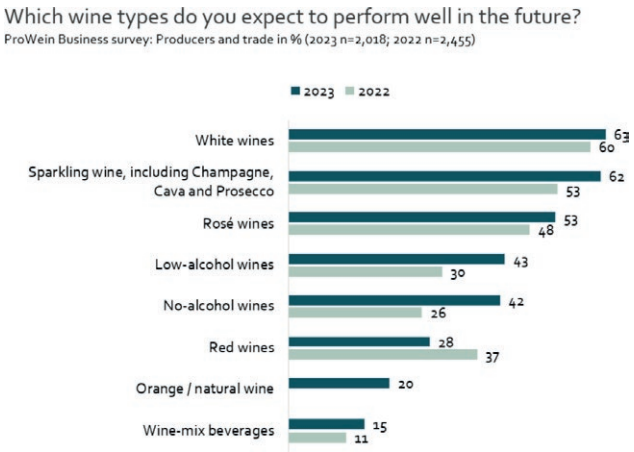

Figure 17. Expected development of product categories [9].

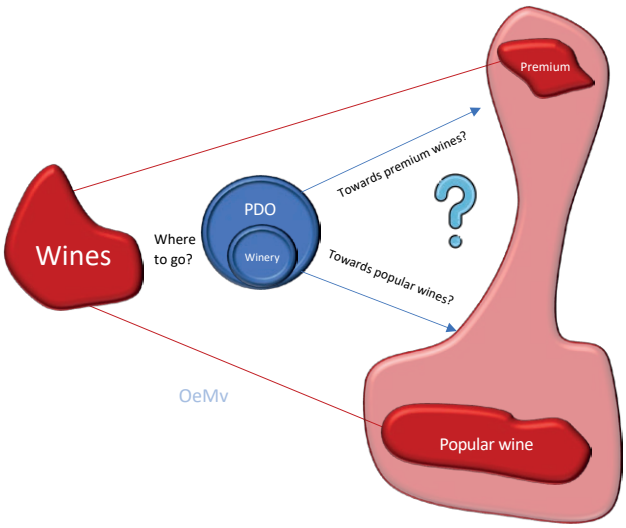

Figure 18. Polarisation of wines [5].

4. WHAT CAN WE DO ABOUT IT? – STRATEGIC INDUSTRY RESPONSE

This article has demonstrated a moderate negative trend in world wine trade in 2023, impacting most producers, markets, and wine categories, particularly in volume but also in value. Exceptions include the better performance of sparkling and white wines as well as bag-in-box wines over red wines. As discussed in Chapter 3, the key question for the wine industry is whether this decline is a short-term downturn or part of a longer-term trend linked to a decrease in global wine consumption and potential image issues. Correctly assessing these phenomena and developing effective strategies will be crucial for the survival of firms and regions in the wine industry.

Assuming the polarization hypothesis by Del Rey & Loose (2023) is accurate, there is potential growth for both super-premium wines and popular, fresh wines. The challenge lies with traditional wines, primarily reds from traditional regions, which are becoming less appreciated by high-level aficionados and cannot easily be converted into fresh, inexpensive, mostly white and sweeter wines. Without stable or growing consumption, these traditional wines may need publicly-supported distillation and grubbing-up schemes.

This situation is a significant concern for private professionals, firms, regional and national institutions, and particularly EU Commission officials [3], who must define new public policies. Whether this issue is temporary or indicative of a long-term trend will determine the necessary policy measures.

Based on the current analysis of the wine sector, three key strategies can be pursued. The advantage is that these strategies are complementary and can be implemented together, depending on the grower, company, region, or country involved. These strategies are:

1. Fostering traditional consumption of more traditional wines.
2. Enhancing and promoting new types of wines and their communication to appeal to new consumers.
3. Reinventing the wine product to attract consumers who are further removed from traditional wines.

Efforts in all three areas can help reverse declining consumption and attract new consumers. These approaches are not mutually exclusive. The crucial point is to acknowledge the increasing diversity of consumers in the wine industry and to understand and engage with these consumers better for long-term survival.

4.1. Fostering traditional consumption

The wine industry should not concede that wine is becoming unfashionable. While wine consumption may be changing or declining, there is potential for a revival. This potential exists among classic aficionados who enjoy super-premium wines from traditional, often expensive regions, as well as traditional consumers of more popular wines that accompany regular meals.

However, there is increasing concern, particularly in the USA but also in Europe, about the health effects of regular wine consumption as part of the broader negative perception of alcohol. Despite this, scientific evidence supports the beneficial effects of moderate wine consumption for cardiovascular health. Wine has been compatible with a healthy lifestyle for thousands of years. Yet, there is pressure against wine due to its alco-

hol content and campaigns highlighting potential cancer risks [13]. This has particularly influenced new generations, who may oppose alcohol consumption entirely or opt to reduce their intake.

Health concerns, especially post-COVID, are a major driver of consumption patterns worldwide. Alongside health, environmental sustainability is a crucial factor. Wine, more than any other beverage, is deeply connected to the land and rural societies. This connection, while true, requires more effective communication to highlight its environmental, social, and economic benefits, especially in rural areas. Other industries, such as McDonald's with its "big good" campaign, effectively use their connection to the land in their marketing efforts.

Increasing global wine consumption, including traditional wines, is feasible. While health benefits may not be the primary argument, sustainability can be a compelling factor. A concerted effort is needed to highlight the strong connection between wine consumption and the rural environment.

4.2. Promoting new types of wine – adapting regulation

Recent trends in international wine trade indicate a preference for whites over reds, sparkling over non-sparkling, and fresher, lighter, sweeter wines over traditional varieties. To meet this growing demand, it makes sense to shift some supply accordingly. Many companies have been doing this for years, though with some resistance from traditional producers.

The wine industry often exhibits a conservative bias, particularly in regions with stringent regulations, such as Europe. These regulations include limitations on closures, container types, labelling, grape varieties, and wine styles. Most European wine production occurs under "protected designation of origin" (PDO) or "protected geographical indication" (PGI). Particularly detailed production regulations for PDO wines are difficult to change and require consensus among growers, producers, and distributors, who may not all be aligned with recent market trends.

This rigid regulatory system can hinder the adaptation of wines to new consumer trends. However, companies are responding by diversifying their portfolios. Wine producers, even small family-owned firms, are compelled by the market to manage a variety of brands and wine categories. For medium to large producers, managing a diverse portfolio is crucial for success. If market demands are diverse, the supply must diversify as well. Companies may balance producing wines under protected indications for certain markets with other wines for different segments.

Figure 19. Innovative product trends [5].

The key issue is whether consumers and distributors will continue to prioritize origin over price or other factors. Maintaining traditional wine-making practices and regional identities can be reasonable and beneficial. Consistency and recognized quality linked to collective names often drive success. However, flexibility is also necessary in regions without such protections, where stakeholders wish to adapt to new trends.

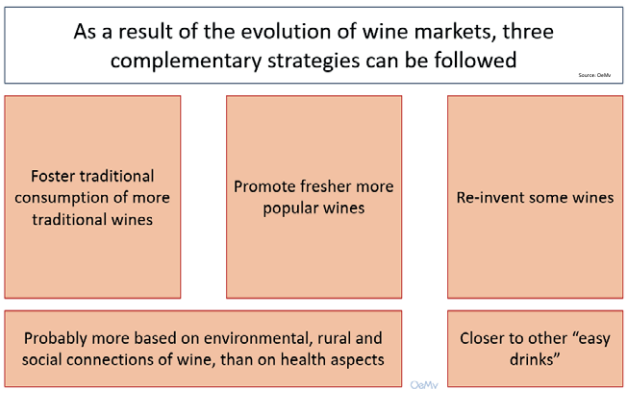

Figure 20. Future strategies [5].

Wine companies often include wines from both traditional and flexible regions in their portfolios, adapting quickly to market changes. The challenge lies with the regions themselves: should they adapt or remain consistent with their traditions?

Recognizing that global wine consumers may have different preferences is essential for producers to follow new consumption trends. This understanding necessitates changes in regulatory systems and company practices to produce wines that better meet diverse consumer preferences. Successful distributors adapting to new demands provide valuable examples for the industry to follow.

5. CONCLUSION

The global wine market is characterized by diverse consumer segments and varying consumption patterns. While some negative trends are evident, such as declining sales of traditional red wines from established regions, there are positive trends in premium and super-premium wines, fresher and lighter wines, and innovations in cocktails, containers, labels and closures. There is also growing interest in no- and low-alcohol wines.

Demographic shifts are influencing wine consumption, with declining sales among traditional consumers but increasing interest in regions like Latin America and Africa. To address these changes, two primary strategies are essential: (i) fostering traditional wine consumption, leveraging the connection to rural heritage rather than health benefits, and (ii) promoting and facilitating wines that align with new consumer trends. A third strategy (iii) involves the radical reinvention of wine products, including wine-based drinks and cocktails, which could become significant market segments.

The main questions concern the relative size and future evolution of these three segments. Traditional wines, including premium and non-premium, currently dominate the market. Modern, fresher wines are growing but still represent a smaller segment, while new wine-based drinks are emerging and could expand rapidly. It is crucial for growers, companies, regions, and institutions to monitor these transformations closely to maintain a profitable and sustainable wine industry. Flexibility and regulatory freedom, including the acceptance of partially fermented must as a new product, are vital for the industry's relevance. If the industry does not finally start to look at the problem from the consumer perspective, it will not stay relevant for consumers.

The cessation of the long-term premiumisation trend has raised concerns about whether the decline is due to temporary or structural factors. Future data on the wine trade in 2024 will be crucial to understanding these dynamics. Monitoring market trends is more important than ever to enhance future wine sales and sustain the industry's growth.

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Wine law, sustainable innovation and the emergence of a wine constitution

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Abstract. Innovation is essential for addressing the current challenges of the wine sector and ensuring its sustainable future. Law plays a pivotal role in fostering and disseminating innovation. At the same time, innovations can present legislators with significant challenges and cause legal disruption. This paper evaluates the innovativeness of European Wine Law in light of the ongoing sustainability transformation. The focus of EU regulations is wine quality and authenticity, mainly through the protection of Geographical Indications (GIs). In Regulation (EU) 2021/2117, the EU legislator recently introduced new rules on fungus-resistant grape varieties, de-alcoholised products, and digital labelling. We describe the effects of these rules on the respective innovation systems and assess how, vice versa, these innovations exert disruptive pressure on wine law. While the legal framework shows remarkable flexibility, a reconfiguration seems necessary at the level of GIs. The sustainability transformation implies an openness to innovation even for traditional producers. Regulatory Sandboxes in GI product specifications could allow for more experimentation without compromising heritage. A wine constitution could guide the transformation towards a more resilient and sustainable wine system.

Keywords: wine regulation, innovation systems, fungus-resistant grape varieties, de-alcoholised wines, digital labelling.

1. INTRODUCTION

«Se vogliamo che tutto rimanga com'è, bisogna che tutto cambi» (Everything must change, so that everything stays the same) - Giuseppe Tomasi di Lampedusa, Il Gattopardo, 1958

Innovating is essential for the sustainability of the European Wine Sector. New technologies and practices can help with current challenges of climate change, disease pressure and shifting demand. They are also critical to minimize the environmental and health impact of wine production and consumption in the context of the ongoing transformation of food systems

[1]. European Wine Law is an essential factor for turning terroir into economic value. It is also critical for the development and diffusion of innovation, especially in "mission-oriented" innovation systems characterized by strong directionality and high urgency [2], [3]. At the same time, innovation can present legislators with significant challenges and might even require a "reinvention" of the existing legal framework [4]. In this contribution, we seek to assess the effect of European Wine law on innovation system development as well as its adaptive capacity in light of the sector's current challenges.

The European Union is the most significant wine-producing region in the world. It is also the most regulated wine market [5]. EU wine law, i.e., the current Common Market Organization (CMO) Regulation (EU) 1308/2013 and its various delegated and implementing acts, mainly focus on wine quality and fraud prevention, especially with regard to Geographical Indications (GIs) [6]. GIs are seen as central to creating economic value and distributing it fairly by enabling the build-up of collective reputation [7]. GIs may benefit public interests such as rural development or environmental sustainability, although such a contribution is not automatic [8], [9], [10]. The EU promotes the GI system worldwide through bilateral and multilateral agreements [11]. Through its case law, the European Court of Justice has accorded GIs a very high level of protection [12].

EU regulations also cover aspects such as mandatory schemes of authorizations for vine plantings, national vineyard registers, accompanying documents and certification for all wine transport and grape must in the EU, inward and outward registers, compulsory stock, and harvest declarations (cf. Reg. (EU) 2018/273), as well as an EU-wide isotopic database for authenticity control (cf. Implementing Reg. (EU) 2021/1007). The Delegated Regulation (EU) 2019/934 specifies ingredients, additives, enrichment, and specific oenological practices. All of these regulations into a complex international legal architecture. The CMO aligns with the International Organisation of Vine and Wine (OIV) standards. Concrete rules on names, controls, etc., are set out in national or sub-national laws.

In addition, the production of grapes and wine is also subject to general agriculture and food regulations. This includes sectoral interventions in the framework of national strategic plans of the new Common Agricultural Policy (CAP), which strongly focuses on innovation and sustainability. The CAP Strategic Plan Regulation (EU) 2021/2115 contains various related general (Art. 5 lit a and b) and specific objectives (Art 6 (1) lit b, d, e, f, i), as well as the cross-cutting objective of « *fostering and sharing of knowledge, innovation and digitalisation in agriculture* ». For the wine sector, Art. 57 and 58 offer a selection of specific objectives and related interventions, including, for example, varietal conversions related to climate change (lit. a i) or tangible and intangible investments in innovation of various kinds (lit. e).

2. ASSESSING THE INNOVATIVENESS OF EUROPEAN WINE LAW

Innovation, according to Schumpeter's classic definition, can be described as a new *combination* of resources or institutions [13]. In that sense, many processes are ongoing in the wine sector ranging from viticulture (e.g. breeding, pest control, precision viticulture) and oenology (e.g. sulphur alternatives, new yeast strains, CO_2-recuperation) to marketing (e.g. blockchain, digital marketing) and wine tourism. These innovations simultaneously affect and are affected by the regulatory system.

In recent years, innovation research and policy increasingly look at how innovation contributes to solving environmental and societal challenges [2]. The goal is to achieve "better" innovation [14]. The innovativeness of wine law, therefore, must be considered in light of the transformation towards sustainable food systems, as proclaimed by political and scientific actors in high-level fora and strategic documents, such as the 2021 UN Food Systems Summit and the EU's Farm-to-Fork-Strategy. The food system approach calls for a holistic consideration of environmental and social aspects, including effects on climate, biodiversity, public health, and working conditions; it also implies a meaningful involvement of all stakeholders [1].

Starting from Schumpeter [13], evolutionary economics has described the complexity and non-linearity of innovation processes, characterized by a co-evolution of knowledge, organizational structures and institutions. To analyse the impact of regulation on this process, one must adopt a systemic perspective that captures both direct and indirect influences.

An intuitive and pragmatic heuristic tool of analysis is provided by the Technological Innovation Systems (TIS)-framework [15]. The TIS-framework is connected to other analytic frameworks on sustainability transformations, such as the Multi-Level Perspective or Strategic Niche Management [16] and has been applied in a range of sectors, including innovations related to food systems. At its core, the TIS-framework proposes a systematic analysis of the "functional dynamics" of an innovation system, i.e., seven processes that are seen as essential for the system's performance: Knowledge Development and

Diffusion, Guidance of Search, Entrepreneurial Experimentation, Market Formation, Resource Mobilization, Legitimation and Development of Positive Externalities. In this contribution, we employ the TIS-framework to analyse the effects of the European wine law on the functionality of the innovation system.

In the following, we employ the TIS-framework to assess the impact of European Wine Law on three innovations that have been subject to recent legislative intervention in Regulation (EU) 2021/2117 [17]: Fungus-resistant grape varieties; (partially) de-alcoholised wines; and digital labelling. These innovations cover the diverse areas of viticulture, oenology and marketing and exemplify various dimensions of the food system transformation.

2.1. Fungus resistant grape varieties

Fungal diseases are responsible for high economic losses as well as costs and environmental implications of disease control [18]. The advancement of climate change may increase the relevance of fungal diseases even further. Although reduced precipitation can reduce disease pressure in some regions, increasing temperatures at the beginning of the year counteract the expected benefits of declining rainfall, creating a more welcoming environment for diseases to spread [19].

Fungus Resistant Grape Varieties (FGRV) result from interspecific crossbreeding between Mediterranean, American and Asian species, with the latter being more resistant to fungal diseases [20]. The first-generation FGRV stemming from efforts in the late 19th and early 20th century resulted from direct crossbreeding. They were usually deemed inferior due to unwanted organoleptic qualities [21]. In the following decades, successful reverse crossbreeding led to tolerant varieties, such as Regent, carrying a significant part of Vitis Vinifera genetics. Numerous fungus-resistant varieties have been admitted into the official European varieties catalogue [22], containing up to 99% *Vitis Vinifera* genome [23]. FGRV could help achieve a more sustainable and resilient wine industry [24], [25]. Wine is one of the most plant-protection-intensive products, especially regarding fungicides [26]. Pesticide reduction is a key objective of the Farm-to-Fork Strategy. Literature suggests that many consumers increasingly ask for sustainable products [27], [28]. At the same time, FGRV, are yet to be showcased widely to consumers [21] who might therefore have reservations about wines made from FGRV, that need to be alleviated through better education on the topic [20], [29].

Whilst using FGRV for wine production was already legal, their use for GIs has only been allowed by Regulation (EU) 2021/2117. This regulation explicitly acknowledges the potential sustainability benefits of crossbred *Vitis vinifera* species as they are better suited to climatic changes and more disease resistant (see recital 28 of Reg.). It amends Art. 93 of the Common Market Organization by broadening the term "designation of origin" and "geographical indication" to include crossbred *Vitis* varieties. The regulation, however, does not automatically allow producers to use GIs for wines made from FGRV. It must be specifically allowed in the respective GI product specification drafted by each producer organisation (i.e. *consorzio*, *interprofession*, *Schutzgemeinschaft*, etc.).

Allowing GIs for FGRV wines can positively affect the functionality of the innovation system. Most importantly, it can contribute to legitimate FGRV in the eyes of all stakeholders, laying the ground for market formation. National regulators can provide additional support, for example, by mobilizing specific resources or strengthening knowledge diffusion. However, all these effects require, that producer groups actually open the rules of their GI. In practice, some producer groups are still hesitant to allow (significant amounts of) FGRV or exclude them from the highest traditional quality terms, although FGRV do not necessarily alter the product identity [30]. Table 1 summarizes the effects on the innovation system for FGRV.

2.2. De-alcoholised wines

De-alcoholisation methods have existed for more than 100 years [31]. The demand for (partially) de-alcoholised wines has recently increased [32]. The new interest in the market has several reasons, e.g., religion or health [31]. Several techniques exist to reduce/remove the alcohol from wine. As de-alcoholisation is a rather complex and technology-intensive process, some new business models are evolving (e.g. groups of small producers creating joint de-alcoholised products).

Reg. (EU) 2021/2117, for the first time, contains rules for de-alcoholised wine products at the EU level. Recital 40 explicitly acknowledges the increasing consumer demand for innovative grapevine products with lower actual alcoholic strength than the minimum alcoholic strength set out for grapevine products in the CMO. To fulfil the requirements of the regulation, as a first step, an unfortified winegrowing product as defined by the CMO (e.g., wine or sparkling wine) must be produced, which is then de-alcoholised. Annex VIII, Part I, Sec. E of the CMO allows partial vacuum evaporation, membrane techniques and distillation to reduce part or almost all of the ethanol content in grapevine products.

Table 1. Impact of wine regulations on the innovation system for FGRV.

Function	Regulatory Impact
Knowledge Diffusion (KD)	Some transparency on FGRV use through the official eAmbrosia database of GI specifications (however, it is not very user-friendly!). Some national projects to increase transparency on FGRV use (cf. the French Observatoire national du déploiement des cépages resistants).
Guidance of Search (GS)	Strong "extemal" guidance through increased restrictions on pesticide use. Some guidance towards FGRV through national legislation.
Entrepreneurial Experimentation (EE)	The possibility of experimenting within GIs depends on individual product specifications. New marketing efforts specifically focusing on FGRV.
Market Formation (MF)	Integration in some famous GIs increases the market relevance of FGRV. Significant improvement of the market for breeders (FGRV are currently out of stock at many breeders).
Resource Mobilization (RIM)	More resources through integration into cuvées and sparkling wines. Access to specific subsidies.
Legitimation (LEG)	Lighthouse GIs (e.g. Champagne) increase legitimation with producers and consumers. Alignment with green values and the sustainability transformation of food systems. Corresponds to increasing desire for variety in the wine sector.
Development of Positive Externalities (PE)	Better environmental performance. Opening up the GI system to such innovations.

Table 2. Impact of wine regulation on the innovation system for de-alcoholised wines.

Function	Regulatory Impact
Knowledge Diffusion (KD)	Transparency through eAmbrosia (see above).
Guidance of Search (GS)	Some "extemal" guidance towards de-alcoholized products through stricter alcohol regulations [e.g., waning signs in Ireland].
Entrepreneurial Experimentation (EE)	Technological restrictions (only technology-intensive processes are allowed, and no chaptalization is allowed for de-alcoholized wines, creating problems for producers who usually apply this technique). GIs are only available for partially dealcoholized products and only if expressly pennitted.
Market Formation (MF)	Better access to younger customers, who drink less alcohol, and new customers, e.g., Middle East (but without GI!). GI restriction prevents development of a premium market for dealcoholized products.
Resource Mobilization (RIM)	Potentially better access to subsidies. Permitted de-alcoholization techniques are relatively expensive and know-how intensive. Not feasible for most producers.
Legitimation (LEG)	Explicit legal framing and integration into GIs can raise legitimation of dealcoholized wines with producers and consumers. In line with ongoing political ambition to "tum down the alcohol flow" (WHO). Sustainability issues (energy-intensive).
Development of Positive Externalities (PE)	De-alcoholization strongly linked with broader food imnovation, recuperation [46]. Opening up the GI system to nnovation and replacement products (replacement products are becoming more relevant in other areas too, e.g., vegan); however, restrictions remain, e.g., for fully de-alcoholized products.

The de-alcoholisation processes used shall not result in organoleptic defects of the grapevine product. Also, eliminating ethanol in grapevine products shall not be done in conjunction with enrichment. Unlike alcohol-reduced beer, (partially) de-alcoholised wine cannot be produced by prematurely stopping alcoholic fermentation or using yeast strains that synthesize less alcohol. The use of GIs is only authorized for partially de-alcoholised wines and only if the product specification contains a description of the specific oenological practices to be used for de-alcoholisation.

From an innovation systems perspective, the new regulation has mixed effects. Whilst it may contribute to *legitimizing* de-alcoholised wines in member states, where they did not exist before, the various restrictions limit further technological innovation, market formation and resource mobilization. The incomplete permission to use GIs will probably drive producers away from the GI system, instead of incentivising highly visible frontrunners to explore opportunities in this market (for example de-alcoholised champagne). In some countries, e.g., Germany, the new regulation even presents new restrictions compared to the previous status quo, which had tolerated de-alcoholised wines as long as the general Food Information Regulation (EU) No 1169/2011 requirements were fulfilled.

2.3. Digital labelling

Digital labelling refers to the use of digital technologies (e.g. QR codes) to display food labels on user devices [33]. Digital labelling may bring several improvements compared to conventional labelling practices. It allows for the display of precise information in several

Table 3. Impact of wine regulation on the innovation system for digital labelling.

Function	Regulatory Impact
Knowledge Diffusion (RD)	Already established for prepacked food (cf. Regulation (EU) No 1169/2011). It could allow for tracking and statistics.
Guidance of Search (GS)	The regulation strongly incentivises the use of digital labels for nutrition and content.
Entrepreneurial Experimentation (EE)	Only mandatory information may be shown.
Market Formation (IMF)	Only minor changes to existing labelling. Easy to update and display different languages possible. Uncertainty remains regarding the exact content labelling requirements.
Resource Mobilization (RM)	Some costs for a subscription to a digital label provider (like U-Label). Easier to use a digital label than putting all infonnation on the bottle to keep the label simple and not change much on the bottle label.
Legitimation (LEG)	Potentially high legitimation with producers (compared to altematives). Provides few obstacles and some benefits. Potentially high legitimation with consumers. Those interested in the information can access it quickly, and those uninterested need not check for it. Transparency is in line with the general values of the food system. However, the digital label is mainly perceived as a tool for obfuscation rather than transparency.
Development of Positive Externalities (PE)	Potential to align with requirements regarding sustainability information and the green claims regulation.

languages. Information can be easily modified so that products do not have to be destroyed when mislabelled. Combining physical and digital information might also allow for a more immersive and informed consumer experience that integrates ongoing initiatives in digitalising wine marketing and wine trade, although certain questions remain [33]. An example of digital labels is the "U-Label" proposed by the European wine industry's main representative body, the Comité Européen des Entreprises Vins (CEEV), which provides a technological platform for establishing digital labels in the wine and spirits sector.

Until 2023, an ingredient list and a nutrition declaration were not mandatory for wine under EU food law (Art. 16 IV of the Food Information Regulation (EU) No 1169/2011). However, from December 2023, because of the changes in the CMO under Regulation (EU) 2021/2117, wine labels must include a nutrition declaration and a list of ingredients (see Rec. 80). Details are spelled out in Commission Delegated Regulation (EU) 2023/1606, in particular the use of the terms "grapes" and "concentrated grape must" in the ingredient list. At the same time, Art. 119 II of the reformed CMO Regulation now offers wine producers the unique opportunity to limit the nutrition declaration and omit the list of ingredients on the label if this information is available electronically. Restrictions apply, however, most notably that only mandatory particulars may be linked through the QR code. In November 2023, the European Commission issued Commission notice C/2023/1190 to clarify implementation details, some of which are still subject to debate. For example, the CEEV has criticized the Commission's position on how to inform about the content of the QR-Code on the label [34].

The reformed wine law provides the first use case for digital labels in all of EU food law. It sets a strong incentive for producers to use digital labels, but also legitimizes them amongst consumers, who – for the first time – receive information on nutrition values and ingredients of wine. Positive effects on the functionality of the innovation system would be even greater, if the use of digital labels was permitted beyond mandatory information, for example to back up sustainability claims.

3. DYNAMIC PERSPECTIVE: ADAPTATION AND LEGAL DISRUPTION

Our analysis shows that the dense framework of EU wine law poses several obstacles to innovation, especially with regard to the "entrepreneurial experimentation" and "market formation" functions. At the same time, we also find positive impacts on innovation system performance, particularly for the "legitimation" function: regulatory endorsement of innovations like FGRV or de-alcoholised wine on all levels from OIV to GIs can contribute to consumer and producer acceptance. This, in turn, positively affects "market formation" and "resource mobilization." The "guidance of search" function, which could in principle be a key channel for regulatory impact, seems relatively unaffected by wine law *stricto sensu*.

In a dynamic perspective, wine regulation shows a relatively high adaptiveness to change, as witnessed by frequent legislative changes and quick reactions to new developments. EU and national wine regulations already contain several experimental clauses, e.g., oenological practices. The adaptive capacity of wine regulation is particularly noticeable compared to other agri-food regulations, such as the novel food or organic regulations or the CMO's marketing standards (cf. the ECJ decision C-422/16 TofuTown that forbids the use of any milk-

related terms for vegan alternatives). By contrast, wine law actively facilitates products that could be considered more sustainable (FGRV) or "healthy" (de-alcoholised wine).

A key factor for this adaptiveness probably lies in the wine sector's integrated yet inclusive governance architecture. GIs provide for bottom-up decision-making and play an essential role in producer organizations, extending to various intermediate organizations [35]. At the international level, the OIV achieves a high level of representation of actors from the private sector, science and even civil society. Most stakeholders appear to be interested in creating a system that works for the benefit of both producers and consumers. Some existential cleavages (e.g., between large and small producers or producer and consumer countries) are less pronounced than in many commodity sectors (e.g., the polarized International Cocoa Organization ICCO). The mandate of the OIV explicitly includes promoting scientific and technical research, making it a functional part of a global Knowledge and Innovation System.

Despite this adaptiveness, we see some potential for legal disruption in the medium term, especially with regard to the GI system. The innovations discussed in this contribution may currently not be very significant on the market. However, they relate to key aspects of the food system transformation that will become increasingly relevant in the future. The restrictions for using GIs for FGRV or de-alcoholised products already lead to evasion strategies by market actors. For example, the German association "*Zukunftsweine*" focusses its marketing exclusively on using FGRV regardless of the geographical origin. Similarly, many producers of de-alcoholised wines do not follow the origin-related quality pyramid envisioned by EU regulation. Especially for sparkling wines, as the most critical market segment of de-alcoholised products, brands provide a way to circumvent GI restrictions.

This evasion weakens the power of GIs for consumer orientation and, hence, the effectiveness and relevance of wine law altogether. The erosive effect will become increasingly pronounced as innovative producers specifically target the next generation of wine consumers. Building a regulatory cage may also cause some of the most innovative producers to leave the GI system. Parallels might be drawn to the so-called Super-Tuscans of the 1980s [36] or the disenchantment of some of the most progressive actors with the organic framework [37].

The case of FGRV wines also points to the legally disruptive effect of climate change [38]. Climate change will drastically affect most of the current wine production areas. Some of the most famous areas will have to adapt their wine profiles completely [39], [40]. New breeding techniques could potentially help with climate adaptation and sustainability, by introducing targeted genomic changes [41] while preserving the typicity of popular varieties [42]. However, the availability of such products is still unclear [14]. Consumer acceptance would also not be automatic, and would probably require an active promotion policy e.g. through educational campaigns [43].

4. CONCLUSIONS: REGULATORY SANDBOXES AND A WINE CONSTITUTION

Through its bottom-up and multi-stakeholder elements, the governance of the wine system already corresponds to important demands regarding a food system transformation. This has allowed the wine system to respond relatively quickly to sustainability issues (e.g., the OIV principles for sustainable viticulture OIV-CST 518-2016, its implementation guidelines as well as many other recent OIV resolutions). The inclusive governance structures and some of the recent regulations might even be considered a model for other sectors.

The dense regulation, however, also creates significant barriers to individual innovations and the sustainability transformation at large. This is especially true for the rigid rules of many GIs which petrify a certain status quo in the interest of some producers.

An enabling framework for (sustainable) innovation at a local scale can be seen as an essential element of future-proof GIs. This implies a reconfiguration of GIs and the underlying idea of tradition and heritage. To design future-proof GIs, actors must ensure openness to new developments and consider all conditions for a healthy wine sector at a concrete location (e.g., changing climatic conditions and disease pressures). Such an approach would probably be more aligned with the conditions under which some of the most valuable GIs developed, namely by constantly improving technology and marketing [45]. Petrifying specific production patterns works for the short-term interests of certain actors but not necessarily for the long-term interests of all affected stakeholders.

In many areas, from finance to health and AI, experimental regulation in the form of "regulatory sandboxes" has become a key policy instrument. Sandboxes are an integral part of the EU's Better Regulation Toolbox. The European Council (13026/20) defines them as "*concrete frameworks which, by providing a structured context for experimentation, enable where appropriate in a real-world environment the testing of innovative technologies, products, services or approaches […] for*

a limited time and in a limited part of a sector or area under regulatory supervision ensuring that appropriate safeguards are in place." In our opinion, such they could also be created at the level of individual GI product specifications. Product specifications could also set clear sustainability targets to ensure that new approaches actually imply broader benefits. The new GI regulation (EU) 2024/1143 sets a general frame for such an approach but requires active efforts at the level of each producer group.

Of course, innovation will not accomplish the transformation by itself: resistant varieties may reduce some of the ecological footprint of wine production. However, their resistance may not be permanent. They are not available for all diseases and not relevant for some wine-producing regions. De-alcoholised wines theoretically represent a "healthy" alternative but will foreseeably remain a niche product and do not address the root causes of problematic alcohol consumption. The de-alcoholisation procedures prescribed by EU law also imply an even bigger ecological footprint than alcoholic wines [46]. Digital labels increase transparency regarding contents, nutritional values and potential sustainability claims. However, they will hardly have a tangible impact on public health and are generally perceived as a tool to maintain secrecy rather than to enable consumers to make healthy and sustainable choices.

Overall, the transformation of the wine system requires a more explicit orientation towards fundamental values in the form of a *wine constitution*. This constitution need not be conceived as a new legal document. All the relevant principles are already prescribed by European primary law, national constitutions and public international law. National and European courts increasingly carve out the constitutional implications of sustainability in all its three dimensions and set clear obligations for states to address climate change. Wine regulators on all levels must recognize this constitutional dimension even when dealing with "technical" questions. This also implies a more consistent approach to overproduction, which lies at the heart of most of the current economic challenges of the European wine sector as well as its negative environmental and health impacts.

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Examining the impact of wine influencers' characteristics on consumer attitudes, purchase intention, and actual wine purchase

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Abstract. Wine influencers have emerged as one of the crucial elements in shaping consumer perceptions and behaviours. However, the specific characteristics of these influencers that effectively influence consumer attitudes, purchase intentions, and actual buying decisions remain inadequately understood. Therefore, using the Elaboration Likelihood Model, this study examines the impact of wine influencers' characteristics on consumers' attitudes, purchase intentions, and actual buying behaviour. A survey of 404 social media users was conducted using a structured questionnaire. The structural equation modelling analysis found that perceived credibility impacts attitudes toward influencers but not recommended brands. However, perceived expertise and trust strongly predict attitudes toward influencers and brands. Congruence has no significant impact. Attitudes toward influencers and brands positively correlate with purchase intention, which, in turn, leads to actual purchases. These insights offer marketers a roadmap for leveraging wine influencers' characteristics to impact consumer behaviour effectively.

Keywords: wine influencers, characteristics, attitude, purchase intention, actual behaviour.

1. INTRODUCTION

Over the last decade, digital transformation has exerted an unparalleled impact across all industry sectors [1]. Particularly, the emergence of social media (SM) has significantly transformed the process of information sharing, marketing, and consumption [1], [2]. In recent years, the rise of social media influencers (SMIs) has surged, making influencer marketing a pivotal component in companies' marketing strategies [3]. Thus, it becomes increasingly important for retailers to investigate and consider their use and adoption of social media [4]. About 5.07 billion individuals around the globe were using SM in the first quarter of 2024 [5]. SM refers to electronic communication platforms that allow individuals and communities to co-create, share, mod-

ify, and discuss ideas, information, and messages. They are highly interactive [6], including platforms like Facebook, Twitter, and Instagram. SM has become integral to daily life worldwide [7], [8]. For many individuals, SM has become a basic need; checking the SM has become a habit, and a day does not pass without it [9].

As it has enabled them to connect and discuss with each other easily and quickly, individuals have increasingly turned to SM platforms for product reviews and recommendations. In this digital space, consumers' opinions on products and services are increasingly dominated by strangers [10]. This increased interaction among SM users paved the way for the emergence of Social Media influencers who can exert significant influence over others [11]. Generally, SMIs are individuals who have built up a large follower base in SM and can shape followers' perceptions, preferences, choices, attitudes, and behaviours [9], [12], [13]. Indeed, SMIs are widespread [11], [12], [14].

Not surprisingly, SMIs have become an important subject in scholarly research due to their powerful impact on consumers [15]. Market research on Trust in Influencer Marketing 2023 indicates that about 50 per cent of consumers have purchased the products based on the recommendations of SMIs [16]. Hence, marketing organisations have invested heavily in influencer marketing to achieve several marketing-related objectives [14]. As a result, spending on social influencer marketing by organisations has also increased significantly [12]. Thus, SMIs have become an essential part of brands' marketing strategies in business domains around the globe [11]. Influencer marketing is considered an affordable and modern type of celebrity endorsement [9].

While planning to incorporate SMI marketing as part of the promotion campaign, modern marketers faced two challenges in choosing SMIs. First is identifying SMIs who exhibit a good fit with their products and services [12], [14], [17]. Second, selecting the right SMIs aligned with the consumer's characteristics [11], [17], [18], [19]. As consumers are more likely to adopt SMI recommendations when they perceive endorsers shared values, interests, and characteristics, choosing the right SMI becomes essential [20]. Nevertheless, the research on wine influencers' characteristics and relationships with customers' attitudes towards the brand remains scant. Moreover, many studies have been conducted to examine SMIs' characteristics on consumers' behavioural intention [14], [17], [18], [21], [22], but they have failed to demonstrate whether the behavioural intention is translated into actual purchases of products or services. Examining the actual purchase behaviour is essential as there is a gap between intention and actual purchase behaviour [23], [24], [25].

As SMI marketing becomes pervasive in all business domains, wine marketing has also not been immune to this transformative influence. The research study is particularly relevant in India, where the consumption of wine was considered taboo [26], and consumers need to be educated on types, quality, and the way it should be consumed, thus facilitating wine consumers' informed decisions [27]. According to a recent systematic review, there is a lack of studies on social media influencers in the context of food, drink and cosmetics [28]. Further, the same study also revealed that there is a scarcity of studies in the Asia-Pacific region. Additionally, the findings of this study suggest that researchers sparingly use the Elaboration Likelihood Model (ELM). Therefore, considering these gaps in the literature, based on ELM, this study intends to investigate the role of wine influencers' characteristics on consumers' attitudes, behavioural intentions and actual behaviour. ELM is a social psychology theory that examines the dual process through which individuals are persuaded. It explains how one is persuaded through either a central or peripheral route, where the central route involves careful and thoughtful consideration of the content, and the peripheral route relies on superficial cues and heuristics. Additionally, the current study examines the relationship between wine consumers' attitudes toward brands and influencers and their impact on wine purchase intentions. Furthermore, it explores whether wine consumers' intentions translate into actual wine purchases.

Understanding the characteristics of wine influencers that influence consumers' attitudes toward both the influencer and the endorsed brand holds profound implications for the wine market. Wineries can strategically shape consumer perceptions and purchase intentions by aligning with SMIs possessing credibility, attractiveness, similarity, engagement, and relevance traits. Positive attitudes toward wine brands and influencers fostered by effective social influencer marketing campaigns can significantly influence consumers' purchase intentions, ultimately driving actual purchase behaviour. Thus, the result of the study is expected to provide important practical implications by examining the impact of wine influencers' characteristics on consumers' attitudes towards wine influencers, brands recommended, purchase intention, and actual wine purchase.

This study followed a standard structure. The introduction section provides background information on the topic, highlights the significance, and outlines the research objectives, followed by a literature review that synthesises previous research. The methodology sec-

tion details the operational design, study population, sampling design, and analytical design. Followed by the method section, results are presented. The final section includes a discussion, implications, limitations, and scope for future study before concluding with a summary.

2. THEORETICAL FRAMEWORK

2.1. Elaboration Likelihood Model (ELM)

Persuasion is one of the critical factors studied by SM researchers [29], [30]. Persuasion is an intentional process aimed to change an individual's attitude and behaviour [31]. While researchers have documented the effect of persuasion on consumer behaviour using theories such as the Source Credibility Model, Para Social Interaction Model, and Persuasion Knowledge Model, the ELM of persuasion is sparingly used [28]. The ELM, a two-stage persuasion theory, explains how consumers process stimuli differently and how these processes change their attitudes and behaviour [32].

According to this model, there are two routes to persuasion: the central and the peripheral. The central and peripheral routes to persuasion differ in processing information types. The central route involves in-depth analysis of message-related arguments, demanding cognitive effort for comprehension, evaluation, and comparison with existing knowledge. As a result, decisions made through the central route tend to be more stable and enduring as they result from thoroughly considering relevant arguments. In contrast, the peripheral route relies on a superficial association with positive or negative cues, requiring less cognitive effort. This distinction highlights the varying cognitive demands and stability of decisions between the two routes [33]. According to the ELM, consumers with a high elaboration likelihood state are likely to scrutinise the information they publish on social media and, therefore, tend to be more persuaded by the central route. Conversely, individuals with the low elaboration likelihood state lack the ability to deliberate thoughtfully and, therefore, are less likely to engage in elaboration. Such individuals are more likely to be influenced by peripheral cues [34]. Assuming the propositions of ELM, we present empirical evidence on the link between the central and peripheral routes of persuasion on consumer attitudes and behaviour in the following paragraphs. While credibility and expertise are considered as cues of the central route of persuasion [35], [36], the consumer's perceived congruence [32] and trust [37] are considered cues of the peripheral route of persuasion that leads to wine consumer's attitude formation and behaviour.

2.2. Influencer characteristics

2.2.1. Perceived credibility

The credibility of a source greatly influences the persuasiveness and effectiveness of a message, as individuals tend to be more persuaded by sources they perceive as credible [38]. Credibility refers to the attributes associated with a message's source that affect the consumers' willingness to accept that message [39]. It is frequently assessed by considering factors such as credentials, past performance, the reliability and accuracy of the information presented, and goodwill, which encompasses the perceived care, empathy, or responsiveness of SMIs towards the needs and concerns of the consumers. Therefore, an influencer who is more credible has a greater chance of positively impacting consumers' attitudes towards them [40], [41], [42], [43], [44]. It was also found that influencer credibility positively impacted consumer brand attitudes [45], [46], [47], [48], [49]. A recent meta-analysis on SMI impact also suggests that perceived credibility emerged as an essential predictor of consumers' attitudinal outcomes [12] . Therefore, the following hypotheses are postulated.

H1: Wine influencers' perceived credibility significantly influences attitude towards a) wine influencer and b) wine brand.

2.2.2. Perceived expertise

Expertise refers to the influencers' perceived knowledge, skills, and experience [12], [50]. It focuses more on influencers' qualifications and capabilities [50]. Many studies have revealed that perceived expertise is an essential factor in consumers' evaluation of product endorsement messages [51], [52]. It is also found that perceived expertise impacts attitude significantly [44], [53]. The findings of the studies have revealed that perceived expertise influences consumers' attitudes toward the influencer [40], [54] and brand [55]. A recent meta-analysis on SMI impact also suggests that perceived expertise emerged as an essential predictor of consumers' attitudes toward influencers and brands [12]. Therefore, the following hypotheses are proposed.

H2: Wine influencers' perceived expertise has a significant positive influence on attitudes towards a) wine influencers and b) wine brands.

2.2.3. Perceived congruence

According to the Congruity theory [56], consumers seek cognitive consistency in evaluating attitudes and

opinions. In the SM communication context, this theory suggests that a message delivered by an influencer is more likely to be persuasive and embraced by consumers if it resonates with their attitudes and beliefs. Conversely, an incongruent message may be less persuasive and lead to a negative evaluation of the product [12]. It is suggested that consumer–product congruence influences consumers' attitudes toward products [57]. Specifically, it is anticipated that congruence influences consumer attitudes. For example, recent studies show that congruence with an ideal self predicts brand attachment [58]. Findings suggest that a higher degree of influencer-consumer congruence enhances persuasiveness and increased purchase intentions [41], [59], [60], [61]. Consumers tend to form more positive attitudes about products when they believe a greater perceived congruence exists. Thus, the following hypotheses are suggested.

H3: Wine influencers' perceived congruence has a significant positive influence on attitude towards a) wine influencers and b) wine brands.

2.2.4. Perceived trust

Trust is established when individuals have confidence in their exchange partner's reliability and integrity. [62]. It is conceptualised as a relationship trait established through continuous interactions [63]. Trust in the influencer is likely to impact the influencer-consumer relationship positively [21]. In SM marketing, trusting an influencer reflects consumers' attitudes and willingness to rely on the message. Consequently, consumers sought to engage with influencers and intend to purchase the endorsed product. The positive relationship between trust and attitude has been established in past studies [64]. In other words, in an online marketing context, when a consumer demonstrates trust in the influencer, they are more persuaded to trust the recommendations made by that influencer. This change in attitude toward the product can subsequently influence their purchasing behaviour [55], [60].

H4: Perceived trust has a significant positive influence on attitudes toward a) wine influencer and b) wine brand.

2.3. Attitudes and Purchase Intention

Attitude is one of the important factors studied in consumer behaviour studies. It is an important direct predictor of behavioural intention. It refers to the individual's positive or negative evaluation of performing the behaviour. If a person believes that the outcome of the behaviour will be beneficial, they are more likely to have a favourable attitude toward engaging in it. Studies conducted to examine the relationship between both central and peripheral routes of persuasion using ELM revealed that attitude and purchase intention are significantly correlated [65], [66]. Particularly, in wine consumer literature, it is found that attitude had a significant influence on the behaviour of young people in relation to wine consumption, with attitudes being a crucial component, especially the "interest in alcohol" [67]. Research also indicates that attitude has the strongest direct impact on behavioural intention [68], [69].

Numerous studies in the past have demonstrated a positive correlation between attitude and purchase intention [70], [71], [72], [73]. Purchase intention in the context of social media marketing refers to the likelihood or inclination of consumers to make a purchase based on their interactions and experiences on social media platforms [74], [75], [76], indicating the likelihood of purchasing. Several studies have demonstrated that virtual influencer endorsements will likely increase purchase intention [77]. Studies have also suggested that brand attitude positively impacts customers' purchasing intention [78], [79], [80]. Accordingly, the following hypotheses are posited.

H5: Attitude towards wine influencers has a positive impact on purchase intention.
H6: Attitude towards wine brands has a positive impact on purchase intention.

2.4. Purchase intention and actual purchase

The relationship between consumer purchase intention and actual purchase behaviour represents a significant research area within specific business contexts [81]. Purchase intention is often used to predict actual behaviour, but the relationship between the two can vary. Studies exploring online purchase intention assume that intention predicts behaviour [82]. However, dependence on purchase intentions to predict behaviour is not immune to criticism, as a disparity between the two can exist [83]. This disparity may be attributed to systematic biases in self-reported intentions and changes in true intentions over time, influenced by unexpected factors[84]. Thus, it is recommended that purchase intentions and actual behaviour need to be measured simultaneously [85], [86]. In line with Li, Kuo, and Rusell [87] and Verhagen and van Dolen [88], the purchase frequency can be used to measure the actual purchase behaviour, and the following hypothesis is proposed.

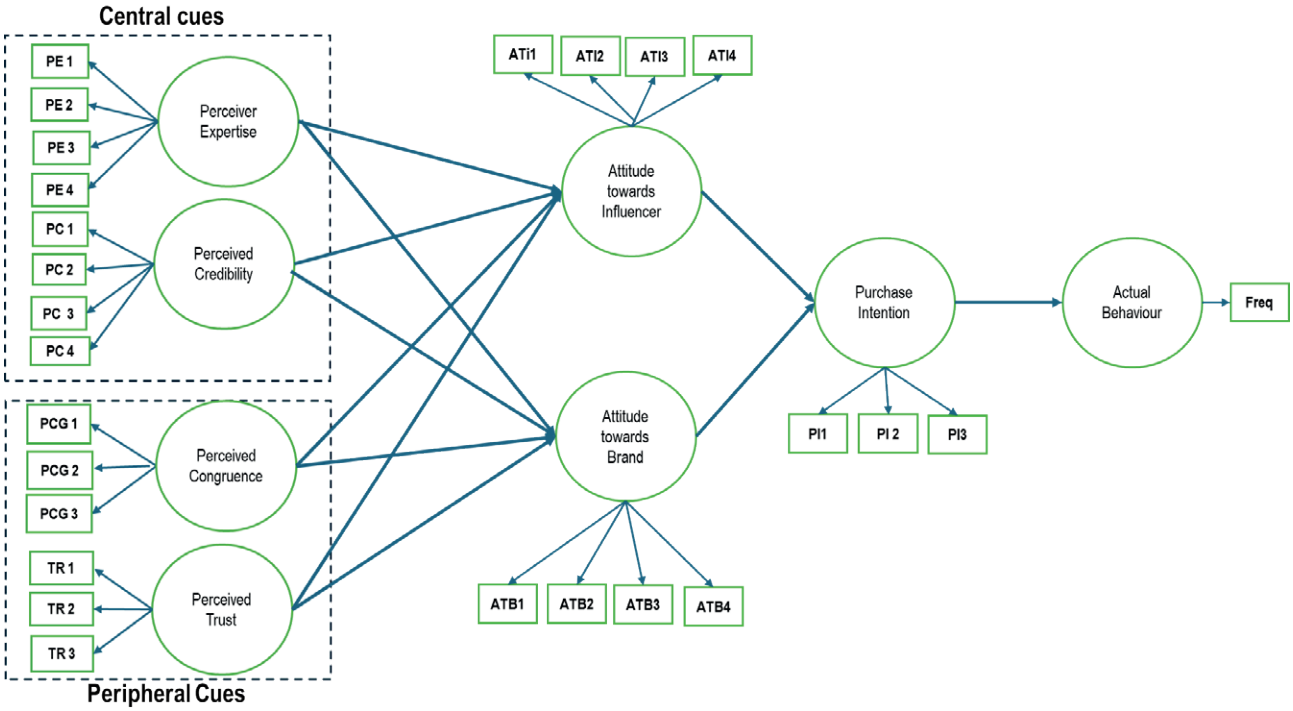

Figure 1. Proposed Research Model.

H7: Purchase intention has a positive impact on frequency of purchase.

This study aimed to investigate the influence of wine influencers' perceived characteristics as central and peripheral cues that influence consumer attitudes and behaviour. Based on the propositions of ELM, along with the support of empirical evidence on both central and peripheral cues of SM influencers, we propose the following hypothetical conceptual framework in Figure 1.

3. METHODOLOGY

The survey instrument had two sections. The first section included constructs related to the study: Perceived credibility, perceived congruence, perceived expertise, perceived trust, Attitude Towards the wine Brand, Attitude Towards the wine influencer, purchase intention, and actual purchase. The constructs of perceived credibility, expertise, congruence, trust, and attitude toward the wine influencer were adapted from a previous study[40]. Perceived credibility included four items, including "*I do believe that the online wine influencers I follow are convincing*" and " *I do believe that the online influencers I follow are credible*". Perceived expertise as well had four items, such as "*The wine influencers I am following are experts in their field*" and "*The wine influencers I am following have great knowledge*". Perceived congruence comprised of three items, "*I perceive the compatibility between me and my preferred wine influencers* " and "*I perceive the level of match between my personality and my preferred wine influencers*". The perceived trust had three items, including "*I do believe that the wine influencers I follow are sincere*" and "*I do believe that wine influencers I follow use the same products they recommend*". Attitude towards wine influencers covered four items such as "*I do believe that wine influencers serve as model connoisseurs for me*" and "*I do believe that wine influencers present interesting content*". These items were rephrased to suit the objectives of this study. The construct of attitude towards the brand was adapted from [89]. The construct had four items, including "*I do trust brands recommended by wine influencers I follow*" and "*I have positive perception about brands endorsed by wine influencers*". The dependent variable, purchase intention, was measured using the scale adapted from the previous studies [40], [90]. The construct had three items, such as *"I would purchase a brand based on the advice I am given by the wine influencers that I follow."* All these items were measured using a 5-point Likert scale varying from 1 being strongly disagree to 5 strongly agreeing. The actual purchase was measured based on the [40], [41], [42]. Purchase frequency, using

categorical variables, such as once a month, twice a month, thrice a month, many times a month, and Never. The second section captured the demographic details of the wine consumers, such as gender, age, city of origin, education, annual income, occupation, marital status, and amount spent on wine per month.

3.1. Participants and data collection

Participants familiar with SM and at least 21 years old, the legal drinking age in India, were included in the study. Consumption of wine, either regularly or occasionally within the past three months, was considered an essential inclusion criterion. The study gathered primary data through an online and offline questionnaire administered to wine consumers in various Indian states. The online questionnaire was developed using Google Forms and made available in SM platforms. The online survey was also distributed via email, with participants asked to fill it out and share it with others. The physical questionnaire was distributed among wine consumers. Researchers visited retail wine shops and asked the respondents to participate in the study. The objective of the study was explained to them. Upon consent, respondents were requested to fill out the measuring instrument. This approach offered a direct means of gathering insights into consumer preferences, behaviours, and attitudes toward wine consumption.

This study uses a non-probability sampling method, combining purposive and snowball sampling. In May 2023, researchers pre-tested the questionnaire using 63 samples with diverse demographic backgrounds. Feedback and suggestions regarding unclear instructions or questions were gathered from pilot test respondents. Data from the pilot study were not included in the analysis. After the pilot study, the online and offline survey instruments were distributed to 556 respondents. 413 responses were received after four months, resulting in a 74% response rate. The analysis did not include nine responses due to age constraints (respondents were below 21 years). Thus, the final 404 responses were included in the analysis.

3.2. Analysis of data

The data collected from the respondents were analysed using both descriptive and inferential statistics. Descriptive statistics have been used to measure the central tendency and the data normality, including skewness and kurtosis. Structural equation modelling (SEM) is adopted to analyse the proposed conceptual model. SEM is an advanced statistical approach that effectively combines the benefit of factor analysis and multiple regression that help the researchers to analyse the complex relationships between research constructs. The IBM AMOS version 24 software was used to analyse the SEM.

3.3. Characteristics of respondents

The sample included 64.9% males, 33.4% females, and 1.2% non-binary respondents, along with 0.5% respondents who did not want to disclose their gender. The number of respondents aged between 21 and 41 was high (57.4%), followed by 41 and 51 (18.1 %), 51 and 61 (20.5%). The respondents aged 61 and 71 were meagre (4%). Regarding marital status, most respondents were married (50 %). 47.8% of respondents were single. 2.2% of respondents were separated. Most of the respondents were undergraduates (48.3%), followed by postgraduates (39.4%), doctoral degrees (4.2%), and (5.1%) respondents have other qualifications, including technical diplomas. Most of the respondents in the study were employed (43.8%). While 30.0% of respondents were professionals and 17.3% were self-employed. Among the respondents, 5.9 % were students, and 3.0% were unemployed. The respondents with an annual income of less than five lakhs were 39.9 %, 5–10 lakhs 20.3%, and 10–20 lakhs 27.2 %. About 12.9% of respondents did not disclose their income.

The monthly wine purchases of respondents with frequency once a month were 43.1%, twice a month 14.9%, thrice a month 28.0%, and respondents buying wine many times a month were 14.1%. The monthly amount spent on wine purchases by respondents was Rs. 2000–5000 (59.7%), 5000–10000 (36.9%), and the respondents above INR 10000–20000 were 3.5%.

3.4. Common Method Bias (CMB)

In the current study, we have adopted statistical and procedural methods to address the CMB [91]. Harman's single-factor test was adopted as part of the statistical method to estimate the potential common method bias. This statistical analysis assumes that there is a potential CMB if a single factor explains more than 50 per cent of the variance in a model. In the current study, Harman's single factor analysis revealed that the unidimensional solution accounted for 34.43 variance, less than the recommended value of 50 per cent, indicating that CMB is unlikely to be a concern in the study. Second, we have adopted online and offline data collection modes to overcome the common method bias. Moreover, we have

guaranteed the anonymity of participants and requested them to provide honest responses, as there were no correct or incorrect responses.

4. RESULTS

The proposed hypotheses were tested using covariance-based structural equation modelling, a well-established multivariate data analysis method. It has two general components: measurement and structural [92]. The measurement model assists researchers in validating the proposed relationship between latent and manifest variables, while the structural path model enables researchers to explore the direction and strength of the relationships between latent variables. Before the structural equation modelling through IBM AMOS Version 27, multivariate assumptions associated with normality and outliers were assessed. The descriptive statistics, factor loading (λ), Skewness (S), Cronbach alpha(α), and the Average Variance extracted (AVE) of constructs and the items used in the study are presented in Table 1.

The data normality of each item in every construct was assessed using the scores of Skewness and Kurtosis. Since all of the skewness and kurtosis scores lie in the ±2 range, it implies that all the items under the study follow a normal distribution [93].

4.1. Construct reliability and validity

Besides the item-level descriptive statistics, Cronbach alpha (α), the most popular measure of reliability, was estimated to analyse the consistency and the stability of items under each latent variable. The estimated α value is between 0.857 and 0.9, above the suggested threshold value of 0.70 [94]. These values indicate that the scale possesses an adequate and acceptable level of reliability. The validity of the different study constructs was assessed through convergent and discriminant validity (Table 2).

Regarding the convergent validity, the factor loading ((λ) of all items in the scales surpassed the cut-off point of 0.50, and the AVE, which is greater than 0.50, exhibited an adequate level of convergent validity. Further, composite reliability (CR) of more than the cut of the value of 0.70 indicates the good convergent validity of the scale (Hair et al., 2018). The Cronbach's alpha (α), CR, and the AVE for each construct are presented in Table 2.

Further, correlation estimates among latent constructs were analysed to examine the discriminant validity per the guidelines [95]. It is considered that discriminant validity has been achieved when the AVE exceeds the correlations between all latent constructs. The estimated value of inter-correlation estimates among all constructs lower than the square root of AVE indicates the sufficient discriminant validity of the constructs (Ibid). The intercorrelation among constructs and a square root of AVE is presented in Table 3.

4.2. Measurement model

The measurement model in structural equation modelling is concerned with how well the indicators measure the proposed latent constructs. It assesses the relationship between indicators and their latent variables and estimates the measurement error. By conducting a confirmatory factor analysis (CFA), the model fit of the measurement model was analysed. The proposed model has seven constructs. The IBM AMOS version 24 software provides several statistics to estimate the model fit. The various goodness of fit indices used in the study, along with threshold values for acceptance [92], are presented in Table 4.

The result of the goodness of fit indices of the proposed measurement model, CMIN/Df= 1.394, CFI=0.98, GFI=0.94, SRMR=0.01, AGFI=0.92, and RMSEA=0.03, demonstrate that the model has a good fit.

4.3. Structural model

In the current study, we have proposed multiple hypotheses based on the past literature. The structural model examined the proposed conceptual model's hypothesised relations among various constructs. The structural or path model provides both strength and signs of a relationship between constructs, negative and positive. The result of hypothesis testing is presented in Table 5.

The aim of this study is to investigate the impact of various characteristics of wine influencers on consumer attitudes towards them. The results of the structural equation model indicate that perceived trust, credibility, and expertise are significant predictors of wine consumers' attitudes toward wine influencers. The result of hypothesis testing presented in Table indicates that all other hypotheses were supported by the data except for hypotheses H1b, H3a, and H3b. The result indicates that perceived trust (β=0.720, $p< 0.01$), perceived expertise (β=0.598, $p< 0.01$), and perceived credibility (β=0.441, $p< 0.01$) have been the strong predictors of consumers' attitude towards wine influencer. These factors can explain the target variable's 58.2 percent

Table 1. Descriptive statistics, normality, reliability, and validity.

Items	Mean	SD	Skewness (S)	Kurtosis (K)	λ
Perceived Expertise					
PE 1 - The wine influencers I am following are experts in their field	3.866	1.028	1.063	-1.138	0.883
PE 2 - The wine influencers I am following have great knowledge	3.963	0.999	0.638	-0.99	0.892
PE 3 - The wine influencers I am following provide references based on their expertise	3.882	0.923	0.749	-0.91	0.843
PE 4 – The influencers I follow have the qualification to suggest wines.	3.933	0.93	1.606	-1.189	0.816
Perceived credibility					
PC 1 - I do believe that the online wine influencers I follow are convincing	3.706	0.994	1.219	-1.137	0.87
PC 2 - I do believe that the online influencers I follow are credible	3.906	0.906	0.759	-0.9	0.878
PC 3 - I do believe that online wine influencer's recommendation is a good reference for purchasing wines	3.885	0.995	0.848	-1.011	0.867
PC 4 - I find purchasing wine recommended by online Influencers I follow to be worthwhile	3.826	0.986	0.598	-0.889	0.891
Perceived congruence					
PCG 1- I perceive that there is a compatibility between me and my preferred wine influencers	3.487	0.858	0.311	-0.201	0.813
PCG 2 – I perceive that there is a level of match between my personality and my preferred wine influencers	3.62	0.973	0.027	-0.385	0.902
PCG 3 – I assess the relevance of my preferred wine influencers' publications with regard to my personal beliefs and life mode	3.644	0.972	-0.012	-0.411	0.861
Perceived trust					
TR 1- I do believe that I can depend on online wine influencers I follow to make purchasing decisions	3.666	0.98	0.52	-0.829	0.875
TR 2 - I do believe that the wine influencers I follow are sincere	3.786	1.056	0.34	-0.864	0.892
TR 3 - I do believe that wine influencers I follow use the same products they recommend	3.684	1.141	-0.25	-0.715	0.889
Attitude towards brand					
ATB 1- I do trust brands recommended by wine influencers I follow	3.861	0.952	0.727	-0.933	0.854
ATB 2 - Brands recommended by wine influencers are more reliable	3.85	0.95	0.212	-0.748	0.894
ATB 3 - I have positive perception of brands endorsed by wine influencers	3.866	0.918	0.966	-0.918	0.891
ATB 4 - I have favourable opinions about the brands recommended by wine influencers	3.933	0.867	0.967	-0.833	0.884
Attitude towards influencer					
ATI 1 - I do believe that wine influencers serve as model connoisseurs for me	3.775	1.004	0.435	-0.858	0.827
ATI 2 - I do believe that wine influencers present interesting content	3.973	0.913	1.926	-1.238	0.837
ATI 3 - I do believe that wine influencers provide new knowledge and deals with different wine products and services	4.013	0.9	2.069	-1.264	0.862
ATI 4 - I do consider wine influencers as a reliable source of information and discovery	3.955	0.948	1.036	-1.005	0.879
Purchase intention					
PI 1 - I have intentions to purchase products recommended by wine influencers I follow	3.767	0.993	0.067	-0.705	0.882
PI 2 - I generally recommend products and/or services recommended by the wine influencers I follow	3.781	1.011	0.401	-0.86	0.921
PI 3 - In the future, I will purchase the products of brands recommended by the wine influencers that I follow.	3.799	1	0.69	-0.91	0.917

variance(R^2=0.582). Perceived trust has emerged as the strongest predictor of consumers' attitudes towards SMIs and wine brands.

Further, perceived trust (β=0.295, p< 0.01) and perceived expertise (β=0.224, p< 0.01) were found to be strong predictors of consumers' attitudes toward the wine brands promoted by the wine influencer, able to explain about 68 per cent variation (R^2=0.680) in followers' attitude towards the wine brands associated with the SMIs. However, perceived congruence between the wine

Table 2. Reliability and convergent validity.

Constructs	α	CR	AVE
Purchase intention (PI)	0.900	0.903	0.834
Attitude toward the wine brands (ATB)	0.915	0.916	0.798
Attitude towards wine influencer (ATI)	0.880	0.881	0.736
Perceived Creditability (PC)	0.890	0.891	0.751
Perceived congruence (PCG)	0.797	0.800	0.712
Perceived Expertise (PE)	0.883	0.885	0.741
Trust (PT)	0.857	0.857	0.778

influencer and the followers was insignificant in predicting their attitude towards influencers and wine brands.

Though attitudes towards the SMIs and the attitude towards wine brands promoted are significant predictors, followers' attitudes towards wine influencers alone could explain a 78 per cent variance in wine purchase intention (β=0.768, $p< 0.01$). This finding underscores the significant impact that a positive attitude towards the influencer also translated into followers' intention to purchase the wines recommended by that influencer. It was also found that purchase intention explains about 85.2 per cent of the variation in actual purchase behaviour, which is measured through the purchase frequency of influencer-recommended wine brands. The result also demonstrated the significant predictive power of followers' purchase intention on wine purchase behaviour ((R^2=0.645). The above findings emphasise the vital role played by the SMI in shaping wine consumers' attitudes, purchase intentions, and, ultimately, the actual purchase decision in the wine industry.

5. DISCUSSION

Based on the Elaboration Likelihood Model of persuasion, this study investigated the impact of wine influencers' characteristics, such as perceived credibility, congruence, expertise, and trust, on consumers' attitudes toward influencers and brands. Further, this study investigates the relationship between attitudes and wine

Table 3. Discriminant validity: Fornell-Larcker Criterion.

Constructs	PI	ATB	ATI	PC	PCG	PE	TR
Purchase intention (PI)	**(0.913)**						
Attitudes toward the wine brands (ATB)	0.846	**(0.893)**					
Attitude towards the wine influencer (ATI)	0.827	0.8567	**(0.858)**				
Perceived Creditability (PC)	0.750	0.808	0.776	(0.867)			
Perceived congruence (PCG)	0.601	0.622	0.605	0.655	(0.844)		
Perceived Expertise (PE)	0.789	0.857	0.856	0.781	0.602	(0.861)	
Perceived Trust (PT)	0.781	0.836	0.813	0.808	0.653	0.824	(0.882)

Numbers between brackets represent the Square root of AVEs.

Table 4. Goodness of fit indices of the measurement model.

Model fit indices	Threshold	Measurement Model	Observation from the result
Chi-square value/Degrees of freedom	< 3 – Good < 5 Acceptable	(CMIN = 313.5 /225) = 1.394	Good
Comparative Fit Index (CFI)	> 0.95 – Great > 0.90 – Good	0.98	Great
Goodness of Fit (GFI)	> 0.95 – Excellent > 0.90 – Good > 0.80 – Permissible	0.94	Good
Standardised Root Mean Squared Residual (SRMR)	< 0.08 – Acceptable	0.01	Good
Adjusted Goodness of Fit Index (AGFI)	> 0.08 – Acceptable > 0.90 – Good	0.92	Good
Root mean square error of approximation (RMSEA)	< 0.05 – Good 0.05 to 0.10 – Moderate	0.03	Good

Table 5. Results of hypotheses testing.

Hypothesis	Path from		Path to	Standardised estimate	t-value	Decision
$H1_a$	PC	→	ATI	0.441	8.937**	Accept
$H1_b$	PC	→	ATB	0.181	1.833^{NS}	Reject
$H2_a$	PE	→	ATI	0.598	12.340**	Accept
$H2_b$	PE	→	ATB	0.224	4.560**	Accept
$H3_a$	PCG	→	ATI	-0.070	-1.831^{NS}	Reject
$H3_b$	PCG	→	ATB	-0.010	-0.281^{NS}	Reject
$H4_a$	PT	→	ATI	0.720	10.003**	Accept
$H4_b$	PT	→	ATB	0.295	5.441**	Accept
H5	ATI	→	PI	0.768	14.510**	Accept
H6	ATB	→	PI	0.101	3.550*	Accept
H7	PI	→	Actual Behaviour	0.852	32.027**	Accept

*Significant at 5 per cent. ** Significant at 1 percent, NS=non-significant.

consumers' behavioural intentions. More specifically, this study measures the role of behavioural intention on actual behaviour.

Regarding the perceived credibility, it was found that it had a significant positive impact only on wine influencers. This implies that consumers attribute greater credibility to wine influencers than wine brands when making purchasing decisions. It highlights the influential role of influencers in shaping wine consumer attitudes. This finding is in line with previous studies [72], [96]. However, the results of previous studies also suggest that influencers' credibility does not always have an impact on consumer attitude towards the brand and purchase decision [97]. The inconsistencies in this finding could be attributed to many factors, such as the context of the study, sample characteristics, and the rapidly changing nature of the social media landscape.

The positive impact of perceived credibility on wine influencers indicates that consumers perceive these influencers as trustworthy and reliable sources of information due to their perceived authenticity or relatability. This finding aligns with the previous studies [40], [41], [42]. However, contrary to the previous studies [45], [47], [48], [49], this study did not find any significant positive impact of perceived credibility on wine consumer attitude toward wine brands. This non-significance can be attributed to several factors, such as cultural differences, market dynamics, and consumers' perceptions of the wine industry in India. Non-significance could also be due to the evolving nature of consumer behavior, influenced by emerging trends, technological advancements, and shifts in SM usage patterns in India.

The study's findings also revealed that, except for perceived congruence, all the other three characteristics (perceived expertise, perceived trust, and perceived credibility) had a significant positive impact on wine consumers' attitudes toward influencers and brands. In other words, the study's results highlight the significant influence of central route factors, specifically perceived expertise and perceived credibility, on wine consumers' attitudes toward influencers. The positive and statistically significant coefficients between these two characteristics and attitudes indicate that consumers actively engage in thoughtful processing, considering influencers' perceived expertise and credibility when forming attitudes towards influencers and brands. These findings emphasise the importance of substantive information and the influencer's professional standing in impacting consumer attitudes. These findings align with previous studies [41], [44], [49], [54], [55].

The study's finding also emphasises the role of perceived trust as a significant peripheral predictor of wine consumers' attitudes toward wine influencers and brands. The highly positive and significant coefficient associated with trust and attitude suggests that consumers when engaging in heuristic-based processing, rely on the perceived trustworthiness of influencers. This finding highlights the importance of building and maintaining trust for influencers looking to impact attitudes through more surface-level cues. This finding corroborates the previous study findings [98], [99].

However, contrary to the previous study findings [41], [59], [60], [61], perceived congruence did not show statistical significance in this study. The non-significant impact of perceived congruence on attitudes towards wine influencers and brands may be attributed to several factors. For example, the distinctiveness of consumers' preferences. Wine consumers' preferences are highly individualistic and can vary widely across cultures.

Another factor that might have impacted the non-significant impact of perceived congruence and attitude is consumers' wine knowledge. Knowledgeable consumers likely have well-defined preferences for wine brands. Consumers with more wine knowledge often possess a discerning palate and an understanding of wine culture and are likely to critically evaluate the influencers' recommendations. Therefore, congruence between wine consumers and influencers and brands is unlikely.

The findings also revealed that attitudes toward wine influencers and brands positively impacted consumers' behavioural intentions. These findings are in line with previous studies [77]. Attitudes toward wine influencers and brands can be powerful predictors of purchase intention. The findings also indicate that wine consum-

ers' behavioural intention positively impacted their actual wine purchase. This positive association emphasises the critical phase of converting consumer intent into action. This finding aligns with previous studies [87], [88].

6. IMPLICATIONS

6.1. Theoretical implications

Investigating the characteristics of SMIs and their impact on consumer attitudes towards influencers and wine brands represents an important theoretical contribution to this study. This study sheds light on wine influencers' essential central and peripheral route characteristics, such as credibility, expertise, congruence, and trust. These characteristics play crucial roles in shaping consumer perceptions and attitudes. Expertise, which reflects the influencer's knowledge and proficiency in the wine industry, enhances their authority and persuasiveness, positively affecting consumer attitudes. Congruence, the alignment between the influencer's image and the wine brand, ensures the promotion feels authentic and relevant to the target audience. Trust, built through consistent and honest interactions, further solidifies the impact of wine influencers on consumer attitudes. This study examines how these attitudes toward wine brands and influencers subsequently influence wine consumers' purchase intentions and actual wine purchases, thereby contributing to understanding the attitude-behaviour relationship. By exploring the link between influencer characteristics and consumer attitudes, this study provides valuable insights into how influencers' positive perceptions translate into favourable brand attitudes and increased purchase intentions.

Furthermore, this study contributes to knowledge of the decision-making processes of wine consumers by demonstrating the positive correlation between the characteristics of influencers and consumer attitudes toward influencers and wine brands. This knowledge is essential for the wine industry, particularly for refining marketing strategies to promote wine through social media in India. Considering the increasing influence of social media in shaping consumer behaviour, the findings of this study can assist wine brands in effectively utilising influencers to reach and engage their intended audiences.

Understanding the relationship between purchase intention and actual wine purchases has important theoretical implications, which help predict the strength and reliability of purchase intentions as indicators of actual consumer behaviour. This aspect of the study is vital for marketers and researchers aiming to design interventions that effectively convert consumers' intentions into tangible purchases by bridging the gap between intentions and behaviour. This study provides a comprehensive understanding of the factors driving wine purchases, enabling marketers to tailor their strategies accordingly.

6.2. Practical implications

This study has several practical implications for the wine industry, marketers, brands, and influencers. First, perceived credibility, expertise, and trust emerged as significant predictors of attitude toward wine influencers and brands. Therefore, wine marketers and influencers should prioritise building and maintaining perceived trust, perceived expertise, and perceived credibility. Second, though the study findings did not support the positive relationship between perceived congruence and attitudes, wine marketers should still consider aligning influencers with their target audience. Ensuring wine influencers resonate with their followers' values and preferences can build a stronger connection. Third, the attitudes towards wine influencers and brands have significantly impacted purchase intention, suggesting that wine marketers should recognise the role of influencer marketing and formulate appropriate SM marketing strategies. Fourth, the study findings also revealed that purchase intention impacted the actual wine purchase. Therefore, wine marketers should focus on influencing followers' intentions to purchase by incorporating persuasive strategies in their influencer marketing campaigns. Understanding the relationship between purchase intentions and actual behaviour can lead to more successful outcomes.

7. RECOMMENDATIONS FOR FUTURE STUDIES

Though there are several implications, this study has several limitations that provide opportunities for future studies. First, this study uses a few central and peripheral route characteristics. Therefore, future research in wine marketing can examine the additional central and peripheral characteristics of wine influencers and their impact on wine consumers. For example, assessing the relevance of brand content, attractiveness, persona, and likeability. Understanding how wine influencers' information, recommendations, and stories shape consumer perceptions is essential for marketers. Second, wine influencers' knowledge could be another key central route characteristic impacting consumer attitudes, intentions, and actual purchases. When wine influencers demonstrate a comprehensive understanding of various aspects of wines, consumers will likely perceive them

as credible and authoritative sources within the wine domain. Third, wine consumer researchers can also explore the influence of wine influencers' interaction and engagement on consumer behaviour. Active engagement, such as responding to comments, encouraging user participation, and involving followers in discussions about wine preferences, fosters a personal relationship between the influencer and consumers. This engagement strengthens the bond between the influencer and consumers and positively reflects on the endorsed wine brand. Finally, wine consumer researchers could also consider peripheral route characteristics, such as the aesthetic presentation of wine influencers. A visually appealing presentation enhances the perception of the influencer's professionalism and indirectly endorses the promoted wine brand. Moreover, the frequency of SM posts plays a vital role in fostering brand engagement and trust. Consistent and informative content establishes trust, while sporadic or low activity may reduce consumer interest.

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Influence of information about fungus-resistant grape varieties on hedonic ratings by consumers – a central location test in Germany

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Abstract. As the wine industry faces increasing challenges from grapevine diseases, Fungus-Resistant Grape Varieties (FRGVs) offer a promising solution for sustainable production. To evaluate their market potential, our study investigates how knowledge of FRGVs affects consumer hedonic quality assessments and willingness to pay for wines produced from these innovative varieties compared to those made from conventional grape varieties. The study utilises data from a central location test conducted with 244 consumers in Germany featuring 8 different wines. The sample was carefully selected to ensure representativeness across gender, age and frequency of wine consumption. The data were analysed using descriptive and multivariate statistical techniques. The results indicate that consumers rate the hedonic quality and willingness to pay for wines made from FRGVs similarly to wines produced from conventional grape varieties when tasted without any prior information about the FRGVs in viticulture. However, providing consumers with information prior to tasting results in a positive effect on their assessment of hedonic quality and willingness to pay for wines made from FRGVs. By offering information about the positive effects of resistant grapes in viticulture, it is possible to enhance consumer acceptance and increase their willingness to pay for wines from FRGVs.

Keywords: PIWI, innovation, wine quality, sustainability, sensory quality.

1. INTRODUCTION

Fungus-resistant grape varieties (FRGVs) assume a pivotal role in realising the objectives outlined in the Farm to Fork Strategy [1], primarily by mitigating the necessity for fungicide applications in plant protection efforts [2]. This transition not only contributes to a reduction in CO2 emissions but also demonstrates the preservation of soil integrity and the advancement of biodiversity [3]. Beyond the ecological effects, the cultivation of FRGVs holds the potential for economic and societal benefits [2,4–6], thus exerting a positive influence across all dimensions of sustainability [7].

Despite the growing demand for organic food [8], challenges such as the unappealing nomenclature of grape varieties, divergent taste profiles, the

established market dominance of conventional grape varieties (CGVs) and the heightened advisory demands associated with FRGVs collectively impede consumer acceptance [2,4,9–11]. Consequently, despite the expanding interest, the production of FRGVs remains at a marginal level in established as well as new wine-producing countries like Italy, France, the USA, Brazil, Denmark, Poland and Germany [12–16]. It is important to note that while FRGVs can complement organic production, they represent a distinct approach within sustainable viticulture. Nevertheless, the utilisation of these varieties holds promise in both organic and conventional viticulture, particularly for diminishing the reliance on fungicides [17].

The phenomenon of assimilation and contrast, as described by Tajfel & Wilkes (1963) [18], is related to the discussion of consumer neophobia. According to Ram & Sheth (1989) [19], it is crucial to break down entrenched conventional perspectives, which could indicate a tendency to assimilate when consumers receive information that supports their existing beliefs. This could mean that consumers perceive information about resistant grape varieties as "different" or "not as good enough" when they already have a strong preference for CGVs.

To address the assimilation in consumer education, Pedneault and Provost (2016) [3] advocate for further research into effective communication strategies. Furthermore, studies affirm that disseminating information regarding the environmentally friendly production practices of FRGV wines positively influences the likelihood of purchase [20–22], considering that 46% of respondents attribute significance to the environmental impact of wine production. Kiefer and Szolnoki (2023) [10] conducted a qualitative study and found that providing information increased the willingness to pay in certain consumer groups. Thus, consumer education in this domain becomes indispensable [23] and is tested by the following hypothesis.

H1: The willingness to pay for wines made from resistant grape varieties is comparable with wines produced from conventional grape varieties.

Sensory distinctions between wines produced from FRGVs and conventional grapes negatively impact consumers' willingness to pay [20]. Similar to organically produced wines, FRGVs confront the historical challenge of overcoming perceptions of inferior quality [3,24]. However, several studies affirm that wines produced from FRGVs can attain comparable quality levels to those produced from CGVs [4,8,11,17,25–28]. Analytically, the study by González-Centeno et al. (2019) [25] stated results for red wine FRGVs, demonstrating promising total phenol content, anthocyanin and proanthocyanin levels, volatile compounds and sensory properties when compared to established red grape varieties, such as Cabernet Sauvignon, Merlot and Syrah. While discrepancies exist in colour, taste, overall balance, astringency and body, the findings underscore the potential of these new grape varieties to yield wines of marketable quality. A study by Duley et al. (2023) [29] emphasises the need for optimisation in winemaking methods, addressing challenges posed by high protein levels, titratable acidity and pH as well as low tannin levels inherent in most FRGVs and their derivative wines. This forms the basis for the subsequent hypothesis:

H2: The sensory quality perception of wines made from resistant grape varieties is comparable to that of wines produced from conventional grape varieties.

However, numerous studies underscore that increased knowledge about FRGV positively correlates with increased consumer willingness to purchase [20]. Noteworthy is Nesselhauf et al.'s (2019) [30] revelation that consumers with a high level of involvement and receptiveness to innovations from the organic sector are predisposed to purchasing wines derived from FRGVs. Additionally, Mann et al. (2012) [31] discover that enhanced knowledge about organic production augments the likelihood of consumers opting for organic wines. On the producer side, concerns have arisen about providing information on resistant varieties, as it can discredit the other CGVs and, thus, reduce their value [32]. Furthermore, the provision of information on environmentally friendly production practices enhances subjective quality perceptions [33]. The following hypothesis was therefore formulated to test the influence of information on both sides at the sensory level.

H3: The sensory quality perception of wines made from resistant grape varieties increases with the provision of information about resistant grape varieties.
H4: The provision of information about resistant grape varieties has a negative impact on the evaluation of conventional grape varieties.
H5: The willingness to pay for wines made from resistant grape varieties increases with the provision of information about resistant grape varieties.

Although existing literature investigating consumer motives and barriers associated with FRGVs, research focusing on the impact of information on hedonic sensory quality and price estimation remains limited. This study attempts to bridge this research gap by examining consumers' sensory evaluations of wines produced from FRGVs in a comprehensive three-stage model.

2. MATERIALS AND METHODS

In order to examine the influence of information on FRGVs and their positive environmental impact, a cross-sectional design was employed using the central location test (CLT) methodology. This commonly used test procedure involves controlled testing in a standardised environment. The products to be evaluated by the participants are typically presented without attributes that directly affect sensory perception, which may introduce some artificiality into the testing process but enables a controlled measurement [34].

2.1. Materials

Eight representative and experimental samples from resistant and conventional grape varieties were selected for consumer evaluation based on market share and sensory attributes. The samples were produced by our cooperative partner, Weincampus Neustadt, which conducts research on the oenological development of resistant grape varieties. These wines were specifically produced for research purposes of grapes from the institutes' vineyards, which are dedicated and managed exclusively for scientific study. This ensures that the wines are consistent with the experimental requirements and tailored for accurate evaluation in our study. In total, four different red wines and four different white wines were tested, with each group including two wines produced from FRGVs and two from CGVs. The following Table 1 presents the grape varieties along with their codes and analytical data.

The vinification process was meticulously and equally conducted for both the FRGV and conventional wines to ensure the production of comparable samples for consumer evaluation. For the white wine, the process began with manual harvesting followed by crushing without destemming. In some variations (Muscaris & Sauvignon Blanc) with extended skin contact, a maceration of approximately 18 hours was allowed. The subsequent steps included pressing, flotation with N^2 for must clarification, yeast addition and, in selected cases (Sauvignac & Riesling), the introduction of medium-toasted wood chips at the time of yeast addition. After 24 hours, nutrient supplementation was provided, and the fermentation occurred in stainless steel tanks at 18°C. Post-fermentation, the wine underwent racking to separate it from the coarse lees followed by the addition of 70 mg/L SO^2.

For the red wines, the process commenced with manual harvesting followed by destemming. Two variations were explored: a mesh fermentation (Cabernet Sauvignon & Satin Noir) and a mesh fermentation with 10% juice extraction (Merlot & Laurot). The subsequent steps included yeast addition and, in case of Cabernet Sauvignon and Satin Noir, the incorporation of medium-toasted wood chips. After 24 hours, lactic acid bacteria were introduced for simultaneous malolactic fermentation. Pressing occurred after 14 days, once the fermentation was complete. The wine was then allowed to settle overnight and decanted. In December/January, the wines were sulphured with 100 mg/L. These carefully executed vinification processes contributed to the diverse range of samples representing both resistant and conventional grape varieties in our consumer hedonic sensory study.

2.2. Test procedure

The samples were randomly assigned to two different orders to ensure balance, and each consumer evaluated the

Table 1. Presentation of the samples categorised by fungus-resistance and conventional grape varieties, including the utilized grape variety, the corresponding codification and analytical data.

Type	Grape Variety	Code (blind/informed)	Alcohol %vol.	Sugar g/L	Acidity g/L	Volatile Acid g/L	Free SO_2 mg/L	Total SO_2 mg/L
White Grape Varieties								
FRGV	Sauvignac	582/642	12.53	6.20	7.20	.33	33	77
FRGV	Muscaris	468/975	12.02	8.30	6.40	.34	21	83
CGV	Riesling	674/312	12.25	4.70	6.80	.34	26	78
CGV	Sauvignon Blanc	361/543	12.74	11.00	5.50	.49	30	65
Red Grape Varieties								
FRGV	Satin Noir	625/436	13.06	3.80	5.20	.63	28	66
FRGV	Laurot	514/874	12.82	7.30	5.80	.47	30	102
CGV	Merlot	734/154	13.34	4.20	5.00	.44	28	98
CGV	Cabernet Sauvignon	275/235	14.83	3.70	5.50	.64	31	106

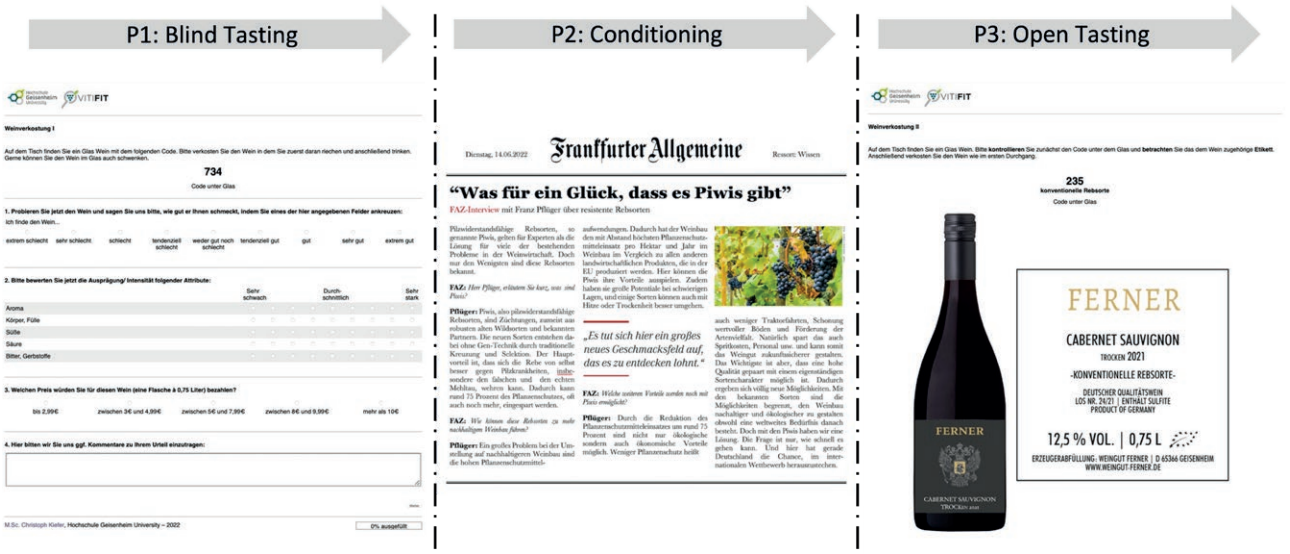

Figure 1. Schematic description of the progression of the three-step test procedure.

same wine samples in two separate steps. Approximately 60 ml of each wine sample was poured into a standardised wine glass and served with a three-digit code.

The tasting took place in a controlled environment using a three-step method [35,36], as shown in Figure 1. Initially, participants took part in a blind tasting where they were presented with four different wines in a complete block design, as implicated by Macfie et al. (1989) [37] to avoid first-order carry-over effects. The bottles were coded, the wine was brought to an equal temperature and poured evenly per sample to avoid bias. Subsequently, the participants were provided with general information in the form of a newspaper article about the characteristics of resistant grape varieties (see also Figure A1 in the appendix). In the next step, a conditioned tasting was conducted, where the same four wines were presented again, this time with the grape variety openly indicated and information about the resistant grape varieties provided. Additionally, labels were shown to the participants in the accompanying questionnaire to establish a visual association.

2.3. Sample description

A representative sample of 244 consumers was recruited through a panel provider using an online screening questionnaire at locations in Munich, Frankfurt and Berlin. The participating consumers were compensated with a remuneration of 20 EUR. The distribution of the participants is based on the age and gender distribution of German wine consumers, as reported by the 'GFK Wine Consumer Report' (2020), which was derived from representative surveys of over 30,000 participants [38].

The participants were <29 years (15%), 30–49 years (45%) and <50 years (39%) old, 46% female, 52% male and 2% diverse. Compared to the German population [38], the sample is overrepresented by males (50%) and middle-aged participants (36%). All participants consume wine (at least once per month) resulting in 56% of the participants stated that they consume wine more than once a week, and 12% mentioned that they consume wine less than twice a month.

Furthermore, half of the participants in the sample completed university degree which results in a higher educated sample compared to the German population (22%). In terms of monthly net household income, 60% of the sample earning less than 3,000 EUR, which indicates that the sample has a lower income level than the German population as a whole, where 38% have a monthly net household income below 2,500 EUR (Central Bureau for Statistics, 2019) [39]. Table 2 provides a comprehensive overview of the sample distribution, allowing for a deeper understanding of its characteristics.

In addition to sociodemographic information, the participants were asked about their wine consumption patterns. Within the sample, the highest share of 39% of the participants reported that they prefer dry wines, and 46% reported their preferences for white wine. The preferred purchase channel was the supermarket, chosen by almost half of the sample participants, followed by discounters (19%) and specialised wine stores (18%).

Table 3 presents the absolute and relative distributions of various parameters that indicate the attitudes

Table 2. Sociodemographic and wine consumption behavioural characteristics of the participants.

Soc. Variable	Level	n	% of Sample	% of German Population	Behaviour Variable	Level	n	% of Sample (SD)
Gender	Female	112	45.9	50	Wine Consumption Frequency	Several times a week	58	23.8
	Male	127	52.1	50		Once a week	79	32.4
	Diverse	5	2.0	NA		Two to three times a month	78	32.0
Age	< 29	37	15.2	19		Once a month	27	11.1
	30–49	111	45.5	36		Less than once a month	2	.8
	> 50	96	39.3	45	Taste Preferences	Dry	96	39.3
Education	High school or less	6	2.5	34		Semi dry	77	31.6
	Secondary school	55	22.5	31		Sweet	51	20.9
	Upper secondary school	61	25.0	13		Extra sweet	20	8.2
	University degree	122	50.0	22	Wine Type	White wine	244	46.1 (22.3)
Income	< €1,000	12	4.9	NA		Rosé	244	20.3 (17.6)
	€1,000–€2,000	41	16.8	NA		Red wine	244	34.3 (22.9)
	€2,000–€3,000	94	38.5	NA	Purchase Channel	Discounter	244	18.9 (24.0)
	> €3,000	46	18.9	NA		Supermarket	244	44.7 (31.2)
	Not specified	51	20.9	NA		Specialised wine store	244	18.0 (22.7)
						Wine estate	244	8.7 (14.6)
						Online retail	244	9.4 (19.5)
					Willingness To Pay		244	7.1 (3.1)

towards wine and purchase criteria within the sample. On a 5-point scale ranging from 1 (I completely disagree) to 5 (I completely agree), the average interest in wine is above average (mean: 4.06), indicating a strong interest in wine among the participants. Conversely, the average involvement score is below the neutral midpoint (mean: 2.89), suggesting moderate levels of involvement. Additionally, there is a notable interest in new grape varieties with a mean score of 4.21, while the relevance of sustainability in wine production receives a neutral indication (mean: 3.50). This indicates a moderate influence of neophobia on the participants' evaluation of the wine tasting and can therefore be neglected in the analysis.

Regarding different purchase criteria evaluated on a 5-point scale ranging from 1 (not important at all) to 5 (very important), taste has a high influence (mean: 4.89). All the other criteria scores range from 3.26 (bottle design) to 3.77 (origin), indicating a heterogeneous pool of influential factors in the purchase decision, depending on personal preferences.

2.4. Data

The data were collected using a digital questionnaire developed through an online tool called SoSciSurvey [40] and administered on a tablet computer. The participants were provided with an explanation of the testing station at the beginning and then given instructions to follow in the questionnaire during the tasting. The questionnaire included questions regarding the sensory perception of the wines, preference ratings, reactions to the information on resistant grape varieties and sociodemographic and behavioural characteristics of the participants. Each group of 5–6 participants took approximately 30 minutes to complete the questionnaire, and this process was carried out up to 9 times per day.

The samples were evaluated on the established 9-point hedonic scale [41] from 1 (very bad) to 9 (very good) for overall taste, beginning with the question, "How much do you like the wine?". Additionally, participants evaluated the wine on a scale of 1 (very low) to 9 (very high) in terms of aroma, body, sweetness, acidity and bitterness. This was done to ascertain the impact of fundamental sensory attributes on wine quality [28]. Finally, participants were asked to indicate the price they would be willing to pay for a 0.75-litre bottle of the wine, with price estimation evaluated on a 5-point scale from "< 3.99 EUR" to "> 10.00 EUR", which covers the main price range of the German wine market [42].

In the subsequent analysis, the collected data are analysed quantitatively with R [43]. Appropriate statistical methods such as the Mann-Whitney U test [44] are used to evaluate sensory perception and preference, aim-

Table 3. Wine involvement and purchase criteria (alpha = .73).

Habits	Variables	Mean	Median	SD
Wine Involvement	I am very interested in wine.	4.1	4.0	.8
	My wine knowledge is above average.	2.9	3.0	.9
	When buying wine, I value sustainability.	3.5	4.0	.9
	I like to try new grape varieties.	4.2	4.0	.8
Purchase Criteria	Price	3.5	3.0	.9
	Design	3.6	4.0	1.0
	Certification	3.3	3.0	1.1
	Brand	3.4	3.5	1.1
	Information	3.4	3.0	1.1
	Origin	3.6	4.0	1.2
	Grape Variety	3.8	4.0	1.1
	Seal	3.4	3.5	1.1
	Taste	4.9	5.0	.4

ing to investigate potential differences between resistant and conventional grape varieties. Since the study involved a paired comparison, the test was appropriately adjusted. Furthermore, the analysis of variance (ANOVA) [45] was employed to assess the sensory attributes of each wine sample, with a view to elucidating the impact on quality perception. To further clarify the group differences, a post hoc analysis is performed using the Dunn test with Holm adjustment [46,47]. Finally, a proportional odds logistic regression analysis [48] is carried out to analyse the effects of various factors that influence the interest in resistant grape varieties.

3. RESULTS

The following chapter presents the outcomes derived from the conducted study. Specifically, the impact of information on the evaluation of FRGV wines was analysed. Due to the non-normal distribution of the data, non-parametric tests were employed [49].

3.1. Overall comparison

In the initial phase, the assessments of the tasting samples from the blind tasting were analysed. This was done with the aim of gaining insight into the deviations among the samples and establishing a foundation for the subsequent analyses. To facilitate the analysis, the wines from FRGVs and those from conventional grape varieties were aggregated into a single variable. This aggregation was accomplished using the means of the taste ratings and price evaluations. On the 9-point scale, the FRGV wines received an average overall taste rating of 5.77, while the conventional wines recorded 5.69. On the 5-point price scale ranging from 1 "< 3.99 EUR" to 5 "> 10.00 EUR", a price range for the FRGV and conventional wines was indicated as being between 3.00 EUR and 7.99 EUR, with the FRGV wines being rated as slightly more expensive. A mean comparison for both rating categories was conducted using the Mann-Whitney U test, revealing no significant differences, as depicted in Table 4. Consequently, it can be inferred that consumers provided a qualitatively and price-wise equivalent assessment, suggesting a neutral basis for further tests and supporting the hypothesis that the hedonic quality and price evaluations of FRGV wines do not differ from those of conventional wines. Thus, hypotheses 1 and 2 can be confirmed.

Subsequently, the conditioning effect (i.e. the influence of information presentation on the perception of FRGV wines and its impact on viticulture) was examined and is also shown in Table 4. When evaluating the

Table 4. Comparison of the evaluation of the hedonic quality and price of the wine from FRGVs and CGVs with a focus on the grape varieties.

Stage	Measure	FRGV		CGV		*V*	*r*
		M	*SD*	*M*	*SD*		
Blind	Quality	5.77	1.29	5.69	1.38	11688.5	.087
	Price	2.31	.78	2.25	.79	7834.5	.071
Informed	Quality	6.17	1.35	6.01	1.37	13264.5	.115
	Price	2.84	.89	2.69	.84	10882.5*	.145

$^{*}p < .05$. $^{**}p < .01$. $^{***}p < .001$. $^{****}p < .0001$.

ratings from the conditioned stage, the hedonic quality of the conventional wines was rated as 6.01, while that of the FRGV wines received a slightly higher score of 6.17. However, this difference was not statistically significant (p = .283), indicating that we cannot assert with certainty that there was a genuine difference in the taste ratings between the FRGV and conventional wines after the participants received information. In the conditioned tasting, where the participants received information about the wines in advance, the price evaluation of the FRGV wines was on average higher (2.84) than that of the conventional wines (2.69). This suggests that the participants were willing to pay a higher price for the FRGV wines after receiving information about them. This difference was statistically significant (p = .015) but with a small effect, indicating an increase in the price evaluation between the FRGV and conventional wines after the participants received the information.

To statistically verify the change in ratings, representing the conditioning effect, a mean comparison using the Mann-Whitney U test was conducted, as shown in Table 5. This facilitated the examination of the difference between the unconditioned, blind evaluation and the evaluation when information was available.

Analysing the change in hedonic quality revealed interesting results. In both categories and with regard to the wines from resistant grape varieties and conventional wines, a highly significant improvement was observed. While the FRGV wines exhibited an increase of .4 with an effect size of .291, the conventional wines showed a slightly lower, but still relatively large, increase of .32 with an effect size of .233. Both changes are considered highly significant, indicating a moderate positive effect of conditioning and mentioning grape varieties. Thus, hypothesis 3 can be confirmed.

A similar but stronger pattern emerged regarding the price evaluation. Positive effects were observed due to conditioning, with both the FRGV and CGV categories showing significant increases in price evaluations.

Table 5. Comparison of the evaluation of the hedonic quality and price of the wine from FRGVs and conventional grape varieties with a focus on the conditioning effect.

Grape Type	Measure	Blind		Informed		V	r
		M	SD	M	SD		
FRGV Wine	Quality	5.77	1.29	6.17	1.35	6785.5****	.291
	Price	2.31	.78	2.84	.89	3275.5****	.531
CGV Wine	Quality	5.69	1.38	6.01	1.37	7773***	.233
	Price	2.25	.79	2.69	.84	3088****	.486

$^{*}p < .05$. $^{**}p < .01$. $^{***}p < .001$. $^{****}p < .0001$.

The increase in the FRGV ratings was stronger (r = .531) compared to those of the wines from CGVs (r = .486). Therefore, hypothesis 4 can be rejected, as the evaluation of the conventional grape varieties improved despite the information presentation. Hypothesis 5 is confirmed.

3.2. Comparative analysis of grape varieties

In the following section, the aggregated ratings of the FRGV and CGV wines are presented to provide more detailed insights. These are broken down into blind tasting and conditional tasting and summarised in Table 6. The table contains hedonic quality and price assessment as well as sensory attributes ratings. This enables a comprehensive interpretation of the differences between the grape varieties. Table 6 shows the mean values for each attribute together with the corresponding standard deviations. In addition, ANOVA and Dunn test statistics are presented for each stage and attribute. This analysis reveals significant differences between the groups.

The preliminary findings suggest that wines from both conventional and resistant grapes have the potential for sensory consumer appeal. In the blind tasting, the FRGV Satin Noir received the highest rating of 6.1, surpassing the conventional variety Cabernet Sauvignon with a rating of 5.9. These were followed by Muscaris with 5.6, Sauvignon Blanc with 5.3 and Merlot with 5.2. The FRGV Sauvignac received the lowest rating of 5.0. However, during the conditioned and open tasting, this ranking was reversed. In this scenario, Sauvignac (5.9), Cabernet Sauvignon (5.8) and Merlot (5.7) emerged as the top-rated varieties. Varieties such as Sauvignon Blanc and Muscaris, which received high ratings in the blind tasting, experienced a decline in their scores in the conditioned tasting. This suggests that preconceived notions may adversely affect the perception of these wines. In the conditioned tasting, Laurot and Satin Noir received notably lower overall ratings. These findings highlight the significant impact of context and expectations on wine evaluation and underscore the absence of consistent patterns in the assessment of conventional versus resistant grape varieties. The disparity between the blind and conditioned tastings was pronounced.

The assessment indicates that evaluating wine quality goes beyond the classification of grape varieties and whether they are innovative, resistant or conventional. It suggests that additional sensory components should be considered to enhance the overall evaluation. A detailed analysis of sensory attributes in correlation with overall quality has revealed that multiple factors significantly influence taste assessment. Evaluations of hedonic quality ratings in both the blind and conditioned tastings

Table 6. Sensory acceptance of the tested wine samples in the blind and conditioned stages of the experiment.

Stage	Samples	Overall Taste[1]	Aroma[2]	Body[2]	Sweet-ness[2]	Acidity[2]	Bitter-ness[2]	Price[3]
Blind	Riesling	5.13^{ab} (2.25)	5.73^{abc} v(1.72)	4.47^{a} v(1.62)	4.19^{a} (1.89)	5.65^{b} (1.82)	5.22^{ab} (1.82)	2.81^{ab} (1.28)
	Sauvignon Blanc	5.26^{abc} (2.31)	5.10^{a} (1.53)	4.78^{a} (1.56)	5.16^{b} (1.92)	5.36^{ab} (1.83)	4.64^{a} (1.83)	3.35^{c} (1.01)
	Sauvignac	4.96^{a} (2.21)	5.89^{bc} v(1.73)	5.51^{bc} (1.71)	4.28^{a} (1.84)	5.27^{ab} (1.64)	5.50^{b} (2.00)	2.84^{ab} (1.16)
	Muscaris	5.61^{abc} (2.20)	5.26^{ab} (1.69)	5.85^{c} (1.75)	5.23^{b}bv(2.00)	5.11^{ab} (1.84)	4.49^{a} (1.77)	3.13^{bc} (1.34)
	Merlot	5.22^{abc} (2.09)	5.87^{bc} (1.91)	5.46^{bc} (1.98)	3.85^{a} (1.86)	5.70^{b} (1.90)	5.72^{b} (2.18)	2.52^{a} (1.31)
	Cabernet Sauvignon	5.89^{bc} (2.40)	6.14^{c} (1.88)	4.96^{ab} (1.70)	4.28^{a} (1.96)	5.69^{b} (1.79)	5.60^{b} (1.81)	3.12^{bc} (1.34)
	Satin Noir	6.09^{c} (2.49)	6.01^{c} (1.74)	4.78^{a} (1.55)	4.08^{a} (1.82)	5.68^{b} (1.71)	5.88^{b} (1.75)	2.98^{abc} (1.25)
	Laurot	5.00^{ab} (2.33)	6.12^{c} (1.78)	4.99^{ab} (1.63)	4.37^{a} (2.13)	4.95^{a} (1.69)	5.54^{b} (1.88)	3.16^{bc} (1.26)
	ANOVA (F(7,968))	*4.12****	*6.04****	*9.12****	*8.19****	*3.34***	*8.87****	*5.29****
	η2	*.029*	*.042*	*.062*	*.056*	*.024*	*.060*	*.037*
Conditioned	Riesling	5.20^{ab} (2.19)	4.80^{a} (1.73)	5.64^{cd} (1.67)	4.38^{a} (1.67)	5.80^{d} (1.73)	5.15^{ab} (1.73)	2.49^{a} (.89)
	Sauvignon Blanc	4.40^{a} (2.12)	5.56^{bc} (1.46)	5.20^{bc} (1.56)	4.29^{a} (1.75)	4.19^{a} (1.72)	4.80^{a} (1.84)	3.65^{c} (1.03)
	Sauvignac	5.89^{b} (2.26)	6.47^{d} (1.72)	5.98^{d} (1.66)	4.82^{a} (1.83)	5.38^{cd} (1.79)	5.00^{ab} (1.87)	3.30^{bc} (1.29)
	Muscaris	4.54^{a} (2.18)	5.52^{bc} (1.46)	6.08^{d} (1.53)	5.53^{b} (1.65)	5.08^{bc} (1.70)	4.52^{a} (1.66)	3.63^{c} (1.05)
	Merlot	5.74^{b} (2.38)	6.12^{cd} (1.86)	5.94^{d} (1.76)	4.22^{a} (1.96)	5.87^{d} (1.87)	5.70^{b} (1.94)	3.17^{b} (1.29)
	Cabernet Sauvignon	5.79^{b} (2.39)	6.42^{d} (1.74)	4.19^{a} (1.51)	4.67^{a} (1.90)	5.74^{cd} (1.86)	5.69^{b} (1.85)	3.49^{bc} (1.18)
	Satin Noir	4.63^{a} (2.39)	5.46^{b} (1.64)	5.23^{bc} (1.67)	4.48^{a} (1.85)	5.42^{cd} (1.79)	5.14^{ab} (2.03)	3.50^{bc} (1.14)
	Laurot	4.37^{a} (2.20)	5.32^{ab} (1.60)	4.97^{b} (1.71)	4.84^{ab} (1.91)	4.61^{ab} (1.81)	5.08^{ab} (1.83)	3.54^{bc} (1.28)
	ANOVA (F(7,968))	*10.42****	*15.09****	*18.53****	*6.71****	*13.96****	*5.86****	*13.63****
	η2	*.07*	*.098*	*.118*	*.046*	*.092*	*.041*	*.09*

Note: All variables were logarithmically transformed prior to the post hoc analysis, but the original mean scores are presented in the table above. Superscript letters indicate groups that are significantly different based on the Dunn test with Holm adjustment.
[1] 9-point scale from 1 (very bad) to 9 (very good). [2] 9-point scale from 1 (very low) to 9 (very high). [3] 5-point scale from 1 "< 3.99 EUR" to 5 "> 10.00 EUR". *p = < .05 **p = < .01 ***p = < .001.

were found to positively correlate with sensory attribute ratings. Additionally, the perceived intensity of acidity and bitterness also had a positive effect on overall hedonic quality assessments, indicating that these characteristics should be present in a robust sensory profile. The results indicate that there is a preference for wines with a lower residual sugar content, regardless of the tasting condition. This suggests that hedonic quality rating increase as sweetness level decrease. These findings highlight the importance of sensory quality and profiles in the comprehensive evaluation of wines, regardless of the grape variety's resistance or conventional status.

Considering the sensory characteristics, the differences between blind and conditioned tasting are particularly noticeable. The effect sizes are generally higher in conditioned tasting than in blind tasting, indicating a more precise differentiation of the ratings. The hedonic quality evaluation showed significant differences among the varieties. Riesling exhibited the greatest decrease, from 5.73 to 4.80, while two FRGVs, Sauvignac and Satin Noir, showed the greatest increase, with an average of approximately .5 points. The wine type and grape variety did not affect the hedonic quality evaluation. The body rating generally increased for every sample after conditioning, except for Cabernet Sauvignon, whose rating decreased from 4.96 to 4.19. The perception of sweetness generally increased in the conditioned tasting, although the differences were not as distinct as in the blind tasting. The rating for acidity remained largely unchanged, except for Sauvignon Blanc, whose rating shifted significantly from 5.36 to 4.19. The bitterness ratings exhibited a significant difference between conventional and resistant grape varieties. The ratings for CGVs remained largely unchanged or decreased slightly, while they sharply decreased for resistant red varieties. The effect size of the differences in this category decreased, indicating an equalisation of perceptions.

The evaluation of wine prices revealed that the conventional grape varieties of Sauvignon Blanc (3.35) and Cabernet Sauvignon (3.12), as well as the FRGVs Laurot (3.16) and Muscaris (3.13), received the highest ratings in the blind tasting. In the conditional tasting, the price assessment generally increased, except for Riesling, which decreased from 2.81 to 2.49. The ratings primarily reflect the sensory ratings, with the exception of Laurot, which received a lower rating. A decrease in acidity and bitterness, as well as an increase in sweetness, led to a higher price rating, regardless of the wine type or grape

variety, indicating a grape variety-specific rating.

3.3. Regression analysis of FRGV quality predictors

To gain a deeper understanding of the data, a multiple proportional odds logistic regression was conducted to examine the influence of various factors on the hedonic quality perception ratings of the wine samples from resistant grapes. The model included a number of variables, including demographics (gender, age, education and income), wine preference (e.g. dry, semi-dry, sweet), frequency of consumption, rating of sensory attributes, interest in wine and FRGVs and several other factors, such as price, features, certification, brand, information, origin, grape variety and seal. The model shown in Table 7 was built by progressively reversing the model. Various tests were used to calculate the quality of the model. In the analysis, the multicollinearity of the model variables was first checked using the variance inflation factor, and no value above five was found. This indicates low multicollinearity and strengthens the stability of the model. Several pseudo-R^2 values were calculated, including McFadden (.36), CoxSnell (.54), Nagelkerke (.61) and AIC (350.68), indicating an acceptable model fit. The generalised Hosmer-Lemeshow test confirmed the fit of the ordinal model to the data, as the p-value was not significant (.553). The predictive performance of the model was assessed using a reference matrix with an accuracy of 67.5%, indicating satisfactory predictive performance. A likelihood ratio test showed that the model was significantly better than the null model, with a chi-squared statistic of 186.59 and a very low p-value (< .001). This highlights the superiority of the model in explaining the observed flavour ratings.

Table 7 displays the results of the multiple proportional odds logistic regression, which demonstrate the significant influence of various variables on the hedonic quality evaluation of wine from resistant grapes. One particular result is that female participants exhibit a preference for the sensory characteristics of FRGV wines, as evidenced by an odds ratio (OR) of 2.016. Furthermore, the data show that an increased purchase probability is significantly correlated with a better taste rating of these wines (OR = 5.923). Similarly, a positive correlation between the hedonic price rating and quality rating for FRGV wines was found (OR = 3.864). Additionally, individuals with an interest in wine tend to rate FRGV wines more favourably (OR = 1.626), suggesting that a general interest in wine leads to a more open attitude towards new or specific types of wine. Furthermore, the study found that consumers who value sustainability tend to rate the hedonic quality of FRGV wines more highly (OR = 1.858).

Additionally, the importance of price when purchasing wine was found to have a positive influence on taste perception (OR = 1.457), highlighting the complex nature of price perception and its impact on hedonic quality rating. A minor influence of information in the purchase decision is associated with a more critical perception of quality, as indicated by an OR of .706 for the importance of information. The significance of regional preferences and terroir is emphasised by the OR of 1.558 for the origin of the wine. A lower emphasis on grape variety when making a purchase decision is associated with a negative impact on the hedonic quality rating (OR = .64). This suggests that individuals who place less importance on grape variety tend to rate FRGV wines more highly in terms of quality. Additionally, an OR of .625 indicates a negative impact when organic production is less important for quality rating. This suggests that individuals who are less concerned about organically produced wine tend to rate the hedonic quality of FRGVs more highly.

Table 7. Results of the multiple proportional odds model to analyse the impact of different variables on the taste ratings of the resistant grape samples.

Variables	Estimate	*SE*	*p*	Odds Ratio	95% CI	
					LL	*UL*
Intercept 1 (bad/mid)	10.998	1.62	< .001	-	-	-
Intercept 2 (mid/good)	14.395	1.769	< .001	-	-	-
Gender (female)	.701	.304	.021	2.016	1.116	3.692
Purchase Probability[a]	1.779	.231	< .0001	5.923	3.838	9.523
Price Rating (FRGV)[b]	1.352	.209	< .0001	3.864	2.602	5.921
Wine Interest[c]	.486	.180	.007	1.626	1.147	2.330
Sustainability[d]	.620	.206	.003	1.858	1.248	2.808
Price[d]	.376	.184	.041	1.457	1.018	2.096
Information[d]	-.348	.137	.011	.706	.537	.921
Origin[d]	.443	.157	.005	1.558	1.151	2.131
Grape Variety[d]	-.447	.153	.004	.640	.470	.860
Organic Production[d]	-.470	.176	.007	.625	.440	.879

Note: CI = confidence interval; *LL* = lower limit; *UL* = upper limit. [a] 5-point scale from 1 (very unlikely) to 5 (very likely). [b]5-point scale from 1 "< 3.99 EUR" to 5 "> 10.00 EUR". [c] 5-point scale from 1 (I completely disagree) to 5 (I completely agree). [d] 5-point scale from 1 (not important at all) to 5 (very important).

4. DISCUSSION

Several sensory studies have been conducted with both experts and consumers to evaluate the sensory characteristics of wines made from FRGVs, which is crucial

to understanding consumer preferences [50]. In general, providing information can enhance sensory acceptance [51,52], particularly in relation to ecological production methods [35]. However, the influence of information on consumers' sensory perception has yet to be investigated.

Although the area under cultivation is limited, and only 12% of the German population is familiar with wines from resistant grape varieties [13,53], it is important to recognise the benefits of these grape types [4]. This highlights the need for more extensive education [10,11,54]. Therefore, a three-stage test was conducted to determine the influence of information on sensory acceptance and to assess possible future changes in perception.

The results of the blind tasting showed moderate differences in the evaluation by the subjects, both in terms of hedonic quality and price, thus providing a neutral basis for the evaluation of the conditioning effect. The study indicates that hedonic sensory quality does not have a direct influence on price perception. It was found that individual wines with higher quality ratings did not necessarily receive higher prices. The hedonic quality assessment of wines from resistant and conventional grape varieties showed moderate differences, with the former being rated higher. This indicates that these products are comparable in quality and competitiveness.

In a qualitative study conducted by Kiefer and Szolnoki (2024b) [53], producers expressed concerns that providing information on resistant grape varieties could potentially discredit CGVs. This is due to the fact that resistant grape varieties are often considered a niche product and cover only a small part of the product range [11,32]. As a result, many producers tend not to emphasise the advantages of FRGVs. However, the results indicate that conditioning can also improve the hedonic quality of conventional grape varieties. Additionally, the moderate differences in hedonic quality assessment between resistant and conventional varieties (also shown by González-Centeno et al., 2019) [25] could potentially alleviate producers' concerns. Therefore, it may be advisable to provide information in the marketing context to ensure that recipients are well informed and the effect of neophobia can be reduced.

During the conditioned tasting, adjustments in price perception were observed in response to the information provided. It was noted that wines that received higher hedonic quality ratings, such as Riesling and Cabernet Sauvignon, were also rated higher in terms of price. On average, conventional wines received lower ratings compared to FRGVs, suggesting that consumers were less sensitive to price after conditioning. According to other studies, there are certain consumer groups who are less sensitive to price and willing to pay more [10,20].

Both the blind and conditioned taste tests showed significant changes across all the categories, which is expected since providing information about products that have been tasted tends to lead to significant variation [35,55]. The hedonic quality and price assessment of the wines from both resistant and conventional grape varieties showed significant improvement. This fragment highlights the potential advantages of providing information about the characteristics of resistant grape varieties. The findings are consistent with previous studies on positive conditioning effects [20,23,33], suggesting that various sensory attributes can directly impact quality perception and indirectly influence the perceived value of wine samples. The study suggests that resistant grape varieties have the potential to produce wines that are sensorially appealing by the consumers. The ratings of the wines in the tasting tests varied independently of the grape variety category, indicating that wine quality is determined by various factors.

It was observed that the perception and evaluation of the wines were significantly influenced by the tasting conditions. In the blind tasting, certain resistant varieties were found to have scored higher than conventional ones, suggesting that the former can compete with or even surpass conventional varieties in sensory terms, provided there are no biases. This observation is supported by other studies [25,28,33].

The change in most of the ratings when prior information is provided emphasises the importance of expectations and prior knowledge. The principles of assimilation and contrast as described by [18] may be relevant in this regard. If consumers have certain perceptions of wine based on their perception of grape varieties, this could influence their preferences during tasting. For example, if consumers have a strong preference for conventional grape varieties, they might tend to rate wines from resistant varieties as less appealing due to assimilation effects, even if they are of high quality. On the other hand, consumers who are open to new experiences or have an aversion to conventional varieties may find wines from resistant varieties a refreshing alternative due to contrast effects. Therefore, it is important to consider developing strategies to enhance the acceptance of resistant varieties, with a focus on quality and the sensory profile based on conventional grape varieties [28,33,56].

Furthermore, the combination of sensory information from tasting and additional information can enhance the preservation of acquired knowledge about resistant grape varieties [57]. Both types of grape variety exhibit positive correlations between aroma intensity and the perception of acidity and bitterness, as well as their overall ratings. This underscores the importance

of the sensory profile beyond the grape variety category. However, it is important to note that external information usually has a greater impact on consumer perception than sensory characteristics [58].

Moreover, the findings suggest that various demographic and psychographic factors, including gender, purchasing inclination, interest in wine, sustainability appreciation, price perception and attitudes towards regional origin and organic production, have a significant impact on the assessment of hedonic quality and therefore the acceptance of wines produced from FRGVs. The study confirms that female participants tend to favour the taste of wines from resistant grape varieties, which is consistent with the findings of a previous qualitative study conducted by Kiefer and Szolnoki (2023) [10]. Furthermore, it suggests that a positive taste perception is strongly associated with the purchase probability, indicating that the initial sensory impression is a key predictor of taste evaluation. This highlights the importance of reducing the risk associated with the first purchase [2]. Thirdly, with an increasing interest in and appreciation for sustainability in viticulture, the hedonic quality perception of FRGVs is being positively influenced and provides an opportunity to market wines from FRGVs to consumer groups that are interested in wine and sustainable wine production [30,54,59]. Finally, it can be inferred from the correlation between the price and quality evaluations that pricing may serve as a quality indicator in consumer perception, as suggested by Weber et al. (2021) [28]. To effectively develop the market, it is recommended to use a pricing strategy that targets either the upper segment for unique products with an individual sensory profile or the lower to middle segment for products with a known sensory profile.

The study suggests that individuals who possess a general interest in wine and value sustainability may exhibit a more positive and receptive attitude towards wines produced from FRGVs. In order to increase awareness and acceptance of sustainable viticulture, it is essential to conduct education and awareness campaigns, as highlighted by Doye et al. (2005) [4], Kiefer and Szolnoki (2023) [10] and Sloan et al. (2010) [11].

The study examines the complex relationship between price, information and origin in wine purchasing decisions. It is proposed that a positive perception of quality is associated with a diminished effect of information and a decreased importance of the grape variety. This indicates that consumers often use familiar grape varieties as benchmarks. Promoting transparency and education on the benefits of wines produced from FRGVs could enhance acceptance and overcome barriers [60]. In particular, the product label should provide information on the sensory characteristics and benefits of the production of FRGVs adapted to the target group [52]. This reduces the asymmetry of information and thus facilitates the consumer's purchase decision [54].

5. CONCLUSIONS

This study highlights the significant potential of FRGVs to successfully establish themselves in the future wine market. By combining distinctive sensory characteristics with environmental benefits, FRGV wines could offer an appealing option for consumers who value quality, sustainability and innovation. The communication of information about FRGV wines is considered crucial in increasing their market acceptance and contributing to more sustainable viticulture. A well-thought-out marketing strategy is needed to effectively communicate the unique sensory profile and environmental benefits of FRGVs, considering the complex relationship between price, information and origin.

The present study has limitations that could potentially influence its interpretation. The psychoactive effect of wine, particularly in terms of contributing to a favourable mood, could affect evaluations as well as the learning effect created by the variety of products. In real-world scenarios, additional factors such as social context or prior experiences could also influence consumer behaviour and sensory perceptions, aspects that this controlled environment study does not fully accommodate a real-life tasting experience. Additionally, the data collected are based on self-reported information from the participants, and these could be strengthened in a future study by adding actual purchase decisions and general interests of the participants to improve reliability. It has been suggested that the presence of self-confidence or personal involvement may lead to bias, as the willingness to pay more may not be limited to FRGV wines but may also extend to conventional wines. Furthermore, the assumption that providing specific information increases acceptance is currently being questioned. To gain a more accurate interpretation of the results, it may be beneficial to include control groups with non-FRGV-specific information, which could help clarify the role of information content. Finally, the sample is highly educated compared to the general German population, which may result in a different processing of information. This higher level of education could amplify the influence of information, potentially introducing bias into the results.

It is suggested that future research adopts a similar testing approach and focuses on consumers' actual

purchasing decisions, information sources and interests. This would allow for a more accurate assessment of purchase propensity and further strengthen the study's validity and applicability. A study with an international focus could be conducted to explore the perception of FRGV wines in global markets while considering cultural differences and global marketing trends. Furthermore, future studies could evaluate the impact of education and awareness campaigns on consumer knowledge, attitudes and behaviour, using both quantitative and qualitative analysis to measure their effectiveness. Additionally, incorporating an experimental auction method or a discrete choice model in future research could provide more truthful WTP estimations, offering deeper insights into consumer purchasing behaviour and enhancing the practical applicability of the findings.

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APPENDIX

Tuesday, 13.06.2023 Frankfurter Allgemeine Ressort: Knowledge

"What luck that there are Piwis"

FAZ-Interview with Franz Pflüger about resistant grape varieties

Experts consider fungus-resistant grape varieties, known as Piwis, to be the solution to many of the existing problems in the wine industry. However, only very few people are aware of these grape varieties.

FAZ: *Mr Pflüger, could you briefly explain what Piwis are?*

Pflüger: Piwis, i.e. fungus-resistant grape varieties, are cultivars, mostly from robust old wild varieties and known partners. The new varieties are created without genetic engineering through traditional crossing and selection. The main advantage is that the vine is better able to defend itself against fungal diseases, especially downy and powdery mildew. This means that around 75 per cent of plant protection can be saved, often even more.

FAZ: *How can these grape varieties lead to more sustainable viticulture?*

Pflüger: A major problem in the switch to more sustainable viticulture is the high level of pesticides used.

As a result, viticulture has by far the highest use of pesticides per hectare and year in viticulture compared to all other agricultural products produced in the EU. This is where Piwis can show their advantages. They also have great potential in difficult locations, and some varieties can also cope better with heat or drought.

"A huge new field of flavours is opening up here that is worth discovering."

FAZ: *What other advantages are made possible with Piwis?*

Pflüger: By reducing the use of pesticides by around 75 per cent, not only ecological but also economic benefits are possible. Less plant protection also means fewer tractor journeys, protection of valuable soils and promotion of biodiversity.

Of course, this also saves petrol costs, personnel etc. and can therefore make the vineyard more future-proof. The most important thing, however, is that high quality paired with an independent varietal character is possible. This opens up completely new possibilities. With the known varieties, the possibilities for making viticulture more sustainable and ecological are limited, although there is a worldwide need for this. But with Piwis we have a solution. The only question is how quickly it can be realised. And this is where Germany in particular has the chance to stand out from the international competition.

Figure A.1. Newspaper article (English translation, originally written and presented in German)

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The market for non-alcoholic wine in Germany – Structural analysis and implications for competitive strategies

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Abstract. Non-alcoholic wines have become increasingly important in recent years in Germany. A constant stream of new market players and products is evidence of a dynamic market development and for the creation of a new branch in the highly competitive wine sector. Thus, the central aim of this article is to provide a first analysis of the structure of the German market for non-alcoholic wines in order to derive implications for industry competition and possible competitive strategies of individual market participants. An explorative research approach has been applied including in-depth interviews with experts from various companies along the value chain (n=24). Results show that competition in the market for non-alcoholic wines must be regarded as dynamic due to strong external market forces. A high risk of new companies entering the market can be emphasised as well as the high bargaining power of the retail and a high threat of substitutes. Within the industry, however, rivalry is currently considered to be low, resulting in low profitability and a tendency towards high fluctuation of market participants. With regard to possible competitive strategies it becomes clear that especially for smaller wineries, a long-term successful survival within the market can only be realised with strong differentiation. Ultimately, the transfer of the products into an own category which departs from the classic image of non-alcoholic wine represents a promising approach in order to address entirely new target groups.

Keywords: non-alcoholic wine, dealcoholisation, structural analysis, five forces, competitive strategies, competition.

1. INTRODUCTION

In the European Union, a steady decline in wine consumption can be observed for decades, particularly in the main wine-growing countries of France, Italy and Spain [1,2]. In Germany, wine and sparkling wine consumption has long remained at a constant level of around 24 litres per capita. Since 2019, however, a slight decline of around one litre per capita was observable [3]. While overall alcohol consumption is decreasing in Germany and the EU – not only with regard to wine[1] – non-alcoholic alternatives are

[1] For instance, beer consumption in Germany dropped from 141 litres per capita in 1970 to 95 litres in 2020 [4].

becoming more and more important [5]. This development is often associated with increasing health awareness and new lifestyle trends, especially in younger generations [6]. Not only in Germany, wine producers are therefore focusing on non-alcoholic[2] wines, which differ from grape juices and sparkling wines in that the alcohol is removed from already fermented wine through the use of a dealcoholisation process [7].

Germany is a special market for non-alcoholic wines in several respects. On the one hand, the process of dealcoholising wine was developed and patented in the winegrowing region Rheingau at the beginning of the 20th century. This makes Germany the pioneer in the field of wine dealcoholisation, which is ultimately reflected in the comparably high number of five domestic service providers for this refinement step. At the same time, Germany has become the most important market for products in the "no & low" category[3] [8], including non-alcoholic still and sparkling wines. Non-alcoholic sparkling wines accounted for around five per cent of the total German sparkling wine market in 2020. Still wines are less significant with a market share of under one per cent [9]. According to the market research institute IRI, the main distribution channel is food retail, where sales of non-alcoholic still wines totalled 3.7 million bottles in 2020, while sales of sparkling wines amounted to 21.7 million bottles [10].

Despite its still minor importance, the market is developing dynamically in comparison to the traditional alcoholic wine products, which are increasingly less consumed. For instance, the compound annual growth rate for non-alcoholic wine is indicated at 9 percent for the period from 2021 to 2025 [8]. While the overall data situation is so far still rather uncertain, a look at the market reveals clear trends: Large companies in the sparkling wine industry, such as Henkell-Freixenet and Rotkäppchen-Mumm, are increasingly being joined by wine cellars, cooperatives and small and medium-sized wineries with vineyards of less than 50 hectares. While non-alcoholic wines are primarily produced by existing companies in the wine industry, which are mostly focusing on complementing their portfolios of alcoholic wines, start-ups and winegrowing companies that focus exclusively on marketing non-alcoholic wines are also entering the market.

These developments not only raise questions about suitable production processes, the optimization of sensory characteristics or marketing issues [11–16]. One relevant aspect that has so far remained untouched is the strategic positioning of individual companies. This seems all the more important as companies in a young, rapidly developing (sub)sector are sometimes faced with major challenges due to technological and strategic uncertainties, high costs, spin-offs and the confrontation with first-time buyers [17], which go far beyond the search for suitable manufacturing processes or possible marketing issues. Rather, the question of strategic positioning is essential for consolidating a company's market position and for long-term success. In the face of steadily declining wine consumption, which could be strongly influenced by social trends and developments in alcohol policy in the future, the discussion of non-alcoholic alternatives represents an important building block for the development of the industry. With its long history and the comparatively high market relevance of non-alcoholic wines today, Germany is a particularly good case to consider.

The aim of this paper is therefore (1) to provide an initial comprehensive overview of the structure of the non-alcoholic wine industry in Germany and (2) to derive strategic implications for (potential) market participants from the data collected. For this purpose, an explorative approach in the form of expert interviews with a subsequent qualitative content analysis was chosen. A total of 24 interviews were conducted with experts from nine different types of companies along the value chain.

The remainder of this article is structured as follows: Section two outlines the development of the market for non-alcoholic wines in Germany. In addition, the basic production processes and the legal framework are presented. In section three, these initial findings are translated into a framework for analysing the intensity of competition according to Porter [17]. Section four is dedicated to the qualitative research approach. Section five presents the most important implications of the findings for possible competitive strategies. Finally, the results of the article will be discussed in section six.

2. NON-ALCOHOLIC WINES IN GERMANY

2.1. Market development of non-alcoholic wines in Germany

Non-alcoholic wines have been produced for over 100 years. In 1907, the German winegrower Carl Jung applied for a patent for his invention of vacuum distillation for wine. This process made it possible to separate the ethanol under vacuum low temperatures, which served to better preserve the volatile flavour compo-

[2] According to the German law, the term can be used for products with an alcohol content of up to 0,5 ABV.

[3] In a recent study conducted on behalf of the European Commission, products in the no & low category are defined as "any beverage whose market positioning recalls, mimics or evokes that of an alcoholic beverage, but whose alcoholic content is lower than the minimum required for the alcoholic beverage of reference, or equal to zero" [5].

nents of wine. The development of the technology, which is still used today, took place at a time when the critical social and political debate about alcoholic beverages such as spirits, beer and wine reached a peak in Germany [18]. The First World War and the lack of a legal framework for production of non-alcoholic wines put an early brake on the success of the products. A second development stage began at the end of the 1980s, when innovative products were sought as a reaction to a new health movement, the so-called "light wave" [19]. Although there was a significant increase in production at this time, non-alcoholic wines did not achieve significant market shares [20].

Over the past five years, however, a dynamic market development can be observed, even if the absolute share of the products is still at a very low level in the context of the overall German wine market. As noted, the market share of non-alcoholic sparkling wines in Germany was estimated at around five per cent, that of still wines at under one per cent in 2020. The market volume of non-alcoholic sparkling wines in the overall sparkling wine market would therefore amount to around 14 million litres, while that of still wines would be even higher in relation to the total German market for still wines (approx. 16.9 million hectolitres in 2018) - in 2020, however, the German Wine Institute (DWI) assumed only three to five million litres, which would correspond to a market share of less than 0.3 per cent [9].

In summary, non-alcoholic sparkling wines have higher market relevance than their counterparts in the still wine sector.

Despite their low relevance for the German wine market as a whole, both categories are recognised as having high growth figures. According to IRI, non-alcoholic wine recorded sales and turnover growth of 40.8 per cent and 42.7 per cent respectively in the German food retail sector in 2020. Non-alcoholic sparkling wines grew at a much slower rate, with sales up 1.6 per cent and volumes up 5.9 per cent [10]. These developments are also reflected in an increasing variety of products. In 2023, the world's largest wine fair ProWein dedicated a separate area to the category of non-alcoholic products for the first time [21].

2.2. Manufacturing processes

According to the legal framework in Germany, thermal processes and membrane processes are permitted for the dealcoholisation of wines. Thermal processes rely on distilling the wine under reduced atmospheric pressure, whereby the ethanol contained in the wine vaporises at temperatures of around 30 degrees Celsius [22]. The spinning cone column is one of the most widespread variants of distillation under vacuum [16]. In this process, the wine to be dealcoholised is passed over a moving, rapidly rotating cone, reducing the necessary dwell time in the column compared to classic vacuum rectification [23].

Membrane processes, on the other hand, work by separating the ethanol through special membranes that are only passable for certain volatile substances in the wine [24]. Although these systems do not require the product to be heated, membrane processes also have several disadvantages such as a high amount of water input or a significantly longer process time for complete dealcoholisation [25]. Thus, four of the five service providers for dealcoholisation operating in Germany are working with thermal processes. They play an overall important role, as the purchase of an in-house dealcoholisation plant is hardly feasible for smaller companies for financial reasons. At the same time, they offer dealcoholisation from small minimum quantities starting at 300 litres [26].

Before the process of dealcoholisation, a suitable base wine is required. While dealcoholisation can be applied for both red and white wine, grape varieties with a high aroma concentration such as Gewürztraminer, Muscat or Sauvignon Blanc are particularly recommended for dealcoholisation. In addition, the shortest possible time between fermentation and dealcoholisation is suggested in order to achieve the highest possible aroma concentration [27]. Nevertheless, some of the products differ greatly from the original in terms of flavour as the processes are associated with a changed sensory profile due to a loss of certain characteristics such as body and fullness [11]. Additionally, the concentration of acidity through the process and the volume loss of up to 20 per cent necessitates the addition of sugar, which is why many non-alcoholic contain residual sugar levels of 40 grams or more per litre.

2.3. Legal framework for non-alcoholic wines in Germany

As products with an alcohol content below 0,5 ABV, non-alcoholic wines have some special legal characteristics, such as the mandatory labelling with a best-before date. With Regulation 2021/2117, the European Union has decided to standardise the product designation of non-alcoholic wine throughout the EU as part of the revision of the Common Agricultural Policy (CAP) [28]. Accordingly, the term "alcohol-free" will be changed to "dealcoholised". Even after the new EU legislation comes into force, the term "alcohol-free" will remain an optional addition to the mandatory term "dealcoholised".

With EU Regulation 2021/2117, further regulations for non-alcoholic wines were adopted, which are to be transposed into national law. Accordingly, in the German case, non-alcoholic wines will in future be treated as products within the meaning of the German wine law. Although much discussed, this has no consequences for the indication of grape varieties on the labels: the varieties specified in Paragraph 42 of the German wine regulation, including Riesling, Spätburgunder, Weißburgunder or Grauburgunder, may therefore continue to be indicated on the label of non-alcoholic wines in future.

Furthermore, the EU regulation provides for the prohibition of the dealcoholisation of wines which have been chaptalized before alcoholic fermentation [28]. Legal obstacles also occur due to the current ban on the production of non-alcoholic organic wines in the European Union, as dealcoholisation as a permissible oenological process has not been included in the legislation for organic products (EU 848/2018).

While the legal framework conditions in the EU are being standardised, regulatory intervention in the market is also becoming increasingly important, as shown by the EU Parliament's recent decisions to beating cancer [29,30]. Although the focus here is specifically on ethanol as one of the main risk factors for cancer, the latest accusations of "alibi marketing" show that non-alcoholic beverages could also be the centre of EU alcohol policy in the future [31,32]. Alibi marketing refers to attempts by companies in the alcohol industry to promote their brands without explicitly advertising products containing alcohol or excessive sugars which they also manufacture. Beer producers, for example, often use the same brand images and slogans for their non-alcoholic beverages as for their alcoholic products [33].

In summary, non-alcoholic are the subject of extensive regulatory adjustments and efforts that will have a far-reaching impact on the beverages and still leave unanswered questions for producers and sellers.

3. FRAMEWORK OF COMPETITION INTENSITY

3.1. Porters five forces

The five forces analysis based on Porter [17,34] has established itself as a classic instrument for analysing industries and is has already been applied to analyse different aspects of the international wine sector [35-38]. Richter and Hanf [35] used the model to derive strategic implications for winegrowers' cooperatives in the highly competitive German wine market. In an international context, Mizik and Balogh [37] analysed the structure of the Chinese wine market using the Five Forces. Bitsch et al. [36] have done the same for the largely unexplored Armenian wine market, also taking a qualitative approach. Lorenzo et al. [38] analysed generic strategies of different types of companies in the Spanish wine industry.

According to this market-oriented approach, the structure of an industry is a key factor influencing industry competition and the strategic options of individual companies. An industry is interpreted as a space within whose boundaries companies are exposed to five competitive forces, whose intensity ultimately determines the attractiveness of an industry. (1) **The risk of new companies entering the market** leads to reduced profitability as prices are depressed or costs for existing market players are increased. Barriers to entry, which are increased by the existence of economies of scale or existing product differentiation, are considered a decisive factor for the market entry of potential competitors. (2) **Rivalry between existing companies in an industry** is increased, for example, by slow industry growth or greater competition for market share. In addition, there are possible exit barriers, which are defined as those factors that cause a company not to leave the industry, even if they "generate lower or even negative rates of return" by staying. These include, for example, specialised assets or emotional barriers. (3) The **threat of substitutes** limits the profit potential of companies in the sector, as pricing for companies in a sector is restricted by the pricing of substitute products. At the same time, competition is intensified by the possible use of the same distribution channels and cooperation with the same supplier groups. Finally, the (4) **bargaining power of suppliers** and the (5) **bargaining power of buyers** can also exert an increasing influence on competition in the sector, especially if both groups are dominated by only a few companies. In view of the description of the market for non-alcoholic wines in Section 2, this provides an initial rough picture of the industry, which is shown in Figure 1. Consequently, service providers for de-alcoholization are in the position of suppliers, wineries and cellars make use of the service and pass the products on to the retail, which consists of various types of companies.

In the following, the findings from section 2 are transferred to the model in order to develop predictions for the empirical analysis.

3.2. Threat of new entrants

As described in section 2, the constant adjustments to the legal framework conditions or the possible accusation of alibi marketing not only tend to lead to a high level of uncertainty on the part of producers, service providers and retailers, but also to potentially high admin-

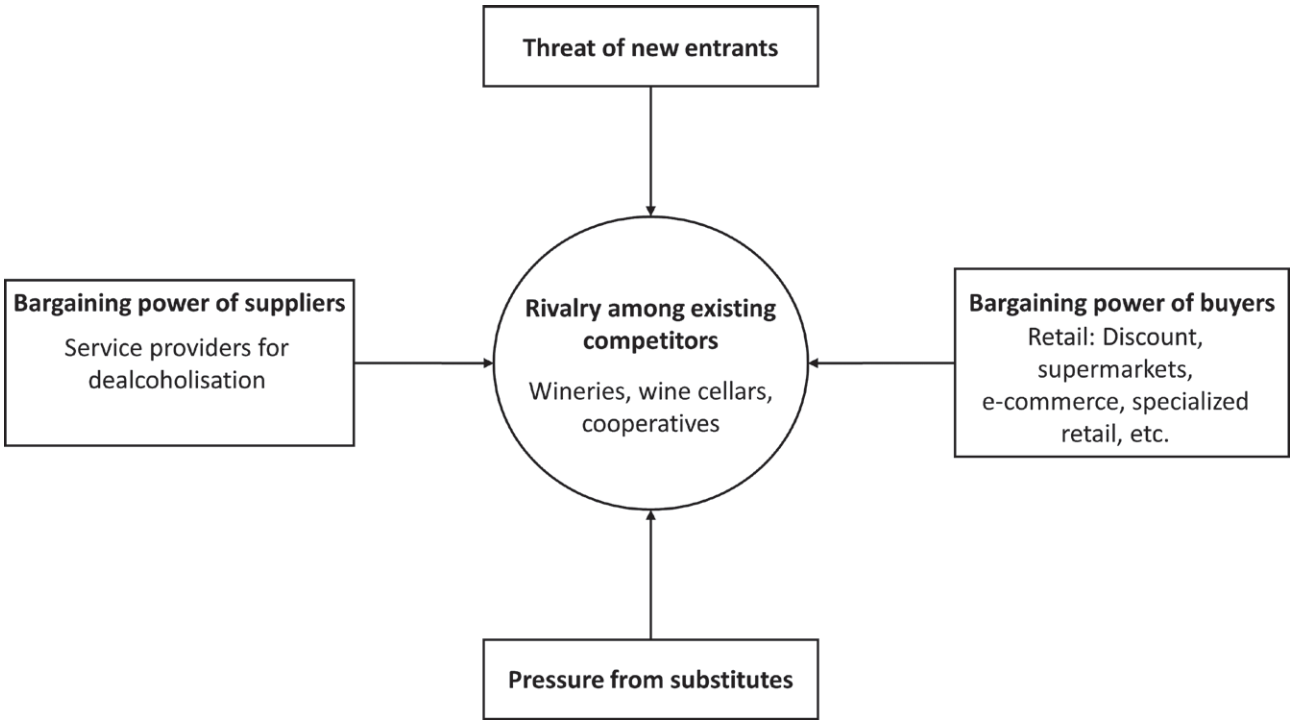

Figure 1. Framework for market structure.

istrative barriers. On the other hand, low entry barriers can be assumed in the area of production, as smaller companies are allowed to deliver small minimum quantities from 300 litres to contractors. Purchasing own equipment to vertically integrate is not economically worthwhile for smaller companies in view of the small quantities produced. While high economies of scale can also be expected in the non-alcoholic wine sector if production is increased beyond a certain point, the low minimum quantities requested suggest that this aspect is rather irrelevant for market entry. Apart from the potentially high costs for marketing and distribution, non-alcoholic products can be produced without major capital expenditure: Base wines can be purchased on the bulk wine market and service providers can be commissioned to deal with dealcoholisation, filling and packaging. As most industry players produce non-alcoholic wines as a supplement to their existing portfolio, the additional capital expenditure, for example in the areas of marketing and sales, is rather low as existing structures can be used.

For vertically integrated companies with own dealcoholisation plants, there is no possibility to offer other non-alcoholic products made from wine using the dealcoholisation process. The capital invested therefore represents sunk costs. In smaller, non-vertically integrated companies, on the other hand, low switching costs can be expected, as other non-alcoholic products made from grapes can easily be offered, such as grape juice, still wine or sparkling wine.

The German wine market is highly competitive due to a large oversupply, and retailers in particular have great negotiating power. Thus, entry to distribution channels can be challenging. Existing companies in the wine industry, such as Rotkäppchen-Mumm or Henkell-Freixenet, already serve existing distribution channels with their dealcoholised products. Potential newcomers to the industry must therefore either persuade the channels to favour their product or create entirely new distribution channels. However, as the industry can still be considered in an early development phase, access to retail channels may still be more open than in the wine and sparkling wine sector.

Prediction 1: Except from administrative obstacles, barriers to entry in the market for non-alcoholic wines are low.

3.3. Rivalry among existing competitors

At the moment, there still exist comparatively few competitors in the market for non-alcoholic wines, although major companies in the German wine industry are already operating in this sector, such as the sparkling wine producer Rotkäppchen Mumm, which holds

a market share of 50 per cent in the sparkling wine market [39]. At the same time, the market for non-alcoholic wines is characterised by dynamic growth, which means that companies are already improving their results by keeping up within the industry [17], indicating an overall low rivalry. As non-alcoholic wines must display a best-before date, this "deadline" implies that the products are difficult to store and must be marketed comparatively quickly. Companies are therefore more tempted to lower prices unnoticed (price shading), ultimately leading to high rivalry. On the other hand, product differentiation may still be possible due to the dynamic development of the sector – the buyer's decision is not based solely on price and service.

High exit barriers which ultimately lead to an increased competition arise primarily for vertically integrated companies with their own dealcoholisation plant due to highly specialised assets and sunk costs. For smaller companies without own plants there exist low exit barriers as the switching costs to traditional wine production are low.

Prediction 2: The intra-industry competition in the market for non-alcoholic wines is low.

3.4. Threat of substitutes

In theory, all non-alcoholic drinks can be counted as possible substitutes for non-alcoholic wines. There is a wide range on offer in Germany, from juices and soft drinks to non-alcoholic beer. Following mineral water, non-alcoholic refreshments including lemonade and juices were the most popular beverage category in Germany in 2023, with a consumption of 124.9 litres per capita [40]. Non-alcoholic beers have steadily gained in importance in recent years and now account for seven per cent of the beer market [41]. Furthermore, flavoured wine-based drinks are introduced as well as new innovations in the field of juices and sparkling juices. With regard to the entire non-alcoholic beverage market, the threat from substitute can therefore be considered high. Additionally, substitutes can be purchased in all traditional sales channels and consumers have low switching costs.

Prediction 3: The threat of substitutes in the market for non-alcoholic wines is high.

3.5 Bargaining Power of Buyers

The food retail in Germany operates as an important buyer of wine and is highly concentrated in Germany. In 2018, almost 90 per cent of wine in Germany was sold through retailers. Discount stores (50 per cent) and supermarkets (28 per cent) were the strongest channels. In food retail, the five largest market players have a combined market share of 75 per cent. This conditions may lead to a high bargaining power in the context of non-alcoholic wines. Furthermore, the range of non-alcoholic alternatives on offer in Germany is wide, the switching costs for retailers therefore low. Ultimately, the variety of non-alcoholic wines is constantly increasing. A wide selection of different products increases the bargaining power of retailers, especially when product differentiation is low.

Prediction 4: The bargaining power of the buyers (retail) is high.

3.6. Bargaining power of suppliers

The group of companies which offer dealcoholisation is dominated by a small number of companies and is more concentrated than the group producers (wineries and wine cellars), leading to a high bargaining power of the suppliers. However, producers of non-alcoholic wine alternatives (wineries or cellars) often have the opportunity to produce close substitutes such as sparkling or still grape juices, lowering the bargaining power of the service providers as suppliers of non-alcoholic wines. Three of the five German service providers specialise in the dealcoholisation of wines. The performance of wineries and wine cellars is therefore of great importance to the service providers, leading to a lower bargaining power of suppliers. Within the industry for non-alcoholic wines, there are only a few companies that exclusively offer these products. Rather, there are wineries that supplement their portfolio with non-alcoholic products. This ultimately leads to a low bargaining power of suppliers (service providers for dealcoholisation) as their product/service is currently not a key input for the business of most buyers.

Prediction 5: Due to the high concentration of service providers but an overall lower importance of non-alcoholic wines for wineries and wine cellars, the bargaining power of the service providers as suppliers is medium.

4. EMPIRICAL STUDY

4.1. Methodology

To answer the research questions, an explorative approach in the form of guided expert interviews with

Table 1. Summary of predictions for competition intensity.

Market Force	Prediction
Threat of new entrants	High
Rivalry among existing competitors	Low
Pressure from substitute products	High
Bargaining power of buyers	High
Bargaining power of suppliers	Medium

a subsequent qualitative content analysis was chosen. This takes the following facts into account: Firstly, no industry structure analysis of the market for dealcoholised wines is available to date, which means that no existing knowledge can be used as a basis. Secondly, an explorative research approach seems particularly suitable for gathering initial insights into the characteristics of previously unconsolidated market structures. Thirdly, a qualitative approach is generally recommended in the context of industry structure analyses [17].

Between July and October 2022, a total of 24 interviews were conducted with experts from various types of companies along the value chain. The selection was based on the aim of examining the market for dealcoholised wines as broadly as possible. Experts from the following companies were interviewed:

- 5 dealcoholisation service providers
- 5 wineries
- 5 wine cellars
- 9 retail companies: discount (1), supermarket (1), specialised trade (2), online trade (2), gastronomy (1), distribution (1), consulting (1)

The survey of all five operating dealcoholisation service providers in Germany thus ensured representativeness in this area. This cannot be achieved with wine estates and wine cellars due to their large number in the German wine market. In the selection of interviewees from wineries and wine cellars, attention was paid to the availability of non-alcoholic wine in the assortments. Furthermore, differences in the strategic and regional orientation were considered. While wineries tend to have smaller business structures and their own vineyards as well as more regional distribution, wine cellars are considerably larger and are usually characterised by the purchase of bulk wine and large-scale distribution to the food retail. The same selection process applies to retail, where interviews with all key sales channels were carried out in order to obtain maximum diversity of information. The experts selected hold the position of managing directors, sales managers and marketing managers. All interview partners agreed to the recording of the interview. The average duration of the interviews was 30 minutes. In total, guidelines were designed for five groups in advance of the interviews: Contractors/service providers, wineries and wine cellars, specialist retailers, supermarkets and discounters, and gastronomy. The semi-structured interview guidelines were oriented towards the theoretical framework of the five forces outlined in chapter three. Together with the predictions made about the intensity of the competitive forces, open interview questions were formulated. These guidelines were adapted depending on the position of the companies within the value chain. For instance, the guideline for wineries and cellars included the topics supplier relationship and buyer relationship. The guideline for the retail companies, on the other hand, focussed in particular on the buyer relationship due to the position of companies as purchasers and distributors of the products. Substitutes as well as the perception of general competition in the market were addressed in all interviews. Overall, questions were asked in an open manner to ensure a sufficient degree of freedom and a natural dialogue. This favoured obtaining as much information as possible from the interviewees and strengthened the explorative character of the study.

The interviews were fully transcribed and anonymised. A qualitative content analysis was carried out using MAXQDA software. For this purpose, a search grid was initially created based on the Five Forces. Each competitive force represented a superordinate category to which information from the interview texts was assigned in the form of sub-categories during the extraction process. For instance, information on possible minimum quantities for dealcoholisation, legal requirements such as the best before date, cost drivers or obstacles in the product development contributed to the analysis of market entry barriers. This information was therefore recorded in the search grid under the superordinate category "Threat of new entrants". A total of 31 subcategories were identified and assigned to the superordinate Five Forces.

4.2- Empirical results

Regarding **threat of new entrants**, nine out of ten wineries and cellars describe extensive administrative barriers in the market for non-alcoholic wines. One central issue is the labelling according to deviating legal requirements. In addition, at the time of the interviews, there was a general uncertainty regarding the further development of the legal framework, particularly concerning the adoption of non-alcoholic wines in the German wine law, the indication of grape varieties on the label or the option of dealcoholising chaptalised wines.

On the other hand, the entry barrier for potential newcomers to the industry are kept at a low level as all service providers offer dealcoholisation from low minimum quantities of between 300 litres and 5,000 litres. However, two of the five service providers made it clear that they tend to focus on batch sizes from 10,000 to 12,000 litres for reasons of profitability. The high cost factor due to the already very time- and energy-intensive "start-up and shut-down" of the vacuum distillation systems is emphasised. Therefore, the consideration of economies of scale shows the financial advantage of large quantities for service providers. One of the experts from the part of the wine cellars also emphasises that larger batches in his company help to compensate for volume losses incurred during the process. As the service providers describe, dealcoholisation is associated with a loss of volume during the process of around 15 percent.

In terms of production costs, the service provider that uses the membrane process describes that the unit costs remain at a stable level of around one euro per litre when the production volume is increased from 1,000 litres to 5,000 litres. To summarise, economies of scale are only relevant for wineries with large batches as an increase in the production volume has no significant influence on unit costs if production is already low.

The analyses also show that possible backward integration, leading to cost advantages and complicating the market entry of newcomers, does not play a relevant role. Acquiring an own dealcoholisation plant is associated with enormous costs, which is why even three of the five wine cellars interviewed work with service providers. According to one expert from a wine cellar, purchasing their own vacuum distillation primarily helped to minimise production risks. However, the company also continues to rely on external services in order to be able to react flexibly in the event of bottlenecks. Smaller newcomers, on the other hand, can engage the support of service providers, who even offer the option of purchasing pre-bottled dealcoholised wines.

A high level of existing product differentiation would make it more difficult for new companies to enter the market. The statement of a sales manager of an internationally operating wine cellar is noteworthy here: According to him, non-alcoholic wines under newly introduced brand names have not been successful on the market, whereas they have been very successful to date as an addition to an already established brand. An interviewee from a winery describes a different approach: The winery would like to differentiate the non-alcoholic range as far as possible from the alcoholic wines so as not to create a comparison between the alcoholic and non-alcoholic products for the end consumer. Still, the industry appears to be primarily utilising existing consumer loyalty for non-alcoholic wines, although consumer loyalty can overall be described as rather weak in the German wine industry due to the lack of strong brands. Product differentiation therefore tends to play a subordinate role in the German market for non-alcoholic wines so far, leading to a low barrier to entry.

In general, high switching costs to the production of other products could prevail the entrant of newcomers. However, two experts from wineries emphasise low switching costs because to the possibility of producing alcoholic wines always remains.

Finally, sales channels are also highly relevant for the potential market entry of newcomers. In four out of five cases, the experts from the wine cellars states that they use the same channels as for their alcoholic wines. Only one expert emphasises the focus on export business as part of a collaboration with British supermarket chains. A more differentiated picture emerges among the wineries surveyed: Here, the experts describe the search for new distribution channels specifically for non-alcoholic products. In this respect, the information on the attitude of the retail towards non-alcoholic wines is remarkable: On the one hand, it is emphasised that the marketing of the products requires a great deal of explanation as consumers don't know much about them. On the other hand, problems with the sensory profiles of the products are described as well as the fact that the products have not been able to assert themselves in the test runs to date.

The combination of the producer's and retailer's views makes it clear that access to distribution channels is likely to become more limited in the future, although it still tends to be easier at the moment due to an overall dynamic market development. In summary, the first assumption is confirmed: Besides the uncertainties concerning administrative issues, barriers to entry are low, leading to a high threat of new entrants.

The **degree of rivalry among existing market players** initially depends on the number of competitors in the market. Four of the ten experts from wineries and wine cellars interviewed recognise that more and more competitors are appearing on the market. At the same time, the market structures are considered to be rather "unstable". The fact that the number of competitors is perceived as growing, but not as a threat, is well illustrated by the following statement: *"And yes, that's why I don't see myself facing too much competition at the moment, because there is simply still so much open space that everyone can find their customers"*. A look at the statements by the service providers and retailers also shows that the actors perceive an increased competition

but emphasise that the number of participants currently remains low.

Furthermore, 17 of the 24 experts interviewed describe gradual growth in the market for non-alcoholic wines. The remaining seven companies did not provide any information on this. Seven out of the ten experts from wine cellars and wineries emphasise a steady increase in demand and production. One sales manager states that the strongest demand in the entire portfolio can currently be observed in the non-alcoholic wine segment.

Possible price shading for non-alcoholic wines could arise primarily because the products are subject to a "deadline" due to their best-before date, which may lead to an unnoticed price reduction by competitors. According to several experts, the best-before date does lead to a certain amount of sales pressure, but the possibility of influencing pricing was not mentioned.

Possible sunk costs could lead to high exit barriers and ultimately to high industry rivalry. As eight of the ten wineries and wine cellars work with external service providers to carry out dealcoholisation, sunk costs in production are kept at a low level. If there are no long-term contracts in place, the costs of exiting the market are expected to be low. Overall, the second assumption is confirmed: The intra-industry rivalry is low due to low competition and a so far rather "unstable" market structure.

Concerning the **pressure from substitute products**, 18 of the 24 experts interviewed name one or more substitutes for non-alcoholic wines. The spectrum ranges from carbonated juices and non-alcoholic spirits, to tea drinks and beer through to soft drinks. Five of the eight experts from retail state that they also market the named substitutes themselves. Switching to competing products is therefore easy for the end consumer. The experts name several products that have been developed and launched on the market in recent years as close substitutes that could create the same "moment of pleasure" as drinking a glass of wine: Kombucha, wines and sparkling made from old fruit varieties or aperitif drinks such as sparkling tea. It can therefore be assumed that these product innovations are not only recognised by retailers, but are also increasingly included in their portfolios. Ultimately, the interviews show that four of the eight retail companies do currently not consider the inclusion of non-alcoholic wines into their portfolios to be a necessity. Only one interviewee from food retail describes non-alcoholic wines as a "must" on the shelf. In summary, the third prediction of a high threat of substitutes is confirmed.

Regarding the **bargaining power of buyers**, all wineries and wine estates market their products through retailers, primarily in cooperation with the food retail and specialised retail. The latter distribution channel is primarily used by wineries, although they also market a proportion via direct sales. In summary, the food retail is an important distribution channel for non-alcoholic wines, both via central listings and via independently managed markets. This leads to a high bargaining power of the retail, as the retail in German is not only highly concentrated [42], but also and accounts for a large share of the total turnover of suppliers of non-alcoholic wines.

In addition, as already described, four of the eight retail companies surveyed do not currently regard the inclusion of de-alcoholised wines as a necessity. Ultimately, both experts interviewed from the specialised retail describe an enormous number of wines that are sent in for tasting every week. Considering this development, the following statement by the consultant interviewed is remarkable: *"There are times when I think: Wait, wait, wait, isn't the supply growing faster than the demand?"*. In summary, prediction 4 of a high bargaining power of the retail is confirmed.

Regarding the **bargaining power of suppliers**, both the service providers and the wineries and wine cellars estimate the overall number of contractors that carry out dealcoholisation to be low. The experts from the service providers emphasise high capacity utilisation due to numerous enquiries - one expert even speaks of selecting enquiries, leading to high bargaining power. On the other hand, only one of the five service providers based in Germany specialises purely in the dealcoholisation process. The remaining four companies offer the service in addition to their main business (bottling plant, winery, fruit juice company and producer of natural aromas). Furthermore, the dealcoholisation process is used or can potentially be used for other products in all companies: In addition to non-alcoholic beer, the production of non-alcoholic fruit wines and chemical flavourings is discussed by the experts. One expert emphasises that the vacuum distillation system was only purchased because it also enables the desulphurisation of sweet reserve and thus the production of grape juices. Ultimately, this allows the service providers to spread their risk. This is reinforced by the fact that five service providers based in Germany rely on different minimum quantities required and slightly modified technologies. For instance, one service provider works with a special absorber resin that is supposed to better preserve the flavours. Companies that decide in favour of a service provider could therefore be exposed to high switching costs. However, only one of the ten wineries and wine cellars specialises purely in the non-alcoholic wine segment. The remaining companies focus on alcoholic wines and have added

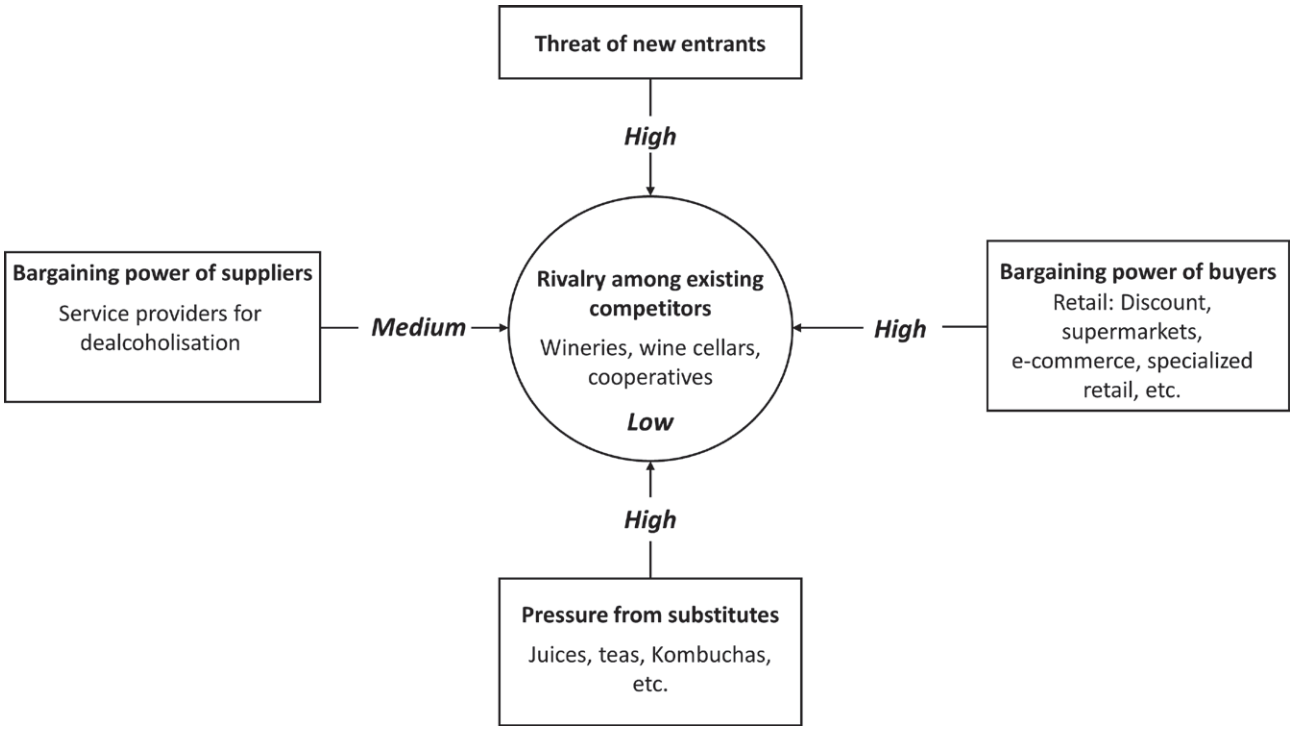

Figure 2. Framework for competition in the market for non-alcoholic wines.

non-alcoholic wines to their portfolios in recent years. Although several experts emphasise the growing importance of these products, a status as a "central input" cannot be derived from this, which ultimately lowers the bargaining power of the suppliers. Overall, prediction 5 of a medium bargaining power of the suppliers is confirmed due to a high concentration of service providers but an overall low importance of non-alcoholic wines for wineries and wine cellars.

Figure 2 summarises the findings on the intensity of competition in the market for non-alcoholic wines.

5. IMPLICATIONS FOR COMPETITION AND COMPETITIVE STRATEGIES IN THE MARKET FOR NON-ALCOHOLIC WINES

Although the market for non-alcoholic wines has only developed significantly in recent years, the competition in the market for non-alcoholic wines must already be regarded as dynamic, as the industry is subject to strong market forces.

While the service providers as suppliers are characterized by a medium bargaining power, the retail finds itself in a much stronger position. In addition, there is high pressure from substitutes. On the other hand, the current low rivalry between the existing companies in the sector plays an important role for the strategic positioning of individual companies, also due to a pronounced atmosphere of "trial and error". Ultimately, the importance of strategic considerations is reinforced by low entry barriers and a rising number of competitors within the market. Following on from the Five Forces, the generic competitive strategies according to Porter [17] are discussed for the market of non-alcoholic wines in Germany. Companies in the wine industry should thus either choose one of the following strategies: cost leadership, differentiation or focus strategy. The latter refers to a focus on market niches and thus on specific customer groups, specific products within the overall product range or on a specific geographical region [17]. This form of competitive strategy is therefore particularly relevant for smaller companies in the wine industry. Downstream, the focus strategy is also orientated towards cost leadership or differentiation.

5.1. Cost leadership and cost focus strategy

The aim of cost leadership is to achieve a competitive advantage through the lowest possible cost positioning compared to the competitors. An important prerequisite for the realisation of this strategy is the consistent

pursuit of cost advantages, e.g. realized by economies of scale. In the market for non-alcoholic wines, this is particularly relevant for larger, vertically integrated wine cellars with own dealcoholisation plants. For smaller companies, dealcoholisation via service providers is unavoidable in view of a possible entry into the market for non-alcoholic wines. As a result, the negotiating power of suppliers only becomes effective for smaller companies. At the same time, the service has an impact on the cost position: The lower volumes result in comparatively high unit costs, which in turn are reflected in higher product prices for smaller wineries.

5.2. Differentiation and differentiation focus strategy

To differentiate themselves from competitors and thus gain a competitive advantage, several experts from smaller wineries emphasise certain product attributes as a possible strategic dimension. For instance, some wineries rely on dealcoholisation of wines from specially selected vineyard parcels are from wines that have been matured in barrique barrels. It can be assumed that such attributes in a young, rapidly developing industry could still be more relevant than in the overall German wine industry, where product attributes that are associated with quality have largely been harmonised at a consistent high level over the past few decades [43]. It is therefore questionable to what extent this strategic dimension in the market for non-alcoholic wines can ensure a sustainable competitive advantage in the long term.

A classic way to achieve competitive advantages through differentiation is to establish brands which provide orientation, recognition value and an identification function for the customer [44]. Ultimately, establishing strong brands is about giving the customer added value and retaining their loyalty to the product in the long term. This strategy, however, is time-consuming and cost-intensive and is particularly feasible for larger companies. Still, the interviews show that in the non-alcoholic wine segment, large companies are primarily focussing on their existing brands and supplementing them with non-alcoholic variants.

A deeper look at the analyses shows that smaller companies with low brand strength almost entirely supplement their portfolios with non-alcoholic wines without clear differentiation from their alcoholic products. This group of "followers", which is expected to grow steadily in view of the growing demand for dealcoholisation is strategically positioned between companies who are either focusing on cost leadership or differentiation. In view of the competitive forces affecting the market, this can be estimated as unfavourable position. Still, these companies are currently able to "survive" in the market primarily due to the fact that in a young industry, "running with the pack" already leads to profits. It is this group that is to be characterised by enormous fluctuation in the long term – low entry and exit barriers are likely to show their full effect here.

Some market players, on the other hand, tend to position their non-alcoholic products as an extension of their range and thus deliberately attempt to differentiate their products from alcoholic wines. A classic example of this is the Dr. Loosen winery, which markets its non-alcoholic wines under the name "Dr. Lo".

Still, these considerations raise the question of whether the positioning of the products is sufficient to secure long-term competitive advantages in a steadily growing and successively saturated market. A closer look at the way companies are positioning their products reveals that companies focus strongly on the characteristics of the "originals" when marketing non-alcoholic wines. This circumstance repeatedly leads to comparisons between alcoholic and non-alcoholic wines and negatively emphasises unavoidable differences in their sensory properties. This ultimately leads certain retail companies in Germany to take a rather cautious view of the products as the interviews showe. Therefore, one promising approach of differentiation for smaller businesses could be to transfer non-alcoholic wines into a separate category by communicating independent and ultimately unique product characteristics, creating a product range that is completely different from the appearance of the remaining portfolio. In view of the growing number of young people who do not consume any alcohol at all [41], this could ultimately open up completely new target groups: People who have not yet consumed wine. The experts from wineries and cellars interviewed mostly perceive those people as a target group who have to refrain from consuming wine due to pregnancy, age-related restrictions or participation in road traffic. However, the possibility of addressing completely new target groups that were previously not part of the customer base is also being addressed. Placing the products as an independent category could ultimately give companies a comfortable competitive position, albeit with higher strategic risk but also higher profit potential.

6. DISCUSSION

Compared to the late 1980s, when non-alcoholic wines failed to achieve a market breakthrough in Germany, the framework conditions influencing the mar-

ket have changed significantly today. While back in the 1980s, an increased health and fitness awareness was primarily identified as the motive for the consumption of non-alcoholic wines, the fundamental social attitude towards alcoholic beverages has gradually changed at the latest since the beginning of the 2010s: The consumption of non-alcoholic beverages is increasingly accepted in the social environment, abstinence is even perceived as desirable and is an increasingly insignificant factor for social exclusion, especially among the younger generations. Increased health awareness is particularly evident among this population group, which manifests itself in social trends such as "Dry January" of "Sober October", in which people actively call for temporary abstinence [45]. In September 2022, a study by the market research institute YouGov caused a stir, according to which almost half (49%) of young adults (aged 18 to 24) living in Germany do not consume alcohol [46].

It can therefore be assumed that alcohol-free alternatives will become increasingly relevant in the future, also due to the growing influence of the European alcohol policy [47]. One e-commerce company interviewed for this study is already actively incorporating the increased regulatory efforts for alcoholic beverages into its corporate strategy as a way to counteract future advertising restrictions. This reinforces the impression that non-alcoholic wines could represent an important market for the German wine industry in the future.

However, as the interviews show, expectations are far from uniform. The assessment of the expert from the discount sector stands out in particular. Accordingly, non-alcoholic wines will have minor relevance for this company type in the German food retail sector in the future. Other experts are sceptical with regard to the sensory properties and pricing of non-alcoholic wines, as the additional production step is associated with additional energy input and volume losses.

It is therefore of central importance to what extent the development of the market for non-alcoholic wines could currently be "overestimated". The findings on the industry structure gathered in this study paint a rather sobering picture: the industry is characterised by strong competitive forces, low barriers to entry and exit, and a tendency towards a high fluctuation of market participants in the future, which ultimately also leads to a small size of the market in the long term. In view of the analyses carried out, one promising approach is to transfer non-alcoholic wines into a new, independent category – similar to what the German company "Bionade" has successfully achieved by moving away from classic lemonade.

This approach could also be highly relevant in order to be able to assert non-alcoholic wines against ever more diverse substitutes. Tea drinks, Kombucha, lemonades, alcohol-free craft beers – the number of innovative alcohol alternatives is constantly increasing. Compared to these substitutes, non-alcoholic wines are clearly a niche product that is strongly oriented towards the sensory and emotional characteristics of its "original product".

New innovations in the field of wine, such as fermentation of vine leaves [48,49], represent promising opportunities to create something "new" that can also stand out from strong substitutes. Additionally, products in the "low" category should not be neglected, as they are not only becoming increasingly important, but could prove to be very promising when it comes to "introducing" consumers to non-alcoholic variants.

Overall, the study highlights the need for further research in the field of non-alcoholic wines with regard to consumer research and market strategies. This study has made a first attempt to analyse the structure of the market for non-alcoholic wine in Germany and to derive possible strategic implications for existing and potential market participants. The explorative approach chosen, in conjunction with the expert interviews conducted, has made an initial contribution to this. In particular, the qualitative approach has helped to better understand the current uncertainty of industry participants with regard to legal changes, competitors or market developments through personal dialogue. Due to the limitations of qualitative research, this initial approach should be quantified with further research. For instance, surveys of individual company types on a broader scale are conceivable, which would enable an enhanced depiction of the different perceptions of market players. As shown, this study revealed slight differences in the attitudes towards non-alcoholic wines between specialised retailers, supermarkets and the discount with the latter tending to be less open to the products than the former.

Germany was a suitable case for this initial look at a market for non-alcoholic wine. With its highly competitive wine market, the country has some special features that significantly increase the relevance of competitive strategies. Ultimately, the findings gathered may not only be relevant to the German market, but also to other markets in which non-alcoholic wines are becoming increasingly important.

7. SUMMARY

Although non-alcoholic wines still occupy a clear niche position in the German wine industry, they are currently one of the most discussed products in view of the declining wine consumption in most European countries.

The aim of this study was therefore to gain an initial overview of the structure of the German market for non-alcoholic wines and to derive implications for market competition and possible strategic positioning of individual market participants. On the supplier side, service providers for dealcoholisation play a central role, especially with regard to the market participation of smaller wineries. As the mood of "trial and error" still seems to be pronounced at the moment, competition in the market between small wineries and large cellars is currently limited. Low entry barriers make it easy for new companies to enter the market. The retail has undiminished bargaining power, while at the same a wide range of substitutes exerts high pressure on non-alcoholic wines. Clear differentiation strategies therefore appear to be important for strategic positioning and long-term survival in the market, especially for small companies. Ultimately, this could also help to transform non-alcoholic wines into an own category, thereby separating the products from their originals and reaching entirely new target groups.

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A Lean Six Sigma, Industry 4.0 and Circular Economy-driven methodology for wine supply chain process improvement

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Abstract. Scientific literature recognizes that Lean Six Sigma (LSS), Industry 4.0 (I4.0) and Circular Economy (CE) offer significant opportunities to improve operational performance and decrease the environmental impact. Wine supply chains represent a strategic asset for the world economy and an ideal setting for the implementation of LSS, I4.0 and CE, but studies that integrate these three approaches to improve wine supply chain processes are lacking. The present research intends to demonstrate how wine supply chain processes (SCPs) can be improved by deploying the synergies between LSS, I4.0 and CE, so as to face the quality, efficiency and sustainability challenges modern competition poses to wine companies. To this aim, this study proposes an original methodology that adopts a step-by-step procedure inspired by the Define-Measure-Analyze-Improve-Control (DMAIC) cycle to systematically improve SCPs throughout the different phases of wine supply chains (i.e., vineyard, cellar, distribution). The methodology has been conceptualized starting from three sources - review of scientific literature, interviews with experts and personal contribution – and assembles in an original way some concepts and tools referring to different bodies of literature such as strategic decision making, data-driven process improvement, lean management, industry 4.0 and circular economy. The methodology has been tested in a real case to evaluate its utility for practice and relevance.

Keywords: Lean Six Sigma, circular economy, winemaking.

1. INTRODUCTION

In recent years, wine supply chains have faced new and demanding challenges. The traditional problems of controlling variability in winemaking processes to guarantee the homogeneity of wine quality, alongside cost savings and waste elimination to pursue efficiency, have recently been complemented by the digitization and automation of production processes and the design of new products and processes with a low environmental impact [1,2,3]. In this

context, wineries must be prepared to analyze and modify their supply chains to make them more efficient and sustainable by increasing their capacity for innovation and improving performance using available resources [4,5].

The digital and sustainable transitions represent the perfect playground in which wineries can prove their ability to change their processes at an accelerated pace to face growing competition challenges, new customer expectations, and regulatory compliance. The journey toward such transitions depends not only on technology availability but also on the company's ability to identify the right actions to implement. There is a broad consensus in the scientific literature that Lean Six Sigma (LSS), Industry 4.0 (I4.0), and Circular Economy (CE) can offer companies several opportunities to reduce variability, increase efficiency, improve process control, and decrease the environmental impact.

The concept behind the LSS model is quite recent and was first mentioned in the book "Lean Six Sigma: Combining Six Sigma with Lean Speed" [6]. By combining the principles and tools of Lean and Six Sigma into a single solution, the authors demonstrate how companies can achieve better results than implementing the two approaches separately. LSS focuses on what the consumer really expects from the product or service they purchase (i.e., the value for the customer) and relies on data collection and analysis to identify opportunities to reduce waste and increase the quality of the product or service offered. LSS requires the adoption of specific tools, inspired by Lean Management and Statistical Process Control, within a formalized problem-solving approach following the Define, Measure, Analyze, Improve, and Control (DMAIC) cycle, which is an evolution of Edward Deming's Plan-Do-Check-Act cycle for continuous process improvement [7].

I4.0 has developed more recently to promote the use of digital technologies to optimize production processes and lays its foundation on information and communication technology [8]. The main tools of I4.0 are based on advanced technologies such as the Internet of Things (IoT), artificial intelligence (AI), robotics, cloud computing, sensors, and smart devices [9]. I4.0 technologies enable the connection and monitoring of machinery, production, and information flows with the goal of providing strategic guidance to managers so as to create production systems (and supply chains) that are not only more efficient, reactive, and reliable, but also more sustainable [10, 11].

CE refers to an economic production and consumption model pursuing the reduction of environmental impact that proposes practical solutions to waste and pollution problems caused by the linear economic model [12]. With a focus on sustainability, modern wineries are committed to implementing strategies that enable them to achieve cost savings to gain a competitive advantage over time through proper management of internal resources [13]. Specifically, through new approaches to design, production, and delivery of products and services, CE can support companies in extending the value of the resources they use over time [14]. According to literature, the main methods to achieve this goal are reuse, remanufacturing, and recycling [12].

Generally, the LSS, I4.0, and CE domains are addressed separately or in pairs [15, 16, 17]. Focusing on wine supply chains, the lack of studies integrating these three views of process improvement is even more evident. I4.0 represents a significant stream of studies, often related to the Agriculture 4.0 framework, which is an evolution of precision agriculture [18], or Viticulture 4.0 and Oenology regarding the winemaking phase in wine supply chains. A recent study [19] explored the potential of applying an I4.0-based decision support tools (DSS) to simulate different scenarios in the wine industry and aid decision makers in choosing the most appropriate strategy to achieve business objectives, but without integrating it with LSS or CE tools.

CE is a rich and promising field of research in the wine supply chain context, but studies exploring the connections with LSS and I4.0 are lacking. As for the literature specifically related to LSS concepts in wine supply chains, it is very limited, mainly focused on the winery and bottling areas, and not related to CE and I4.0 issues.

This research aims to demonstrate how wine supply chain processes (SCPs) can be improved by deploying the synergies between LSS, I4.0, and CE to face the quality, efficiency, and sustainability challenges of modern competition. To this end, this study proposes an original methodology that enables the systematic improvement of SCPs throughout the different phases of wine supply chains, integrating LSS, I4.0, and CE. The methodology has been tested in a real case to evaluate its relevance and utility.

The paper is structured as follows: The next section describes the conceptual and implementation frameworks of the proposed methodology. It is followed by the application to a real winery. In the following section, we discuss and evaluate the Decision Support System (DSS) and derive some conclusions. The final sections report the theoretical and practical implications and the conclusions and future developments.

2. PROPOSED METHODOLOGY

The methodology proposed by this study has been conceptualized based on three sources: a review of the

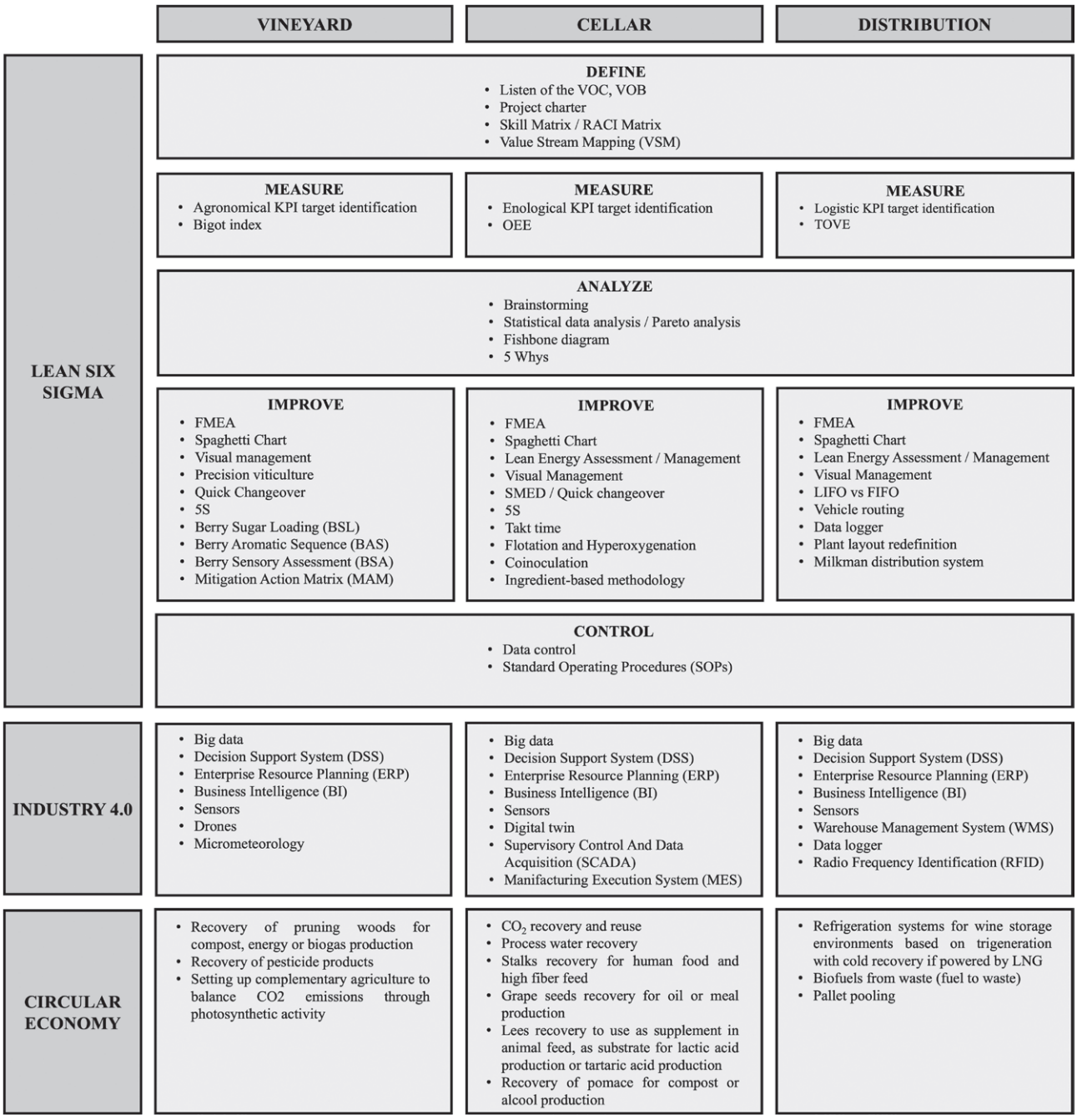

Figure 1. The conceptual framework ("What").

scientific literature, interviews with experts, and personal contributions. The literature review on Lean Six Sigma (LSS), Industry 4.0 (I4.0), and Circular Economy (CE) in the wine sector was conducted on the combination of keywords "Wine supply chain", "Lean Six Sigma", "Industry 4.0", "Circular Economy", "Waste reduction strategies" using the Scopus and Science Direct databases, and with the supports of books and grey literature. The research focused on the three main areas of the wine supply chain: the vineyard, the cellar, and distribution.

Since two co-authors possess extensive consulting expertise in the wine supply chain, their knowledge supplemented the literature with practical insights into

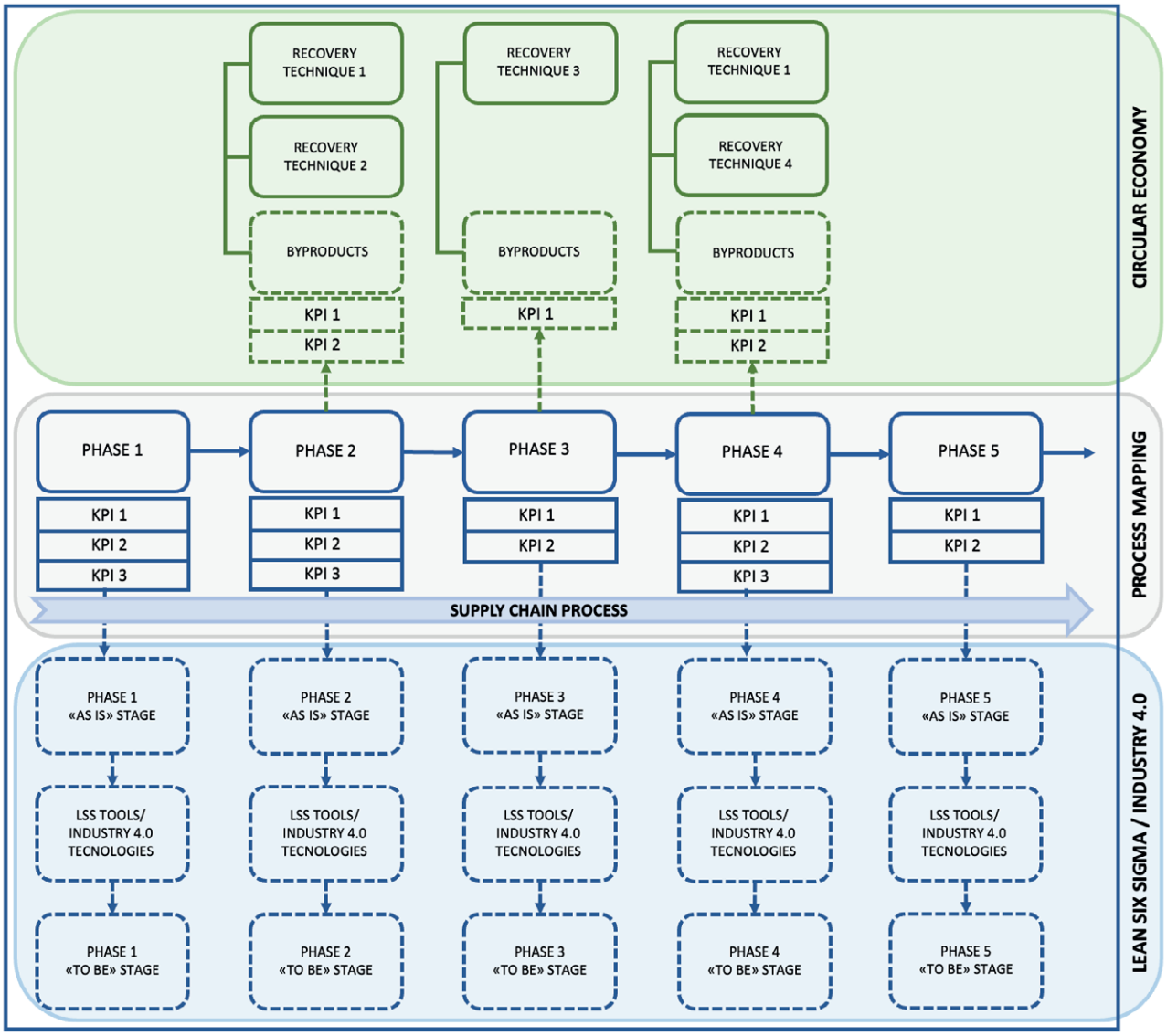

Figure 2. The implementation framework ("How").

solutions for winemaking, waste reduction, and waste by-product recovery. Before testing the model's validity through application in a real case study, we discussed and refined it with three professionals, one from each of the main areas of the wine supply chain. The resulting conceptual framework is synthesized in Figure 1, which presents the main LSS, I4.0, and CE decision-supporting tools for each stage of the wine supply chain.

While Figure 1 reports the conceptual framework and indicates *what* can be done, Figure 2 highlights the implementation framework and suggests *how* to deploy new supply chain processes that use decision supporting tools included in the conceptual framework.

The core of Figure 2 is the SCP, namely the supply chain macro-process that contains all the phases from the vineyard to the final consumer (from vine to dine). Each SCP phase is associated to a set KPIs essential to measure the improvement actions. The upper part of Figure 2 integrates the SCP with circular economy, as it highlights the phases where by-products are generated as well as possible recovery and valorization actions. The lower part integrates the SCP with LSS and I4.0, as it highlights the phases where lean tools and/or I4.0 technologies can be used to reduce waste.

Implementation requires a preliminary phase, called target definition, followed by the iterative repetition of the five phases of the DMAIC cycle.

2.1. Target definition

The aim of this phase is to make explicit the "oenological objective", which consists in the performance target of the SCP, in terms of quality, cost, environmental impact and/or resource consumption, etc. The clarification of the Voice of the Customer (VOC) and the Voice of the Business (VOB) is a prerequisite for properly identifying the oenological objective. The VOC represents the needs and expectations of end customers, which are gathered using questionnaires inspired by the Quality Function Deployment (QFD) methodology. The VOB represents the perspective and expectations of the management, collected through interviews.

2.2. Define

This phase focuses on the governance of the project aimed at achieving the oenological objective. The initial step involves forming a multidisciplinary work team equipped with the necessary skills. The team typically comprises agronomists, oenologists, bottling technicians, sales personnel, IT experts, plant engineers, and external consultants. The Skill Matrix, a tool recommended by the LSS approach, is used to ensure that team members have all the required skills. The team plans the main steps of the project and defines roles and responsibilities. The Gantt Chart and the RACI (Responsible, Accountable, Consulted, Informed) matrix are two project management tools that are utilized at this stage. The team is also tasked with the detailed mapping of the Supply Chain Process (SCP), which forms the foundation of all implementation actions (refer to the central part of Figure 2).

2.3. Measure

This phase is dedicated to collecting data on the SCP and conducting preliminary assessments. Taking the oenological objective into account, the multidisciplinary team initially identifies the strategic KPIs for each phase of the SCP and defines their target values or ranges. The adoption of I4.0 technologies, such as Viticulture 4.0 and Oenology 4.0, can facilitate data collection by simplifying the activities of operators and enhancing the effectiveness, speed, and reliability of data gathering. Furthermore, I4.0 technologies provide company databases with a continuous flow of real-time data, which is crucial for monitoring KPIs. Data collection should also cover by-products, enabling data-driven decision-making on the CE actions to be implemented (see dotted arrows in the upper part of Figure 2).

2.4. Analyze

In this phase, the collected data are analyzed to identify hotspots and areas for improvement. At this stage, investigating the root causes of problems is important. To this aim, the availability of accurate data and the multidisciplinary expertise of the team are crucial. Data collected by sensors and other digital systems must be organized in databases and processed using statistical techniques and DSS, which make extensive use of visual management tools (e.g., dashboards and maps representing the variability of the production process based on the monitored parameters). During data-driven brainstorming sessions, the multidisciplinary team identifies those KPIs that are not aligned with the target ranges defined in the Measure phase and investigates the root causes of this misalignment, also using LSS cause-and-effect analysis tools (e.g., the Ishikawa diagram or the 5 Whys model).

2.5. Improve

In this phase, the team identifies the corrective actions to address the root causes of problems identified in the analysis phase. The conceptual framework (Figure 1) aids the brainstorming process by proposing for each stage of the wine supply chain a structured set of LSS solutions specifically dedicated to the "improve phase," along with CE practices and I4.0 technologies. In line with the learning-by-doing logic, this set can be updated and enriched with the knowledge the team acquires and develops over time. During the brainstorming, the team assesses the suitability of the solutions, practices, and technologies listed in Figure 1 in terms of their impact, costs, time, and resources required. The final outcome is the reconfiguration of the SCP in alignment with the oenological objective, and an implementation plan that defines for each phase how to transition from the current state to the to-be state.

2.6. Control

In this phase the team evaluates if the actions launched in the previous phase (i.e., the new SCP) effectively improve the KPIs identified in the Measure phase and if further improvement cycles are needed. Through data-driven decision-making, the team verifies whether the oenological objective has been achieved. Interviews with customers and assessments of manager satisfaction can be used to ascertain that the VOC and the VOB have been satisfied. The Control phase also includes formalizing the new SCP with

the creation of the Best Practice Manual and Standard Operating Procedures (SOPs).

3. TESTING AND EVALUATION

The proposed methodology was applied in a real setting of a winery with 100 hectares of vineyards located in Apulia, in the Taranto area, specialized in the production of organic wines. The company's product portfolio includes a dozen labels, most of which are Primitivo red wine. In addition to the winery, the company has a wine resort where it organizes guided tastings, special events and gourmet dinners. All these activities allowed the company to establish direct channels with its customers over time and to collect their feedback.

3.1. Target definition

The research team initially met with the company owner and the winery manager. From the interviews, it emerged that a general idea of the oenological objective was already present. Considering the winery's medium-term strategy to enter new international market segments, one of the main concerns was the variability in the quality of Primitivo wines in the product portfolio.

The VOB was clear: to increase customization (i.e., to tailor wines in the portfolio to the needs of the market segment) and to produce Primitivo wines that consistently meet customer expectations (i.e., to reduce supply chain process variability).

Regarding the VOC, reports from tasting sessions confirmed that consumers had noted the high variability of Primitivo wines from different vintages. This problem also affected other wine varieties within the company's portfolio. Feedback data also indicated consumer preferences for wines with balanced aromas, limited alcohol content, and produced with practices that have a low environmental impact.

After a brainstorming session, the research team converged on the following oenological objective: "to improve the quality of the company's wines over time by targeting wine customization, reduced variability, and increased environmental sustainability of supply chain processes". The research was conducted in the 2020 vintage, choosing Primitivo as the test grape variety.

3.2. Define

The research team together with the winery manager identified the set of skills required to address the oenological objective and filled the Skill Matrix reported in Figure 3 to create the multidisciplinary team. In addition to specific technical competences, such as agronomic, oenological and sensorial analysis skills, transversal competences related to problem solving, digital technologies and circular economy were included.

The matrix in Figure 3 shows how the internal staff's skills in sensory analysis, digitalization and circular economy were rated low. The involvement of three university experts and an external consultant enabled the complementation of the internal staff's competencies and the acquisition of a proper level of expertise in all key skills for the project.

As first step, the multidisciplinary team identified the main phases of the supply chain process of the Primitivo wines and the currently generated by-products, and used the BPMN software to map the SCP as reported in Figure 4. Due to space constraints, Figure 4 and the subsequent discussion focus on wine fermentation and aging, two significant phases of the overall SCP. Then, the team created a Gantt chart (project charter) that outlined the main steps of the macro project aimed at achieving the oenological objective, including milestones, timing, roles, and responsibilities.

3.3. Measure

The multidisciplinary team collected data on the Supply Chain Process (SCP) and conducted preliminary assessments deemed essential for pursuing the oenological objective. Agronomists, winemakers, and technicians gathered information on production protocols; the winery manager retrieved data on product and process costs; and the sales manager organized a tasting session with the team to determine the "as-is" sensory profile of the Primitivo wines. As illustrated in Figure 5, for each phase of the SCP, the team identified KPIs and mapped the by-product management practices already in use (indicated by a dotted line).

For each KPI, the team established the optimal target ranges in alignment with the oenological objective and compared them with the "as-is" values. To better measure the fermentation process performance, the team introduced a specific KPI named Production Lead Time (PLT).

The Measure phase also presented a significant opportunity for brainstorming, during which the team identified and evaluated alternative solutions that could be implemented to improve the current process. For instance, cellar and vineyard technicians discussed with the winery manager the possibility of adopting digital technologies to support data collection and monitoring.

			SKILLS								
	STAFF	ROLE	PROBLEM SOLVING	PROJECT MANAGEMENT / TEAMWORKING	VINEYARD	WINEMAKING	SENSORY ANALYSIS / BLENDING	DIGITAL TECHNOLOGIES	CIRCULAR ECONOMY	CUSTOMER BEHAVIOUR	INDIVIDUAL SCORE
INTERNAL STAFF	ID1_FB	Agronomist	2	1	3	2	3	2	1	1	15
	ID3_GS	Director	3	3	2	2	2	2	1	3	18
	ID4_TN	Winemaker	2	2	3	3	2	2	2	1	17
	ID5_ML	Agronomist	2	2	2	1	0	0	0	1	8
	ID6_FD	Intern	1	1	2	2	1	3	0	1	11
	ID7_PA	Technician	2	1	2	3	1	0	2	0	11
	ID8_ML	Technician	0	2	3	2	1	0	1	0	9
	ID9_CF	Technician	1	0	2	2	1	0	1	1	8
	ID10_FD	Marketing	2	2	1	1	0	1	0	3	10
	ID11_EG	Sales	1	2	1	1	2	2	0	3	12
	Total skill score		16	16	21	19	13	12	8	14	
	Average score		1.6	1.6	2.1	1.9	1.3	1.2	0.8	1.4	
EXTERNAL STAFF	ID12_RZ	University expert	3	3	2	3	3	2	3	2	21
	ID13_GB	University expert	3	2	3	2	3	3	2	3	21
	ID14_PR	University expert	3	3	2	2	2	2	3	3	20
	ID15_AZ	Consultant	2	2	2	3	3	3	2	2	19
	Total skill score		27	26	30	29	24	22	18	24	
	Average score		2.5	2.3	2.2	2.4	2.5	2.2	2.2	2.3	

LEGENDA	
0	No skills
1	Basic skills
2	Medium skills
3	Advanced skills

Figure 3. Skill matrix.

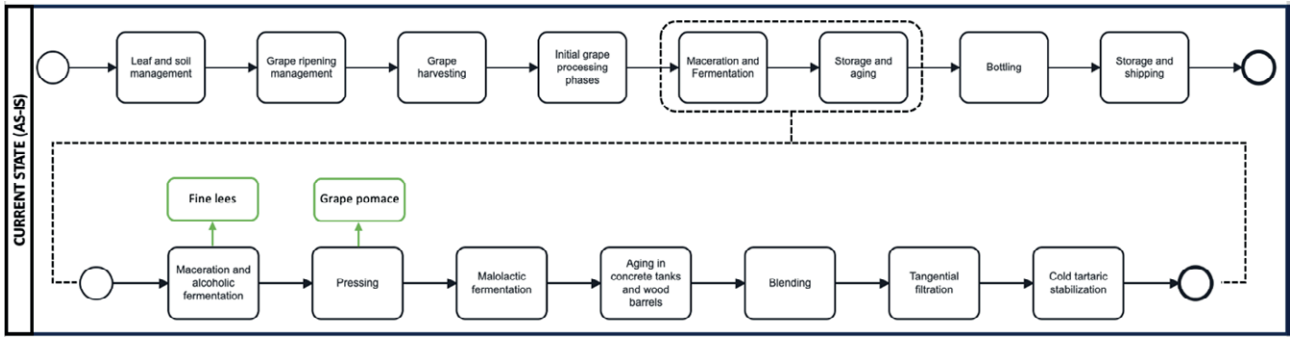

Figure 4. Primitivo wines SCP mapping.

This would potentially reduce the workload, improve the quality of the data collected, and, in turn, more effectively pursue the oenological objective.

3.4. Analyze

The team analyzed the data, work protocols, and KPIs to identify problems and their causes. As illustrated in Figure 6, it was discovered that the most signifi-

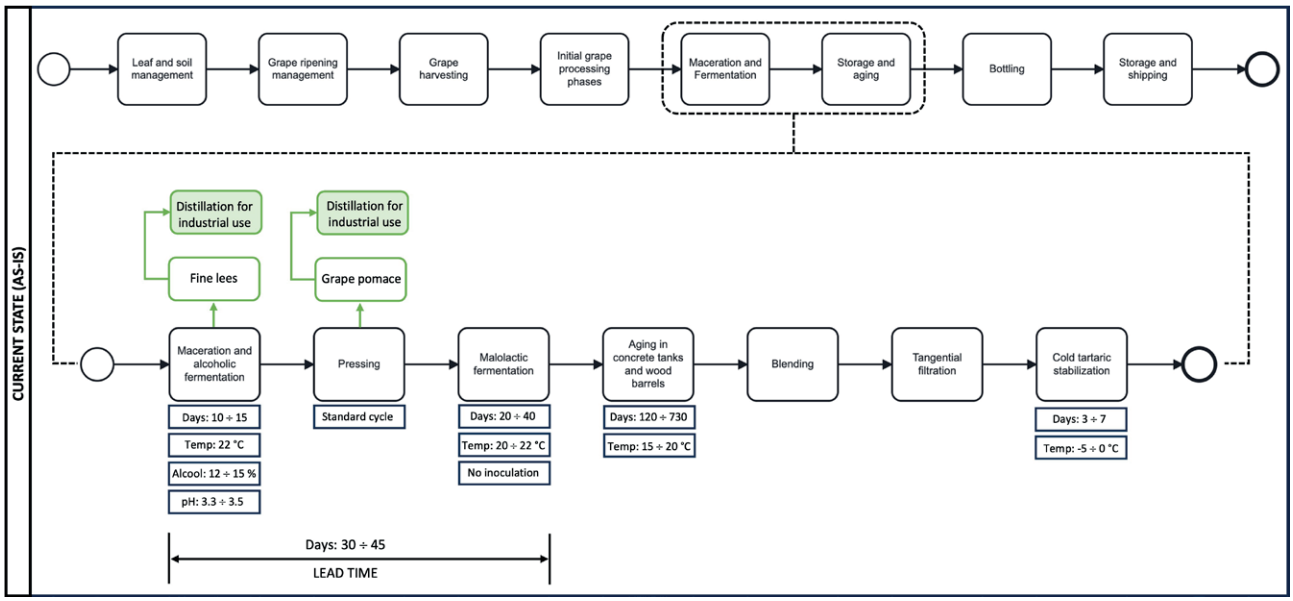

Figure 5. As-is SCP map with KPIs and by-products.

cant discrepancies between the KPI values and the oenological objective pertained to three phases of the SCP: grape ripening, maceration and alcoholic fermentation, and malolactic fermentation.

The 5-Why method, a lean tool commonly used to identify the root cause of problems, revealed the presence of obsolete work protocols and incorrect procedures in both the vineyard and the cellar. These protocols had been established many years prior and had not been updated over time. Due to variations in soil type, microclimate, and other factors, the Primitivo wines had developed different qualitative potentials, which were not being adequately leveraged by the current work procedures. Sensory tasting sessions with the team members confirmed these findings. Another root cause identified was the winery's low level of digitization, especially in data collection, and the complete absence of real-time control over some critical parameters of the production process, such as irrigation water consumption, vineyard micro-meteorological variables, and the temperatures during maceration and fermentation. These two root causes led to numerous errors and misunderstandings among employees, negatively affecting not only the SCP's performance but also the quality of the grapes and wines produced, and consequently, the achievement of the oenological objective.

3.5. Improve

Firstly, the team classified the problems into categories: digitalization problems and production process formalization problems. As a second step, the team was involved in several brainstorming sessions during which the members consulted the conceptual framework (see Figure 1) to address the problems and identified the following improvement actions:

1. Introduction of smartphones and tablets connected to the ERP system for data collection.
2. Installation of I4.0 sensors and technologies to monitor fermentation temperatures and irrigation system water consumption.
3. Modification of grape harvesting and production protocols to improve the quality and sustainability of the winemaking process by introducing an "ingredient-based" production methodology.

As a third step, the team evaluated the economic impact and time required to implement the identified solutions, producing a report that was submitted to the winery director for approval. Finally, as the fourth and final step, the team proceeded to implement the identified solutions.

Regarding digitalization issues, the paper-based tools previously used by vineyard and cellar technicians were replaced with tablets wirelessly connected to the winery's ERP system, enabling synchronized data uploads and making the information accessible to all staff. Digital temperature sensors were installed in all fermentation and maceration tanks. The outdated irrigation system was replaced with a more modern one equipped with Industry 4.0 technology, allowing for real-time data analysis and remote control.

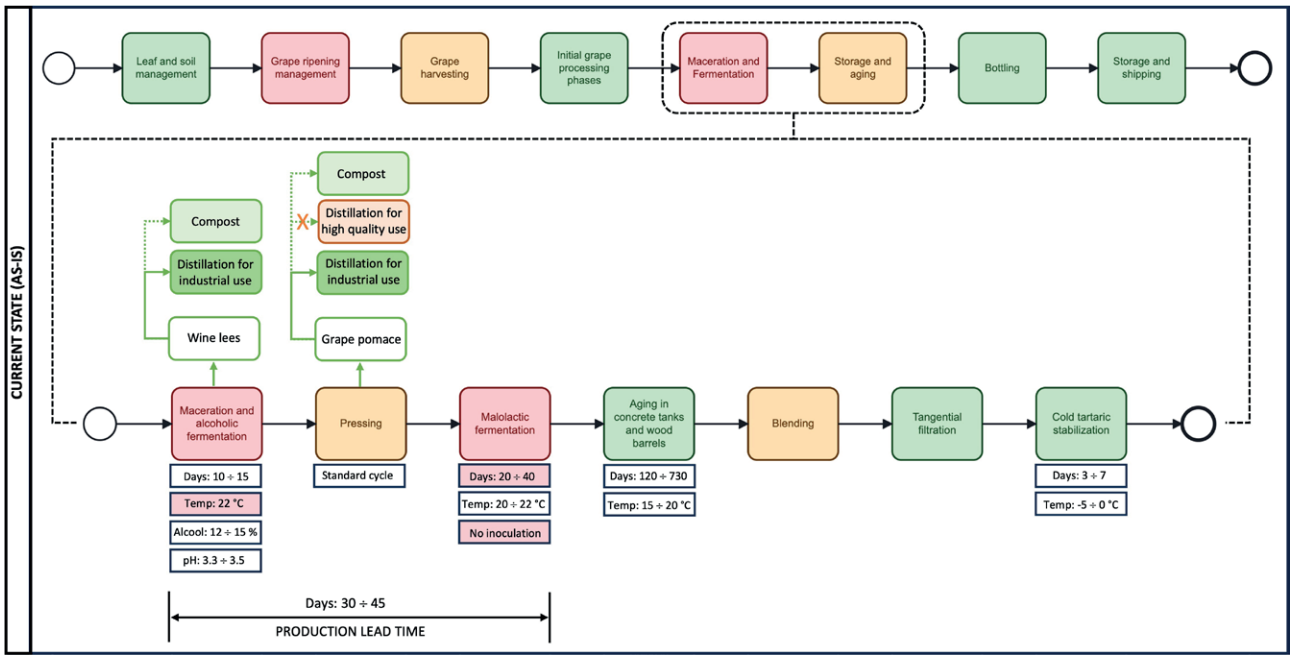

Figure 6. Critical points in the SCP.

Regarding the production process formalization issues, before modifying the current protocols, the team decided to conduct a vineyard potential quality analysis to ensure that the changes aligned with the oenological objective. This methodology revealed the presence of vineyard areas with significantly different quality potentials, leading to their division into quality clusters. Based on these clusters, the team decided to introduce the ingredient-based production methodology. Consequently, the protocols were modified with the goal of producing three distinct ingredients:

- Ingredient 1 (I-1): limited alcohol content but significant acid content.
- Ingredient 2 (I-2): good balance between phenolic and aromatic components.
- Ingredient 3 (I-3): structure, high alcohol and sugar potential obtained by over-ripening grapes.

Once the ingredients were identified, the key parameters (KPIs) to be monitored in the vineyard during the growing season were determined (see upper part of Figure 7).

The team formalized new harvesting protocols by integrating the analysis of grape analytical parameters already in use with the Berry Sensory Assessment (BSA) and Berry Sugar Loading (BSL) procedures [20]. Through BSA, BSL, and periodic monitoring of grape parameters (sugars, acids, and pH), the optimal times for harvesting the grapes needed to produce the three ingredients were identified.

Accordingly, the team defined a specific winemaking protocol for each ingredient (see the lower part of Figure 7). To achieve the oenological objective, the team decided to introduce co-inoculation of yeasts and lactic acid bacteria during alcoholic fermentation. Each ingredient underwent a different fermentation and aging cycle, and at the end of the aging period, the three ingredients were blended in varying proportions to obtain the final wines.

The adoption of an ingredient-based production methodology necessitated modifications to the existing protocols for managing by-products. Compared with the initial SCP, where all winery by-products were sent to the distillery (see Figure 6), in the new SCP (see Figure 8), the wet pomace from I-1 and I-2 can also be used to produce compost for vineyard use. Instead, the wet pomace from I-3 is sent to the distillery for high-quality utilization.

Finally, during implementation, it became apparent that there was a need to organize specific training sessions on blending and sensory tasting of wines and grapes for continuous evaluation of the achievement of the oenological objective. Indeed, the Skill Matrix revealed low scores among the internal company staff in blending and sensory analysis phases. To effectively implement the ingredient-based production methodology, the staff's ability to blend various ingredients to produce final wines with desired sensory profiles is crucial.

VINEYARD	I-1	I-2	I-3
GRAPE MATURITY LEVEL	Phenolic maturity of the skin but not of the seeds	Complete phenolic maturity of the skin and seeds	Complete phenolic maturity of the skin and seeds
TOTAL ACIDITY (g/L)	> 7	5 ÷ 7	< 5
pH	< 3.3	3.3 ÷ 3.5	> 3.5
SUGAR CONTENT (Brix)	20 ÷ 22	22 ÷ 24	> 24
	BSA Indicators for I-1	**BSA Indicators for I-2**	**BSA Indicators for I-3**
	Pulp: film of pulp only slightly visible on skins but juice is released from skins when squashed. Sweet taste, moderately acid and fruity aromas predominate over herbaceous aromas.	**Pulp:** film of pulp only slightly visible on skins but juice is released from skins when squashed. Sweet taste, moderately acid and fruity aromas predominate over herbaceous aromas.	**Pulp:** no film of pulp on skin and seeds and no release of juice when squashed. Very sweet taste, low acid and intense fruity aromas.
	Skin: fairly easy disintegration, mixture almost homogeneous. At the taste the tannins are medium size grains.	**Skin:** fairly easy disintegration, mixture almost homogeneous. At the taste the tannins are medium size grains.	**Skin**: easy disintegration, homogeneous mixture. At the taste the tannins are soft, fine and silky grain.
	Seed: Brown-green seeds color. At the taste the seeds crushes under pressure like a fresh almond. Astringent when chewed.	**Seed:** Grey brown seeds color, no green traces. At the taste most seeds are hard and crack easily. Moderately astringent when chewed.	**Seed:** Dark-brown seeds color. At the taste all seeds are hard, crack quickly and are crunchy. No astringency.
CELLAR	**I-1**	**I-2**	**I-3**
SEEDS EXTRACTION	no	yes	yes
PRE-FERMENTATIVE MACERATION	no	no	yes Temperature: 8 ÷ 10°C Duration: 3 ÷ 4 days
MACERATION WITH ALCOHOLIC FERMENTATION	Temperature: 22 ÷ 23°C Duration: 6 ÷ 8 days	Temperature: 23°C Duration: 8 ÷10 days	Temperature: 20 ÷ 21°C Duration: 8 ÷ 10 days
POST-FERMENTATIVE MACERATION	no	no	Temperature > 20°C Duration > 21 days
MALOLACTIC FERMENTATION	With alcoholic fermentation (Co-inoculation of yeasts and bacteria during alcholic fermentation)	With alcoholic fermentation (Co-inoculation of yeasts and bacteria during alcholic fermentation)	With alcoholic fermentation (Co-inoculation of yeasts and bacteria during alcholic fermentation)

Figure 7. Production process formalization according to the ingredient-based methodology.

Consequently, the team recognized the need to enhance these specific skills of the company personnel.

3.6. Control

At the end of the harvest, the team organized a meeting with the company owner and the winery manager to taste the wines obtained. Subsequently, tastings were held during international fairs and events to collect consumer and importer judgments. The tasting involved a blind comparison between the previous year's wine (wine A) and the one obtained with the new protocols (wine B). The company proceeded with the collection and processing of tasting data for a period of approximately six months. Over 70% of customers indicated a preference for wine B. At the end of the period the winery director was interviewed, expressing satisfaction for the result achieved.

From the 2022 harvest the company has also extended the experimentation to other varieties. All staff have been trained on the new procedures and a company

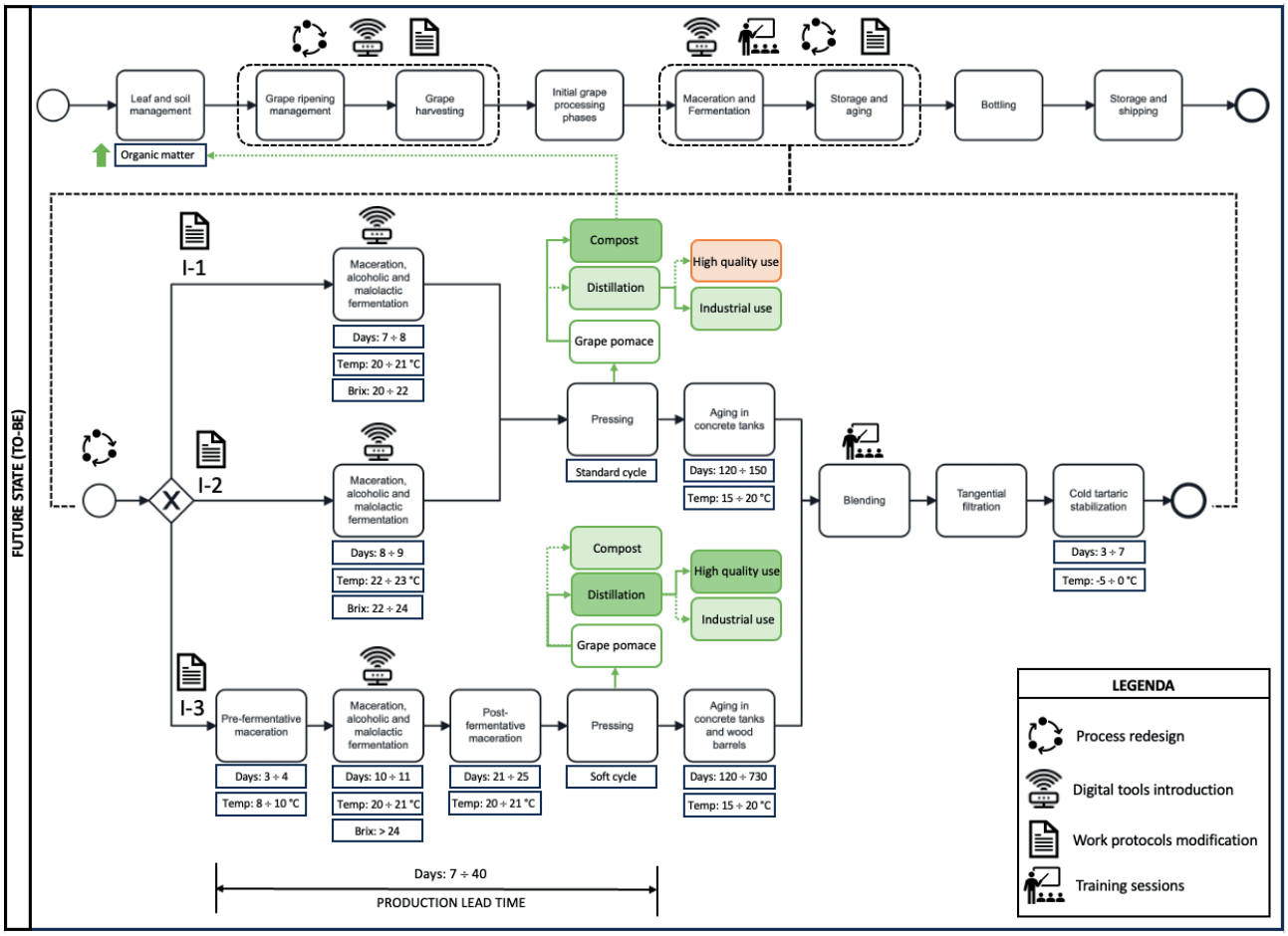

Figure 8. To be SCP map.

best practice manual has been created by the team. The experimentation is still ongoing.

4. DISCUSSION

The aim of this research was to demonstrate how supply chain processes can be improved by deploying the synergies between LSS, I4.0 and CE, so as to face the quality, efficiency and sustainability challenges modern competition poses to wine companies. To this aim, this study proposed an original methodology for systematically improving SCPs throughout the different phases of wine supply chains by integrating LSS, I4.0, and CE. Our findings and evaluation in a real case corroborated that the proposed methodology addresses the gaps identified in the literature concerning the lack of a systemic approach that connects process improvement decision-making to LSS, I4.0, and CE.

The Design Science Research Methodology suggests evaluating decision-support systems considering their novelty, practical usefulness, and relevancy [21]. As justified below, the contribution of the methodology this study proposes is considered novel, practical, and relevant, indicating that it supports decision-making to improve wine SCPs by synergistically exploiting LSS, I4.0, and CE.

Regarding novelty, the methodology uniquely assembles concepts and tools from different bodies of literature such as strategic decision-making, data-driven process improvement, lean management, industry 4.0, and circular economy. It is framed according to the strategic decision-making premise that achieving a goal (i.e., the oenological objective in our case) requires a series of decisions and actions concerning both the conceptualization (i.e., what the strategy entails) and the implementation of the strategy (i.e., how to realize the strategy) [22]. The conceptual framework (Figure 1) aids decision-makers in identifying what can be done in each phase of wine supply chains to achieve the oenological objective, integrating the concepts of LSS, I4.0, and CE, while the

implementation framework (Figure 2) provides guidelines on how to improve each phase of SCPs by following the DMAIC cycle—a data-driven process improvement approach based on the scientific method—and considering the LSS, I4.0, and CE solutions of the conceptual framework.

As for usefulness and ease of use, the case study presented in the testing and evaluation section demonstrates the methodology's applicability and utility. The adoption of a step-by-step procedure inspired by the DMAIC cycle facilitated implementation. The addition of the "Target definition" phase with clear elucidation of the VOB and VOC supported convergence toward the oenological objective, avoiding time and resource losses. Wine companies often prioritize the former, as identifying the latter—which is a pillar of lean management representing the value for the customer—is more complex, costly, and time-consuming. The use of the Skill Matrix in the "Define phase" allowed the company to assess internal staff skills, identifying strengths and weaknesses, and to form a well-balanced multidisciplinary team by incorporating qualified external personnel, bringing new ideas and skills that complement those existing within the company. This blend of external competencies and internal staff experience was crucial during the "Analyze phase" for identifying critical issues and during the "Improve phase" for proposing solutions.

Regarding relevance, the use of the proposed methodology led to several solutions of practical significance that synergistically exploit LSS, I4.0, and CE. One of the goals set by the oenological objective was to enhance the quality of the wines produced, aligning them with consumer expectations. To this end, the team created and implemented an original, flexible, customer-oriented production process, based on the adoption of BSL, BSA, and the ingredient-based production methodology (see Figure 7). Inspired by a key concept in lean literature—product modularity [23]—the team considered that wine could be seen as a complex product made up of interchangeable components each characterized by well-defined standardized functionalities (i.e., the ingredients).

The oenological objective also required an increase in environmental sustainability. Comparing Figures 5 and 8 demonstrates how the methodology enabled the mapping and modification of the company's by-product management strategy. Initially, all cellar by-products were sent directly to the distillery. The team identified two weaknesses in this approach: a high carbon footprint due to the transportation and disposal of the transferred product, and a missed opportunity to capitalize on the by-product rich in organic matter. Figure 8 highlights alternatives identified by the team for recovering and reusing by-products from the pressing phase.

The adoption of the ingredient-based production methodology altered the quality of the pressing phase by-products. The pomace from ingredients 1 and 2 was used to create company compost, thereby reducing the carbon footprint associated with distillery disposal. Conversely, the high-quality pomace from ingredient 3 was sent to the distillery to produce a company distillate (Grappa), sold as a complementary product at the company's retail points.

A further relevant contribution suggested by the lean management approach concerned time compression. Longer lead times imply higher resource utilization/waste. SCP mapping identified maceration and fermentation, pressing, and malolactic fermentation as critical phases in terms of Production Lead Time (PLT). Work protocol analysis allowed the calculation of a PLT ranging between 30 and 45 days. This parameter is directly connected to the energy consumption for cooling and/or heating the tanks and the cellar, thereby indirectly influencing the associated carbon footprint. Therefore, reducing the PLT was essential for decreasing the carbon footprint of the process. The team decided to modify work protocols and adopt co-inoculation, bringing the PLT to a range of 7 to 40 days. Fermentation temperatures were adjusted in the work protocol to enhance the quality of the resulting wines and to lower the energy consumption associated with fermentation.

The outcomes mentioned above were made possible by the increased digitalization of SCPs. As highlighted in Figure 8, specific points in the supply chain were equipped with sensors and other I4.0 technologies for real-time monitoring and analysis of process data. This advancement not only significantly reduced the workload for both vineyard and cellar operators but also enhanced the reliability of the data collected by minimizing the redundancy associated with paper-based systems. The decision on which technologies to implement was guided by the recommendations outlined in the conceptual framework.

5. CONCLUSIONS

Although the agri-food sector represents a strategic asset for the world economy [24] and an ideal setting for the implementation of LSS, I4.0 and CE practices, studies that integrate these three approaches to improve wine supply chain processes are lacking. The present study proposes a methodology to support decision makers in improving SCPs and demonstrates that synergies between LSS, I4.0 and CE can be exploited to make wine

supply chains more competitive and sustainable. The methodology is novel, usable in practice and relevant, but there are also some obstacles that decision makers should consider as they can limit the adoption in wine supply chain, such as the need for highly skilled personnel, the resistance to change, the short-termism and the lack of resources. Furthermore, the framework presented in this article is versatile and could be applicable beyond the context of wine, such as in the food and beverage sector, and, with appropriate adaptations, in the manufacturing sector in general. To ensure maximum effectiveness, it is essential to integrate the LSS techniques, I4.0 technologies, and CE principles outlined in this research with additional methodologies tailored to the specific application context.

It is precisely these limitations and this improvement opportunities that could guide future research: the methodology could be integrated into a DSS that could support decision makers in a more structured and easier way. In addition, it could be explored how the Artificial Intelligence could contribute to propose alternative solutions to decision makers starting from the conceptual framework from the critical points identified in the SCP map.

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Exploring blockchain adoption in the italian wine industry: insights from a multiple case study

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Abstract. Modern blockchain-based product tracking systems have the potential to revolutionize the agrifood industry, ensuring transparency and accountability. The need to comply with stringent regulations and contrast frauds makes applications in the wine industry particularly relevant. However, recent studies suggest that the adoption of blockchain in the wine industry presents unique complexities and opportunities. Adopting a multiple case study approach, this paper uses data from 16 SMEs in the Italian wine industry to provide a comprehensive overview of the drivers and challenges of blockchain adoption in the wine industry. Furthermore, this study extends the literature by identifying the key requirements of a blockchain system that meets the needs of SMEs in the wine industry. This study contributes to the literature through the identification of 8 fundamental challenges and drivers of blockchain adoption in the wine industry, including companies' lack of familiarity with the technology, lack of technological skills, the importance of management vision and partnerships with technology providers. The results also clearly highlight the need to develop blockchain systems combining supply chain management and marketing objectives. Finally, this study provides useful practical implications, which can guide wineries and governments to promote the adoption of blockchain in the wine industry.

Keywords: wine industry, blockchain, SMEs, case study.

1. INTRODUCTION

The modern agrifood industry faces key challenges due to its pivotal role in sustaining the growth and development of society. This is exacerbated by globalization, which increased the complexity and risks of managing supply chains, leading to food safety issues and demands for higher quality and accountability from consumers and governments [1,2]. Agrifood companies are also pressured to build more transparent and equitable supply chains [3,4]. The adoption of advanced tracking systems may provide a solution by helping streamline information and product flows, improve coordination, and enhance transparency throughout agrifood supply chains [5,6]. Blockchain-based systems, in particular, may offer greater security, integrity, and

accountability compared to traditional ICTs [7,8]. This is crucial in tracking agrifood products, which are especially sensitive to environmental factors, including temperature or humidity, and must meet high safety standards [9,10].

From this perspective, a particularly compelling scenario concerns the adoption of tracking systems in the wine industry, which must also contend with serious counterfeiting, imitation, and label adulteration issues [11,12]. Indeed, while many agrifood products are treated as commodities, high-end wines can be considered premium products, enabling companies to focus on differentiation strategies [13–15]. Since the origin and variety of grapes play a crucial role in determining wine quality and influencing consumers' choices, producers and consumers require reliable systems to guarantee product authenticity [16,17]. This is especially true also due to the proliferation of unreliable food certification schemes, which fuel trust and communication issues between companies and consumers [18,19]. Despite this, the diffusion of advanced product tracking systems in the wine industry remains limited and it is essential to investigate the reasons explaining the low adoption rates.

However, this topic currently remains under-investigated, as most studies adopt one of two approaches. On the one hand, several articles focus on describing the impact and main advantages of blockchain-based solutions for supply chain management compared to traditional tracking systems [20–24]. These inquiries adopt a technology-centric perspective and do not consider specific applications in the agrifood industry. On the other, some papers focus on investigating the potential of advanced tracking systems for a variety of applications in the agrifood industry [5,6,25–27]. However, most studies provide purely theoretical contributions. While offering valuable insights, these articles typically stress the novelty and benefits of blockchain solutions over implementation challenges and business implications.

Indeed, it is only recently that the first studies focusing on the adoption of blockchain-based systems in the wine industry started to emerge [11,17,28–30]. These investigations suggest that the adoption of blockchain in the wine industry entails significant managerial and organizational complexities which require careful analysis. For example, Brookbanks and Parry [30] show how the use of blockchain systems does not remove the need to implement trust-building processes between wineries, partners, and consumers. Galati et al. [29] suggest that effective blockchain adoption depends on wineries' ability to invest and redefine knowledge management processes within the organization. Cordeiro and Olsen [31] investigate the differences in the diffusion of blockchain in European and Chinese wine value chains, emphasizing the influence of the environment and the international context.

Despite the contributions, most of the articles focus on isolated success stories [11,17,29]. Due to the limited diffusion of blockchain in the wine industry, this helped provide much-needed evidence of how the adoption of advanced tracking systems may affect wineries' business models and performances. At the same time, this led to a somewhat biased perspective, emphasizing the benefits and positive outcomes over complexities. This highlights a gap in the literature related to the lack of studies investigating the challenges of blockchain adoption in the wine industry, and the in-depth analysis of the requirements that tracking systems must possess to meet the needs of actors in wine supply chains. This study aims to help bridge this gap and offer a new perspective by analysing the challenges, drivers and requirements of blockchain-based solutions in the wine industry.

Additionally, we note how most studies investigating specific applications of tracking systems in supply chains focus on large-scale projects, involving multinationals, tech companies and several partners around the world [32–34]. This approach is not suitable for the wine industry, due to the prevalence of SMEs and local productions in the sector. Thus, we try to help bridge this gap by providing an empirical investigation of the drivers and challenges of blockchain adoption for SMEs in the wine industry. Ultimately, we aim to answer the following research questions:

> What are the drivers and challenges of adopting blockchain-based systems for SMEs in the wine industry?
>
> What are the requirements for a blockchain-based system to meet the needs of SMEs in the wine industry?

To answer these research questions, we adopt a multiple case study approach, focusing on the case of the Italian wine industry. Specifically, we investigated companies' perception of blockchain solutions by performing semi-structured interviews with the managers of 16 Italian wineries. Then, we use thematic analysis, supported by a three-step coding process, to identify overarching themes and develop the results. In selecting the cases, our primary goal was to obtain a detailed picture of the current situation of traceability and blockchain adoption in the Italian wine industry.

The originality of the study lies mainly in two aspects. It is one of the first studies to investigate the problem of blockchain adoption in the agrifood industry concerning a specific application, namely product tracking in the wine industry. Second, this study does

not analyse single cases, but adopts a multiple-case study approach, leading to a nuanced perspective introducing new relevant elements into the debate.

Finally, this study has important theoretical and practical implications. From a theoretical perspective, it effectively complements the results of previous literature, by providing an in-depth analysis of key managerial and organizational factors influencing wineries' decision to adopt blockchain technology. It also advances the theory by analysing the requirements that a blockchain system must possess to meet the needs of SMEs in the wine industry. In terms of practical implications, this study helps wine companies assess the opportunities and implications of adopting blockchain. Furthermore, it provides policymakers and governments with suggestions on how to support the diffusion of advanced tracking systems in the wine industry.

The rest of the paper is organized as follows: the next section provides a brief yet rigorous review of available literature. Then, we describe in detail the case study and thematic analysis methodology. Next, we present and discuss the results. Finally, we conclude and provide some useful theoretical and practical implications.

2. LITERATURE REVIEW

In recent years, blockchain technology has been increasingly applied to supply chain management. In the agrifood industry, the adoption of blockchain-based tracking systems enables real-time monitoring of products throughout the supply chain, enhancing safety, transparency, and accountability [6,26,27]. This is crucial as most agrifood products deteriorate rapidly and are sensitive to changes in environmental parameters such as temperature or light exposure, which could undermine their quality in the passage from production to consumption [9,35]. Furthermore, product tracking is also essential to help agrifood companies demonstrate compliance with the stricter standards that institutions recently enforced to ensure accountability of agrifood supply chains [36,37]

These advantages may be particularly felt in the wine industry, which is also affected by serious fraud and counterfeiting issues, and product tracking systems are crucial to safeguard companies and allow consumers to make informed purchasing decisions. Furthermore, the ability to provide reliable information about grape origin and production methods may help wineries implement differentiation strategies, strengthening their brand identity and increasing margins [15,38]. On this note, Bandieri and Castellini [14] explore the impact of different strategic orientations on the performance of Italian wineries, showing how the most successful companies adopt a differentiation strategy. Similarly, Del Rey and Loose [39] highlight that the growth of the global wine market is driven by premiumization, reinforcing the importance of differentiation strategies.

As for the crucial role that blockchain technology may play in the wine industry, Malisic et al. [12] note how the development of global wine value chains has emphasized the role that blockchain can play in ensuring traceability and safety. Adamashvili et al. [40] used an agent-based simulation model to show how blockchain adoption can help wine companies not only improve traceability but also assists detection of potentially harmful products. At the same time, recent studies suggest that blockchain adoption entails significant managerial and organizational challenges.

Among these, Luzzani et al. [16] show how the majority of companies have only basic knowledge of blockchain. Interestingly, this holds even for wineries possessing a sustainability certification, suggesting that companies are not yet thinking of blockchain as a means to complement certification mechanisms. Furthermore, in their analysis of traceability systems in the Italian agrifood industry, Corallo et al. [41] confirm that Italian agrifood companies are interested in traceability issues, but are not aware of the profound connections between digital technologies and product tracking systems.

Danese et al. [11] investigate whether blockchain-based tracking systems can effectively overcome the limitations of existing counterfeiting measures in the wine industry. The authors focus on how different design choices influence the level of counterfeiting protection guaranteed by specific blockchain solutions. Results show that the level of protection obtained depends on the information feeding and reeding processes and that companies may design such mechanisms balancing costs and safety targets. In general, more frequent updates and timely controls increase the level of protection, to the detriment of complexity and costs. Thus, companies offering low-priced wines may choose to implement limited protection mechanisms and focus on preventing consumers from assuming that low prices entail a low-quality product. On the opposite side, companies producing high-end wines may adopt tighter protection mechanisms to enhance company reputation and leverage the unique qualities of their products on the market.

Overall, several theories and conceptual models have been used to analyse the challenges and opportunities of adopting blockchain systems in the wine industry.

Galati et al. [29] and Silvestri et al. [28] move from the Resource Based View (RBV) to analyse the enablers

of blockchain technology adoption in the wine industry. Both studies investigate how the development of knowledge and capabilities may help wine companies gain a competitive advantage from the use of blockchain-based tracking systems. In this, both studies combine the RBV with the theory of dynamic capabilities, stressing how the adoption of disruptive technology such as blockchain requires wineries to change their knowledge acquisition and management processes. Results suggest that one of the main challenges of blockchain adoption is wineries' lack of technological skills. However, while Galati et al. [29] emphasize the role of management in bridging such knowledge gaps and suggest that wine companies can effectively delegate key innovation activities to technology providers, Silvestri et al. [28] propose that targeted hiring and partnerships with tech companies can help wine companies develop the capabilities required to integrate blockchain technology into the business internally. Interestingly, the study also proposes that the adoption of blockchain solutions may be favoured by vertical integration processes. As for the ability to gain competitive advantages, Galati et al. [29] suggest that the adoption of blockchain systems does not lead to direct savings, but can effectively enhance brand identity and wineries' marketing efforts. Silvestri et al. [28] instead propose that blockchain helps firms control processes and information flows. In addition to favouring vertical integration of the supply chain, this helps firms to ensure security, transparency and accountability of the supply chain.

On a different note, Tiscini et al. [17] investigate the implications of blockchain adoption on business model sustainability in the agrifood industry focusing on an exemplary case in the wine sector. The authors refer to the Value Triangle Business Model Canvas (VT BMC) framework, a conceptual model expressly designed to consider the sustainability aspects underlying a business model. Results suggest that blockchain adoption can help wineries improve their value proposition by providing reliable information to consumers. In turn, this can push consumers to promote sustainability practices throughout the supply chain. Furthermore, increased transparency of the supply chain allowed the company to define customers' education initiatives, aimed at increasing consumer awareness of product features. At the same time, the introduction of blockchain entailed set-up costs due to staff training and the need to update information systems. However, these could be offset by improved efficiency in business transactions and simplified accounting and reporting activities.

Tackling the problem from a broader perspective, Cordeiro and Olsen [31] provide an empirical assessment of the effectiveness of blockchain adoption as an anti-counterfeiting and traceability tool in the wine industry. Referring to the UTAUT theory, the study identifies key factors for technology acceptance, including perceived usefulness and ease of use. Results suggest that companies expect blockchain to significantly influence the development of the wine industry, although reservations regarding set-up costs and efficiency remain. Additionally, producers seem concerned about the time and knowledge needed to adopt the technology, while traders' perspective is more nuanced and depends significantly on the local and international business environment.

Brookbanks and Parry [30] investigate how blockchain-based platforms might affect trust and trust-building processes in buyer-supplier relationships in wine supply chains. The authors show that blockchain does not remove the need to develop trust-based relationships between partners and perform physical controls on products. At the same time, the use of a shared blockchain platform helps to reduce information asymmetry, duplication of information, and errors caused by the management of paper documents.

Overall, available literature suggests that blockchain technology could play an important role in the development of the wine industry, increasing security, and transparency and favouring the establishment of trust relationships with partners and consumers. At the same time, several challenges remain and the full implications of blockchain adoption remain unclear. In an exploratory study on the impact of blockchain technology on the sustainability of companies in the wine industry, Luzzani et al. [16] show that wineries' familiarity with blockchain remains limited and that only a marginal share of companies is willing to invest in blockchain systems in the coming years. Kang et al. [42] developed a Stackelberg Game model to evaluate the impact that a blockchain product tracking system could have on wine supply chains. Comparing different equilibrium conditions, the authors conclude that the implementation of a blockchain system leads to an increase in wine prices depending on consumers' traceability preferences and privacy concerns.

Indeed, most studies investigating blockchain adoption in the wine industry empirically focus either on limited applications, or isolated success cases. Thus, the requirements necessary for a blockchain system to meet wine companies' needs are currently under-investigated. In this study, we move from previous literature results and try to gain a deeper understanding of the mechanisms and implications of blockchain adoption in the wine industry, by analysing the perception of companies in the Italian wine industry.

3. METHODOLOGY

3.1. Research design

This study aims to provide empirical evidence of the drivers and requirements of blockchain adoption in the wine industry, using a multiple-case study approach. Case studies are particularly suited for exploratory research, especially when analysing emerging phenomena for which no established theoretical framework is available [43]. From this perspective, case studies enable the empirical investigation of the key factors driving a phenomenon, even in the absence of established measurement models that would allow for quantitative analysis [43]. Indeed, the nascent literature on blockchain adoption in the wine industry effectively resorted to the case study approach, as the novelty of the phenomenon and the limited diffusion of blockchain make quantitative analysis impractical [11,17,30]. This is also appropriate due to the prevalence of SMEs and micro-enterprises, which navigate a delicate balance between traditional business models and the push for technological innovation driven by the evolving needs of stakeholders. In this, case studies allow us to grasp nuances in companies' perceptions, enabling the representation of complex phenomena. Specifically, in this study, we opted for a multiple-case study approach to advance the literature and provide a novel perspective. Indeed, multiple case studies allow for the consideration of multiple sources of evidence and enable cross-case analysis, which enhances the reliability of the results and allows to address multiple explanations [43]. Furthermore, in analysing each case, we opted for a holistic design. Holistic case studies focus on a single unit of analysis. This is appropriate when it is not possible to identify relevant sub-units of analysis [43]. We chose to adopt a holistic design as we focus our attention on SMEs, which can be considered single business units.

Consistent with the case study design, we adopt a theoretical sampling technique. Different from statistical sampling, this is effective when the number of observations is limited. Also, theoretical sampling is based on a replication logic aimed at increasing the consistency of the results [43]. For data analysis, we use an abductive approach. This means conducting case studies moving from an initial understanding of the theory. This allows to identification of key themes while highlighting novel results [44,45]. Figure 1 summarizes the key features and steps of our research. The subsequent sections provide more details on data collection and data analysis procedures respectively.

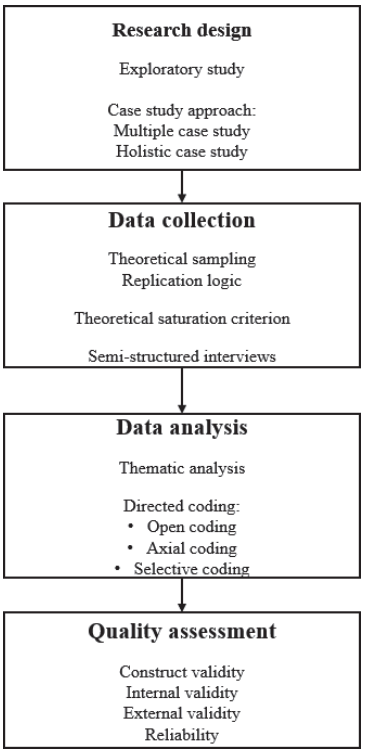

Figure 1. Research design and methodology.

3.2. Data collection

The preliminary step of data collection is the identification of data sources, which requires the definition of appropriate case selection criteria [46]. Thus, we chose to focus on the Italian wine industry, which is among the most relevant globally and is characterized by the variety of its products, which range from low-priced to high-end wines [16,29]. This makes the Italian wine industry the ideal scenario to investigate the nuances and complexities entailed in the development of blockchain solutions. Second, we chose to focus on SMEs, which represent the majority of Italian wine companies [47], and thus allow us to better analyse the current situation regarding companies' perception of blockchain technology. It is important to note that we chose not to focus solely on companies already using blockchain systems, for two main reasons. First, the literature already offers authoritative studies analysing exemplary cases of blockchain adoption in the Italian wine industry [11,28,29]. Second, our objective was precisely to move beyond the analysis of these exceptional cases and provide a more realistic representation of the overall state of blockchain adoption in the Italian wine industry. To this end, we gathered and analysed the perceptions of Italian companies regarding the

challenges and opportunities associated with adopting advanced tracking systems.

To ensure that the selected companies met these criteria, we moved from a database of Italian wine companies identified by the ATECO code. This is an identifier assigned by the Italian government to classify companies by industrial sector. Then, we distinguished between SMEs and larger companies by considering the information on the revenues and number of employees if available. Next, we chose to consider only companies possessing an active website and e-commerce service, aiming to select firms with a good level of familiarity with digital technologies. Subsequently, we selected only companies producing at least one certified wine, trying to include firms deeply invested in product traceability issues. Finally, we reached out to the remaining companies via email, explaining the objectives of the study and proceeding with those who agreed to take part in the investigation.

Following Dul and Hak's [46] suggestions, we provide multiple sources of evidence, to highlight patterns, create chains of inferences, and generalize findings.

Operationally, we adopted the criterion of theoretical saturation, stopping when the analysis of subsequent cases did not provide new elements [48]. Ultimately, we analysed 16 cases. We collected information performing a semi-structured interview with a manager from each of the selected companies. These allow the researcher to focus the analysis on key themes while allowing the interviewee to introduce new elements of debate [45]. The interviews were conducted between May and July 2023. Each interview lasted approximately 45 minutes and was structured as follows. An introductory part, aimed at collecting information on the organization, the business model, and the core activities. The second part focused on the analysis of regulations, standards, and traceability in the wine industry. The final part focused on blockchain applications, possible advantages, and challenges. We deemed sufficient to conduct a single interview for each company, as due to the small size of the companies, the management proved to possess a holistic view of the company's characteristics, objectives, and strategies, representing the most authoritative and reliable source of information available. To ensure data triangulation and complement managers' insights, we also gathered information from the companies' websites and any available document. Specifically, we analysed the websites and official documents in search of information regarding the use of blockchain technology, the companies' stance on traceability issues, certified products, and certification processes, in line with the topics discussed during the interviews.

3.3. Data analysis and quality assessment

Data were analysed using thematic analysis. This qualitative methodology is particularly useful for performing cross-case comparisons, highlighting similarities and enabling pattern matching [49]. Subject to the interviewee's consent, each interview was recorded and transcribed. This resulted in a 94-page document, used as a starting point for the coding activity. In this, we followed the three-step process suggested by Corbin and Strauss [50]. In the first step of open coding, we carefully scanned the transcript of the interviews to assign first-level codes. These are descriptive labels, useful to highlight key passages of the text. In the second step of axial coding, we merged codes establishing logical connections, to define categories. These are units of analysis characterized by a higher level of abstraction and are the first step that leads to the identification of themes. Finally, in the third step of selective coding, we refined the categories to identify patterns and create chains of evidence leading to theory testing. To ensure reliability, two researchers independently performed the coding activity, moving from a shared understanding of previous literature. Then, a third researcher acted as a mediator to help reach an agreement on the definition of the main themes and explanations.

We conclude this section by providing some information on the criteria we considered to guarantee the robustness and replicability of the results. We refer to the four main criteria illustrated by Yin [43] and discussed in numerous relevant studies [49,51,52]. Construct validity evaluates how accurately the results of a case study answer the research questions. To ensure construct validity we resorted to data triangulation, i.e., using multiple sources of evidence.

Next, we used coding to extract key themes and create chains of evidence. Finally, we asked respondents to review their answers and provide feedback or clarifications.

Internal validity considers the strength of the causal relationships allowing the researchers to make inferences. To enhance internal validity, we first performed within-case analysis and then moved to cross-case analyses to identify patterns and make logical inferences. External validity concerns the extent to which the results of a case study can be generalized to similar contexts. We addressed this issue by adopting a multiple-case study approach and by following a replication logic in the selection of cases. Finally, reliability considers the consistency and replicability of the findings with respect to the research questions. We aimed to achieve reliability by following a strict case study protocol, and by performing a rigorous coding activity.

4. RESULTS

4.1. Descriptive analysis

The selected companies produce between 18.000 and 230.000 bottles annually, and perform all production activities, from grape cultivation to bottling, internally. Each company produces at least one wine with IGP, DOC, or DOCG certification. Additionally, five companies hold organic certification, confirming the importance of product traceability, both to meet regulatory requirements and as a marketing tool. The permanent workforce ranges from 4 to 30 employees, with up to 15 temporary workers hired during peak periods, such as harvest season. The owners also act as general managers, shaping the company's strategy and value proposition, while frequently overseeing key production processes themselves. Alternatively, each company employs a production manager responsible for supervising the transformation process, as well as an oenologist. Furthermore, all the companies hired a sales manager, who handles social media and customer relations, indicating an awareness of market trends and a willingness to strengthen customer relationships. Notably, firms are utilizing new sales and communication channels, including digital platforms, while focusing on high-quality wines with unique features and actively promoting their brand identity.

The companies are distributed across Italy: 5 are based in Northern Italy, 3 in the central region, and 8 in the South. Interestingly, even if only one company, located in the South, currently uses a blockchain tracking system, overall knowledge of the technology appears to be higher among the companies in the North. Finally, only three respondents were women, despite women being part of the management teams in nearly all the companies. Table A1, in the appendix, provides information for each respondent. The names of the companies are indicated only for those that have provided consent.

4.2. Thematic analysis

In this section, we present the results of the thematic analysis, which led to the identification of eight main themes regarding blockchain adoption in the wine industry. These findings support and expand previous literature results and enable the definition of the key requirements necessary for the development of a blockchain-based system that meets the needs of SMEs in the wine industry. In introducing the main themes relevant to the adoption of blockchain technology, we begin by framing companies' perception of blockchain within the broader context of technological innovation management within the companies. From this perspective, the first theme to emerge is the limited familiarity of companies with blockchain technology. Indeed, among the 16 companies interviewed, only 5 had a clear understanding of the technology and its potential applications for product tracking in the wine industry. Furthermore, only one company currently uses a blockchain-based tracking system, while the other 4 only searched for information, scouting the market in the hypothesis of a future investment. As for the remaining 11 companies, their knowledge of blockchain varies, as some companies show relative awareness of technological developments, while others claim to have only basic information. Consistently, we notice a strong difference in perception between the company that adopted a blockchain-based solution and the others. The manager of the company that uses blockchain states: "*[blockchain adoption] was a fundamental step, to improve business performance and provide guarantees to customers*". On the contrary, scepticism remains among other companies, as witnessed by one of the managers who explains: "*I've heard about it, it's certainly interesting but we need to understand what advantages it can bring or if it's just a temporary trend*".

In investigating the reasons behind this scepticism and companies' limited understanding of blockchain, we introduce the next theme, concerning the lack of technological skills. Results show that one of the shortcomings of wineries is the lack of advanced technological capabilities. Only five companies hired IT or technology specialists, and only two companies have a technology management team. In contrast, all companies pay great attention to aspects related to quality and communication, hiring marketing specialists. This suggests that companies may not consider technological innovation a priority at present. As explained by one of the managers: "*For us, the authenticity of the product is very important [...] even if we use advanced technologies, we make sure to follow the tradition at each step*". On a different note, results highlight the difficulty of companies in hiring qualified personnel. One of the managers complains: "*It is difficult for us to hire, say, an engineer, for two reasons. First, it would be a non-negligible cost, and second, it is difficult to find engineers willing to work in a small company in the agrifood industry*". Furthermore, another company explains "*We can't find young people with technical skills willing to work with machinery in the fields*".

Consistently, another key theme concerns costs. Possessing limited resources, SMEs must carefully evaluate investments, and managers' scepticism towards blockchain technology can be partly explained by the diffi-

culty of correctly assessing costs and benefits. As effectively summarized by one of the managers: "*Investing in blockchain technology seems to entail significant costs [...] then we would have to hire qualified personnel and change all our IT systems*". This is a significant obstacle for small wineries, which due to their limited knowledge, could also be underestimating the benefits associated with blockchain implementation. The manager of the company using a blockchain-based traceability system explains: "*It was certainly an important investment, but then we realized that our management costs have significantly decreased [...] previously we wasted a lot of time managing the information, now we have everything available and the advantages are clear.*"

Moving to the fourth main theme, results highlight the over-reliance of companies on management vision and external technology providers as drivers of innovation. The lack of specialists within the company places the responsibility of fostering innovation on the management. Among the companies in the sample, those adopting advanced technological solutions are characterized by the strong determination of the management to pursue innovation goals, as evident from the following quote: "*Product improvement must go hand in hand with technological progress*". However, managers do not always possess the means and foresight to foster technological innovation in the company. It is in this scenario that external technology providers play a pivotal role, offering agrifood companies technological solutions tailored to their needs. As illustrated by one of the companies "*We have an advanced weather monitoring station, which was proposed to us by an external provider [....], and they helped us implement the system and make it work*".

After examining companies' stance on technological innovation and their perception of blockchain technology, we take a step forward and investigate the role that blockchain could play in the wine industry. First, we highlight the importance of digital solutions for supply chain monitoring and control. Companies are deeply concerned with traceability issues and with the need to comply with strict national and international regulations. One of the managers interviewed explains "*Every step is monitored [....], we must provide the government with precise information on the grapes, on the production processes and on what we sell*". Furthermore, given the prevalence of counterfeiting phenomena in the global wine industry, companies feel the need for innovative solutions capable of ensuring transparency and safety. As emerges from the interviews: "*Unfortunately counterfeiting is a problem in the wine industry and depends on many factors*". In this scenario, digital technologies can offer a solution. The Italian government developed the National Agricultural Information System (SIAN) to monitor and help companies in the wine industry. In essence, the SIAN is a digital platform allowing the government to control wine production. Overall, companies are convinced by the need to use digital technologies to increase transparency and accountability in the wine industry, but at the same time highlight the shortcomings of current solutions. One of the interviewees explains "*The government provides a valid control mechanism, but we need systems that allow us to manage the entire supply chain and also evaluate product performance*".

This passage allows us to introduce two, deeply intertwined, themes. First, the firms observed a recent shift in the market and consumer preferences. This led companies to emphasize marketing and communication. The prevailing opinion among managers is that: "*Consumers have become much more selective, drinking wine has turned into an experience [....] so, we must be able to stand out among the competition*", and more: " [...] *it is important to know how to promote the product, demonstrate its authenticity to consumers*". Consistently, 14 of 16 companies recently hired a marketing or social media specialist to enhance brand identity and customer awareness. As for the second theme, management expresses a strong interest in digital product tracking solutions that can help the company not only monitor the supply chain but also provide new opportunities to interact with the customers. As highlighted by one of the managers: "*It would certainly be useful to have a digital tool allowing us to promote the qualities and tell the story of the products directly to consumers*". Some executives also highlight how this could enable new strategies. Indeed, following market trends, several companies started to focus on the production of high-end local wines. Managers explain that these are less prone to imitation, generate higher margins, and help the company differentiate itself from competitors. At the same time, companies highlight the difficulty of making this type of product known to less experienced consumers. From this perspective, the use of blockchain-based tracking systems could offer SMEs in the wine industry a viable opportunity to make their products known to a larger share of consumers.

In light of the arguments presented so far, we can now introduce the last main theme, which also represents one of the most relevant results of this investigation. Indeed, evidence confirms the great potential for the development of blockchain solutions in the wine industry, from two complementary perspectives. These are the development of blockchain tracking solutions both for supply chain management, and marketing purposes. Overall, the literature seems to consider

Table 1. Overview of the main findings from the thematic analysis. Drivers and challenges of blockchain adoption in the wine industry.

Themes	Driver/challenge
Lack of familiarity with blockchain	Challenge
Lack of technological skills	Challenge
High investment costs	Challenge
Reliance on management support and technology providers	Both driver and challenge
Traceability as a supply chain control mechanism	Driver
Change in market and consumer preference	Driver
Traceability as a marketing opportunity	Driver
Blockchain to combine control and marketing goals	Challenge

these aspects as two distinct issues. Our findings suggest instead that SMEs in the wine industry require integrated solutions allowing them to monitor all stages of the supply chain, from production to sales. Specifically, firms need solutions that allow them to increase transparency and accountability of the supply chain, guaranteeing safety, compliance with regulations, and authenticity of products. Thus, SMEs could reconcile supply chain control and marketing objectives, building relationships of trust with governments and consumers. Table 1 provides an overview of the main themes.

5. DISCUSSION

Following the thematic analysis, in this paragraph we analyse the results in light of previous literature, highlighting elements of continuity, differences, and novel insights. Thus, we leverage the knowledge obtained to identify the requirements that a blockchain-based system must possess to meet the needs of SMEs in the wine industry.

We move from the first theme to emerge from the thematic analysis. Results show that wineries are relatively unfamiliar with blockchain technology. This is consistent with Luzzani et al. [16] and Corallo et al. [41] who confirmed that, although Italian wineries are interested in product tracking, they show little familiarity with blockchain and do not perceive the connection between the technology and certification schemes. This leads to the definition of the first requirement, which is the need to increase wineries' familiarity with blockchain technology. From this perspective, government intervention can prove decisive, to foster strategic partnerships between agrifood companies, research institutions, and technology providers.

Moving on, results show that another key element to explain the limited diffusion of blockchain in the wine industry is companies' lack of technological skills. This aligns with previous findings by Silvestri et al. [28], who stress the need to enhance the technological skills of employees, invest in hiring IT specialists and rethink knowledge creation systems within the firm. In this scenario, we provide an additional element, showing how the development of the technological skills of firms is hampered by the difficulty of attracting qualified human resources. Results show that companies struggle to find both machine operators with good technical skills and technological specialists willing to work for SMEs in the wine industry. Furthermore, companies are discouraged by the high costs of hiring and training human resources. This leads to the identification of a second requirement relating to the need to develop the technological capabilities of SMEs in the wine industry. To this end, government actions are needed to set up training programs and support investments. Furthermore, schools and universities can contribute through the training of new professional figures, combining technological expertise with a focus on the agrifood industry.

The lack of technological skills connects to two relevant issues, namely the attitude of top management towards technological innovation, and the role of technology providers. Results confirm these are two primary drivers of technological innovation for SMEs in the wine industry. Investigating cases of blockchain adoption in wineries, Galati et al. [29] and Silvestri et al. [28] note the essential contribution of top management in defining objectives and carrying forward the innovation project despite the high costs. In our investigations, we noted a significant difference in attitude between the manager of the company who has chosen to adopt blockchain technology, and the owners of other companies, who are more sceptical and show a stronger attachment to traditional business practices. Thus, the third requirement for the adoption of blockchain technology in the wine industry is the support of top management.

Regarding technology providers, several studies highlight their pivotal role in assisting wineries to set up blockchain-based product tracking systems [11,29,30]. At the same time, papers precisely focusing on examining the dynamics of such partnerships are currently lacking. Also, available literature seems to focus on the advantages provided by these collaborations, while the potential negative effects are often overlooked. Indeed, we argue that, although interaction with external partners can help agrifood companies become familiar with blockchain technology, and fill their skill gaps, over time this can cause a stagnation of companies' technological skills and increase their dependence on external providers. However, the results do not allow us to move beyond

this tentative explanation, and we stress the need for future studies on the topic.

The next theme we analyse concerns costs. Literature confirms how high investment costs are one of the major concerns of managers of SMEs in the wine industry when considering investments in blockchain technology [11,35,42]. Our findings suggest how this issue may be exacerbated by executives' difficulty in assessing the costs and benefits of blockchain adoption. This is caused by multiple factors, including the company's lack of familiarity with blockchain, low technological skills, and top management scepticism. Thus, we advance that a fundamental requirement for the diffusion of blockchain technology in the wine industry is the development of simple-to-use and low-cost solutions, tailored to the needs of small wineries. Danese et al. [11] demonstrate that blockchain tracking systems can be designed to balance cost and complexity depending on performance needs, enabling cost-efficient solutions.

After examining the key drivers and challenges of blockchain adoption by SMEs in the wine industry, we may reflect on how product tracking systems affect companies' business models and performance.

The literature agrees that the main applications of blockchain in the agrifood industry focus on product tracking. This is particularly relevant for two reasons. First, agrifood products are highly sensitive to environmental factors, which makes them prone to deterioration, affecting quality and threatening consumers' health. Second, the agrifood industry is heavily regulated, with laws and standards aimed at ensuring transparency and accountability. In this context, blockchain tracking systems can provide a crucial advantage in helping agrifood companies comply with regulations and access the market. This also holds in the wine industry, where blockchain technology could be effectively employed to enhance transparency and support supply chain management [12]. The results of this study confirm this thesis, showing how SMEs in the Italian wine industry are invested in product traceability issues and require innovative solutions allowing them to comply with regulations while improving supply chain management. Indeed, factors such as provenance, grape variety, and cultivation methods significantly impact wine pricing and consumer perception. Furthermore, differently from most agrifood products, high-end wines are premium items often produced in limited quantities. This allows wineries to invest in developing a stronger brand identity and enhance their marketing efforts [15]. At the same time, this exposes the wine industry to severe counterfeit and label adulteration issues [11,12]. Consistently, the results of this study show how SMEs in the Italian wine industry perceived a change in the market and consumer preferences. For this reason, wineries began to execute differentiation strategies, focusing on the unique characteristics of the wines while trying to build stronger relationships with consumers.

Overall, these considerations allow us to introduce the last requirement for the development of an effective blockchain tracking system tailored to the needs of SMEs in the wine industry. Specifically, we argue that issues of traceability as a supply chain control mechanism, and as a marketing opportunity should not be considered separately. Instead, results show how wineries need integrated solutions, capable not only of supporting product tracking in the production phase but also of providing a competitive advantage on the market. Thus, blockchain systems must help businesses comply with regulations, build more secure supply chains, and establish stronger relationships with consumers. Table 2 provides an overview of the requirements we identified throughout the discussion.

Finally, Figure 2 provides an overview of the main findings, and illustrates the connections between drivers, challenges, and requirements of blockchain adoption in the wine industry. Representing opportunities and enablers, drivers also allow us to identify challenges and obstacles to overcome. For example, management support and collaboration with technology providers can play a pivotal role in driving the adoption of blockchain technology but can also lead wineries to over-rely on management vision or the contribution of external partners. Furthermore, this helps explain wineries' lack of familiarity with blockchain technology. The analysis of drivers and challenges allows the identification of key requirements that a blockchain-based tracking system must possess to meet the needs of companies in the wine industry. These include both organizational and technological aspects. For example, the lack of technological capabilities and the unfamiliarity of wineries with blockchain technology leads to the need to raise companies' awareness, overcome dependence on management vision and external knowledge, and foster the development of advanced skills. At the same time, high investment costs and the possibility of combining supply chain control and marketing objectives lead to the need to develop simple-to-use, low-cost blockchain systems, which enable control throughout the supply chain and also offer businesses new ways to interact with customers. Finally, Figure 2 connects the requirements to the interventions necessary to develop effective blockchain tracking systems. These invite us to consider the contribution that government institutions can provide and to reflect on the design of modern blockchain solutions.

Table 2. Overview of the requirements and interventions needed to develop an effective blockchain tracking system for the wine industry.

Requirement	Interventions
Need to increase companies' familiarity with blockchain	Partnerships between wineries, research institutions, and technology providers
Need to develop companies' technological skills	Government support to fund training programs and elicit investments Training of new professional figures
Need to develop low-cost blockchain systems	Design blockchain systems balancing complexity, performance, and cost
Need to enable supply chain monitoring and control	Design blockchain systems that help companies comply with regulations and contrast fraud
Need to consider the potential of blockchain traceability systems as marketing tools	Design blockchain systems that help companies market their products and interact with consumers
Need to combine supply chain management and marketing goals	Design blockchain systems that integrate control mechanisms and means to interact with consumers

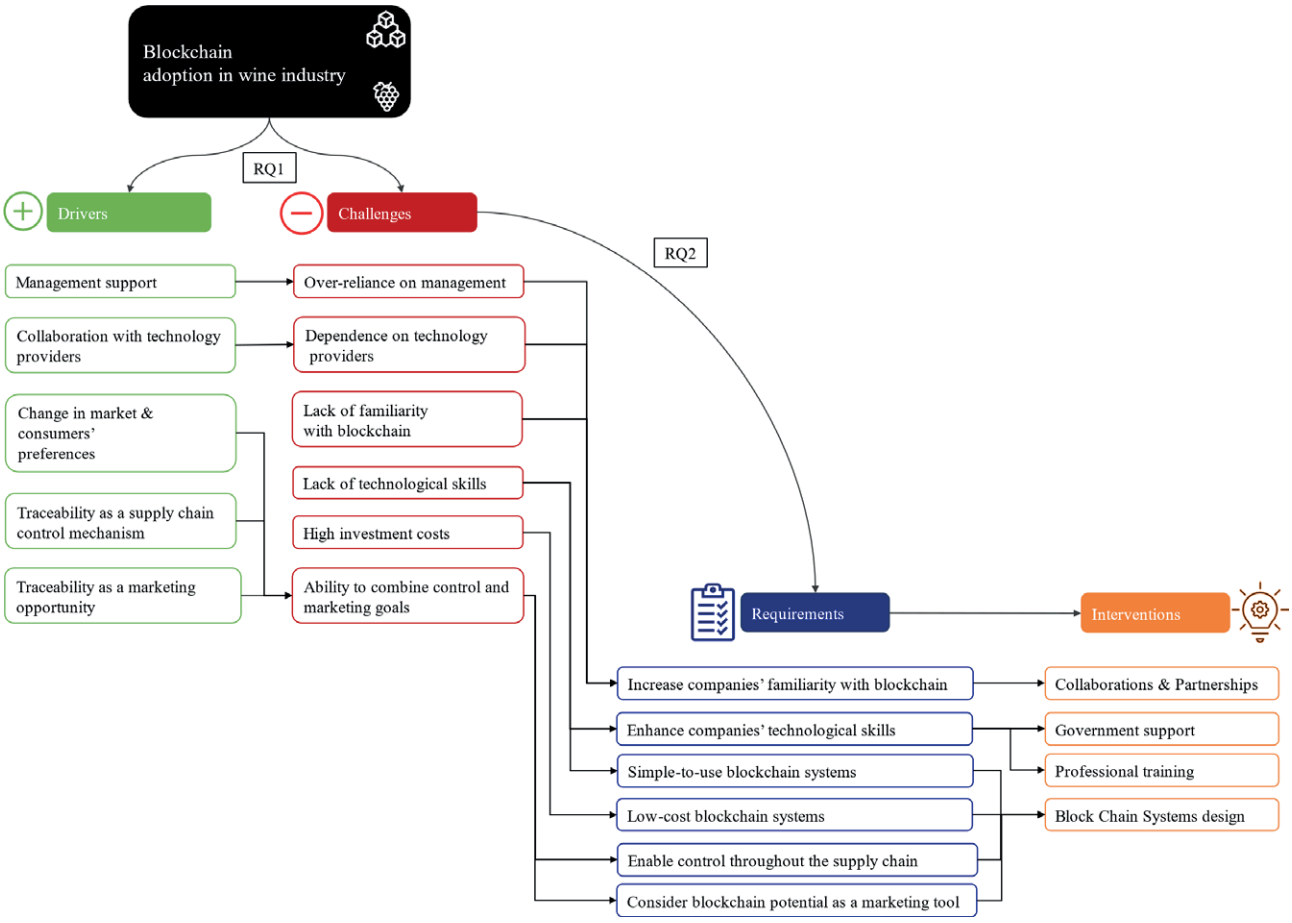

Figure 2. Drivers, challenges, requirements of blockchain adoption in the wine industry and possible interventions.

6. CONCLUSIONS

Blockchain is a potentially disruptive technology for innovative product tracking applications in the wine industry. The need to comply with stringent regulations, combat fraud, and the opportunity to strengthen relationships with consumers make the wine industry a particularly relevant scenario for the development of block-

chain-based systems. However, the diffusion of blockchain in the wine industry is hindered by several organizational and managerial complexities. Despite this, most of the literature provides only theoretical contributions, focusing on generic agrifood applications [6,36]. Furthermore, most studies highlight technical and regulatory limitations, partly overlooking managerial issues [53,54]. Finally, several inquiries focus on large-scale applications, involving big companies and global supply chains [32,55]. Thus, only a few studies investigate the role that blockchain technology can play in the wine industry. Among these, some analyse the potential of blockchain tracking systems from a theoretical perspective [40,56] and a minority focus on the analysis of real cases [11,29]. While providing valuable contributions, these investigate isolated success stories, which may lead to somewhat biased conclusions, leaving a gap in the literature. In this study, we aimed to help bridge this gap by providing empirical evidence of the drivers and challenges to the diffusion of blockchain technology in the wine industry. Specifically, we use a multiple case study approach, interviewing the managers of 16 Italian SMEs. Thus, through a rigorous thematic analysis and a three-step coding process, we effectively support and complement the literature and identify the requirements for the development of blockchain-based tracking solutions that meet the needs of wineries.

From a theoretical perspective, this study offers two main contributions. First, it moves the literature one step forward by analysing the problem of blockchain adoption in the wine industry using a multiple-case study approach. This allowed us to perform cross-case analysis and compare multiple sources of evidence, ultimately introducing new relevant elements into the debate. Second, the study offers a novel perspective on the challenges and opportunities of blockchain adoption in the wine industry by avoiding focusing on single success stories and broadening the scope of the study to take into account the perception of companies representative of the current state of the Italian wine industry. This enabled the identification and analysis of the requirements that a modern blockchain-based system must possess to meet the needs of SMEs in the wine industry.

The results suggest that one of the main obstacles to the diffusion of blockchain is the lack of familiarity with the technology. While valuing supply chain accountability, companies show limited awareness of the potential of blockchain to enhance product tracking. This is exacerbated by several factors, including the lack of technological skills, and the over-reliance of wineries on management support and external technology providers. As for technological skills, the companies stress the difficulty of hiring human resources with advanced technological skills, due to high costs and lack of expert professionals in the sector. As regards the other two factors, results show that the processes of technological innovation in SMEs in the Italian wine industry depend significantly on the vision of top management and collaboration with external providers. This can be a strong driver or a severe hindrance. Managers do not always have the foresight to focus companies' efforts on technological innovation, and it is not guaranteed that partnerships with external providers will provide favourable outcomes. Also, the reliance of Italian wineries on external partners could lead to a stagnation of technological skills. Overall, further studies on the topic are necessary to assess whether these results also hold in different scenarios.

Moving beyond the technological aspects, results suggest that blockchain could play a pivotal role in the wine industry, both as a supply chain control mechanism and as a marketing tool. Indeed, stringent standards require the development of modern digital solutions that help companies monitor the supply chain, track products, and comply with regulations. At the same time, companies may be able to leverage innovative tracking systems to develop new ways to interact with consumers. However, further studies are required to test the validity of these findings in the wider context of global wine value chains.

In terms of practical implications, this study provides institutions, policymakers and companies with useful suggestions to assess the opportunities and challenges of blockchain adoption and to guide the development of blockchain solutions that meet the needs of Italian wineries.

First, to encourage the diffusion of blockchain in the wine industry it is necessary to increase companies' familiarity with the technology. To this end, the creation of strategic partnerships between companies, research institutions and technology providers is crucial. Indeed, companies seem interested in supply chain traceability and transparency issues but struggle to assess the benefits provided by blockchain solutions. At the same time, it is necessary to foster the development of wineries' technological skills. At present, Italian companies struggle to find and hire technology specialists who can drive and manage technological innovation. For this reason, governments must fund training programs and support hiring, while universities may contribute by training new professional figures. Regarding technological issues, a key requirement is the ability of technology providers to develop simple-to-use and low-cost blockchain systems. This is essential to overcome the limited invest-

ment capabilities and skill gaps of SMEs.

As for direct actions that firms can take, the results suggest that wineries could benefit from greater technological expertise. Whereas hiring specialists is too costly or impractical, companies could still make an effort to acquire knowledge by collaborating with universities and research centres and attending conferences. Another initiative is to perform a cost-benefit analysis related to the adoption of an advanced product tracking system. Firms should consider how the use of blockchain solutions could affect their business models and marketing activities, playing into global trends in the industry. Indeed, the wine market is experiencing rapid and significant changes, favouring differentiation strategies and requiring companies to enhance their communication efforts. In this, reflecting on the unique features of the products is crucial, as the literature suggests that product tracking is particularly effective in supporting the sales of high-end products and combating counterfeiting and label adulteration phenomena. Finally, results clearly show that companies in the wine industry might be able to leverage product tracking solutions to prove their compliance with regulations and increase supply chain accountability.

Despite the contributions, this paper is not exempt from limitations. First, this study uses a qualitative approach. This is suitable for exploratory empirical investigations and allowed us to identify key themes related to blockchain adoption in the wine industry. Furthermore, we used a rigorous thematic analysis procedure to reduce the subjectivity of the analyses and increase reliability. At the same time, future research could focus on larger-scale quantitative studies to consolidate and test the findings. Second, this study focuses on SMEs. This helps bridge a gap in the literature, which investigated applications of blockchain in the agrifood industry focusing primarily on large-scale applications. However, this reduces the generalizability of the results, and future studies could analyse the effect of firm size on the choice to adopt blockchain technology. Third, this study focuses on the Italian context. This scenario aligns with the scope and objectives of the investigations but reduces the generalizability of the results, which could change depending on geographical, regulatory or social context. In addition to evaluating the influence of such factors, quantitative analyses are needed to test these findings in cross-national investigations. Finally, this study focuses on the wine industry. While representing one of the most interesting cases for the adoption of blockchain technology, this also limits the generalizability of the results. Wine supply chains present unique characteristics that influence the analysis. Future research could expand these findings by extending the investigation to other sectors of the agrifood industry.

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APPENDIX

Table A1. essential information about the companies and the informants.

Company name	Headquarters	Role of the respondent	Interview date
Tralci Hirpini	Southern Italy	Owner	05 – 31 - 2023
Joaquin Wines	Southern Italy	Sales manager	05 – 26 - 2023
Sella delle Spine	Southern Italy	Sales manager	06 – 05 - 2023
Vini Malavasi	Northern Italy	Owner	07 - 13 - 2023
Francesco Maggi	Northern Italy	Owner	07 – 28 - 2023
Company A	Southern Italy	Owner	07 – 10 - 2023
Company B	Southern Italy	Owner	06 – 01 - 2023
Company C	Southern Italy	Owner	06 – 15 - 2023
Company D	Southern Italy	Production manager	06 – 20 - 2023
Company E	Southern Italy	Production manager	06 – 21 - 2023
Company F	Northern Italy	Owner	07 – 06 - 2023
Company G	Northern Italy	Owner	07 – 28 - 2023
Company H	Northern Italy	Production manager	07 – 12 - 2023
Company I	Central Italy	Owner	07 – 10 - 2023
Company L	Central Italy	Owner	06 – 08 - 2023
Company M	Central Italy	Production manager	07 – 04 - 2023

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Can Geographical Indications foster local development? Evidence from Montefalco Sagrantino DOCG

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Abstract. One of the main goals in the establishment of Geographical Indications (GIs) for European agri-food products was to help foster development in rural communities. Given the cultural and economic importance of wine production in Italy, this paper aims to understand how a wine GI in the Umbria region may have influenced local socio-economic development and, if so, its perceived magnitude among local stakeholders. By conducting semi-structured interviews and carrying out a qualitative analysis through the grounded theory model, results indicate a mirroring ascent, during the last three decades, in the pursuit of a unique identity, for both the territory and the wine product.

Keywords: Geographical Indications, local development, qualitative analysis, stakeholders, wine, Umbria.

1. INTRODUCTION

In times of swift and significant change, rural areas on the fringes face urgent questions regarding their future sustainability. Many of these regions find themselves in precarious situations within the global dynamics of primary production. One of the goals of the European Union (EU) regulation governing Geographical Indications (GIs) is to foster the economic development of rural regions. As clearly stated in the Regulation (EEC) 2081/92, the protection and promotion of products with these specific characteristics was expected to improve farmers' income and retain the population in rural areas [1].

Many researchers have investigated the existence and magnitude of the development of EU rural communities thanks to GIs, trying to assess how much of this impact can actually be attributed to the GI's presence [2, 3, 4, 5]. For instance, Vaquero-Piñeiro [5] has considered the municipalities where some of the best performing Italian food and wine Protected Designation of Origins (PDOs) are produced, to define the contextual conditions that have mostly contributed to the success of the local economy. The author affirmed that for food PDOs a successful GI product may emerge from thriving socio-

economic preconditions. Instead, concerning wine PDOs, a high production value may derive from other contextual socio-cultural factors, such as cultural traditions, community-based expertise, and local identity.

Moreover, wine GIs can become a symbol of their own territory, pushing the local economy also through wine tourism development [6]. Indeed, landscape and wineries foster the establishment of wine routes, wine tastings, and other correlated events and cultural activities that can result in the creation of new hospitality services, such as hotels and restaurants [6]. Nunes and Loreiro [7] have assessed the impact of winery landscape and high-quality wine productions in Tuscany, and found that tourism arrivals are positively influenced by the typical countryside patchwork image created by the presence of different crops and vineyards. Moreover, their results also show that the production of DOC and DOCG wines also has a positive influence on international tourist arrivals in a territory [7].

Among EU member states, Italy has the highest number of GI certifications for both food and wine products[1]. As of January 2024, there are 528 GI wines in the country, including both DOC (*Denominazione di Origine Controllata*) and DOCG (*Denominazione di Origine Controllata e Garantita*) labels, revealing how much this product is part of Italian culture and is embedded in its different territorial contexts. Moreover, Italy is also the world's largest wine producer [8]; in 2021, the national wine production was estimated to have generated a revenue of around 13 billion euros [9]. It is then easy to imagine that wine production must have had, to some extent, a socio-economic impact on the different wine-producing areas.

This study aims to address the research question "What is the influence of a wine GI on local development?", focusing on the Sagrantino di Montefalco DOCG area in the Umbria region, Central Italy. We have chosen a qualitative approach to gain a deeper insight from the direct experiences of local stakeholders. This is to determine whether there has been a noticeable socio-economic development in the area following the establishment of the GI and, if so, to assess its perceived scale. The Sagrantino di Montefalco DOCG was established in 1992, the same year that the EU labelling system based on GIs was introduced. Considering that Sagrantino had already been recognised as a DOC in 1979, this case study allows us to examine a product with a rooted tradition and history, but that is still not as known or recognisable as other Italian wines from Central Italy, such as Chianti or Brunello di Montalcino. Also, in the Umbria region, agriculture has a higher impact on the local economy than the national average [10]. In addition, most of the stakeholders interviewed were able to give us a first-hand report of the main socio-economic developments that took place in the area since the recognition of the DOCG in 1992.

The next section illustrates some previous studies that have been conducted regarding the link between GIs and the development of rural areas. The following section describes the methodology used to collect and analyse the data, accompanied by a brief description of the case study of the Montefalco area. Subsequently, the main findings of this work are shown, thus presenting the first and second-order concepts and the aggregate dimensions that emerged from our analysis. Next, the main results are discussed. Finally, the article ends with the conclusions and limitations of this work.

2. LITERATURE REVIEW OF GIS IMPACT ON RURAL DEVELOPMENT

In the last years, the study of GIs has attracted the attention of an increasing number of scholars and policy-makers, even from non-EU countries, in particular with respect to their impact on social and economic development [11]. Indeed, more and more countries, in all continents, are now considering the establishment of GIs, supporting these policies with arguments such as the positive impact of GIs on local development processes and the protection of natural and cultural resources [12]. Cei et al. [2] have tried to assess the impact of the GI policy on a single indicator of rural development, the agricultural value added. The authors investigated GI schemes implemented at the NUTS3 level in the Italian region. Through the implementation of a fixed effect estimator, findings indicate that the implementation of GI protection in Italy has a positive effect on the agricultural value added, suggesting a positive contribution of this policy on rural development [2].

Through two specific case studies, Williams and Penker [13] have considered, instead, the Jersey Royal and Welsh Lamb, to assess the benefits that these two GIs have brought to rural areas. The authors conducted 25 in-depth interviews with both stakeholders and large retailers. They identified mostly indirect links between the GIs investigated and sustainable territorial development, through economic and social benefits brought to rural areas. Moreover, no significant cost for GI protection was found [13].

Sgroi [14] has focused his research on the GI Pachino tomatoes' production in Sicily, to illustrate a compre-

[1] Updated list available at https://ec.europa.eu/agriculture/eambrosia/geographical-indications-register/.

hensive political approach regarding the contribution of GI productions to sustainable development. He emphasised the characteristics of GIs as public goods; with results showing how GIs can help to create a territorial public good that can lead to the agricultural landscape's resilience and the economic growth of the entire region of origin [14].

With respect to wine, a product for which origin is particularly important, the establishment of GIs may have different results, depending on, for example, production volumes or the age of the GI itself, as shown by Belletti et al. [12]. Many reputed successful GI wines, such as Champagne or Chianti, have a long history and high average prices, indicating the existence of a quality (quasi) rent, which enables to cover a multitude of individual and collective costs [12]. Specifically for Champagne, Charters and Spielmann [17] illustrate that, unlike traditional corporate brands, the development of a territorial brand (such as PDOs) is deeply intertwined with the characteristics of their region. Key elements such as effective brand management, cooperation among stakeholders, a commonly shared mythology, and local engagement are critical for the strength of a territorial brand. Moreover, coopetition is proposed as potentially enhancing the market competitiveness for all firms involved in the brand [17]. Differently, Crescenzi et al. [3] specifically considered Italian wines protected by GI rules, to evaluate if this certification promotes local development in rural areas. By comparing rural municipalities with GIs since 1951 with municipalities without GI status, main results indicate that the former areas experience population growth and economic development in non-farming sectors, including high value-added activities [3].

However, there are also examples of wine GIs that, on the other hand, can present some drawbacks. Firstly, considering the number of producers, if a GI becomes too large, or quality standards are not enforced properly enough, free-riders could damage the GI's quality to the point that consumers may end up relying more on private brands as signs for product's quality [15]. In this regard, López-Bayón et al. [15] have considered the Spanish wine industry, and found that, above a certain threshold of producers affiliated with a GI, there is a decrease in the average product's quality (thus, there is an inverted U-shaped relationship between number of producers and quality). The authors also find that very large GI areas are also less effective; indeed, a larger geographic area can lead to an increase in heterogeneity among producers, to a less effective control of the standards, and to an increase in internal conflicts. Still in regard to a GI area, Alston and Gaeta [16] consider the case of the Prosecco GI, in Italy. When Prosecco became a DOC, the area included in the GI was greatly expanded with respect to the small original production area within the Veneto region. The original areas were then promoted to DOCG status, which should be considered an advantage. However, in reality, they face a strong competition from the Prosecco DOC area, which has considerably lower production costs and higher yields, due to being located in a plain area and the use of a more mechanized production. Alston and Gaeta [16] also reflect on the strictness of PDO disciplinaries, which can hinder innovation and adaptation to the market, as in the case of "varietal wines", that is, wines usually made from a single variety that is indicated on the wine label. This is especially common for premium wines from New World regions, but this trend is catching up also in Europe, where "varietal wines" are classified as non-GI. Many European producers are now switching from PDO to PGI (Protected Geographical Indication) wines, allowing them to use different varieties and innovations not allowed under PDO rules. This is the case of Super Tuscan wines, which, despite being PGI wines, are now sold at even higher prices than other PDO wines from Tuscany [16].

3. THE SAGRANTINO DI MONTEFALCO DOCG AREA

The Sagrantino di Montefalco DOCG appellation encompasses five adjacent municipalities located in the Province of Perugia, in Central Italy. The municipalities are: Montefalco (its entire area), Bevagna, Castel Ritaldi, Giano dell'Umbria and Gualdo Cattaneo (Figure 1). This area in the Umbria region has been involved in viticulture for nearly a thousand years. Given the importance of Sagrantino wine for this territory, and thanks also to a shift in production from sweet to dry wines, Sagrantino obtained the DOC recognition in 1979. A few years later, in 1981, the local Consortium, "Consorzio Tutela Vini Montefalco", was established with the aim of guaranteeing high production standards and coordinating the local wineries in valuing and promoting Sagrantino wine around the world. In 1992, Sagrantino wine gained the DOCG appellation, which represents the highest level of recognition for Italian GI wines [18]. Currently, the vineyards area part of the Sagrantino di Montefalco DOCG appellation has expanded to 390 hectares, reaching more than 1 million bottles produced in 2021; moreover, the area is cultivated by 118 winegrowers and hosts 76 wineries, of which 61 are members of the Consortium [19].

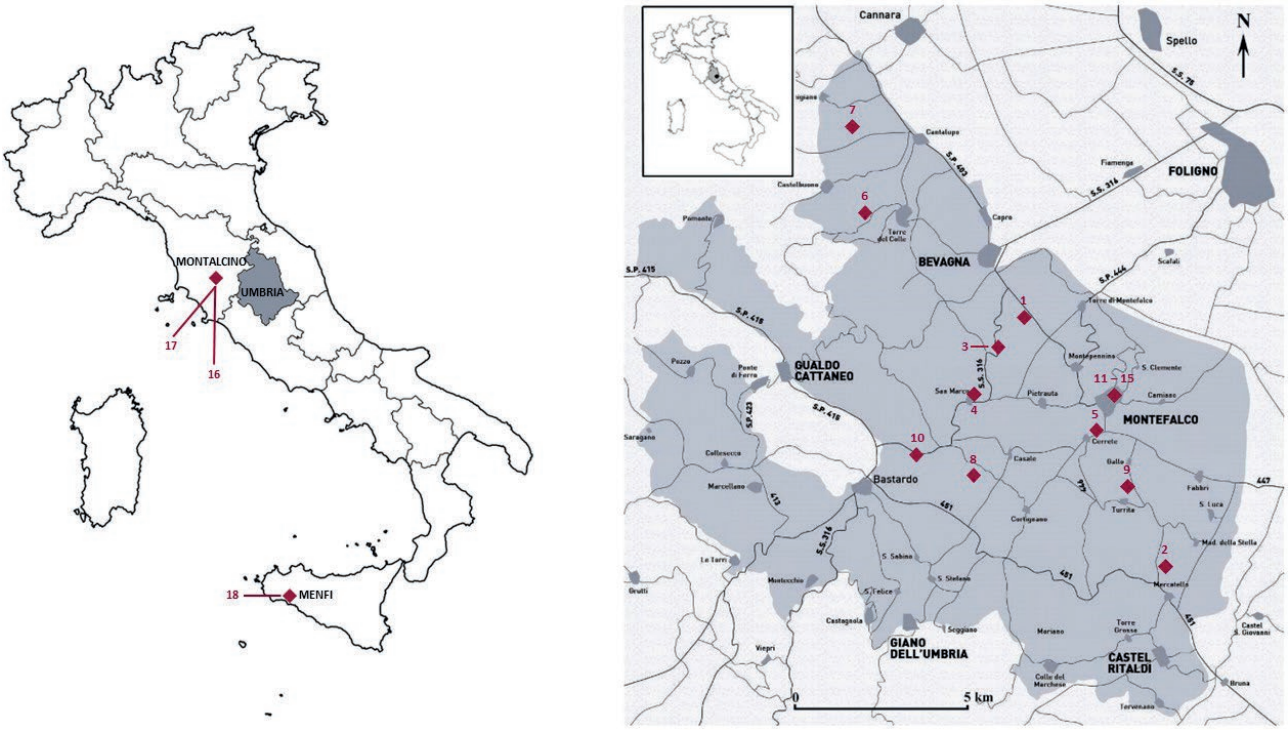

Figure 1. Italy and Montefalco DOCG area; interviewees are represented by the corresponding number (see Table 1). Source: authors' elaboration from Fatichenti [20]

4. METHODOLOGY AND DATA

We used a qualitative approach to answer the question: "What is the influence of a wine GI on local development?". There are different reasons for this choice. Firstly, the main goal is understanding the potential impact of the GI by using the lived experiences of informants [21], without the constraints needed for a quantitative, regressive or statistical approach. Secondly, the inductive approach enables research discoveries to arise from the prevalent, dominant, or meaningful patterns present in unprocessed data, without the restrictions of structured methodologies. Thus, data analysis was based on the so-called grounded theory [22], particularly using the approach of Gioia et al. [23]. This inductive model captures the informants' experience in theoretical terms, allowing to illustrate the dynamic relationships among the emergent concepts that represent the phenomenon of interest [23]. Through this method, the risk of key themes being obscured, reframed, or overlooked, due to preconceived notions in data collection and analysis procedures, is circumvented [24]. In addition, this technique places significant emphasis on how individuals engage with others, and utilise elements from their environment to shape their identity and address challenges [25].

At last, this approach allows to highlight relationships among data, by finding the link between the emerging core constructs.

4.1. Data collection

Data collection was based on primary data sources, through in-depth, semi-structured interviews, which took place between July and October 2022, either in-person or by phone (Table 1). Semi-structured interviews make it possible to trace a direction on the potential topics of interest for the research purposes, while still allowing flexibility and adaptation. The interviews were pre-arranged with the interviewees; thus, each participant was aware that data were being collected on wine and local development regarding the Sagrantino di Montefalco DOCG case study.

In total, 25 individuals were interviewed, and these stakeholders were selected after consulting some local wineries and the Consorzio Tutela Vini Montefalco. These profiles include: 12 winery owners/directors from the Montefalco area; 7 wine experts –journalists, commercial directors, wine consultants, and 5 representatives of local institutions. In particular, 2 of the winery owners/directors were also interviewed due to their role inside the

Table 1. Profile of interviewees.

Case	Corporate / Institutional role	Location	Affiliation	Role in the research
#01	Director	Bevagna (PG), Umbria	Winery	Producer
#02	Director	Montefalco (PG), Umbria	Winery	Producer
#03	Owner	Bevagna (PG), Umbria	Winery	Producer
#04	Owner	Montefalco (PG), Umbria	Winery	Producer
#05	Owner	Montefalco (PG), Umbria	Winery	Producer
#06	Owner	Bevagna (PG), Umbria	Winery	Producer
#07	Director	Bevagna (PG), Umbria	Winery	Producer
#08	Owner	Montefalco (PG), Umbria	Winery	Producer
#09	Owner	Montefalco (PG), Umbria	Winery	Producer
#10	Owner	Montefalco (PG), Umbria	Winery	Producer
#11	President / Owner	Montefalco (PG), Umbria	Wine Consortium / Winery	President / Producer
#12	Councilor / Director	Montefalco (PG), Umbria	Wine Consortium / Winery	Consortium member / Producer
#13	President	Perugia, Umbria	Umbria Region	Local politician
#14	Vice mayor	Montefalco (PG), Umbria	Montefalco municipality	Local politician
#15	Director	Montefalco (PG), Umbria	Montefalco museum	Cultural manager
#16	President	Montalcino (SI), Tuscany	Wine Consortium / Winery	President / Producer
#17	CEO	Montalcino (SI), Tuscany	Winery	Producer
#18	Owner	Menfi (AG), Sicily	Winery	Producer
#19	President	Milan, Italy	Sommelier association	Sommelier
#20	President	Rome, Italy	Sommelier association	Sommelier
#21	Wine consultant	Bordeaux, France	-	Oenologist
#22	Italian reviewer	California, USA / Italy	Wine publication	Journalist
#23	Wine expert	Rome, Italy	Wine publication	Journalist
#24	Wine expert	Rome, Italy	Wine guide	Journalist
#25	Portfolio director	New York, USA	Wines importer and marketer	Portfolio director

local Consortium, and thus considered among the 5 institutional representatives. In addition, our study includes also 2 respondents from Tuscany (Montalcino) and 1 from Sicily (Menfi), in order to understand how other areas in Italy have been able to develop thanks (mostly or in part) to the wines produced there, and eventually highlight differences or similarities between various territories. We consider that the amount of interviews in this study has allowed us to reach an appropriate level of saturation, which is considered the ideal guide for the number of interviews to be conducted, especially when using a grounded approach. This means that including new interviewees would have not provided us with new information on this topic [26]. According to Guest et al. [27], this can occur within the first twelve interviews. The semi-structured interviews lasted between 20 and 50 minutes each, and were all digitally recorded. The interviews were conducted in Italian by the authors, transcribed *verbatim*, and then translated in English.

Then, primary data sources were supplemented with secondary data sources about Sagrantino di Montefalco DOCG, with updated data on production, reputation, and local tourism. Incorporating and validating this information in the analysis aided in piecing together the historical narrative.

4.2. Data analysis

Following the initial phase of data collection, our focus shifted towards systematically mapping the diverse ways in which informants highlighted the contributions of Sagrantino di Montefalco DOCG to local development. We then applied the open coding technique to evince the first-order concepts. The interviews' transcripts were independently coded by the authors, and once the initial round of coding was completed, we consolidated the coded data and engaged in thorough discussions to merge and refine our individual interpretations. By means of multiple iterations, the raw data was gradually aggregated, resulting in the identification of first-order concepts. Then, by summarising the concepts using theoretical lenses, we classified them into five second-order themes. Here, we entered into a more theoretical dimension, and literature is further explored to find

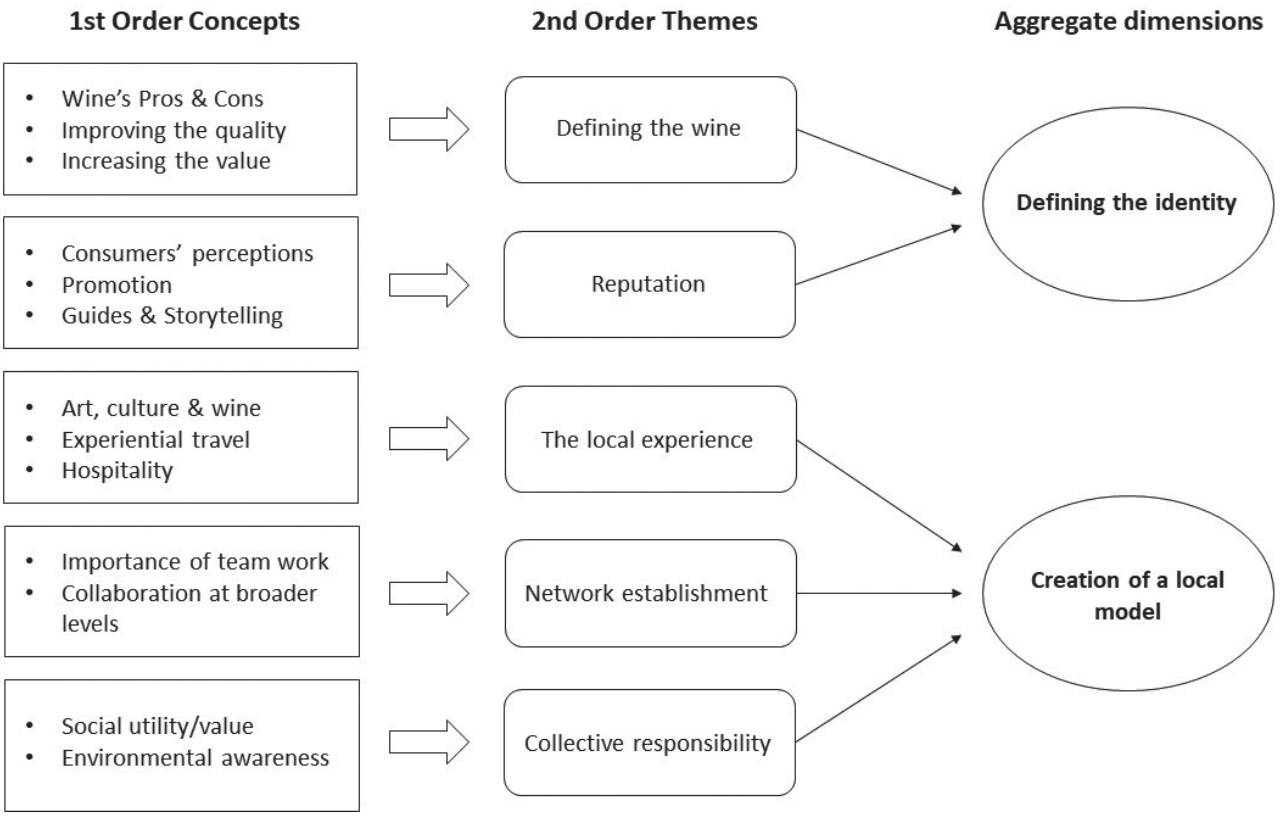

Figure 2. Data structure. Source: authors' elaboration.

emerging themes that could help us describe and explain the phenomenon that we are observing [23]. Finally, by analysing the connections among the second-order themes, two aggregate dimensions were then established.

5. FINDINGS

The analysis of the information obtained through the semi-structured interviews highlights different aspects and layers, that can be used to describe how a rural territory experiences an economic and social development also thanks to the establishment of a wine GI. Two main aggregate dimensions emerge from our analysis: *Defining the identity*, which shows how the wine's quality and reputation have developed during the years, and *Creation of a local model*, that highlights how the development of the wine industry, particularly the production of Montefalco Sagrantino wine, has contributed to the economic and social progress of the territory, showcasing the positive impact of wine-related activities on the local community and economy. Following, we describe these two aggregate dimensions and their underlying second-order themes, also with the support of quotations from the interviews. Moreover, additional quotations from stakeholders to support our analysis and data structure can also be found in Table 2.

5.1. Defining the identity

5.1.1. Defining the wine

The Montefalco area in the Umbria region has a rich history in viticulture, dating back almost a thousand years, with evidence of vine cultivation dating back to as far as 1088. This long-standing tradition and historical presence of vines in the area further emphasise the importance of Sagrantino di Montefalco DOCG as a product of deep-rooted local heritage and expertise.

Local laws to protect vines and wines began to be established during the first half of the 14th century. By 1622, punishments and sanctions were imposed "for any person who cut the grape vine". Sagrantino wine presumably got its name from the Franciscan friars who grew the grapes and produced a sweet wine they would then use for "sacraments" [18]. The Museum of San Francesco in Montefalco bears witness to the ancient his-

Table 2. Data table.

2nd Order Themes	1st Order Concepts	Quote	Case
Defining the wine	Wine's Pros & Cons	"This grape allows us to produce very structured wines, thanks to its polyphenols, its tannins, its alcohol content. A great grape to make a great wine."	#05
		"Necessity to produce an updated version of this wine, the tannin needs to ripen longer while the grapes are still in the vineyard."	#07
	Improving the quality	"Since the 1990s, viticulture here has changed: it is now more specialised, higher planting density and, mostly, a reduction in yields."	#01
	Increasing the value	"Some producers are starting to indicate the specific vineyard on their labels. This is important, because we could start identifying Montefalco as an area suited to produce great cru wines."	#04
Reputation	Consumers' perception	"It still remains a divisive wine, you either love it or you don't. Due to its strong personality, it is difficult to be in the middle. However, continuing to work on its tannins and the vinification process will give him a chance to grow."	#25
	Promotion	"We have been trying to present ourselves to consumers not only as the land of Sagrantino, but also of other wines, such as Trebbiano. We must show our plurality of interpretations of this territory, through our native varieties."	#06
	Guides & Storytelling	"It is important that consumers understand the wine as an emotion, its ability to convey a feeling. While doing so, we also have to tell them about the uniqueness of Sagrantino."	#20
The local experience	Art, culture & wine	"We have made the choice to link the cultural sector with agriculture and the Eno-gastronomy, in order to boost the enhancement of our local excellences."	#14
	Experiential travel	"Tourists, especially foreign ones, want a connection with nature; many of them are interested to have experiences in farms and wineries, and cultural sites. They want to discover and have adventures in special settings."	#14
	Hospitality	"Not only from a quantitative perspective, but also when considering quality, restaurants and hospitality in the area have greatly raised the quality level of their offer."	#02
Network establishment	Importance of team work	"The Consorzio is fundamental to support the collective needs of producers. It deals with promotion, communication, audits, and safeguard. However, we should start working together also regarding more technical issues."	#10
	Collaboration at broader levels	"We need to increasingly team up with other stakeholders in the Umbrian supply chain, including restaurants and catering, hospitality, parks and cultural institutions, but also olive oil and other local foods productions."	#06
Collective responsibility	Social utility/value	"During the years there has been a common enrichment, but without losing our identity as an agricultural territory. For instance, when building wineries, all stakeholders involved have been careful to properly include them in the landscape."	#16
	Environmental sustainability	"There is a great awareness for wines that have sustainability at the core of their image, and this is a great opportunity for Umbria and its wines, since it is a region full of nature."	#18

tory of the territory, where art and products of the land, including wine, have been interwoven since antiquity.

> The museum serves as a true representation of what one can discover in the territory. Just below the museum there are the Franciscan cellars, where Sagrantino wine was first produced. The museum narrates this ancient history with the intention of providing tourists with the tools to explore the current development of the wine denomination. The "Strada del Sagrantino", a dedicated route for wine tourism, offers experiential tourism opportunities, and works closely in collaboration with the Museum of San Francesco. [#15]

The indigenous Sagrantino grape variety is considered by many to be unique due to its high content of tannins and polyphenols, which allows to produce an extremely recognisable wine, with respect to other red wines, especially from Italy (*Wine's pros & cons*).

> Sagrantino wine is a prominent contemporary Italian red, which has been a part of the movement of renaissance in Italian winemaking that began in the 1980s and continues today. […] It gained international recognition and success in the 1990s, becoming a standout wine with acclaimed labels. What sets Sagrantino apart is its uniqueness and irreplaceability outside the Montefalco territory. [#24]

> The strength of Sagrantino lies in being an indigenous grape variety, characterized by its uniqueness, and a wine must distinguish and qualify itself for specific features. […] I believe that due to the grape's characteristics, Montefalco Sagrantino is truly a one-of-a-kind wine. It is easily recognizable thanks to its distinctive sensory traits,

> and of course, it has a rich narrative to share. […] A wine must be unique, […] and it is a great symbol for the promotion of a territory. [#19]

Indeed, the theme of quality has always been at the heart of Montefalco's wine production, and this is likely due to the unique characteristics of the Sagrantino grapes. As already mentioned, the nature of Sagrantino grapes has never allowed for a simplistic or naive approach to their production and management (*improving the quality*). The search for a wine that could be appreciated by consumers has indeed driven the pursuit of quality, with local producers now trying to position this product more firmly in a medium to high price range on both the national and international markets (*increasing the value*).

The exceptionally high polyphenol content of Sagrantino grapes has presented and, to some extent, continues to pose a challenge for local producers. While polyphenols are beneficial compounds that contribute to the wine's structure, colour, and aging potential, they can also result in intense tannins and astringency, which may make it difficult for non-expert consumers, to fully appreciate its qualities. In the past, this intensity might have limited the wine's appeal to a broader audience. However, local producers have been working to strike a balance in winemaking techniques, experimenting with different maceration times, fermentation methods, and aging approaches to soften the tannins.

> For quite some time, our focus has been to produce wines that are not overly strong, aiming, instead, to create wines that are "drinkable" and enjoyable. While it is important for the wines to convey the distinctive characteristics of Sagrantino and exhibit its unique personality, we also strive to ensure that they are approachable and not challenging to be appreciated. [#02]

> There has been a technical evolution after the pursuit of concentration, richness, extraction, and significant maturation typical of the 1990s. […] The wines we taste today are more relaxed, more elegant, more balanced, and fresher, as much as a polyphenol-rich grape variety allows. This is an extremely positive fact because it shows the intelligence, attention, and sensitivity of a generation of producers who are facing international markets and are capable of […] providing a more modern interpretation of the wine. [#24]

5.1.2. Reputation

The high level of quality perceived by consumers has played a crucial role in Sagrantino di Montefalco DOCG's success on the markets. Additionally, recognition from wine experts and guides has further solidified its reputation, particularly since the 1990s (*consumers' perception*).

Wine is commonly referred to as an "experience good", which means it can be evaluated by consumers only after consumption. Therefore, they frequently rely on signals such as price, firm reputation, and assessed product quality in order to make their choices [28]. In particular, consumers have started to turn more frequently to wine guides, helping them to mitigate the uncertainty associated with experience goods and enhances their confidence in their purchasing choices [29]. Oczkowski and Doucouliagos [30] even showed that there is a moderate and statistically significant partial correlation between quality ratings and wine prices, thus proving the importance for individual producers and regions alike to be positively featured in wine rankings.

> A top wine is a wine that receives unanimous acclaim from critics and is capable of producing bottles and labels that are excellent at the time of release. However, these wines are also able to evolve and convey great emotions even in the following years, making them suitable for medium to long-term aging. In the case of Sagrantino, it benefits from extended aging, as we taste bottles that are 10-15-20 years old and still in excellent condition. [#24]

Even among producers there is an awareness that Sagrantino di Montefalco DOCG can give impetus to other local products as well (*promotion*), thanks to its reputation:

> Today, in my opinion, having Sagrantino in a winery is essential; it is of utmost importance. Nowadays, people come to Umbria, or to this part of the region, to visit these wineries specifically for Sagrantino. Then they discover the other products and enjoy them as well. But currently, there is a great interest in Sagrantino. [#03]

This wine appropriately conveys the profound relationship between territory and wine, and the increasing recognition that Sagrantino di Montefalco DOCG has been experiencing during the last years on national and international wine guides strengthens this link (*Guides & storytelling*).

> It is the wine's quality that determines its score, and this remains true. But in the context of wine storytelling, creating a narrative around that wine is, in my opinion, the modern key to good wine journalism. It involves telling the whole story that revolves around that glass - the culture, the art, the entire experience. Because consumers seek more than just the wine's quality; they also want to understand its symbolism and what it represents. [#22]

The efforts of producers and the Consorzio in redefining and improving Sagrantino di Montefalco DOCG seem to have borne fruit, particularly in terms of

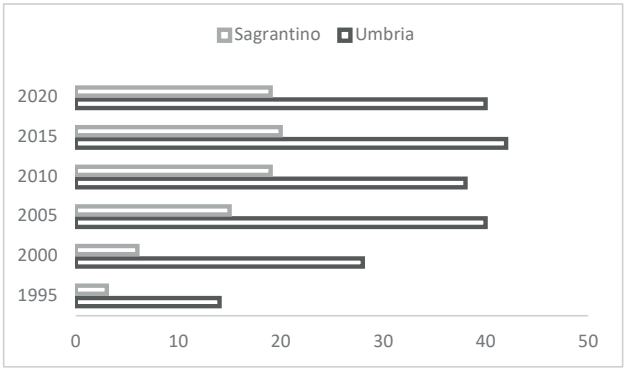

Figure 3. Wineries in Umbria and the Montefalco Sagrantino DOCG area ranked on Gambero Rosso Vini d'Italia (1995-2020). Source: authors' elaboration based on data from Gambero Rosso Vini d'Italia.

enhancing the wine's reputation. As a flagship wine of the Montefalco area, Sagrantino has also had a helpful impact on promoting other wine products in the region.

Although wine production in Umbria only accounts for around 1% of the national production [9], the region boasts an impressive diversity with about 13,000 hectares of vineyards and a remarkable presence of 21 different wine GIs, including 2 DOCGs, among which Sagrantino di Montefalco stands out. The wines of Montefalco region represent approximately 22.26% of the total production of GI wines in Umbria and, specifically, Sagrantino di Montefalco DOCG accounts for 7.6% [19]. Figure 3 illustrates the number of wineries from Umbria evaluated by Gambero Rosso, one of the leading wine guides in Italy.

Indeed, there has been a significant increase in the number of Umbrian wineries producing Sagrantino over the years. In 1995, the percentage of wineries included in the guide that produced Sagrantino di Montefalco DOCG was less than 20%. However, by 2020, this figure has nearly doubled, with almost half of the total regional wineries now producing Sagrantino di Montefalco DOCG.

Furthermore, Sagrantino di Montefalco DOCG has achieved remarkable success in the Gambero Rosso guide, as it now represents half of the Umbrian wines that has received the highest ranking, known as "Three Glasses".

5.2. Creation of a local model

5.2.1. The local experience

> Even the producers have transformed into connoisseurs and promoters of this area. Not only they have knowledge of the landscape's beauty and the uniqueness of exceptional products like Sagrantino and other wines produced here, but they have also deepened their understanding of the cultural heritage associated with the area. Therefore, there is a close synergy between art, culture, territory, landscape, and the excellent products part of our Enogastronomy, which has allowed the local community and the territory to grow. [#13]

Local institutional stakeholders recognise the role that wine producers have played in creating a stronger link between the different factors that make this area so unique and special; that is, wine, food, and culture (*art, culture and wine*). Indeed, local foods are conceived as "authentic" products that symbolize the place and culture of the destination and can connect consumers to the region and its perceived culture and heritage [31]. Local stakeholders have expanded their services and enhanced visitor engagement in Montefalco. This has been applicable to both enotourism, and the local culture and nature, making the area appealing to a wide range of demographics.

Local politicians have demonstrated effectiveness in recognizing the growing demand for *experiential travel*, particularly after the impact of the Covid-19 pandemic.

> Many younger tourists come to Montefalco to visit the Museum of San Francesco because they are interested in Sagrantino, in nature and sustainability, in the good local products; they want to have experiences. Wine producers have now a very high standard of hospitality: they offer guided tours, tastings, concerts, picnics, etc. […] At the end of the day, the overlap between art and wine is very high; this combination represents the territorial experience, and it is successful. [#15]

Enotourism can sometimes become a driving force for the development of a certain territory, increasing its competitivity and improving its wine production, thus leading to the economic regeneration of rural areas and to a higher quality of life for local inhabitants [32]. Different studies have illustrated that there is a positive correlation between GI wines and tourism activities [33, 34], with accommodation and food service being among the economic sectors in DOCG municipalities that grow the most with respect to the share of employment [3]. Confirming these findings, many respondents acknowledge that the increasing recognition of Sagrantino may have contributed to the overall growth and reputation of the entire Montefalco DOCG area, fostering the creation of more accommodations and dining establishments of higher quality, catering to the growing influx of visitors.

> Previously, there were probably only one hotel and one restaurant in the area, but today there are approximately

> 20-25 restaurants. […] This growth in the hospitality sector has started a virtuous circle: as more tourists began to visit, the demand for accommodations, wineries, and the excellent wines, increased as well. Consequently, this attracted more tourists to the area, further stimulating the expansion of the restaurant and hospitality industry. Notably, the qualitative aspect of the touristic offer has also seen a substantial improvement. [#02]

Figure 4 and 5 prove that both the number of tourists and the number of hospitality structures in the municipalities that constitute the DOCG area have indeed increased overall during, at least, the last 21 years (except for 2020, due to the Covid-19 pandemic), thus supporting the statements of the local stakeholders interviewed.

Notably, in the Sagrantino di Montefalco DOCG area, which includes part of the Folignate and Spoletino districts, there is a clear majority of non-hotel accommodations (which include camping and agritourism), proving the importance that landscape and nature have for visitors, especially foreign ones.

> At the end of the 2000s, when agritourism was mentioned, people in this area were not well acquainted with the concept. They were uncertain if it was an experience they could try, questioning whether it involved spending a vacation on a farm. However, over the years, agritourism has flourished and grown significantly. [#07]

The local economy based, on one hand, on tourism and, on the other hand, on agriculture has developed especially during the last thirty years, with bottom-up collaborations between wineries and hospitality accommodations, started from the mutual necessity to drive the local economy and help each other. The respondents highlighted the role of regional institutions in recognizing the opportunity to foster rural tourism linked to the experience provided by farms.

> The Region of Umbria played a crucial role in this development by funding the renovation of old farmhouses and increasing the availability of accommodations. […] In the last two decades, the entire Umbria region has witnessed a substantial increase in offerings, including accommodations and dining options. Consequently, there has been a shift in perception, and now the area is rich in hospitality and culinary options. […] Significant emphasis has been placed on providing training courses in communication and foreign languages. [#07]

Overall, the theme revolving around the *local experience* in rural communities, and the transformation that occurred in Montefalco to become an increasingly popular tourism destination, can also be found in the community of Menfi, in Sicily. One producer from the area shared his perspective:

> I have noticed a great change. While Menfi used to be a strictly agricultural area, nowadays tourism has become a fundamental aspect. This is a very beautiful but little-known area. […] There has been a proper structural shift from an agricultural and viticultural area to an agri-touristic one. [#18]

5.2.2. Network establishment

> If a DOC does not have the ability to become a territorial brand (a collective trademark), it may not be very effective. […] A DOCG linked to a group of producers who collaborate in promotion, establish shared and certain rules, and self-regulate through Consortia can be a successful approach. [#23]

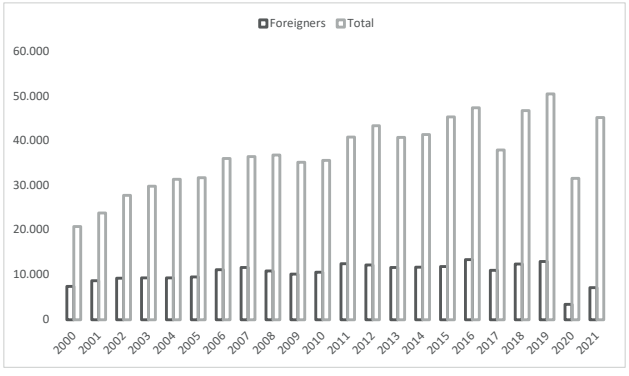

Figure 4. Tourist arrivals in the Montefalco Sagrantino DOCG municipalities. Source: authors' elaboration based on data from Regione Umbria.

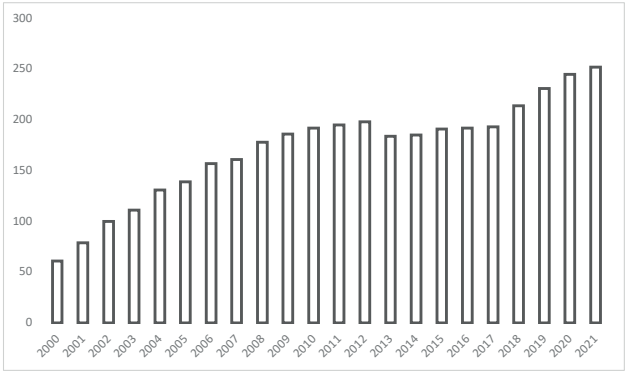

Figure 5. Number of hospitality structures in the Montefalco Sagrantino DOCG municipalities. Source: authors' elaboration based on data from Regione Umbria.

In the past, Sagrantino di Montefalco DOCG was promoted on the markets with a focus on its strength and tannic structure. However, in recent years, the Consortium has adopted a different strategy: instead of solely promoting Montefalco as the land of Sagrantino, they have chosen to present the area as a place where other outstanding wines from native grape varieties, such as Trebbiano Spoletino, are also produced. These wines are seen as an opportunity not only to showcase the great diversity of the region's wine production, but also to attract consumers who might be hesitant to try such a distinctive wine as Sagrantino. This approach opens new possibilities for consumers to discover and appreciate the diverse and exceptional wine offerings the region has to offer beyond the well-known Sagrantino.

> There is an ongoing reflection about the potential of the wines produced here. Luckily, it is not an area defined by a single product, but is capable to offer to international consumers a variety of high-quality wines. [#24]

Wine, food, and tourism can provide a unique experience and lifestyle to visitors, thanks also to the synergy and cooperation of the different entrepreneurial activities [35]. This means that the local stakeholders must be able to work together in order to accomplish their common goals. In the Montefalco area there are different institutional actors that can influence the local economic development and the growth of the wine sector. These are the municipalities, the Consortium, and public associations such as Strada del Sagrantino (which aims to promote the territory and its products). However, it is important to acknowledge that their collaboration has also presented challenges and conflicts along the way. Nonetheless, the efforts put into working together have ultimately proven to be fundamental in attaining the positive outcomes associated with local development.

> As administrators, we have listened and sought to understand the issues faced by the Municipality, the Consortium, and the Strada del Sagrantino. The first achievement of this administration was to facilitate communication among all the key stakeholders in the region. […] By doing so, we began to realise that, if we all move in the same direction, we can accomplish significant and meaningful results together. [#14]

However, the collaboration, especially among individual producers within the Consortium, appears to not be fully developed yet to effectively address future challenges, particularly those related to climate change and more innovative and sustainable agriculture. The current focus seems to be mostly on promotion and quality control, and this approach may hinder the development of more substantial cooperation among member wineries.

> The consortium plays a crucial role in supporting the collective needs of producers. It handles various aspects such as promotion, communication, audits, and safeguarding. However, it does not address technical issues due to their complexity and the substantial financial requirements involved. […] Climate is a critical element in the production of wine; […] however, addressing climate-related challenges can give Montefalco an advantage over other wine-producing regions. By effectively handling this issue, the region can position itself favourably and stand out in the global wine market. [#10]

The above statement by respondent #10 seems to confirm part of the findings of another research involving Montefalco DOCG wineries. Maghssudipour et al. [36] analysed the role played by different local knowledge ties to investigate the driving forces of the knowledge flows. It appears that local actors were more likely to provide knowledge to others in the case of economic ties based on material exchanges rather than on a friendship basis. In addition, local wine-related institutions did not provide a statistically significant result as drivers of exchanging knowledge; also, local actors were more likely to form knowledge ties if they were linked to other external institutions rather than to local ones [36]. These results illustrate the chance to implement different forms of interaction among firms and a more inclusive knowledge-sharing within networks. This is particularly important with respect to wine consortiums, which are fundamental to implement formal relationships and trust among competitors [36].

Some producers also recognise the absence of an agreed minimum threshold price for Sagrantino di Montefalco DOCG in the market. Setting a minimum price, below which the wine should not be sold, could significantly enhance the perceived economic value of the product, contributing to better position Sagrantino di Montefalco DOCG as a premium and high-value wine. This could benefit both producers and the overall market perception. Additionally, other interviewees expressed their concern about the lack of a proper zoning system for the Montefalco DOCG area. The implementation of such system could identify vineyards that are more suitable for producing higher quality wines, thus enabling the production of cru wines that could be sold at higher prices. In this way, the region can strengthen its identity and reputation as a premium wine-producing destination. Indeed, as wine consumers become increasingly knowledgeable about quality and reputation indicators, they will pay more attention to signals that highlight the

quality of the producer and the specific site where the wine is produced [37].

> Perhaps, from the beginning, we didn't identify specific zoning areas. Initially, we had around 50 hectares, but today we have hundreds, if not thousands. Implementing zoning would have allowed us to produce Sagrantino, grand crus, and premier crus, which could have justified higher prices and helped us improve the overall quality of our wines. [#05]

Several local producers interviewed expressed their aspirations to forge stronger collaborations with other areas and GI districts at the Umbrian regional level. By fostering partnerships with neighbouring areas and districts, they envision enhancing the visibility and appeal of Montefalco's wines and products beyond its immediate boundaries. This strategic approach to regional cooperation can create synergies, increase market opportunities, and elevate the overall reputation of the region's offerings, benefiting both producers and the region's economic growth in the long run.

> If we do not make the consumer understand what Umbria is, no matter how magnificent the Montefalco territory is and how excellent and unique the wine is, we will always face more challenges. It is crucial to continue growing as the Montefalco region, but at the same time, we must work as Umbria, creating awareness of the "Umbria" product in the world of wine. Then, Montefalco can grow, just as all the other DOCs and DOCGs in our region can grow. [#09]

Indeed, it is crucial to recognise the dedication of individual producers, the Consortium, and other local stakeholders in their efforts to promote Sagrantino di Montefalco DOCG and Montefalco territory. Other existing successful models in other regions could be taken as an example, such as the Montalcino area in Tuscany. By studying and adopting some of the strategies and best practices implemented in Montalcino, Montefalco can further enhance its marketing and branding efforts. Emulating successful models while retaining its unique identity will strengthen the overall promotion of Sagrantino and Montefalco wines, contributing to the growth and recognition of the region in the global wine market. The importance of collaborating among individual producers for the success of a GI is well explained in the words of respondent #16 from Montalcino:

> In our opinion, what has made the difference for Montalcino, beyond the individual efforts of the wineries, is the teamwork of the Consortium. It has kept the producers together, pushing for a unified marketing strategy and providing significant support to everyone. Of course, the quality of the wine plays a crucial role, but the Consortium has played, and continues to play, a key role in promoting and raising awareness of the denomination [#16]

5.2.3. Collective responsibility

Given the intrinsic relationship between a GI and its territory, the rural development triggered by the presence of a GI can have not only a strictly economic impact (as already mentioned, on different local economic sectors), but also a social impact. Indeed, by increasing the income of producers and fostering job generation, GIs contribute to the survival of rural communities [38]. The impact that a GI can have on its community also emerges from the interviews with producers from the Brunello di Montalcino DOCG area, an older wine GI with respect to Sagrantino di Montefalco DOCG (it was established in the 1960s). In Montalcino, the local consortium has decided to actively help its community through different actions:

> Acting together as a consortium, we have created a territorial Foundation, subsidised by members, with the aim to help those in need, and to engage in public utility activities. After establishing the Foundation, we have also decided to broaden our horizons: besides wine, we have started promoting other local productions, such as olive oil, honey, pasta, etc. […] In addition, given the increasing request by firms for specialised labour, we have also established an agricultural school in Montalcino. [#16]

The commitment of the successful Consortium of Brunello di Montalcino, towards pursuing and creating socio-economic benefits for their local community, seems to confirm the findings of the work of Rivera et al. [39], who indicate that a stronger sense of community enhances the potential and the development of rural communities. Similar types of social initiatives to the ones created in Montalcino are also emerging in the territory of Montefalco, where some wineries have been collaborating with the regional Higher Technical Institute (*Istituto Tecnico Superiore*), offering specific courses and internships to its young students in order to develop skills in viticulture. Furthermore, the decision by the Consortium in Montalcino to also start promoting other agricultural productions could similarly be applied in Montefalco, where several producers aspire to broaden their network of collaborations with other regional wine GIs and food products.

In addition to the social utility of GIs (*social value*), another important topic emerged from the interviews is related to the environment and sustainability. In par-

ticular, the evolution of the climate in the last years have caused concerns with respect to droughts, floods, climate extreme events and the sustainability of viticultural practices.

> The main challenge is climate. If we are able to overcome this, then we will also be able to face all other future problems, but climate is the most difficult one. This year has been very tough, we have not had the opportunity to irrigate because there is no water available. [#03]

Especially for viticultural areas, which are extremely dependant on geographical and climatic conditions, it is fundamental to be able to cope with the future impact and effects that climate change will have on wine production. The identification of adaptation initiatives to future vulnerability will be fundamental for many winegrowers, especially in Europe [40]. This feeling is also shared by many local producers in Montefalco, with some of them seeing an urgent obligation to start adopting the most innovative technologies to reach a more sustainable production (*environmental awareness*).

> The territory must become "green", organic production is not the end point, but the starting point. We must not settle once all wineries will become organic, but we have to do more […]. We should not just attempt to obtain a mark on a wine bottle, but we have a responsibility towards the environmental impact and the product. Technology is what will help us take the leap […]. We must become aware that technology will be a way of doing agriculture. [#07]

6. DISCUSSION OF RESULTS

The results obtained from the study indicate that a wine GI can play a crucial role in promoting the development of a territory. However, these findings also suggest that this development process can be more effective when approached through a sequence of specific and interconnected steps. These steps encompass various aspects, requiring collaboration among different stakeholders involved in the wine industry and the local community. By taking a systematic and coordinated approach, involving all relevant actors, the wine GI can have a more significant impact in fostering the overall growth and prosperity of the area, benefiting both the wine producers and the territory.

Firstly, when speaking with producers, it becomes evident that they have invested significant effort, over the past decades, in understanding and meticulously working on the characteristics that distinguish Sagrantino di Montefalco DOCG as a wine that is extremely unique when compared to other wines. This, in addition to other ways to add value for the product (e.g., quantity produced, sale prices, etc.), is helping local producers to *define the wine*. By diligently improving and promoting the unique characteristics of Sagrantino, the wineries, and potentially all the municipalities within the Sagrantino di Montefalco DOCG area, are shaping the image they project to both national and international consumers and visitors. This careful cultivation of the wine's identity and reputation will play a pivotal role in attracting and captivating wine enthusiasts, tourists, and potential buyers, positioning Sagrantino di Montefalco DOCG as a distinctive and compelling player on international markets. Considering this responsibility, the producers, along with wine experts such as sommeliers and journalists, recognise their crucial role in effectively communicating the wine and its uniqueness to consumers. By collaborating with wine experts and staying attuned to consumer feedback, producers can refine their messaging, ensuring that the essence of Sagrantino and its distinctiveness are accurately conveyed to the target audience. All these elements concur in what has been described as *defining the identity* of Sagrantino di Montefalco DOCG.

Relatively to the geographical area in which the wine is produced, three main themes emerge through the interviews; these are: the *local experience*, *network establishment* and *collective responsibility*. Regarding the first issue, locals have become increasingly aware that now tourists not only want to visit a place, but they aim to understand what makes it unique, its traditions and culture: they are looking for the so-called *experiential travel*. Also, the awareness of environmental sustainability, biodiversity, and natural resources plays a significant role in shaping tourists' perceptions and preferences. The tourism offerings in the Montefalco area have been adapting to meet these evolving needs, fostering a deeper connection between cultural events, art, wine, and the local natural surroundings. The transformation of Montefalco in a unique tourist destination, thanks also to the presence of its agricultural and viticultural productions, can be compared to what happened in the rural community of Menfi (Sicily) as well, illustrating a proper structural shift from agricultural to "agri-touristic" areas. Furthermore (concerning *network establishment*), it emerges how much important is the collaboration between producers and local institutions, also in the future. Most local stakeholders emphasised the significance of having a shared long-term vision for the territory, recognising its importance in guiding sustainable development and growth. However, some stakeholders acknowledged the need for more concerted efforts in

addressing specific challenges related to climate change and other technical issues. Additionally, many interviewees recognised that cooperation needs to extend to different and broader levels beyond the local context. For example, collaborating at a regional level to promote local wines, products, and touristic resources, to reach an effective communication strategy. Moreover, respondents highlighted the importance for wine industry to create social utility and benefits for the local community, by creating job opportunities, supporting local businesses, but also enhancing community engagement through cultural and social events related to wine tourism. In particular, the idea of the social utility of wine production in a rural area has also emerged from the interviews with the producers from Tuscany, although with their own differences. In Montalcino, the local wine Consortium has taken it upon itself to help those in need in the area and to engage in public utility activities. This initiative could also be developed in the Montefalco area, where it could increase the already strong connection between the community and wine production. However, something that is already being done in both these two GI areas, is to give educational and job opportunities to young students in the area, by providing them with useful skills and knowledge in viticulture. In addition, similarly to social utility, there is a growing awareness of the crucial relationship between wine production and environmental sustainability. Some producers recognised that adopting sustainable viticulture practices should be embraced collectively by as many producers as possible, in order to have lasting positive impacts on the environment. All these aspects contribute to the *creation of a local model* for territorial development.

7. CONCLUSIONS AND LIMITATIONS

What emerges from this analysis can serve as a foundation for reflecting on the future of the territory. What is the *vision* of the future territory? What are the *guidelines* for the development of DOCGs on one hand, and the local economic model on the other?

The dimension of "*Defining the identity*" suggests a conscious and shared vision about the wine product that one would like to obtain: a pleasant, important but fresher wine, which maintains its uniqueness by meeting the taste of consumers. According to several interviewees, Sagrantino di Montefalco DOCG has all the qualities to aspire to international success, with still high potential for improvements in the winemaking process. There is a certainty that, in terms of product quality, much has been achieved, much more can be done, but given the uniqueness of the Sagrantino grape, the results achieved so far are remarkable.

Differently, the definition of which wine is intended to be presented to the markets remains unclear, risking the portrayal of an inconsistent image (and product). In fact, even though under a single denomination, there are quite different types of products present on the market, belonging to different price ranges, creating confusion among consumers and an unclear perception of quality. Price is indeed a fundamental element of communication to the consumer, significantly influencing their purchasing behaviour and perception of quality regarding a product like wine, which can be judged only after consumption. Strategically, there should be a shared reflection between producers and the Consortium regarding the benchmark reference of the product they aim to achieve. In addition, both in Italy and abroad, Sagrantino di Montefalco DOCG is still not widely represented on restaurants wine lists, as reported by the interviewees, and this is another aspect that should be strengthened through shared objectives and investments in quality and promotion.

The "*Creation of a local model*" is rooted in the idea of stakeholders' collaboration and the development of territorial networks. Despite the relationships that emerge among institutions, companies, and the Consortium, a more defined and collaborative strategic direction given by local institutions could help in terms of the relationships between producers and hospitality and cultural structures. The analysis also highlights the issue of infrastructures in Montefalco and the surrounding areas, which are currently accessible mainly by roads, but less so by railways and other infrastructures. Sustainable tourism, based on cycling paths and walking trails, is considered as potentially important and worth developing.

Communication plays a crucial role in addressing both the aggregate dimensions. For Sagrantino di Montefalco DOCG, which is relatively unknown both domestically and internationally, there is a need for improved communication and marketing efforts to increase its recognition and sales.

Finally, the concerns surrounding climate change necessitate proactive measures to adapt viticulture practices and mitigate its impact on wine production. Embracing sustainable practices becomes imperative to secure the future viability of the wine industry and preserve the unique terroir of Montefalco. Moreover, the adoption of cutting-edge technologies presents an opportunity to improve efficiency, quality, and innovation throughout the entire winemaking process, giving the chance to position the Montefalco area as a leader in sustainable wine production and ensuring the continued

success and reputation of its wines on the global market.

The type of analysis employed for this work also presents some downsides. Firstly, the use of a qualitative method does not allow to properly quantify the socio-economic impact that the Montefalco area has experienced thanks to the establishment of a GI. It could be interesting to develop a more in-depth analysis of the repercussions on different industrial sectors in the area, the employment rate, land values, etc. Also, a comparison with other similar qualitative case studies regarding the development of further rural areas thanks to GI wines (in Italy but also abroad) could be helpful to find major similarities or differences and better assess the effects of GIs on local development. In our study we have illustrated, even if through a very small number of interviews from other wine GIs in Tuscany and Sicily, how different rural territories tend to have some common factors in their development. For example, an increase in a collective sense of social responsibility towards their communities, and, also, a strong correlation between the improvements in local viticulture and tourism-related developments, and the opportunities these bring for rural areas.

However, despite relying on qualitative data, the methodology chosen and the findings of this research have allowed us to confirm what has already been demonstrated in previous quantitative studies about the impact of GIs on rural development [3, 5]. This proves how valuable qualitative research can also be in order to assess socio-economic development in rural areas.

Finally, this paper aims to offer an overview of the territorial challenges, but also benefits, that a rural area can experience, during different decades, thanks to the presence of a wine GI, further expanding the scientific literature about this topic. As shown in this study, new opportunities and wealth can be created for those who operate in the area. However, for more precise analyses of this topic in the future, local consortia and institutions should collect data more accurately and more regularly. This would help not only local producers, but all local stakeholders, in better assessing the true impact from a socio-economic perspective, and to become more effective in the management of territorial brands. Indeed, quantitative data still remain limited and not easily accessible to researchers and scholars.

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