MASTER

MANAGEMENT INFORMATION SYSTEMS

ENHANCING STAKEHOLDER CONFIDENCE IN WINE SUPPLY CHAINS THROUGH BLOCKCHAIN SOLUTIONS

DISSERTATION

JOÃO FRANCISCO PEREIRA CONCEIÇÃO

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SUPERVISION:
PROFESSOR RUI GUEDES

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"All hard work brings a
profit, but mere talk leads
only to poverty."

Proverbs 14:23

GLOSSARY

ASAE – Autoridade de Segurança Alimentar e Económica

BCT – Blockchain Technology

CRM – Certified Reference Material

DN – Diário de Notícias

DLT – Distributed Ledger Technology

ERP – Enterprise Resource Planning

GDPR – General Data Protection Regulation

ID – Identification

IS – Information Systems

JRC – Joint Research Centre

LSD – Least Significant Difference

MFW – Master's Final Work

SCM – Supply Chain Management

ABSTRACT

This study seeks to examine how stakeholders view the integration of blockchain in the wine sector due to the industry's limited traceability and transparency. This is a challenging sector where it's frequently hard to monitor every step in its supply chain, resulting in a rise in counterfeit goods. It is important to understand how blockchain would impact an industry as traditional as the wine industry, and how its characteristics could represent benefits or challenges for stakeholders. First, it was conducted primary research with the help of a systematic literature review, followed by a quantitative analysis using a survey aimed at different stakeholders in this industry that were previously identified in the literature review. It was used SPSS to analyse its results. This was followed by a qualitative analysis of the different stakeholder profiles aimed to gather more concrete insights, through interviews using MaxQDA to analyse them. This study responded to five research hypotheses that reflected the research questions.

This study concluded that stakeholders perceive transparency, trust, and traceability as the most impactful benefits however, their limited knowledge of this technology leads them to focus on its benefits and challenges. The connection between trust and the decrease in counterfeiting is crucial, given that it facilitates transparency quickly and readily, where this technology is seen as a tool to enhance processes and enabling business, making the supply chain more transparent to everyone involved. Because blockchain technology is primarily linked to cryptocurrencies, a large number of the study's participants were not familiar with its possible uses in different sectors.

This study addresses how blockchain can enhance confidence in the wine industry and explores stakeholder perceptions regarding its impact on this industry. It was also possible to understand the perception and awareness that consumers have of such a recent technology, as well as its benefits and challenges. By highlighting the most important factors for them, this study established a basis for a future solution.

Keywords: Blockchain Implementation, Wine Supply Chain, Trust, Traceability, Transparency, Wine Stakeholders, Digital Transformation.

RESUMO

Este estudo procura examinar a forma como as partes interessadas encaram a integração da cadeia de blocos no setor vitivinícola, devido à limitada rastreabilidade e transparência da indústria. Trata-se de um setor complexo, em que é frequentemente difícil monitorizar todas as etapas da sua cadeia de abastecimento, o que resulta num aumento dos produtos falsificados. É importante compreender o impacto da cadeia de blocos num setor tão tradicional como o do vinho e como as suas caraterísticas podem representar benefícios ou desafios para todas as partes interessadas. Em primeiro lugar, foi realizada uma investigação primária com a ajuda de uma revisão sistemática da literatura, seguida de uma análise quantitativa utilizando um inquérito dirigido a diferentes partes interessadas nesta indústria que foram previamente identificadas na revisão da literatura. Foi utilizado o SPSS para analisar os resultados. Seguiu-se uma análise qualitativa dos diferentes perfis das partes interessadas, com o objetivo de recolher informações mais concretas, através de entrevistas, utilizando o MaxQDA para as analisar. Este estudo respondeu a cinco hipóteses de investigação que refletiam as questões de investigação elaboradas. Conclui-se que os benefícios percebidos, como a transparência, a confiança e a rastreabilidade, são os que mais afetam os participantes desta indústria, e o seu conhecimento limitado desta tecnologia faz com que acabem por se concentrar nos seus benefícios e desafios. A ligação entre a confiança e a diminuição da contrafação é crucial, pois facilita a transparência de forma rápida e imediata, sendo esta tecnologia vista como uma ferramenta para melhorar processos e facilitar negócios, tornando a cadeia de abastecimento mais transparente para todos os envolvidos. Uma vez que a tecnologia blockchain está principalmente ligada às criptomoedas, grande parte dos participantes do estudo não estava familiarizada com as suas possíveis utilizações em diferentes setores. Com este estudo, foi respondido à pergunta de como é que esta tecnologia pode melhorar a confiança neste setor, tendo sido possível compreender a perceção e o conhecimento que os consumidores têm de uma tecnologia tão recente, bem como os seus benefícios e desafios, bem como, estabelecer uma base para uma futura solução, destacando os fatores mais importantes para eles.

Palavras-chave: Implementação de Blockchain, Cadeia de Abastecimento do Vinho, Confiança, Rastreabilidade, Transparência, Stakeholders do Vinho, Indústria do Vinho.

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The fruit of this work depends not only on me but on everyone around me who made this dream possible.

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1. INTRODUCTION

There is an increasing usage of technology in companies to safeguard their processes, and supply chain, but also from counterfeiting. Increasingly, these companies are facing new challenges in protecting themselves and preventing counterfeiters from taking advantage of their creations. These counterfeits can cause various types of damage, material, moral and even ethical (Gino, Norton, & Ariely, 2010). Detecting them is becoming increasingly complex as new and more ingenious methods are used, which can affect both the customer and the brand (Prajapati, Gadhari, Sawant, Kini, & Solanki, 2023). It is clear that the emergence of these counterfeits has become an epidemic, spreading to all kinds of products and becoming an economic problem with a global impact (Eisend & Pakize, 2006).

This demonstrates the importance of studying and understanding new strategies to combat product counterfeiting (Qian, 2014). This is why a solution like a blockchain-based anti-counterfeit system is so important in protecting products (Anthony, Lee, Pearl, Edbert, & Suhartono, 2023), in this specific case in the context of the Wine Industry. Blockchain can become a part of the solution, helping to protect companies and consumers, since one of the main concerns is assuring the commercialized product is indeed real (Tokkozhina, Ferreira, & Martins, 2022). This study pretends to study how this implementation can decrease counterfeited wine products and be accessible in an easy way since this industry is facing several challenges in countries that import a lot of it, and actual solutions are not accessible to all wine stakeholders in a convenient form like a CRM (Certified Reference Material) released by JRC to verify wine authenticity (European Commission, Joint Research Centre., 2021). Where wines outside of designations of origin do not need to meet certain requirements, that otherwise would be required (Paulo, 2023). Originating the proposed research questions.

R1: How is blockchain perceived by wine industry stakeholders?

R2: How aware is the wine industry of the benefits and challenges of blockchain?

R3: How can blockchain characteristics increase trust and reduce counterfeiting when commercializing wine?

To respond to the research questions, the objectives were these:

O1: Realise the general knowledge of blockchain within the wine industry.

O2: Analysing how the use of blockchain can guarantee security for stakeholders.

O3: Understanding the reach of applying a technology like blockchain in a traditional industry like wine.

To reach these objectives a systematic exhaustive literature review must be made using the best articles on reducing wine counterfeiting, supply chain of wine, blockchain and how it is and can be better used in this sector. To complement this a survey was publicly distributed to reach a broader audience the results were analysed with SPSS (version 29.0), to establish correlations between confidence in blockchain and some variables. Followed by interviews with the existing profiles of stakeholders within the wine industry, additionally, it was carried out a blockchain expert interview, to study the main key points, blockchain awareness, and how it can benefit everyone related to this industry, the interviews were analysed with MaxQDA. This study pretends to give an orientation of the current knowledge of blockchain within this traditional industry, and how this technology can shape its business and reduce counterfeit.

I decided to study this area because it takes me back to my childhood when we used to organise the grape harvest as a family at my aunt and uncle's house. That's also where my passion for wine came from. Another recent passion is blockchain and how it has been changing various industries (Alladi, Chamola, Parizi, & Choo, 2019). This work aims to bring these two passions together, making them work in a healthy and sustainable ecosystem.

This work is composed of several chapters, the first one is the introduction, where it exposes the several research questions and the objectives to answer them. In the following part, is the literature review which aims to support the data that was obtained, trying to better interpret its results. The third chapter contains the hypothesis studied in the course of this work. The following part contains the exposition and explanation of the methodology, which used a mixed-methods approach which is a different methodology from other articles, so it is possible to have a global perspective of how this technology is perceived by analysing the results. The fifth chapter analyses the results. Finally, we have the conclusions, limitations and future research opportunities.

2. LITERATURE REVIEW

To support this work, it was done a deep work of analysis through a systematic literature review contemplating several key aspects of BCT implementation in the wine industry, helping to familiarise with the different concepts surrounding the theme (Boumezrag, 2022), and understanding the standing point of investigation within this theme (Snyder, 2019), as well as identifying the key stakeholders involved in this industry. Nevertheless, the analysed concepts are the wine supply chain, the wine industry, blockchain and its inherent characteristics, benefits and challenges related to this industry, and the presence of the blockchain in each one of the previously mentioned concepts.

2.1. Wine Industry

For a better understanding of this study, it is pivotal to provide a context and a characterization of the wine industry, and the current panorama of it. Wine dates back as far as 6000 B.C. where, through the chemical study of residues from an ancient Georgian flask, evidence of the existence of wine was found. The process of winemaking, on the other hand, can be traced to about 4300 B.C. (Estreicher, 2023). Currently, wine can be divided into two categories: new-world wines, which include Argentina, Chile, New Zealand, Australia, USA, and South Africa; and old-world wines which include France, Italy, Portugal, Spain, Greece, Bulgaria, Hungary, and Romania (Anderson, Norman, & Wittwer, 2019). This industry in 2021 had a market size of about 435 billion dollars with Europe dominating 46% of the market, but it is forecasted to reach 686 billion dollars in 2028, with a yearly growth rate of 6.4% (Grand View Research, 2021). In a more regional aspect of the industry, according to the Vine and Wine Institute, Portugal exported around 172 million litres worth 452 million euros in the first half of 2024 alone (Instituto da Vinha e do Vinho, 2024). The production of wine in Portugal according to the same study is said to have risen about 17%. Characteristics like vintages, wine regions, prices and grape variety are important to the customers (Chandra & Moschini, 2022).

2.1.1. Wine Industry Counterfeit

Although the wine industry is one of Portugal's biggest industries, there are still countless cases of counterfeit wine, such as a report published by DN in 2016 in which it was estimated that 19 million euros are lost every year in Portugal due to counterfeiting

(Pinto, 2016). Wine fraud is a real concept although mostly economic it can be a real problem to consumers and companies since it can come in many ways, where one of the most common ways they can counterfeit it is by increasing the overall volume of wine by adding water or other cheaper wines or by misrepresenting the country of origin (Wilkes, Day, Herderich, & Johnson, 2016). In Europe, wine counterfeiting is responsible for a loss of 530 million euros in this industry, directly resulting in the loss of 4815 jobs meaning this is a real problem with real effects (Wajsman, Burgos, & Davies, 2016). Although there is an existence of some ways of protecting wine such as a system of appellations such as Protect Designation of Origin (PDO), and Protect Geographical Indication (PGI), it only works for wines under these categories, making it not possible to verify wines that don't have a Geographical Indication (GI) (Alston & Gaeta, 2021). Also, there are several chemical methods to authenticate a wine, as demonstrated in the article (Sun, et al., 2021), but all of this is not easily accessible to the end consumer, this can represent an opportunity for BCT to add all of this data in the blockchain it would make it accessible to everyone, from consumers to small producers.

2.1.2. Wine Supply Chain

A supply chain in general can be defined as a set of processes and activities carried out by all the parties involved that end up adding value to products (Li, 2011), making them more sought after. When searching for a single definition supply chain is a network that transforms products into something useful for consumers (Das & Mallik, 2017). The management of these processes can be comprehended as efficient management across the whole process starting from its design to the last step (Gharaei & Pasandideh, 2017). With the increasing adoption of information technology in businesses, the supply chain can benefit from said adoption (Li, 2011).

To get into detail about *Wine Supply Chain Management* it is necessary to comprehend the complex structure that surrounds it, extending from grape growing to bottle, where the primary stages in a winemaking process consist of "harvesting, crushing, fermentation, pressing, ageing, and bottling" (Malisic, et al., 2023). Through the observation of the wine supply chain, we can identify each stakeholder involved (Adamashvili, Zhizhilashvili, & Tricase, 2024):

- **Grape Production/Wine Production:** Producer/farmer; wine oenologist.

- **Packaging/Distribution:** Distributor; Retailer.
- **Sales and Consumption:** Consumer.

A wine supply chain has specific details inherent to it, such as seasonality in production, geographical indication, international markets, compliance with specific regulations, specialized labour, and different wine categories (Psychogiou & Tsoulfas, 2024). This extensive study is important for understanding its current limitations, which can include the lack of traceability and transparency from the wine origin to the end consumer. All these factors can lead to an increase in counterfeiting and fraud. (Adamashvili, Zhizhilashvili, & Tricase, 2024), leading to an opportunity for blockchain to improve its supply chain (Tokkozhina, Ferreira, & Martins, 2022).

2.2. Blockchain

Blockchain's first ideas started in the late 1980s to early 1990s with the transactions being done through cryptography (Yaga, Mell, Roby, & Scarfone, 2018). The pseudonym Satoshi Nakamoto's article presents a closer look at what is blockchain, although the term is not specifically mentioned in it, it refers to the possibility of transactions happening in a decentralised way through hash codes in blocks, composed of a digital signature chain (Nakamoto, 2008). This type of transaction originated Bitcoin a digital currency (European Central Bank, 2018), which is traced using BCT (Warmke, 2024). When a user submits a transaction, and it is verified, the transaction is added to the chain (Ghiro, et al., 2021), where computers create a token when they solve an advanced mathematical equation (Attaran & Gunasekaran, 2019), using a pair of private and public keys mathematically connected through asymmetric-key cryptography (Yaga, Mell, Roby, & Scarfone, 2018). Each block has the transaction specifics, the timestamp and the hash code of the current and previous block (Pierro, 2017), this safeguards the record of the blockchain making it traceable (Meva, 2018).

This technology is becoming more present in several industries (Azevedo, Gomes, & Romão, 2023), including in the interest of this work, the food sector (Alladi, Chamola, Parizi, & Choo, 2019), benefiting from a digital record of transactions that are present permanently (Iansiti & Lakhani, 2017). This innovative technology (Treiblmaier, 2018) is beneficial since it is composed of a network of independent users (Laurence, 2019), and traceable records present in multiple places (Kshetri, 2023).

2.2.1. Blockchain Types

Blockchain can be divided into three main types which they are: public, private and consortium, which is a sort of hybrid of the previous two.

Public Blockchain

Several articles relating to blockchain recall public blockchain as being an open blockchain where it is possible to interact without restrictions, and where all users can access the same data present in the blocks of transactions in the chain (Pedersen, Risius, & Beck, 2019). Trust is built with Proof of Stake (PoS), which depends on the number of tokens a miner has in its possession to create the following block, and Proof of Work (PoW) where miners are challenged to be the first ones to solve a complex mathematical equation (Pedersen, Risius, & Beck, 2019). This type decentralizes completely where the decision is since data isn't kept in a single location (Vaigandla, Siluveru, Kesoju, & Karne, 2023), which means higher costs of operation, with slower-paced transactions (Xinyi, Yi, & He, 2018).

Private Blockchain

A private blockchain, on the other hand, chooses which users are allowed to interact with the chain making each user a known and trustworthy one (Pedersen, Risius, & Beck, 2019). In this type, there isn't necessarily a centralization of the data, although it is safeguarded with the access being done by previously verified users (Vaigandla, Siluveru, Kesoju, & Karne, 2023).

Consortium Blockchain

This type of blockchain as mentioned before has both parts a public and a private blockchain since all users have access to the data, but only authorized ones can approve transactions (Pedersen, Risius, & Beck, 2019). To maintain consensus, it is used smart contracts (Vaigandla, Siluveru, Kesoju, & Karne, 2023). If there is confidence in every user present in this chain, this is a good option to track logs in transactions (Pedersen, Risius, & Beck, 2019), since each node is only added to the chain if authorized by the operator nodes (Perera, Nanayakkara, Rodrigo, Senaratne, & Weinand, 2020).

2.2.2. Blockchain Benefits for the Wine Industry

BCT has numerous characteristics that enhance how this technology works, by reading some scientific articles it was possible to establish the most prominent ones.

2.2.2.1. Decentralisation

Blockchain Technology makes the power of decisions not being centred in one single authority or entity, this means that decisions aren't controlled by "an individual or organization", this eliminates the necessity of having third parties which increases performance while cutting expenses (Vaigandla, Siluveru, Kesoju, & Karne, 2023). The need for decision-making power becomes unnecessary because the information is available at various points, and is managed by using and storing it on various computers or nodes, each of which has a copy of the information, thus giving greater decision-making independence, allowing users to check any changes on the distributed registry (Vacchio & Bifulco, 2022).

2.2.2.2. Immutability

Blockchain tracks each block and saves its record. This happens because BCT is considered tamper-resistant (Viriyasitavat & Hoonsopon, 2019) since it encrypts each transaction before adding it to the blockchain in a consecutive order making it harder to "tamper with a blockchain" (Vacchio & Bifulco, 2022). Although most of the articles refer to this feature as one of the main benefits of BCT. Yaga, Mell, Roby, & Scarfone (2018) referrer that this is not always true as the chain is not always unchangeable. They argue that without the strategy of adopting the longest chain, smaller ones face weaker immutability leading to a greater risk known as a "51% attack", leading to users waiting for several node creations before starting to use the blockchain network.

2.2.2.3. Transparency, Trust and Auditability

Transparency on a blockchain derives from its immutability and decentralization, as everyone involved has access to the same data, which can always be verifiable. (Vacchio & Bifulco, 2022). Literature often highlights transparency and trust as desirable governance qualities (Mohamed, et al., 2022). According to Vizaad, Norman, & Azzuhri (2022), blockchain increases trust by creating a "transparent profile" for each user, where each of their actions is visible, where every node in the system has a copy of the "digital

ledger", this works as an "audit trail" that can track illegal activities. This audit trail supports auditability by ensuring that transactions are recorded in the blockchain, preventing fraud and making it easier to trace and verify each one. Because it is timestamped, the algorithm can make sure of the persistence and sequential arrangement of data in records (Vaigandla, Siluveru, Kesoju, & Karne, 2023).

2.2.2.4. Anonymity

Anonymity is considered not only a feature but also an advantage, by increasing the level of security that this technology offers. In the case of a public blockchain, the fact that this technology does not need a central entity to hold real-world personal information offers a degree of privacy (Viriyasitavat & Hoonsopon, 2019), since users are identified by an alphanumeric address (Attaran & Gunasekaran, 2019). In a blockchain transaction, only the recipient's ID is required, but full anonymity cannot always be guaranteed due to the technology's complexity (Vaigandla, Siluveru, Kesoju, & Karne, 2023). This ID consists of a public key, that has the user's identity ("pseudonymous identity"), and a private key that secures access to their data on the blockchain (Vizaad, Norman, & Azzuhri, 2022).

2.2.2.5. Fraud Prevention

Blockchain can provide a safe supply chain environment making it possible to commercialize products while making sure they are genuine. Pharmaceutical companies are already using it to check up on the veracity of drugs since it is already mandatory to have a system that authenticates the drug labels (Dujak & Sajter, 2018), tracking every single piece of information verifying it through zero-knowledge proof (Mattke, Maier, Hund, & Weitzel, 2019).

2.2.3. Blockchain Challenges for the Wine Industry

The challenges associated with BCT are consistent across several studies, prompting an extensive review of different articles. While blockchain concepts may seem straightforward, their implementation may lack flexibility (Reyna, Martín, Chen, Soler, & Díaz, 2018). A review of multiple articles that address the challenges faced by this technology, reveals several common issues.

2.2.3.1. Scalability

Scalability is a sensitive topic that often limits the applicability of this technology since although only full nodes belong to the chain, it never stops growing at a rate of around 1MB per block (Reyna, Martín, Chen, Soler, & Díaz, 2018). This problem happens because transactions need to be stored in nodes to gain validation (Meva, 2018). According to the same source, the conditions to process many transactions in real-time are not fulfilled since the "time break" necessary to produce a new block and its size restriction causes delays in transactions.

2.2.3.2. Privacy Leakage

According to a survey made by Wang, Zheng, Xie, Dai, & Chen (2018), where they analyse the technological part of the blockchain and its possible applications by analysing a series of documents. The authors refer that blockchain cannot ensure privacy in transactions since the public key is accessible to everyone, and to the fact that each client can be linked with the group of nodes it connects with. With the increase of attacks and increasing security infringements in a technology that was considered to be a "non-hackable technology" (Tripathi, Ahad, & Casalino, 2023), two solutions came into place, an anonymous solution and a mixing solution (Meva, 2018). The first one is using a zero-knowledge proof where instead of the transaction being validated with a digital signature it is by making sure that said transaction belongs to that list of transactions (Wang, Zheng, Xie, Dai, & Chen, 2018). And the anonymity in the mixing solution consists of the transference of funds from "several input addresses to several output addresses" (Wang, Zheng, Xie, Dai, & Chen, 2018).

2.2.3.3. Energy Consumption

As stated by Meva (2018), the fact that the blockchain requires so much energy is because blockchain works through Proof of Work (PoW). This concept consists of that to mine a block they need to solve a "cryptographic puzzle" that is harder to find a solution than to check, where it only depends on computer power to solve it (Sapra, Shaikh, & Dash, 2023). This problem can be solved if it is utilised as a Proof of Stake (PoS) which gives the user with the highest stakes and credibility the opportunity to exploit but cannot be adopted for large-scale uses (Nair & Dorai, 2021).

2.2.3.4. Ethical and Regulatory Issues

There are several ethical and regulatory implications that a technology like blockchain could pose to this industry dealing with challenges such as transparency, privacy, and compliance with regulations. This transparency from the vineyard to the end consumer although increases accountability, can also lead to concerns regarding sensitive data privacy, since everyone could have access to the same data (Vacchio & Bifulco, 2022). For example, the use of the GDPR in the EU, provides an important legal framework, ensuring the security of both producers and consumers. This legal framework would make wine businesses have to certify that the usage of blockchain would not put at risk or violate any privacy laws or leak confidential business information, since with the usage of this technology we don't have a mechanism that controls all data, which difficult in understanding responsibilities, and the fact that data can't be modified or erased to fulfil legal obligations (Finck, 2019). Blockchain from an ethical perspective would need to be redefined to work in this industry, since data would be accessible to everyone, adding the fact that the basis for it, smart contracts, works on the assumption of that same consent (Rubeis, 2024).

On a regulatory level, blockchain implementation in the wine industry has its challenges. Regulatory compliance of blockchain it's still in the beginning, and existing uncertainties on how compliance can be achieved by businesses (Martino, 2021). This compliance with regulations by smart contracts would pose a significant challenge for wineries as it could increase costs to meet those requirements (Abbas, 2024). The European Union is starting to make progress towards data access, sharing and regulation, with the Data Act proposal that will be implemented in September 2025, which aims to harmonize rules for fair data sharing and promote interoperability across sectors (European Union, 2023). Not having a formal proposal of implementation regulations of blockchain in such a traditional industry can generate apprehension, thus the need for new blockchain architectures (Mohammed Abdul, 2024).

2.2.4. Blockchain Implementation in Wine Supply Chain Management and Wine Industry

SCM is currently facing through digital information an increasing implementation of new technologies such as those associated with Industry 4.0, including BCT that companies are starting to understand its potential and integrate into their way of conducting business (Khan, Kumar, & Sahu, 2023). The integrity of the supply chain is an important aspect to take into account in the supply network (Wang, Singgih, Wang, & Rit, 2019), this integrity relates to the security that it can offer (Mattke, Maier, Hund, & Weitzel, 2019), and the fact that it can help decrease errors and increase transparency (Alladi, Chamola, Parizi, & Choo, 2019). This implementation is not easy, since it is essential to ensure regulatory compliance, have proof of transaction, and use zero-knowledge proofs to ensure that the transaction is real, hiding sensitive information while confirming them, however, it can help more traditional industries in solving challenges that only this technology can solve (Mattke, Maier, Hund, & Weitzel, 2019), regarding their auditability (Khan, Kumar, & Sahu, 2023), maintaining confidentiality and transparency (Xu, Lee, Barth, & Richey, 2021). These challenges relate to providing confidence to consumers in a safer and more transparent ecosystem of what they are purchasing while helping wine professionals make better business decisions due to its unchangeable data (Heussner, Kramer, & Hanf, 2023). The use of smart contracts could provide the traceability that this industry lacks, giving a record of all stages that wine goes through from the grape to the bottle (Tokkozhina, Ferreira, & Martins, 2022). This implementation of blockchain technology has the potential to offer a significant competitive advantage, as demonstrated by a case study involving three Italian wineries that have successfully integrated it into their operations (Galati, Vrontis, Giorlando, Giacomarra, & Crescimanno, 2021). Several articles discuss the utilization of smart contracts as a straightforward and transparent method for recording and monitoring transactions across various stages of the wine supply chain (Malisic, et al., 2023). TagItWine in a European Commission Project promoted the implementation of smart tags with a BCT basis, this had a general positive influence in wineries, although the main challenge was related to the fragile technology that is used for creating intelligent tags since there is a scarcity of commercial printing industry solutions (European Commission, 2019).

3. RESEARCH HYPOTHESES

To understand the different concepts and characteristics of the different stakeholder profiles within the wine industry, it is important to do hypothesis tests to comprehend how each one of the studied factors can affect the way this technology can affect their perceptions, and increase confidence in the wine that uses this technology, leading to a revolution in this industry (Adamashvili, Zhizhilashvili, & Tricase, 2024). These hypotheses have as basis BCT benefits and challenges it can offer to an old industry like the wine (Estreicher, 2023), these benefits include, counterfeit reduction, traceability, authenticity, and transparency (Vaigandla, Siluveru, Kesoju, & Karne, 2023), but also challenges, such as regulation compliance (Martino, 2021), security (Wang, Zheng, Xie, Dai, & Chen, 2018), and complexity (Vaigandla, Siluveru, Kesoju, & Karne, 2023). The familiarity level with technology can affect the confidence it transmits to stakeholders, being expected to increase BCT adoption in wine processes (Horowitz, Kahn, Macdonald, & Schneider, 2024). The stakeholder role played within the wine industry can affect the implementation of BCT to boost confidence in this sector or can only depend on individual factors not related to the profession (Lustenberger, Malešević, & Spychiger, 2021). Age may also be one of the factors that could affect how blockchain is observed in its implementation in this industry since different age groups can have different opinions on a new technology acceptance (Dissanayake, Jayathilake, Wickramasuriya, Dissanayake, & Wasala, 2022), in this case, BCT adoption in the wine industry. To study all these factors, five hypothesis tests were carried out.

- *Hypothesis 1* (H1): Can BCT benefits and challenges affect stakeholders' perceptions, and confidence in the wine supply chain?
- *Hypothesis 2* (H2): Can the familiarity level with BCT affect the confidence level of the wine supply chain when implemented?
- *Hypothesis 3* (H3): Can the stakeholder role affect the general acceptance of BCT adoption in the wine supply chain?
- *Hypothesis 4* (H4): Can perceptions of blockchain implementation in the wine industry change with age?
- *Hypothesis 5* (H5): Can wine consumption habits affect overall confidence in blockchain implementation in the wine industry?

4. Methodology And Data Collection

4.1. Methodology

When studying complex subjects, the methodologies chosen can vary depending on the different interpretations of the problem (Rajasekar & Verma, 2023), so choosing an innovative and different methodology is important since this is also a new concept. With this in mind, a mixed methodology was chosen, which means it has both quantitative and qualitative parts in this study, which contrasts with studies of new concepts and technologies, which usually include a case study or interviews/consulting with experts in the field (Skinner, Nelson, Chin, & Land, 2015), this methodology proposes to be a different approach to this complex matter. Implementing the mixed-methods approach helped to achieve more innovatively, a global perspective on the stakeholders' perceptions of this technology and its implementation in the wine industry, providing a wide-ranging analysis of BCT potential.

The first step in establishing how this work would be done with this type of methodology was firstly necessary to perform a systematic and profound literature analysis, that allowed to identify the major stakeholders present in this industry. They are the distributor, the consumer, the producer and the oenologist (Adamashvili, Zhizhilashvili, & Tricase, 2024). This literature review also allowed the identification of key advantages and challenges, that an innovative technology such as this one could offer to a traditional and old industry like wine. This intensive and time-consuming, but important process allowed to establish what is the base for the rest of this study, helping to interpret and analyse the results that were obtained through the different phases of this work. The quantitative phase of this study was composed of a survey. This survey underwent two pilot versions, and through feedback from a small group of respondents, a final version was achieved and was published between August and September (2 months) on several platforms (e.g. LinkedIn). The survey aimed to analyse how each one of the different stakeholders could perceive the integration of this technology in their processes and increase their confidence in the wine supply chain, from the production of wine to buying the wine. It was done students' t-tests and ANOVA, which aimed to comprehend differences in groups, and correlation tests to understand how the confidence levels of BCT implementation are affected by other variables. These were analysed using

SPSS (version 29.0), which allowed a quicker interpretation of the results obtained. On the other hand, the qualitative phase was comprised of interviews with the existing and more prominent stakeholders in this industry previously identified by the literature review. These were the distributor, the consumer, the producer and the oenologist (Adamashvili, Zhizhilashvili, & Tricase, 2024), although the producer and oenologist were the same person since they were responsible for both roles in the company she works for. The interviews tried to reflect on a more detailed point of view, of how each stakeholder perceived this disruptive technology, their general knowledge, and how things are done in their companies. To this lot it was added an interview with a BCT expert, to provide a deeper insight into how this technology can be used as a way to leverage confidence in the wine supply chain, from grape to bottle. The results were analysed with the help of MaxQDA since it can identify keywords in the different interviews, as well as the indication of common themes/perceptions on the subject.

There are several studies regarding the benefits and difficulties of implementing blockchain in the wine industry and possible solutions for the application of BCT (Tokkozhina, Ferreira, & Martins, 2022), the several methods to implement it to be more accessible to consumers (Agnusdei, Coluccia, Elia, & Miglietta, 2022), and the real-world application of BCT, and how the power of investment can dictate the effectiveness of this technology (Galati, Vrontis, Giorlando, Giacomarra, & Crescimanno, 2021). However, there is a lack of research regarding how stakeholders perceive these benefits, and how the usage of the BCT can promote transparency, authenticity, and confidence in the wine supply chain, permitting it to reach a solution that can create a working ecosystem between the traditional and the new.

4.2. Data Collection

The first phase was a survey in Google Forms a survey with 20 questions, divided into several sections aimed at exploring different aspects of the topic. The study began with an introductory section aimed at characterizing the survey respondents, focusing on their relationship with wine and their familiarization with blockchain in general. This was followed by a section regarding BCT familiarity, exploring how and where they had gained their knowledge. The third section focused on stakeholder characterization and questions about the perceived benefits of the blockchain, these questions were designed

to be accessible even to those unfamiliar with it. The final section of the survey was about customer behaviour when purchasing wine, particularly how their buying decisions are influenced when a wine has a reliable authenticity and traceability system behind its production, as well as the best practical method to implement such technology. The following table is a summarized representation of the survey (Appendix 1) outlining the dimensions of analysis within the survey, relating to the objectives of this work and the metrics used to evaluate them.

Dimension	Objective	Metric(s) Used	Reference
Demographics	Participants demographics and role in the industry	Multiple Choice	(Adamashvili, Zhizhilashvili, & Tricase, 2024)
Blockchain Familiarity and Wine Consumption	Assess Familiarity with BCT and wine consumption habits	Likert Scale (familiarity), Multiple Choice (frequency)	(Yaga, Mell, Roby, & Scarfone, 2018)
Sources and Sectors	Identify information sources and sectors for blockchain	Multiple Choice (sources and sectors), Binary (usage)	(Alladi, Chamola, Parizi, & Choo, 2019) ; (Yaga, Mell, Roby, & Scarfone, 2018) (Vaigandla, Siluveru, Kesoju, & Karne, 2023)
Perceived Impact of Blockchain	Evaluate perceptions of BCT impact on wine authenticity and counterfeiting.	Likert Scale (impact), Multiple Choice (benefits)	(Tokkozhina, Ferreira, & Martins, 2022) ; (Biswas, Muthukkumarasamy, & Tan, 2017)
Consumer Preferences	Capturing consumer behaviour and preferences	Multiple Choice (behaviour and preferences), Likert Scale (importance)	(Chandra & Moschini, 2022)
Blockchain Implementation Method	Determine effective blockchain implementation methods	Multiple Choice	(Agnusdei, Coluccia, Elia, & Miglietta, 2022)

Table 1 – Dimensions of Analysis of the Survey. **Source:** Elaborated by Author.

Although the survey is an effective way of gathering data quickly, reaching a broader audience, and providing better flexibility and convenience to the respondents

(Evans & Mathur, 2005), the majority of the survey respondents involved were consumers. To ensure that all roles were thoroughly covered, it was decided to complement the survey with interviews (Appendix 2), where all the questions were open-ended, in Portuguese, given the nationality of the interviewees, and not too extensive since it was important to be succinct. This approach aimed to gather detailed insights from different stakeholders in the wine industry. Focusing on similar themes in the interviews, helped in understating differences in opinions and perspectives, with the support of the existing quantitative data. The stakeholders in the interviews were a wine producer, a wine oenologist, a distributor, and a consumer (Adamashvili, Zhizhilashvili, & Tricase, 2024). Additionally, an interview was conducted with a blockchain expert to gain insights into how emerging technologies could impact these stakeholders, providing valuable context for integrating technological advancements into the industry and enriching the overall analysis. This table, similar to the one in the questionnaire, offers a clear summary of the key dimensions and goals for analysing the interviews.

Dimension	Objective	Role	Reference
Transparency and Traceability	Understanding how each role understood wine authenticity and transparency	Producer Distributor Oenologist BCT Expert Consumer	(Mohamed, et al., 2022) (Vizaad, Norman, & Azzuhri, 2022)
Technology Adoption	Which technologies guarantee transparency each role knows or implements within their role	Producer Distributor Oenologist BCT Expert Consumer	(Tokkozhina, Ferreira, & Martins, 2022) (Alladi, Chamola, Parizi, & Choo, 2019) (Malisic, et al., 2023)
Blockchain Benefits and Challenges	Understanding how blockchain is perceived by the different roles	Producer Distributor Oenologist BCT Expert	(Yaga, Mell, Roby, & Scarfone, 2018) (Vaigandla, Siluveru, Kesoju, & Karne, 2023)
Trust in BCT	Understanding how BCT can enhance trust in the wine supply chain	Producer Oenologist Consumer	(Mohamed, et al., 2022) (Vizaad, Norman, & Azzuhri, 2022) (Vaigandla, Siluveru, Kesoju, & Karne, 2023)
Expectations	Perception of the future impact of BCT in the wine industry	Distributor Oenologist BCT Expert	(Tokkozhina, Ferreira, & Martins, 2022) ;

Table 2 – Dimensions of Analysis of the Interview. **Source:** Elaborated by Author.

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5. DATA ANALYSIS

5.1. Quantitative Analysis - Survey

5.1.1. Profile of Stakeholders

The final version of the survey, which was made publicly available, received a total of 190 responses. These were filtered by excluding any responses that hadn't been fully completed, as well as disregarding those from individuals who did not purchase wine. However, people who did not consume wine could still be able to complete the questionnaire, resulting in three responses from non-consumers who had bought bottles. After filtering the results, a total of 168 valid responses were obtained. Of these, 89 (53%) were female, and 79 (47%) were male. Most responses came from individuals aged between 18 and 30 (58.9%), followed by those aged between 31 and 40 (14.9%), coming mainly from Madeira Island (56%) and Lisbon (19%). As shown in the following table:

		n	%	Place of Residence	n	%
Age Group	18 - 30	99	58,9%	Aveiro	8	4,8%
	31 - 40	25	14,9%	Bragança	2	1,2%
	41 - 50	20	11,9%	Coimbra	4	2,4%
	51 - 60	17	10,1%	Évora	3	1,8%
	> 60	7	4,2%	Faro	1	0,6%
				Leiria	4	2,4%
				Lisboa	32	19,0%
				Other	5	3,0%
		n	%	Portalegre	3	1,8%
Gender	Female	89	53,0%	Porto	4	2,4%
	Male	79	47,0%	Madeira	94	56,0%
				Açores	1	0,6%
				Santarém	1	0,6%
				Setúbal	3	1,8%
				Vila Real	2	1,2%
				Viseu	1	0,6%
				Total	168	100%

Table 3 – Frequency of Residence, Age and Gender.
Source: Elaborated by Author.

Concerning the type of stakeholder profile responding to the survey 89,3% of respondents were consumers, followed by producers (5,4%), and distributors (3,6%).

Wine Role Numeric	n	%
Producer	9	5,4%
Distributor	6	3,6%
Retailer	1	0,6%
Wine Oenologist	1	0,6%
Consumer	150	89,3%
Blockchain Expert	1	0,6%

Table 4 – Profiles of Types of Stakeholders. **Source:** Elaborated by Author.

5.1.2. Descriptive Analysis

Consumer Behaviour

A descriptive analysis of consumer behaviour towards wine reveals that individuals tend to buy (Q6 | 39.3%) and consume (Q5 | 39.9%) it on an occasional basis. This is shown in the frequency table:

		Never	Rarely	Occasionally	Monthly	Weekly	Daily
Q5	**n**	3	23	67	36	34	5
	%	1,8%	13,7%	39,9%	21,4%	20,2%	3,0%
Q6	**n**	0	38	66	49	14	1
	%	0,0%	22,6%	39,3%	29,2%	8,3%	0,6%

Table 5 - Consumer Behaviour Frequencies. **Source:** Elaborated by Author.

The purchase of wines is mostly done at supermarkets (86,3%), or in wine stores (32,1%). Where most of the respondents tend to spend less than 20€ (Q15).

	n	%
Supermarket	145	86,3%
Wine Store	54	32,1%
Online	9	5,4%
Directly from the Winery	15	8,9%
Restaurant	2	1,2%

Table 6 – Wine Buying Location. **Source:** Elaborated by Author.

		n	%
Q15	**Less than 10€**	71	42,3%
	10€ - 20€	70	41,7%
	20€ - 50€	26	15,5%
	More than 50€	1	0,6%
	Total	168	100,0%

Table 7 – Wine Price Range. **Source:** Elaborated by Author.

Regarding the characteristics that respondents in their opinion tend to value the most, although the results are dispersed since this was a ranking question from 1 to 10, people tend to prefer factors such as taste, price, grape, wine region, and authenticity.

n	1	2	3	4	5	6	7	8	9	10
Price	17	5	14	7	8	9	15	20	33	40
Brand Reputation	9	16	10	12	6	12	10	42	28	23
Wine Region	10	13	13	10	7	7	8	39	26	35
Taste	24	11	9	3	3	3	5	35	24	51
Recommendation	10	15	8	13	11	14	12	35	28	22
Expert Review	8	12	10	12	10	21	16	39	20	20
Sustainability Practice	14	6	13	20	6	18	15	28	28	20
Authenticity	11	16	9	11	5	12	9	34	34	27
Design	15	15	14	13	6	14	13	28	24	26
Grape Varieties	17	10	7	7	2	16	11	27	35	36

Table 8 – Preferential Factors in a Wine. **Source:** Elaborated by Author.

Blockchain Familiarity

In terms of blockchain familiarity, we can confidently state that the majority of the population in this study ranged from being largely unfamiliar (54,8%) to moderately familiar (17,9%), with approximately 13 individuals demonstrating a deeper understanding of what blockchain entails. This can be explained since blockchain only started gaining popularity in recent years. (Vaigandla, Siluveru, Kesoju, & Karne, 2023). This is shown in the following table:

		n	%
BCT Familiarization	**Not familiar**	92	54,8%
	Slightly familiar	33	19,6%
	Moderately familiar	30	17,9%
	Very familiar	10	6,0%
	Extremely familiar	3	1,8%

Table 9 – Levels of Blockchain Familiarization. **Source:** Elaborated by Author.

Among those who were aware of blockchain, the majority learned about it through social media (33.9%), friends and colleagues (29.2%), the academic environment (25%), and news articles (24.4%). The main sectors that respondents identified as using blockchain were the financial sector (51.2%), cryptocurrency (40.5%), information security (33.9%), and the supply chain sector (47%). Notably, this selection aligns with the key sectors identified during the literature review (Alladi, Chamola, Parizi, & Choo, 2019). Only 19 participants (11.3%) reported having used blockchain.

BCT Usage	n	%
No	149	88,7%
Yes	19	11,3%

Sources of Knowledge	Selected	
	n	**%**
News Articles	41	24,4%
Social media	57	33,9%
Conferences/Events	16	9,5%
Friends/Colleagues	49	29,2%
Academic Environment	42	25,0%
Professional Experience	12	7,1%
Cryptocurrency	1	0,6%
Google	1	0,6%
Youtube	1	0,6%
Never	61	36,3%

Sectors	Selected	
	n	**%**
Finance Sector	86	51,2%
Supply Chain Sector	47	28,0%
Healthcare Sector	27	16,1%
Real Estate Sector	23	13,7%
Information Security Sector	57	33,9%
Energy Sector	25	14,9%
Agriculture Sector	18	10,7%
E-commerce/Retail Sector	42	25,0%
Cryptocurrency Sector	68	40,5%
Wine Industry Sector	32	19,0%
Not Familiar	50	29,8%
Item Validation Sector	1	0,6%

Table 10 – Frequency of platforms, sectors, and usage of the blockchain. **Source:** Elaborated by Author.

Analysing the questions that identify confidence in wine integrity, respondents tend to agree on the fact that traceability in wine is a benefit (Q11 | 75,6%), the fact that a technology like a blockchain can reduce counterfeiting (Q12 | 73,8%), that it can bring confidence in wine journey (Q18 | 72,0%) and increase brand reputation (Q19 | 76,8%).

		Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Q11	n	1	0	40	88	39
	%	0,6%	0,0%	23,8%	52,4%	23,2%
Q12	n	1	5	38	81	43
	%	0,6%	3,0%	22,6%	48,2%	25,6%
Q18	n	4	8	35	81	40
	%	2,4%	4,8%	20,8%	48,2%	23,8%
Q19	n	2	2	35	86	43
	%	1,2%	1,2%	20,8%	51,2%	25,6%

Table 11 – Level of Agreement in Q11, Q12, Q18, and Q19. **Source:** Elaborated by Author.

Respondents feel like it's quite important (Q17 |41,7%) to trust a wine that verifies its authenticity through a trusted system.

		n	%
Q17	Not important	5	3,0%
	Slightly important	11	6,5%
	Moderately important	43	25,6%
	Quite important	70	41,7%
	Very important	39	23,2%
	Total	168	100,0%

Table 12 - Importance of Confidence in Authenticity Verification. **Source:** Elaborated by Author.

Blockchain can be more beneficial in increasing consumer trust (67,9%), enhancing traceability (43,8%), and reducing counterfeit (43,2%).

		n	%	% of cases
Blockchain Benefits	Enhanced Traceability	71	18,5%	43,8%
	Reduced Counterfeit	70	18,2%	43,2%
	Improved Supply Chain Efficiency	48	12,5%	29,6%
	Increased Consumer Trust	110	28,6%	67,9%
	Better Inventory Management	48	12,5%	29,6%
	Streamlined Regulatory Compliance	37	9,6%	22,8%
Total		384	100,0%	237,0%

Table 13 – Blockchain Benefits. **Source:** Elaborated by Author.

The preferred method of implementation of blockchain is through QR Codes (67,3%), followed by mobile apps with BCT verification (13,7%).

5.1.3. Exploratory Factorial Analysis (EFA)

It is necessary to conduct an exploratory factor analysis to understand the different dimensions that can explain the relationships between various variables. (Tavakol & Wetzel, 2020). As mentioned before, the data was entered into SPSS, giving rise to a database made up of 168 cases and 58 variables, as all the possible choices in multiple questions were transformed into individual columns with two options (1 - selected and 0 - not selected). To analyse whether the data is suitable for this type of analysis, it was done the Kayer-Meyer-Olkim (KMO) test and Bartlett's sphericity. Each variable that employed a Likert scale was tested until a suitable model that met the following criteria was achieved. In the KMO test, the values range from 0 to 1 and represent the variance proportion of the indicators that can be explained by a latent variable. (Rossoni, Engelbert, & Bellegard, 2016), where the closer it is to 1, the more suitable the data is for factor analysis, in this case, the value was 0,758 which indicates a "middling" level of sampling adequacy (Kaiser, 1974). Bartlett's sphericity test, on the other hand, assesses the entire correlation matrix to evaluate the suitability of factor analysis by identifying the relationships between variables, where a value ($p < 0,05$) is statistically significant, indicating that there are enough correlations between the variables to proceed with the analysis. (Rossoni, Engelbert, & Bellegard, 2016), in this case, the value was <0,001. Given that all criteria have been satisfied, this was the best-fitting model.

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		,758
Bartlett's Test of Sphericity	Approx. Chi-Square	284,413
	df	10
	Sig.	<,001

Table 14 – KMO and Bartlett's Test from the survey dataset. **Source:** Elaborated by Author.

Kaiser's eigenvalue criteria have a cut-off point value of 1 (Hooper, 2012), analysing the total variance explained table which to the component be considered acceptable the value should be superior to 50% (Samuels, 2017), having said that the first component explains 55,86% of the data. Through this analysis, it was possible to establish a single component.

Total Variance Explained						
Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	2,793	55,862	55,862	2,793	55,862	55,862
2	,962	19,248	75,110			
3	,530	10,600	85,711			
4	,413	8,250	93,961			
5	,302	6,039	100,000			
Extraction Method: Principal Component Analysis.						

Table 15 – Retained component according to Kaiser Method. **Source:** Elaborated by Author.

The communalities table shows that the variables most explained by this factor are the ones that identify blockchain traceability as an advantage for the wine industry, with the name "traceability as a benefit" (Q11) with a value of 0,675, and the confidence in a brand that uses blockchain to verify the wine's origin, with the name "confidence in brand reputation" (Q19), with the value of 0,681. The same factors are also extremely correlated with the component since the closer to 1 the more correlated it is. In this circumstance "traceability as a benefit (Q11) has a value of 0,822 and "confidence in brand reputation" (Q19) with a value of 0,825.

An appropriate Cronbach's Alpha is considered when above 0,7. In this case, the alpha is relatively high with a value of 0,789 (Taber, 2018), indicating that the construct has solid reliability. The following table reflects the four components assembled by this construct, regarding the confidence reflected in the use of this technology in the wine industry. They are related to the benefits that a technology like this one can provide to an old industry like wine since they can decrease counterfeiting and improve transparency in the supply chain, which are key benefits to increase confidence (Vaigandla, Siluveru, Kesoju, & Karne, 2023).

Component Matrix	Component 1	Cronbach's Alpha
(Q19) Confidence in Brand Reputation	0,825	
(Q11) Traceability as a Benefit	0,822	
(Q18) Confidence in Wine Journey	0,733	0,789
(Q12) Reduction of Counterfeit	0,718	
(Q17) Confidence in Authenticity Verification	0,62	
Extraction Method: Principal Component Analysis.		
a. 1 components extracted.		

Table 16 – Component Matrix and Cronbach's Alpha of the Variables. **Source:** Elaborated by Author.

Analysing the data we can title this construct "Confidence of Blockchain in Wine Integrity", which accounts for 55,86% of the variance within the dataset. As mentioned

in the literature review, the stakeholders' perceptions are affected when implementing a technology that transmits trust (Kuen, Westmattelmann, Bruckes, & Schewe, 2023). This construct helps to comprehend how the stakeholders perceive this technology and its implementation, giving a future outlook of how they would react. A single construct gives a clearer view of what matters the most to the involved parties not only in this industry but also in others, simplifying research (Kumari & Chahal, 2012).

5.1.4. Effect of Other Factors on Confidence of Blockchain in Wine Integrity

In this study, it was important to establish some comparisons between variables. It was used the t-student, ANOVA, and Spearman tests. These tests allowed to confirm which variables were statistically significant to the overall confidence of the blockchain in promoting wine integrity. The following variables were the ones that had statistically significant results (age group and benefits BCT can offer to the industry), factors such as blockchain familiarity (H2), and wine consumption habits (H5), which include wine characteristics that people value the most had low correlation values between groups with the construct, by seeing the values of the significance of which one of these variables in Appendix 4, and 5.

5.1.4.1. Effect of the Stakeholder Role (H3)

To study the effect that each stakeholder role has on the wine industry (H3) it was used the Student's *t*-test since it can compare the means between two groups not being necessary multiple comparisons, this statistical technique is used to analyse if the "mean difference between two groups is statistically significant" (Mishra, Singh, Pandey, Mishra, & Pandey, 2019). In this context, an independent sample t-test is the most appropriate one since we have the variable "Confidence in Blockchain in Wine Integrity" which is the test variable and the role which can have two categories "yes" or "no" (Mishra, Singh, Pandey, Mishra, & Pandey, 2019). The stakeholder role was defined as a binary variable with the value "yes" if the respondent has that specific role within the wine industry or "no" if it hasn't. For a variable to be considered to have significant differences, it needs to have a p-value < 0,05.

When analysing the table of results regarding this subject we can see that there isn't a role that affects the degree of confidence in the wine integrity. This can be explained since blockchain is a complex subject that requires a certain degree of knowledge to

comprehend (Vaigandla, Siluveru, Kesoju, & Karne, 2023). When analysing the frequencies regarding the familiarity with the blockchain it is possible to understand why this happens since 54,8% of the respondents are not familiar with the blockchain. The fact that the majority of respondents are consumers and there isn't more variety in respondents ends up harming the real blockchain knowledge that exists within the wine industry.

		$\overline{X} \pm \sigma$	p-value T-Student
Producer	No	3,92 ± 0,63	0,283
	Yes	3,68 ± 0,43	
Distributor	No	3,92 ± 0,63	0,334
	Yes	3,64 ± 0,52	
Retailer	No	3,91 ± 0,63	0,882
	Yes	4 ± 0	
Oenologist	No	3,91 ± 0,63	0,417
	Yes	3,4 ± 0	
Consumer	No	3,69 ± 0,41	0,117
	Yes	3,93 ± 0,64	
BCT Expert	No	3,91 ± 0,63	N/A
	Yes	3,6 ± 0	

Table 17 – T-Test Analysis of Stakeholder Roles on Blockchain Confidence in Wine Industry Integrity.
Source: Elaborated by Author.

5.1.4.2. Effect of the Age Group (H4)

To perform an analysis regarding the effect age can have on the overall confidence in the use of BCT in the wine industry promoting its integrity (H4) was done an ANOVA test, because the age group was divided into ranges (groups). This test helps to compare the means between three or more groups, indicating if it's the case the variable that has a significant outcome, to detect which variable is statistically significant it is done a *post hoc* test (Mishra, Singh, Pandey, Mishra, & Pandey, 2019), which in this case was used the LSD.

When analysing the table of results, the different age groups can be divided into two distinct categories, as one group shows a statistically significant difference between the groups. Looking at the means, it is evident that the group with a statistically significant difference in opinion is those aged from 18 to 30 years old (58,9%), which tend to give less value to the construct. This difference of opinions can be explained by the fact that this age group was the most prominent one in the survey, with 45,5% of this group of respondents not being familiar with the blockchain, this can then be explained by their lack of knowledge, meaning they don't have an opinion on the subject, which makes them select the middle option, hence the average is closer to the centre (Krosnick, et al., 2002).

The second age group can be comprehended as starting from age 31 onwards, as there are no statistically significant differences between them. In this group, there is a tendency to place greater emphasis on evaluating the confidence in blockchain within the wine industry.

Age Group	$\overline{X} \pm \sigma$	p-value ANOVA
18 - 30	3,77 ± 0,61	0,012
31 - 40	4,07 ± 0,51	
41 - 50	4,17 ± 0,61	
51 - 60	4,09 ± 0,52	
> 60	4,11 ± 1,05	
Total	3,91 ± 0,63	

Table 18 – ANOVA Analysis of Different Age Groups on Blockchain Confidence in Wine Industry Integrity. **Source:** Elaborated by Author.

5.1.4.3. Effect of the Perceived Blockchain Benefits (H1)

From the literature review is possible to establish the most relevant benefits to apply in such a traditional industry like wine, since it is important to maintain that existent tradition as well as innovate into more secure and safer solutions for the stakeholders (Grechi, Pavione, Gazzola, & Cardini, 2024). Looking at the p-value of the different benefits (variables) it is observed that benefits like the "reduction of counterfeit" (p=0,008) and the "increase of consumer trust" (p<0,001) are the ones with statistically significant differences in mean (p < 0,05), since trust is the composite of different factors making them the most important benefits for stakeholders in general, since a wine professional can be a wine consumer and vice versa (Vizaad, Norman, & Azzuhri, 2022). This can be explained by the profile of the stakeholders answering the survey, as most of the part are consumers and identification of benefits such as the increase of supply chain efficiency (Khan, Kumar, & Sahu, 2023), better inventory management (Wannenwetsch, Ostermann, Priel, Gerschner, & Theissler, 2023), streamlined regulation (Khan, Kumar, & Sahu, 2023), requires a technical knowledge of wine production and supply chain, making those benefits less selected by the overall population sample, thus influencing the construct. The enhancement of traceability although it hasn't a significant statistical difference can be an underlying factor in the reduction of counterfeit (Mattke, Maier, Hund, & Weitzel, 2019) and higher consumer trust (Vizaad, Norman, & Azzuhri, 2022).

		$\overline{X} \pm \sigma$	p-value T-Student
Reduced Counterfeit	No	3,8 ± 0,64	0,008
	Yes	4,06 ± 0,58	
Enhanced Traceability	No	3,91 ± 0,67	0,962

	Yes	3,91 ± 0,56	
Improved Supply Chain Efficiency	No	3,91 ± 0,64	0,883
	Yes	3,9 ± 0,58	
Increased Consumer Trust	No	3,66 ± 0,57	< 0,001
	Yes	4,04 ± 0,62	
Better Inventory Management	No	3,95 ± 0,67	0,216
	Yes	3,81 ± 0,5	
Streamlined Regulatory Compliance	No	3,92 ± 0,65	0,643
	Yes	3,86 ± 0,52	

Table 19 – T-Test Analysis of Blockchain Benefits in Confidence in Wine Industry Integrity. **Source:** Elaborated by Author.

5.2. Qualitative Analysis – Interview

As mentioned before, MaxQDA was used to analyse the interview data, firstly with the help of the literature review that supported the interviews, it created 7 main codes that were consistent with the different interviews. These main codes had different subcodes that were identified through the reading of the different interviews. Subcodes were created "*in vivo*" since they help attach featured segments (Godau, 2004). Interviews were then analysed and interpreted repeatedly until a good coding system was developed that captured the best values out of the responses from the interviewees (Appendix 3), eliminating similar categories and repetitive ones. After this initial analysis, 88 subcodes were created within the 7 main codes. The analysis began by uploading the different interviews into the documents tab, making it 4 interviews in total, although we have 5 stakeholder profiles in the interview. This happened because the profile regarding the wine oenologist also worked up close with the wine production phases knowing the different steps and software required in producing wine. The interviews had mostly common questions between them so it's possible to establish a comparison basis, but also specific ones, shown in Appendix 2. The interviews had a lot of common themes between them since they also had a similar script, only with nuances in certain questions. To have a better visualization of the common themes that these interviews had, a word cloud is important to give a quick insight into the interviews (Kuckartz & Rädiker, 2019).
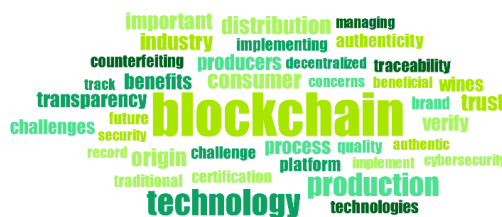

Figure 1 – Interviews Word Cloud. **Source:** Elaborated by Author.

To have a perfect and clear vision of the most recurrent words within this cloud, words that didn't add value to its interpretation and conclusions were excluded. These words were connectors of sentences (for example, "such", "also", "if", and more), and complete words without any significance (for example, "wine"). When observing the words that stand out, are the main themes "blockchain" (40 mentions), "technology" (20 mentions), "origin" (11 mentions), "trust" (10 mentions), and "transparency" (8 mentions).

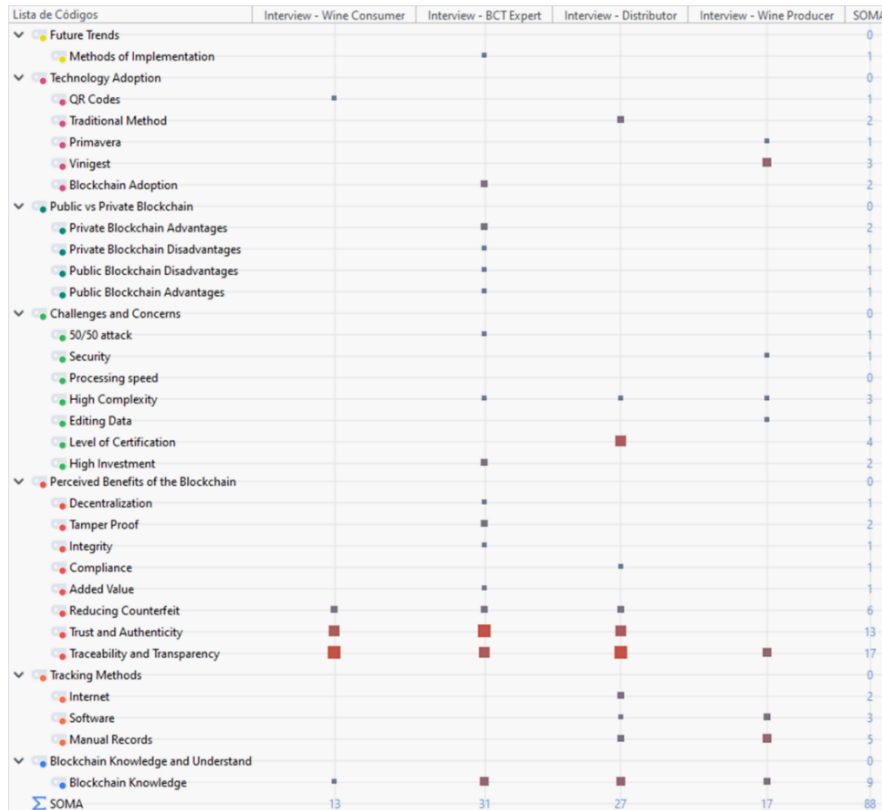| Lista de Códigos	Interview - Wine Consumer	Interview - BCT Expert	Interview - Distributor	Interview - Wine Producer	SOMA
Future Trends					0
Methods of Implementation		■			1
Technology Adoption					0
QR Codes	■				1
Traditional Method			■		2
Primavera				■	1
Vinigest				■	3
Blockchain Adoption		■			2
Public vs Private Blockchain					0
Private Blockchain Advantages		■			2
Private Blockchain Disadvantages		■			1
Public Blockchain Disadvantages		■			1
Public Blockchain Advantages		■			1
Challenges and Concerns					0
50/50 attack		■			1
Security				■	1
Processing speed					0
High Complexity		■	■	■	3
Editing Data				■	1
Level of Certification			■		4
High Investment		■			2
Perceived Benefits of the Blockchain					0
Decentralization		■			1
Tamper Proof		■			2
Integrity		■			1
Compliance			■		1
Added Value		■			1
Reducing Counterfeit	■	■	■		6
Trust and Authenticity	■	■	■		13
Traceability and Transparency	■	■	■	■	17
Tracking Methods					0
Internet			■		2
Software			■	■	3
Manual Records			■	■	5
Blockchain Knowledge and Understand					0
Blockchain Knowledge	■	■	■	■	9
Σ SOMA	13	31	27	17	88

Figure 2 – Code Matrix of the Interviews. **Source:** Elaborated by Author.

A code matrix can complement the visual interpretation and analysis of this study. This matrix can help in realizing which codes were assigned to which interviews and how many times they were present (Kuckartz & Rädiker, 2019). Themes such as the benefits of blockchain were talked about in the interviews, with Traceability and Transparency; Trust and Authenticity, with 17 and 13 occurrences, respectively.

5.2.1. Blockchain Familiarity Level (H2 and H3)

Since its inception, blockchain technology has been closely linked with cryptocurrencies, and many are unaware that it can be utilised in fields beyond digital currencies since this technology can process transactions automatically (Iansiti &

Lakhani, 2017). Regarding, this subject the consumer (I1) was the interviewee who showed the least level of familiarity with blockchain "No, I didn't know about Blockchain". The distributor had deeper levels of familiarity although they were limited, he only knew its benefits and how it would be beneficial for its professional role within the wine industry. The wine producer when asked about her level of knowledge of blockchain, didn't answer directly, instead talked about how a technology with this scope could make certain processes even easier for the company, which is one of the main producers of the region "our company is one of the largest in the region…traceability is also important for process validation, production flowcharts, and ensuring the production of a quality product". Contrasting with these opinions we have the one from the BCT expert for obvious reasons, since he had to "conduct extensive research on the Blockchain" (I2). Aside from the BCT expert and the consumer, who represent the two extremes of the blockchain knowledge spectrum, the interviewees exhibit similar levels of familiarity. This suggests that their familiarity is not linked to the position they hold or company-related (H3), but rather individually (Lustenberger, Malešević, & Spychiger, 2021), which is confirmed by the previous quantitative analysis.

5.2.2. Perceived Blockchain Benefits and Challenges (H1)

To better develop this section, the interviewees, except for the BCT expert, with less knowledge of what constituted blockchain, were explained by briefly comparing it to a notepad. The interviewees were then asked, depending on their level of knowledge of blockchain, what benefits and challenges a technology like this could have for them and their role within the wine industry. That said, the answers changed on the technical side, with one producer saying that it would be important to "record everything from the grape's arrival to bottling and its component" (I4). The consumer (I1) although it was from a customer point of view instead of a technical opinion referred that a company that can track each detail of the wine supply chain would make it more trustworthy since it was more transparent (I1). The distributor (I3) said that blockchain could offer a lot of benefits to their role within the wine industry since it would give them another form to ensure that the wine is authentic (I3). BCT Expert (I2) on the other hand, although it referred to benefits in common with the other interviewees such as consumer trust, traceability, transparency, and reducing counterfeit, also mentions the fact that it can propose one more layer of security for both spectrums of the stakeholders involved (wine producer

and customer) since it is tamper-proof. Overall, the interviewees tend to give high value to benefits such as traceability and authenticity, these benefits also coincide with consumer trust since the blockchain chain can have "biggest effects" on it (Beck, 2018). These benefits are crucial elements and an integral part of the blockchain (Vaigandla, Siluveru, Kesoju, & Karne, 2023). Regarding challenges, I4, mentions high complexity as one of them, since they need to become "easier to handle" (I4), and mentioned the fact that since this technology has as a benefit its immutability, that can also be a hurdle as sometimes it is needed to detect and correct transcription errors. I3 highlighted that in his specific role, there wouldn't be any challenges, but instead for wine producers, and wine estates, since they would be forced to fulfil quality standards. I2 since it was the person with a deeper knowledge of the blockchain and its capabilities, besides its high complexity mentions factors like the possibility of a 50/50 attack also mentioned by Yaga, Mell, Roby, & Scarfone (2018). Factors such as investment could get in the way of implementing it in smaller companies "For small to medium sized producers, it's implementation cost and security risks are not justifiable" (I2). Benefits and challenges are perceived almost equally between stakeholders and in the survey as well, with them showing similar levels of familiarity with this technology. Challenges that are identified in different literatures are also mentioned by the interviewees with a deeper degree of the technical part of the wine industry.

5.2.3. Current Ways of Protecting Wine

It is important to understand which are the current ways companies use to protect and manage wine. The producer (I4) states that they have processes well defined since it works in a very well-established and positioned company in the market, this leads to the use of two software's: Vinigest and Primavera. Vinigest is a software used to manage the production of wines and record all the stages of production. It is also possible to record everything related to production from products to the results of analyses (I4). Primavera on the other hand is an ERP System that helps the company to "manage stocks, from components used in production to packaging, and the finished product" (I4). The distributor on the other hand founded his own company 3 years ago, this means that it is a relatively small company with processes not well established, with businesses being conducted "purely on a trust basis" (I3), this means they still rely on the traditional method of recording information, and occasionally using the internet to check for wine

reviews. The comparison between these two profiles of companies is well compared by I2, mentioning the differences between investment resources in technologies, regarding blockchain, since implementing a private centralized blockchain can require more investment.

5.2.4. Methods of Implementing Blockchain in the Wine Industry

To evaluate the most effective implementation methods for both consumers and industry professionals, stakeholders were asked about the most optimal solution for their area, this implementation could be done with QR codes in bottles for example TagItWine (European Commission, 2019), or through smart contracts such as in the case of the three Italian Wineries already implementing this technology (Galati, Vrontis, Giorlando, Giacomarra, & Crescimanno, 2021).

The consumer (I1) stated that a practical solution like a QR code would not require any special features (Agnusdei, Coluccia, Elia, & Miglietta, 2022), would be more beneficial, as they can relate to them since it is possible to see the wine details (I1). The blockchain expert said that a "decentralized platform…such as public blockchain is most suited for the wine industry" since it would require lower investment to apply, and the fact that having a central ruler can damage the blockchain since it can be "easily manipulated depending on bias and other factors" (I2). The interviewees couldn't refer to a specific solution of implementation only the fact that however the blockchain is implemented it should be "faster and easier to handle" (I4) than the current ones available.

Interviewees reflected that in general, except for BCT experts, they didn't have the knowledge to point out a specific solution.

6. CONCLUSION, LIMITATIONS AND FUTURE RESEARCH

6.1. Conclusion

The main goal of this research was to examine the perception of stakeholders in the wine industry towards blockchain, a decentralised and disruptive technology. More specifically, this study served as an assessment of the current knowledge and familiarity with BCT, which characteristics are perceived as benefits and challenges by stakeholders within the wine industry, and finally how they see this technology changing the current panorama. The literature review played a crucial role in framing this analysis, providing context and helping to validate the conclusions drawn from the interviews and survey data.

By analysing the 168 valid answers to the questionnaire, it is possible to comprehend that factors that otherwise would be perceived as highly correlated to the overall trust of blockchain implementation in the wine industry, weren't so influential. For instance, the age group (H4) was found to have a significant correlation, with opinions differing between individuals aged 18 to 30 and those aged 31 and older. This difference in perception can be explained by the fact that younger respondents had lower levels of blockchain knowledge, while older respondents gave more value to the characteristics of blockchain seeing them as more beneficial. Perceived benefits (H1) also played a significant role in shaping respondents' confidence in blockchain's potential to promote wine integrity, with benefits such as "reduced counterfeit" and "increased consumer trust" having high correlations with the confidence that blockchain has in promoting wine integrity. Surprisingly, factors such as BCT familiarity (H2), wine consumption habits (H5), and wine characteristics (H5), don't affect, at least in this population sample, the degree level that stakeholders trust in blockchain implementation within this industry. It is important to understand that when people don't have awareness of a subject they tend to stay in the middle, so these factors have an individual dependency, for example, a person who drinks and buys wine occasionally, can still have no confidence in blockchain, and can't identify which benefits of this technology can be applied in the wine supply chain. This can also be true on the opposite, since a person who does not know blockchain can still find in its benefits, added to value to this industry. Nor does the role they play

within the industry (H3) reflect their knowledge of the blockchain or their degree of trust within it, as it also depends on an individual factor and a perception and awareness of it.

The interviews confirmed the findings from the quantitative analysis. They reinforced that levels of knowledge are not solely determined by one's role within the wine industry (H3), nor is their implementation contingent on this knowledge alone (H2). The interviewees demonstrated similar levels of blockchain knowledge, yet they identified specific characteristics they perceived as benefits and challenges in implementing the technology within the traditional wine industry (H1). The benefits most frequently highlighted by the interviewees – such as trust, authenticity, transparency, and traceability – align with the findings from the questionnaires and the literature review. These factors were repeatedly identified as key advantages that significantly impact the wine industry's adoption of blockchain technology. Both consumers and wine professionals fully realise how important it is to have a wine that can be traced back to its origin, in this case from the grape. Not only does this safeguard consumers, but it also safeguards those who make a business out of this industry, as this technology can be an effective solution in reducing wine counterfeiting and loss of business. However, it is necessary to think how this implementation would be done.

To sum up, despite the increasing recognition in the wine sector of the advantages linked to blockchain technology like improved trust, authenticity, transparency, and traceability, there is still a notable lack of comprehensive understanding about its wider possibilities. Moreover, uncertainties remain regarding the successful integration of blockchain technology into supply chain operations within the industry. This reflects the need for further exploration and education on the practical applications of blockchain within the sector. I would like to continue working on this study to strengthen it and come to a more concrete conclusion, as well as draw up a plan for the possible realistic implementation of this technology.

6.2. Limitations and Future Research

When analysing the limitations of this study, the variety of respondent profiles in the questionnaire stands out. A broader range of responses across different industry profiles could have enriched the findings. Additionally, respondents often placed themselves in the middle range when they lacked knowledge of a subject, which distorted the results.

This study primarily reflects the views of consumers. Regarding the interviews, it would have been beneficial to include a wider range of companies with varying levels of maturity in their supply chain processes, to offer a more diverse perspective on blockchain's potential impact. Another limitation was that there isn't a defined scale of what makes blockchain more reliable towards wine industry stakeholders and how this technology can impact their business. Interviews with regulatory entities in this sector, such as ASAE and the Instituto da Vinha e do Vinho, would strengthen the work, as well as give context to the perspectives perceived by stakeholders.

For future research, it would be interesting to reach out to companies at various stages of their business. This would help to see differences between companies that are more traditional and the ones with more technology, preferably blockchain. A study that could focus more on each stakeholder individually would be more beneficial instead of one that generalizes blockchain implementation. Using a different methodology than the one used in this study could provide different results on this subject. This study also serves as a basis for future understanding of blockchain implementation not only in this industry but also in other traditional industries that lack transparency, trust and traceability in their processes. Considering the significant investment expenses, it would be advantageous, as observed in other conventional sectors, to create a solution utilizing this technology via a pilot project. This may include a technology centre, working together with business groups, universities, and potentially the Instituto da Vinha e do Vinho. This type of project would enable a practical assessment of the advantages and difficulties of incorporating this technology into the industry, offering valuable, tangible information on its efficiency and economic viability. There isn't still a clear path to this implementation, existing different possible scenarios for blockchain applications to coexist in businesses in the many years to come.

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APPENDICES

Appendix 1: Stakeholder's Survey

Section	Question	Answer
Sociodemographic Data	**Q1.** What is your age?	A1: < 18 A2: 18 – 30 A3: 31 – 40 A4: 41 – 50 A5: 51 – 60 A6: > 60
	Q2. What is your sex?	A1: Male A2: Female
	Q3. Where do you live?	A1: All Portugal districts.[1] A2: Outside of Portugal
Blockchain Familiarization and Wine Habits	**Q4.** How familiar are you with blockchain technology?	A1: Not familiar A2: Slightly familiar A3: Moderately familiar A4: Very familiar A5: Extremely familiar
	Q5. How often do you consume wine?	A1: Daily A2: Weekly A3: Monthly
	Q6. How often do you buy wine?	A4: Occasionally A5: Rarely A6: Never
Blockchain Introduction	**Q7.** Where did you hear about blockchain technology?	A1: News articles A2: Social Media A3: Conferences or events A4: Friends/Colleagues A5: Academic environment A6: Professional experience A7: Never
	Q8. In which sectors can you identify the use of blockchain?	A1: Finance A2: Supply Chain A3: Healthcare A4: Real Estate A5: Information and Security A6: Energy A7: Agriculture A8: E-Commerce and Retail A9: Cryptocurrency A10: Wine Industry A11: Not familiar
	Q9. Have you ever used blockchain?	A1: Yes A2: No
Benefits and Challenges of Blockchain	**Q10.** What is your main role in the wine industry or the blockchain?	A1: Producer A2: Distributor A3: Retailer A4: Wine Oenologist A5: Consumer A6: Blockchain Expert A7: Other
	Q11. Do you think that technology that can track all the stages of wine production can	A1: Strongly Disagree A2: Disagree

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[1] For reading purposes all Portugal districts had an option to select each one individually.

	help ensure that the origin of the wine is reliable and true?	A3: Neutral A4: Agree A5: Strongly Agree
	Q12. Do you think such a technology could reduce wine counterfeiting?)	
	Q18. Would knowing the detailed journey of the wine (from vineyard to bottle) influence your purchasing decision?	
	Q19. A brand would be more reputable, making you trust the quality and origin of the wine more, if it were verified by a technology capable of guaranteeing this (eg: blockchain)?	
	Q17. How important do you think it is to verify the authenticity of wine through a trusted system?)	A1: Not important A2: Slightly important A3: Moderately important A4: Quite important A5: Very important
	Q13. These are some of the benefits of this technology, which ones do you think are most important for you to apply to an industry like the wine industry?	A1: Enhanced traceability A2: Reduced counterfeiting A3: Improved supply chain efficiency A4: Increased consumer trust A5: Better inventory management A6: Streamlined regulatory compliance A7: Other
Wine Habits	**Q14.** Where do you usually buy your wine?	A1: Supermarket A2: Wine store A3: Online A4: Directly from the winery A5: Other
	Q15. How much do you usually spend on a bottle of wine?	A1: Less than 10€ A2: 10€ - 20€ A3: 20€ - 50€ A4: More than 50€
	Q16. Which factors do you consider most important when buying wine (1 - Extremely Important and 10 - Not Important at All)	A1: Price A2: Brand reputation A3: Wine region/origin A4: Taste A5: Recommendations from friends/family A6: Expert reviews/ratings A7: Sustainability practices A8: Authenticity A9: Design A10: Grape Varieties
Blockchain Implementation	**Q20.** Which method of implementing blockchain would you find most effective for the wine industry?	A1: QR codes on wine bottles A2: Digital certificates A4: Mobile apps with blockchain verification A5: Online portals with blockchain verification A6: NFC (Near Field Communication) (eg: Apple Wallet, Google Pay) A7: Other

Table 20 – Survey Questions. **Source:** Elaborated by Author.

Appendix 2: Interviews Script

Type of Question	Section	Question	Stakeholder Role
Common	**Introduction**	**Q1.** Introduce yourself and your role within the wine industry	Everyone
	Importance of Transparency	**Q2.** Are you familiar with any technologies that could help track and verify the authenticity of wine, and their importance?	Everyone
	Benefits and Challenges	**Q3.** What benefits and challenges do you see in implementing a technology like blockchain?	Everyone
	Future Perspectives	**Q4.** How do you think blockchain can change the wine industry?	Everyone
Specific questions	**Wine Characteristics**	**Q1.1.** What factors are most important to you when buying wine?	Consumer
	Importance of Traceability	**Q2.1.** How do you currently track and verify the origin of your wine?	Wine Producer
	Blockchain Implementation	**Q4.1.** Are there any specific blockchain solutions you think are best suited for the wine industry?	BCT Expert
	Importance of Authenticity	**Q2.2.** How do you ensure the quality and authenticity of the wine you work with?	Wine Oenologist

Table 21 – Interview Script. **Source:** Elaborated by Author.

Appendix 3: Interviews Organization

Interviewee	Stakeholder Role	Sex[2]	Type of Interview	Duration[3]	Date	Pages
I1	Wine Consumer	F	Presential	14 min	01/09/2024	2
I2	BCT Expert	M	Online	16 min	06/09/2024	3
I3	Distributor	M	Online	15 min	03/09/2024	3
I4	Wine Producer/Oenologist[4]	F	Online	18 min	04/09/2024	3

Table 22 – Interviews and Interviewees Characterization. **Source:** Elaborated by Author.

Appendix 4: Effect of Blockchain Familiarity

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	0,752	4	0,188	0,475	0,754
Within Groups	64,519	163	0,396		
Total	65,271	167			

Table 23 – Effects of BCT Familiarity in Confidence in the Wine Supply Chain. **Source:** Elaborated by Author.

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[2] M = Male | F = Female.

[3] Min = Minutes.

[4] Wine Oenologist had a deep knowledge of wine production and its supply chain, thus being considered as well as a Wine Producer.

Appendix 5: Effect of Wine Consumption Habits

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	1,735	5	0,347	0,885	0,493
Within Groups	63,537	162	0,392		
Total	65,271	167			

Table 24 – Effect of Wine Consumption Frequency in BCT Implementation in the Wine Supply Chain.

Source: Elaborated by Author.

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	1,258	4	0,314	0,801	0,526
Within Groups	64,013	163	0,393		
Total	65,271	167			

Table 25 – Effect of Wine Buying Frequency in BCT Implementation in the Wine Supply Chain.

Source: Elaborated by Author.

	Price	Brand Reputation	Wine Region	Taste	Recommendation
Correlation Coefficient	0,111	0,107	-0,005	0,046	-0,118
Sig. (2-tailed)	0,151	0,166	0,948	0,558	0,127
N	168	168	168	168	168
	Expert Review	Sustainability Practice	Authenticity	Design	Grape Varieties
Correlation Coefficient	0,028	0,043	0,071	-0,017	0,052
Sig. (2-tailed)	0,718	0,576	0,359	0,825	0,504
N	168	168	168	168	168

Table 26 – Effect of Wine Characteristics in BCT Implementation in the Wine Supply Chain. **Source:** Elaborated by Author.