




Consumer intentions to purchase wines with Blockchain and quick-response code tracking: Insights from an extended stimulus–organism–response model

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ABSTRACT

Consumers' demand for transparency, authenticity and safety in food and beverage products continues to rise. Blockchain technology (BCT) and quick-response (QR) codes have emerged as powerful tools for enhancing product traceability. Understanding the psychological and behavioural mechanisms underlying consumers' acceptance of such technologies is crucial for producers and policymakers alike. Therefore, this study explores the factors influencing consumers' intention to purchase wines traceable through BCT and QR codes through an extended stimulus–organism–response model enriched with constructs from the theory of perceived risk. A survey was conducted in February 2025 with a sample representative of the Italian population ($N = 1001$). The collected data were analysed using a validated partial least squares structural equation modelling approach to examine how external stimuli (transparency and traceability, diagnosticity, subjective norms and facilitating conditions), individual perceptions (perceived value, trust and usefulness), emotional responses (hedonic perception), risk perception, and BCT knowledge shape consumers' purchase intention. The results show that diagnosticity and transparency significantly enhance perceived value, which in turn strongly influences purchase intention. While knowledge of BCT positively affects hedonic perception, it has a limited effect on perceived usefulness or trust, highlighting that technological familiarity is not a dominant driver of technology adoption. However, hedonic perception emerges as the strongest predictor of purchase intention, highlighting the importance of designing engaging and enjoyable traceability experiences. Social and contextual factors, particularly subjective norms and facilitating conditions, significantly affect perceived usefulness, which in turn contributes to purchase intention. Perceived risk has a significant but relatively small effect on purchase intention. The model explains 68.1% of the variance in purchase intention, offering novel insights for technology developers, marketers and policymakers seeking to foster consumers' acceptance of digital traceability in the wine sector.

Introduction

Research background

With the increasing pace of digital transformation, blockchain technology (BCT) has attracted considerable attention in the agri-food sector for enhancing product transparency and traceability (Feng et al., 2020; Gopalakrishna Pillai et al., 2024). BCT is particularly relevant in the wine industry, where consumers increasingly value

authenticity, quality assurance, product origin, environmental sustainability and rich terroir information, as well as sensory quality attributes and price (Agnusdei et al., 2022; Bagnato et al., 2024; Martínez-Falcó et al., 2025; Moulard et al., 2015; Williamson et al., 2016). BCT contributes to enhanced traceability, transparency and certification processes, thereby reinforcing the territorial identity and authenticity of wines through reliable, verifiable data management (Forleo & Benedetto, 2024).

According to Huang et al. (2025), BCT-enabled traceability labels are

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more effective than conventional certification labels in stimulating consumers' purchase intentions. Indeed, [Ibáñez-Jiménez and Palomo-Zurdo \(2024\)](#) and [Kramer et al. \(2024a\)](#) highlighted that BCT-based tokenisation, combined with digital identifiers, not only ensures product authenticity and provides consumers with direct access to verifiable information about each bottle but also enables interactive and immersive experiences that foster deeper trust and emotional connection with the brand.

The integration of quick-response (QR) codes with BCT substantially enhances the value of traceability systems, enabling seamless access to detailed and trustworthy product information ([Wu et al., 2024](#)). Through this digital interface, wineries can ensure instant access to verifiable data on each bottle's journey, from farm to fork, enhancing transparency, trust in the product's authenticity and consumers' confidence in their product ([Jadhav et al., 2022](#); [Parry et al., 2024](#)). Moreover, when thoughtfully implemented, these digital innovations can uphold and even elevate the sense of exclusivity and authenticity that defines the luxury wine experience, ultimately enhancing consumers' perceived value and prestige associated with the brand ([Bartoli et al., 2025](#)).

Research gap

Despite the crucial role of integrating BCT and QR codes in enhancing the transparency of the wine supply chain and influencing the purchase intention of consumers, existing research remains predominantly company-centric, focusing on the benefits and barriers of adopting these emerging technologies from the producers' side ([Cricelli et al., 2024](#); [Kramer et al., 2024b](#); [Sabbagh et al., 2024](#); [Sabbagh et al., 2025](#)). For instance, although [Agnusdei et al. \(2022\)](#) assessed the deployment of BCT and QR codes in the wine industry, they primarily addressed technical implementation, leaving consumers' perspectives on traceable wine largely unexplored. Similarly, [Bentivoglio et al. \(2025\)](#) and [Cricelli et al. \(2025\)](#) investigated BCT adoption in Italian winemaking using approaches based on the unified theory of acceptance and use of technology, highlighting producers' motivations, performance and organisational factors as well as trust; however, both studies mainly focused on winery-level adoption rather than consumers' perceptions.

In contrast, limited research has investigated consumers' perspectives, examining BCT adoption at a broad level, often within the general context of agri-food products, moving beyond the sector-specific factors critical to wine purchasing decisions, such as credence attributes of wine ([Bandinelli et al., 2023](#); [Shahzad et al., 2024](#); [Wang & Scrimgeour, 2023](#)). Some studies have examined consumers' intentions to use or trust BCT-based food traceability systems (BFTS), adopting the theory of planned behaviour (TPB, including extended versions) to assess how attitudes, social norms and perceived behavioural control influence consumers' intention to purchase traceable food products. Their findings indicate that social norms and familiarity with BCT are the main factors shaping consumers' decisions ([Maesano et al., 2024](#)) and that perceived BCT-related information indirectly affects consumers' purchase intention through attitude, social norms and perceived behavioural control ([Duong et al., 2025](#)).

Other research employing the technology acceptance model (TAM) has focused on the determinants of technology adoption, revealing that perceived usefulness (e.g. enhanced transparency and authenticity) and ease of use (e.g. quick access via QR codes) significantly influence consumers' intention to adopt BCT-based traceability systems. Overall, consumers perceive BCT as a reliable means of ensuring authenticity and transparency, with familiarity playing a key role in their adoption decisions ([Khan et al., 2025](#); [Triá et al., 2025](#)), especially among ethnocentric consumers ([Tran et al., 2024](#)). In the wine industry, [Adamashvili et al. \(2024\)](#) explored consumers' attitudes toward purchasing wine traceable through QR codes and BCT. Their findings revealed that knowledgeable and novelty-seeking consumers demonstrate a strong

trust and willingness to adopt these technologies when purchasing wine. Although their study offers practical insights into Italian wine consumers' behaviour, it remains primarily descriptive and lacks a robust theoretical framework to explain why certain consumers are more receptive to these technologies.

In general, studies employing the TPB and TAM have primarily focused on cognitive factors (attitudes, social norms, perceived usefulness and ease of use) without fully integrating emotional and perceptual aspects, which are crucial in the wine sector, as consumers' purchase intentions depend not only on perceived usefulness or social norms but also on their experience, trust, emotion and engagement ([Calvo-Porrá et al., 2020](#); [Drennan et al., 2015](#)). Thus, [Petroccione et al. \(2025\)](#) argued that psychological and behavioural factors strongly shape consumers' intention to adopt digital services, highlighting the need to consider both cognitive and emotional drivers in technology adoption. However, previous studies have not explored established behavioural or psychological theories that could highlight these dimensions, leaving room for further research to explore the deeper behavioural motivations behind the adoption of traceability technology in the wine sector.

Study aims and contribution

To fill this knowledge gap, this study aims to investigate the psychological and behavioural mechanisms underlying consumers' intention to buy wine tracked via BCT and verified via QR codes. It addresses the following two research questions (RQs).

RQ1. How do the characteristics of traceable wine and digital technologies influence consumers' cognitive and emotional reactions?

RQ2. How do consumers' cognitive and emotional perceptions determine their purchase intention for BCT-based traceable wines?

This study proposes a conceptual framework based on the stimulus–organism–response (SOR) model and extended with the theory of perceived risk (TPR). The SOR model conceptualises how the external stimuli, organism, and response are interrelated, highlighting the cognitive and emotional factors shaping attitudes toward traceable wine ([Shahzad et al., 2024](#); [Vergura et al., 2020](#)). The TPR also emphasises that uncertainties related to product value, security and time investment, particularly with unfamiliar technologies such as BCT, can undermine trust and the willingness to adopt new technologies ([Bauer, 1960](#); [Sohn, 2024](#); [Tran et al., 2024](#)).

To empirically test the proposed framework, this study draws on primary data collected in Italy through a quantitative survey of 1001 wine consumers using a stratified sampling approach to ensure demographic representativeness. The questionnaire was open for 15 days in February 2025. It included validated multi-item constructs measured on a 5-point Likert scale, adapted from prior studies on technology adoption and consumer behaviour. The collected data were analysed using partial least squares structural equation modelling (PLS-SEM), which is well-suited to testing complex models with latent constructs and to assessing both direct and indirect relationships among variables. This methodological approach provides a robust basis for examining how BCT-enabled traceability shapes consumer perceptions and purchasing behaviour in the wine sector.

This study contributes to the literature by addressing a critical gap in understanding the psychological, emotional and behavioural mechanisms that drive consumers' intentions to purchase wines traceable through BCT and QR codes, framed within the SOR model and perspective of perceived risk. The findings offer practical guidance for wineries on leveraging transparency and traceability tools to enhance consumers' trust, emotional engagement and satisfaction, thereby strengthening brand loyalty. Moreover, they can inform the design of targeted marketing and communication strategies that integrate digital engagement, interactive experiences and authenticity cues, helping wineries evoke positive emotions, build deeper trust, and secure a

sustainable competitive advantage in an increasingly digitalised marketplace.

The remainder of this paper is structured as follows. Section 2 conceptualises the research framework and develops the hypotheses. Next, Section 3 describes the methodology. Then, Section 4 presents the results and discussion, followed by Section 5, which outlines the conclusions, practical and theoretical implications, study limitations and directions for future research.

Conceptual framework and hypotheses

Consumer adoption of BCT in agri-food purchasing behaviour

Theoretical models play a crucial role in understanding consumer behaviour and bridge the gap between ‘the research in psychology (human decision making) and economics/consumer research’ (Swait & Adamowicz, 2001, p. 143). Different theoretical models have been developed to explain the psychological and behavioural mechanisms that drive decision-making, offering structured frameworks for analysing factors such as attitudes, motivations and deterrents (Sahu et al., 2020). Among these, the SOR model originally introduced by Mehrabian and Russell (1974) emerged as an effective approach for studying consumer behaviour, offering valuable insights into how external stimuli (stimuli) influence internal psychological states (organism) and, subsequently, behavioural responses (response; Li, 2024; Zhu et al., 2020). The SOR model has been increasingly applied to consumer purchasing behaviour (Liu & Zheng, 2019), including the use of specific technologies. For instance, Ho et al. (2024) studied intentions to adopt technology-driven innovations such as BFTS. They found that BCT-enabled traceability and transparency positively influence perceived information and system quality, mediating their impact on organic food purchase intention.

In the SOR model, external factors, such as the transparency and traceability of information (Duong et al., 2024; Shahzad et al., 2024), as well as product diagnosticity (Choe et al., 2009) provided by BCT, act as stimuli, similar to social influences (Alam et al., 2024) and facilitating conditions (Huang, 2023). These stimuli impact consumers’ psychological and emotional reactions, collectively known as the organism. Here, consumers’ perceptions of product quality (Fernández-Ferrín et al., 2024) and trust towards BCT- and QR code-based traceability systems (Irimia-Diéguez et al., 2023; Völter et al., 2023), as well as the perceived usefulness (Irimia-Diéguez et al., 2023) and enjoyment of these systems (Alam et al., 2024), play a key role. Ultimately, these reactions lead to behavioural outcomes (responses), where consumers may be more willing to purchase traceable products (Huynh et al., 2024; Yuan et al., 2020).

In addition, Nguyen et al. (2022) argued that perceived risk significantly influences consumers’ purchase intention toward traceable agricultural products. Perceived risk is a key factor in consumer behaviour, as it induces anxiety, which in turn shapes actions and choices (Taylor, 1974). This influence becomes particularly evident in the context of technology adoption (Galib et al., 2018). Thus, some studies have considered this factor when studying consumers’ purchase behaviour (Bruwer et al., 2013; Outreville & Desrochers, 2016).

Fig. 1 illustrates how consumers’ purchasing behaviour is examined by integrating consumers’ psychological and emotional reactions to external stimuli (SOR model), the technological context and perceived risk, forming the foundation for the hypotheses developed in Section 2.2.

Hypothesis development

Stimulus

Food traceability systems have become essential for enhancing the safety and quality of food products by enabling end-to-end tracking throughout the supply chain. Aung and Chang (2014) argued that a food

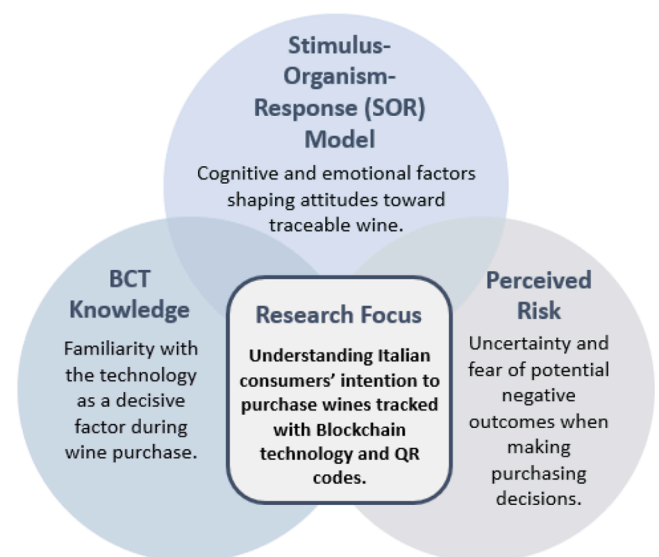


Fig. 1. Integration of theoretical and contextual dimensions underlying the study’s RQs.

traceability system supports not only the verification of product origins but also facilitates faster responses to safety issues, reducing risks of contamination and improving overall food security. As emphasised by Reitano et al. (2024) and Galvez et al. (2018), a traceability system contributes to both consumer confidence and brand reputation, driving consumers’ willingness to buy and pay a premium price. Xu et al. (2021) highlighted how digital technologies represent an important tool for addressing this growing need for transparency and security along the supply chain.

BCT has been at the forefront of this transformation, offering enhanced transparency, an essential component in building consumer trust and influencing purchasing decisions (Vazquez Melendez et al., 2024). Fani et al. (2025) argued that BCT can enhance cognitive-based trust among consumers by providing transparent and traceable information, thereby increasing confidence in product authenticity. BCT is particularly significant in contexts where product authenticity and quality assurance are critical for consumers (Jaeger, 2006), such as the wine sector, where transparency and traceability define product quality (Sun et al., 2022). Gopalakrishna Pillai et al. (2024) highlighted that BCT’s immutable and decentralised nature makes it particularly suitable for high-value products such as wine, where consumers are willing to invest in quality assurance. BCT effectively reduces information asymmetry between producers and consumers, thereby fostering greater trust in product quality and a stronger purchase intention (Adamashvili et al., 2021; Boukis, 2020). Given the above framework, the following hypothesis is proposed:

H1a. Transparency and traceability positively influence perceived value in the context of traceable wine purchase.

Chen and Huang (2013) and Wang et al. (2024) highlighted that traceability systems can play a crucial role in enhancing consumers’ ability to evaluate product quality. In this regard, Choe et al. (2009) discussed the concept of product diagnosticity, referring to how a traceability system helps consumers assess a product’s value. Kempf and Smith (1998) defined product diagnosticity as the extent to which a buyer finds an experience useful in judging a product’s quality, positively impacting their evaluation. This kind of traceability system gives consumers a sense of increased control over their food choices (Miles et al., 2005). Indeed, Yuan et al. (2020) argued that product diagnosticity positively influences consumers’ perceived value and, in turn, their purchase intention. In the wine industry, quality assessment depends directly on the availability of data and knowledge about each step

of the production process (Zava et al., 2020). According to Bastard and Chaillet (2023), a QR code linked to BCT records provides transparent access to information about a wine's origin, grape variety and production methods, enabling consumers to evaluate product quality. Therefore, the following hypothesis is proposed:

H1b. Product diagnosticity positively influences perceived value in the context of traceable wine purchase.

Consumers' adoption of BCT and QR codes, especially for accessing information and making purchasing decisions, can be influenced by subjective norms. This concept describes how consumers may feel encouraged or discouraged by their family, their friends, or other influential individuals when deciding to engage with new technologies (Alam et al., 2024). Lin et al. (2021) explored the determinants of consumers' adoption of a BFTS, but found no evidence for the importance of subjective norms in generating trust towards the BFTS and in its adoption intention. In contrast, Lin and Wu (2021) found that subjective norms significantly affect consumers' views on the practicality of BCT and QR codes, with social pressures fostering a positive outlook on their functionality. In addition, research on QR codes suggests that social influence shapes consumers' perceptions of their usefulness for gathering product information, discussing and socialising about wine, and enhancing purchasing choices (Higgins et al., 2014; Hu et al., 2020). According to Kulviwat et al. (2009), when consumers believe that using such novel technologies aligns with their personal values and societal expectations, they are more likely to engage with them. Therefore, the following hypotheses are proposed:

H2a. Subjective norms positively influence perceived trust of the BFTS in the context of wine purchase.

H2b. Subjective norms positively influence perceived usefulness of BCT and QR codes in the context of wine purchase.

Several studies have investigated the impact of facilitating conditions on consumers' adoption of new technologies (Mahardika et al., 2019; Pieters et al., 2021; Taylor & Todd, 1995). Venkatesh et al. (2003) defined facilitating conditions as the extent to which existing technical infrastructure and favourable environmental factors influence individuals' acceptance and usage behaviour of new technologies. Indeed, when users perceive strong support in terms of technology availability and environmental readiness, as well as assistance availability, their likelihood of adopting innovative solutions increases significantly (Chan et al., 2010). In particular, as Peñarroja et al. (2019) argued, the impact of facilitating conditions on technology acceptance is moderated by perceived usefulness of the technology. Other scholars have stressed that facilitating conditions influence technology use by fostering trust in the technology itself (Lu et al., 2005), thereby affecting marketplace relationships (Ratnasingham, 2004). Building on these insights, the following hypotheses are proposed:

H2c. Facilitating conditions positively influence perceived trust of BCT and QR codes in the context of wine purchase.

H2d. Facilitating conditions positively influence perceived usefulness of BCT and QR codes in the context of wine purchase.

BCT knowledge

Although digital technologies such as BCT and QR codes are being increasingly adopted across the agri-food sector, consumers' responses appear to vary significantly by their level of awareness and knowledge (Zhuo et al., 2025). Shew et al. (2022) argued that there is a general lack of education on digital technologies, which limits their broader use. Indeed, limited awareness of the potential benefits of traceability systems hinders their adoption and delays implementation (Manos and Manikas, 2010). Using a BFTS as an example, Hu et al. (2021) and Duong et al. (2024) reinforced this argument by demonstrating that

consumers who were more familiar with the BFTS had greater trust in and were more willing to adopt it. Indeed, Contini et al. (2023) argued that BCT positively influences consumers' perception of product value and, in turn, their purchase intention when they clearly comprehend the technology. Similarly, Bareen et al. (2025) found that knowledge of novel technologies, especially their potential to enhance product characteristics, correlated directly and positively with consumers' satisfaction and enjoyment, which later translated into their willingness to adopt these technologies during purchases.

Additionally, when consumers have a clear understanding and trust in BFTS, they are more likely to form emotional connections with food brands, which can help offset the price premium associated with BCT-traceable foods (Wang et al., 2024). Conversely, consumers with limited knowledge may not fully recognise its advantages, which can reduce its impact on their trust and purchase intentions (Mazzù et al., 2023; Tran et al., 2024). Graziano et al. (2025) highlighted that consumers' awareness and literacy strongly affected their ability to adopt and effectively use new digital services. Earlier, Graziano et al. (2023) argued that, following the COVID-19 pandemic, even individuals with weak digital skills increasingly began using digital technologies and online services. However, Panero et al. (2025) highlight producers' concerns that consumers may fail to appreciate or value digitalised systems, leading to uncertainty about the economic return on technological investments. In this regard, Raddatz et al. (2023) explained that the perceived usefulness of BCT is relevant only when consumers understand its characteristics. They stated that difficulties in understanding the features of BCT negatively affected consumers' choices and recommended consumer education to fully realise its benefits.

Given the above, the following hypotheses are proposed:

H3a. Consumers' familiarity with BCT positively influences the perceived value of products.

H3b. Consumers' familiarity with BCT positively influences the perceived trust in this technology.

H3c. Consumers' familiarity with BCT positively influences the perceived usefulness of this technology.

H3d. Consumers' familiarity with BCT positively influences the hedonic perception of using this technology.

H3e. Consumers' familiarity with BCT positively influences purchase intention.

Organism

Consumers tend to exhibit positive attitudes toward traceable products, particularly when their characteristics, such as origin, quality and authenticity, are clearly communicated (Yuan et al., 2020). In the case of wine, traceability systems are particularly impactful as these characteristics are central to consumers' purchasing decisions (Moulard et al., 2015). Moulard et al. (2015) found that wine provenance was a determining factor in shaping consumers' perceptions of product value, which in turn influences their intention to purchase and their willingness to pay a premium price. In addition, Vergura et al. (2020) emphasised that positive perceptions of product quality can increase consumers' satisfaction and enjoyment in their purchasing decisions and also serve as a strong predictor of purchase intention. Moreover, the perceived value derived from transparency and verified information reinforces the product's appeal as a premium choice, thereby strengthening consumers' purchase intention and fostering greater brand loyalty (Malik et al., 2024).

Furthermore, familiarity with BCT further amplifies consumers' positive attitudes, as those who understand BCT are more likely to view traceability as an assurance of quality and reliability, thereby increasing their willingness to purchase traceable products (Duong et al., 2024).

This familiarity helps reinforce consumers' perception that a traceable product is a premium choice, strengthening their willingness to pay for products with verified provenance and high standards (Treiblmaier & Garaus, 2023). Given the above, the following hypothesis was proposed:

H4. The perceived value of the product, enhanced by BCT features, positively influences consumers' purchase intention.

The trust consumers place in BCT is crucial to its widespread adoption. The transparency and immutability features of BCT enhance consumer confidence, fostering a sense of reliability in the information provided (Hina et al., 2024; Vazquez Melendez et al., 2024). However, because it is a relatively new technology, stakeholders fall into two groups: those who are sceptical and do not believe it will be perfected in the near future, and those who think that it is a disruptive technology (Levis et al., 2021). Consequently, establishing consumers' trust in BCT is essential for enhancing its acceptance and driving its integration into everyday transactions (Shahzad et al., 2024).

Building on the role of trust, recent findings from the wheat market highlight that while perceived trust has the greatest influence on BCT adoption in consumer purchase intentions, perceived usefulness and ease of use also contribute positively (Bandinelli et al., 2023). Esfahbodi et al. (2022) and Higgins et al. (2014) highlighted the impact of perceived usefulness and ease of use on the adoption of traceability technologies. When consumers find digital tools such as QR codes easy to navigate and beneficial, they are more likely to integrate them into their wine purchasing habits. Similarly, Martinelli and De Canio (2023) identified perceived usefulness and ease of use as decisive factors for the use of BFTS during food purchases. Therefore, the following hypotheses are proposed:

H5a. Perceived trust in the technology positively influences consumers' purchase intention for traceable wines.

H5b. Perceived usefulness of the technology positively influences consumers' purchase intention for traceable wines.

Empirical research has also shown that consumers' willingness to adopt a technology is not solely based on practical benefits; they are also drawn to the enjoyment and novelty it provides (Oh & Yoon, 2014). This hedonic aspect enhances the user experience, making the technology feel more engaging and attractive. For traceable products, when consumers perceive BCT and QR codes as not only informative but also engaging, this dual appeal can shape positive attitudes, strengthen trust in the brand and enhance purchase intention (Alam et al., 2024; Le, 2024). Thus, the combination of transparency and an enjoyable experience can enhance consumers' intention to adopt these systems. Therefore, the following hypothesis was proposed:

H6. Hedonic perception towards the technology positively influences consumers' willingness to purchase traceable wine.

Perceived risk

The TPR has emerged as a key framework for understanding how consumers weigh potential benefits against possible adverse outcomes (Taylor, 1974). Originally introduced by Bauer (1960) within the context of consumer behaviour, the TPR serves as a foundational framework for understanding how individuals approach decision-making under uncertainty. Bauer (1960) proposed that consumers experience uncertainty and fear of potential adverse outcomes when making purchasing decisions. This concept is especially relevant in the digital age, where the adoption of online platforms introduces concerns about the misuse of personal data (Chen & Rea, 2004; Sahut et al., 2022). As digital technologies require users to engage with online platforms, concerns about the risk of misuse of personal data may become an issue for consumers (Morić et al., 2024). This observation aligns with findings from studies on digital technology adoption, which have shown that privacy concerns negatively influence consumers'

willingness to adopt new technologies (Anic et al., 2019; Eastlick et al., 2006). Several scholars have argued that recent technological developments have made consumers feel 'under serious threat' regarding the misuse of their personal information due to the increasing number of organisations collecting it (Inman & Nikolova, 2017; Lebo, 2013). However, White (2004) explained that consumers are more likely to share personal information when they believe the benefits surpass their privacy concerns. Consequently, understanding the perceived risk to personal data security is critical for evaluating consumers' willingness to engage with traceability tools. Given the above, the following hypothesis was proposed:

H7. Perceived risk negatively influences consumers' willingness to purchase traceable wine.

Fig. 2 presents the conceptual model developed, highlighting relationships among external stimuli, internal consumer responses and subsequent behavioural outcomes within the context of consumer purchasing behaviour.

Methodology

This study employed a quantitative approach to investigate consumer behaviour regarding the purchase of traceable wine. Data were collected using a questionnaire structured to capture various psychological and behavioural constructs relevant to consumer decision-making based on the SOR and TPR (see Annexe 1 and Table 1). The questionnaire was designed as a closed-ended survey with an estimated completion time of 10 min and administered via a computer-assisted web-interviewing platform.

To ensure data reliability and validity, sampling was stratified by gender, age group and geographic area to enhance the representativeness of the Italian population (see Annexe 1 and Tables 1, 2a and 2b). The stratification criteria were selected based on the main sociodemographic dimensions used by the *Istituto Nazionale di Statistica* (ISTAT) in national population surveys, as these variables significantly influence consumers' purchasing behaviour and attitudes toward wine consumption. Stratification enabled the proportional inclusion of respondents across key demographic segments, reflecting the national distribution reported by recent ISTAT statistics. Indeed, each stratum's proportional composition reflected the latest national census data, thereby ensuring the inclusion of respondents from all major geographical macro-areas (North, Centre, South and Islands) and from diverse age and gender categories. Within each stratum, respondents were randomly invited to complete the questionnaire to reduce selection bias. The target population included Italian individuals aged 18–80 years who were wine consumers. As wine consumption habits were also considered, only respondents who reported consuming wine at least once in the past 15 days were included (see Annexe 1 and Table 3). The survey was available for 15 days in February 2025 and yielded 1061 responses, of which 1001 were deemed valid after data cleaning and screening for inconsistencies, giving a final response rate of approximately 94 %. This sample size was deemed adequate to ensure statistically robust analyses. The stratified procedure minimised potential sampling bias and improved the external validity and generalizability of the findings, ensuring that they accurately reflected the diversity of Italian wine consumers.

Given the aim to explain and predict variance in purchase intention within a complex model with multiple relationships, PLS-SEM was employed. The model includes several constructs, multiple mediations and reflective measures drawn from validated scales. PLS handles such complexity well with modest distributional demands and performs robustly under non-normal data. The suitability of the established items for PLS-SEM was ensured via indicator reliability, average variance extracted (AVE), Dijkstra and Henseler's (2015) rhoA, and the heterotrait-to-monotrait (HTMT) ratio, which confirm reflective specification and construct distinctiveness (Dijkstra & Henseler, 2015; Hair

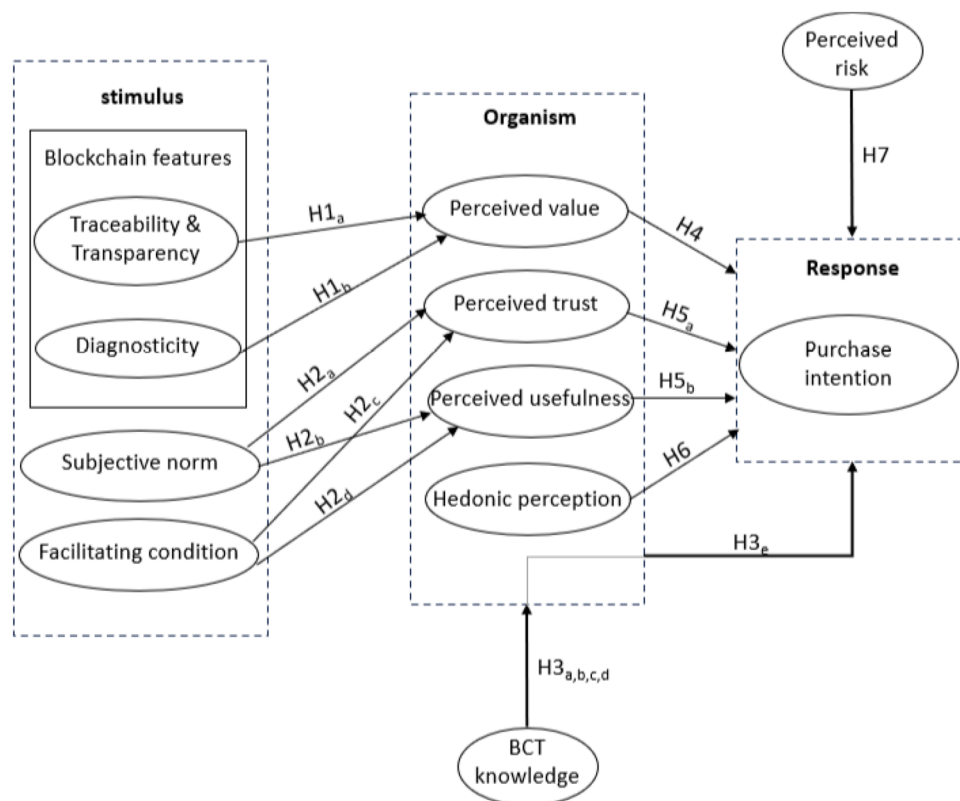


Fig. 2. Conceptual model.

et al., 2022).

Questionnaire design and measures

The questionnaire was developed by adapting items from previously validated scales, ensuring measurement consistency across constructs. It consisted of six main sections based on the proposed conceptual framework. The first section collected data on external stimuli (BCT features, subjective norms and facilitating conditions) that affect consumers’ perceptions of product value, technological usefulness, trust and hedonic experience using items adapted from previously validated scales (Alam et al., 2024; Choe et al., 2009; Huang, 2023; Huynh et al., 2024; Shahzad et al., 2024). The second section collected data on consumers’ perceptions (organism) regarding perceived value, perceived trust, perceived usefulness and hedonic perception using items adopted and adapted from previously validated measures (Irimia-Diéguez et al., 2023; Alam et al., 2024). The third section collected data on consumers’ intentions to buy traceable wine using items adapted from previously validated scales (Yuan et al., 2020; Huo et al., 2023). The fourth section collected data to investigate BCT knowledge and understand consumers’ awareness of BCT and QR codes using a scale adapted from Duong et al. (2024). The fifth section examined consumers’ perceptions of risk associated with adopting new technologies using items adapted from the validated scale developed by Galib et al. (2018). The sixth section collected data on respondents’ sociodemographic characteristics. All items were answered on a seven-point Likert scale ranging from 1 ‘strongly disagree’ to 7 ‘strongly agree’.

Consistent with existing literature, the theoretical constructs in this study are conceptualised as reflective constructs, operationalised as latent variables that manifest through a set of observable indicators. Reflective constructs assume a causal relationship in which the latent variable determines its indicators, reflecting underlying psychological perceptions, attitudes and behaviours. Reflective constructs assume internal consistency among indicators, meaning that each item shares a

common underlying variance (Jarvis et al., 2003).

Assessment of the measurement model

In PLS-SEM, assessing reflective measurement models requires a thorough examination of their reliability and validity. In this study, the evaluation included indicator reliability, internal consistency reliability, convergent validity and discriminant validity, ensuring that the constructs accurately represent the underlying theoretical framework. The first step in assessing the reflective measurement model is evaluating the reliability of individual indicators, which is determined by their loadings on the respective constructs. A loading of 0.708 or higher is generally considered acceptable, as it indicates that the construct explains a substantial portion (>50 %) of the variance in its associated indicator (Hair et al., 2022). The second step is to ensure that the indicators within each construct are internally consistent. Dijkstra-Henseler’s rhoA was employed as a reliability measure, with values between 0.70 and 0.90 indicating a reliable construct (Diamantopoulos et al., 2012). The third step is to assess convergent validity to ensure that each construct effectively explains the variance of its indicators. A construct is considered valid when its AVE is 0.50 or higher, indicating that it captures at least 50 % of the variance among its indicators (Hair et al., 2022). The final step is to verify that the constructs are empirically distinct. The HTMT ratio (Henseler et al., 2015) was employed for this purpose. Henseler et al. (2015) recommend using a 0.90 threshold for constructs with high conceptual similarity, and a stricter 0.85 threshold for constructs that are conceptually more distinct.

Assessment of the structural model

Consistent with the overarching RQs, this study aimed to establish a comprehensive understanding of how various factors shape consumer behaviour. After confirming the measurement model’s adequacy, the next step was to assess the magnitude of path coefficients (β), which

Table 1
Respondents' sociodemographic characteristics.

Socio-demographic data/group	Variable	Frequency	Percentage
Gender			
1	Male	492	49.2
2	Female	509	50.8
Age			
1	18–30	119	11.89
2	31–40	181	18.08
3	41–50	226	22.58
4	51–60	183	18.28
5	61–70	200	19.98
6	Above 70	92	9.19
Marital status			
1	Single	305	30.5
2	Married	565	56.4
3	Divorced	62	6.2
4	Separated	31	3.1
5	Widowed	22	2.2
6	Prefer not to answer	16	1.6
Household			
1	1 Person	137	13.69
2	2 People	340	33.97
3	3 People	251	25.07
4	4 People or more	273	27.27
Occupation			
1	Employee	476	47.6
2	Self-employed	130	13.0
3	Retired	204	20.4
4	Student	37	3.7
5	Unemployed	60	6.0
6	Housewife	75	7.5
7	Other	19	1.9
Income level			
1	With my family's income, we have a lot of difficulty making it to the end of the month	92	9.2
2	With my family's income, we have some difficulty making it to the end of the month	294	29.4
3	With my family's income, we have no difficulty making it to the end of the month	373	37.3
4	With my family's income, we are able to put some savings aside	176	17.6
5	Prefer not to answer	66	6.6
Education level			
1	Elementary school diploma	1	0.1
2	Secondary school diploma	94	9.4
3	High school diploma	554	55.3
4	Bachelor's degree	107	10.7
5	Master's degree	118	11.8
6	Single-cycle degree	79	7.9
7	PhD / master's program	48	4.8
Region of residence			
1	North (Piedmont, Aosta Valley, Liguria, Lombardy, Veneto, Friuli-Venezia Giulia, and Trentino-Alto Adige)	462	46.15
2	Center (Emilia-Romagna, Tuscany, Umbria, Marche, Lazio, and Abruzzo)	201	20.08
3	South and Islands (Campania, Apulia, Molise, Basilicata, Calabria, and the islands of Sicily and Sardinia)	338	33.77
Wine consumption frequency			
1	Every day	239	23.88
2	Two-three times in a week	261	26.07
3	Once a week	219	21.88
4	Once in every 15 days	282	28.17
Wine consumption habit			
1	At home	553	55.24
2	On social events	448	44.76

Table 2
Measurement model results.

Construct/ Item	Loading	Rho a	AVE
Traceability & Transparency			
BT-enabled wines are traceable	0.856	0.956	0.761
BT-enabled wine traceability system provides rich and detailed product information.	0.890		
BT-enabled wine traceability system provides accurate and real-time information about the product.	0.876		
BT-enabled wine traceability system provides complete information about supply chain actors	0.873		
BT-enabled traceable wine production and delivery procedures is transparent	0.871		
BC-enabled traceable wine system ensures wineries are accountable to consumers for their actions	0.848		
BT-enabled traceable wine system provides detailed information about each stage of wine production, from vineyard to bottle, via QR code	0.899		
BT-enabled traceable wine system makes it easy for consumers to access the information they need by scanning the QR code	0.865		
Diagnoscitivity			
The traceability system can help me carefully evaluate the wine	0.894	0.887	0.813
Careful evaluation of the product will make it easier for me to purchase wine	0.905		
The traceability system can help me get the real feeling of the wine	0.905		
Subjective norms			
The people who matter to me think I should use QR codes when purchasing wine.	0.945	0.957	0.883
People who influence my life believe that I should use QR codes to access information about the wine I purchase.	0.953		
People whose opinions are important to me think that I should use QR codes to check the wine I buy.	0.960		
People around me who use QR codes to buy wine seem to have more prestige than those who do not.	0.899		
Facilitating conditions			
I have the necessary resources to use QR codes (ex. smartphone)	0.744	0.730	0.652
When I have trouble using QR codes, I can get help from others	0.829		
I can get technical support for using QR codes	0.846		
Blockchain knowledge			
What is your familiarity with blockchain?	0.919	0.917	0.795
How much do you know about blockchain?	0.929		
How clear is your understanding of the characteristics of tracking systems?	0.803		
How would you rate your knowledge about blockchain relative to your colleagues, friends, family members?	0.909		
Perceived Value			
The quality of wine with traceable information is very good.	0.896	0.884	0.811
The wine purchased from brands that disclose traceable information can meet my expectations.	0.906		
The wine purchased from brands that disclose traceable information make me feel very happy	0.899		
Perceived Usefulness			
BC-enabled wine traceability systems are useful	0.929	0.910	0.836
Using BC-enabled wine traceability systems makes it easier to purchase product	0.923		
BC-enabled wine traceability systems allow quick access to the information through QR codes	0.891		
Hedonic Perception			
The fun derived from using QR code will be / is a significant factor that influences my usage.	0.920	0.930	0.877
The experience of using QR code will be / is enjoyable.	0.944		
The process of tracing wine using QR code will be / is pleasurable and entertaining	0.946		
Perceived Risk			
I am worried that my personal information could be stolen	0.920	0.944	0.830

(continued on next page)

Table 2 (continued)

Construct/ Item	Loading	Rho a	AVE
I am worried that my personal information collected could be misused	0.907		
The security systems built into the BC and QR code-enabled wine traceability system would not be strong enough to protect my personal data	0.906		
Purchase intention		0.937	0.751
Traceable wine can arouse my interest in purchasing	0.847		
I will buy wine that uses traceable systems	0.857		
I will give priority to the use of traceable system of wine	0.895		
I am willing to spend more money on traceable wine than regular wine	0.862		
For me, it's worth buying traceable wine despite high price	0.876		
I am willing to pay a premium price for traceable wine	0.862		

indicate the strength and direction of relationships, and to determine whether they are statistically significant and practically meaningful. The bootstrapping method was employed to derive *t*-values and 95 % confidence intervals (CIs), which serve as the basis for evaluating the significance of the relationship and hypothesis testing (Roldan & Sanchez-Franco, 2012). Additionally, the coefficient of determination (R^2) was employed to determine the model's ability to explain variance in endogenous constructs. To complement the R^2 , the proportion of variance explained and effect size (f^2) are reported, which indicate how much an exogenous construct contributes to explaining an endogenous construct's variance. Finally, while R^2 measures in-sample explanatory power, it does not indicate out-of-sample predictive ability (Chin et al., 2020). To assess predictive power, the PLS_{predict} algorithm was employed, which utilises *k*-fold cross-validation to estimate the cross-validated redundancy index (Q^2) for the dependent variables (Shmueli et al., 2016); a $Q^2_{predict}$ greater than 0 indicates that the model exhibits predictive relevance.

Common-method bias

Potential common-method bias was addressed procedurally by ensuring anonymity and stratifying measurements by gender, age group, and geographic area (Podsakoff et al., 2012). Common-method bias was also addressed post-hoc using the full-collinearity variance inflation factor (VIF) approach for PLS-SEM (Kock & Lynn, 2012). Each latent variable was regressed on all remaining constructs using latent scores; the resulting VIFs ranged from 3.69 to 3.94, below the widely applied 5.0 threshold for problematic collinearity, although slightly above the conservative 3.3 threshold sometimes used specifically for common-method bias (Kock & Lynn, 2012). A proxy-marker adjustment (Lindell & Whitney, 2001) was employed. The smallest positive inter-construct correlation ($r_m = 0.027$) was used to assess common-method bias. It was confirmed that the direction and

substantive inference of all adjusted correlations were preserved, indicating that common-method bias does not impact the study's conclusions.

Results and discussion

This study aimed to identify and explain the psychological and behavioural factors that drive consumers' intention to purchase wine traceable through BCT and QR codes. Consistent with this objective, drawing on key constructs from the SOR model and TPR, this study identified the cognitive, emotional and risk-related factors most strongly predicting consumers' willingness to purchase traceable wine. The constructs demonstrated strong reliability and validity (Table 2). Item loadings exceeded the recommended threshold of 0.708, and the AVE values exceeded the 0.50 threshold. Furthermore, rhoA values were well above the acceptable threshold across constructs (Diamantopoulos et al., 2012), confirming internal consistency reliability. The HTMT ratios were all below the suggested thresholds (Table 3), demonstrating that the constructs are empirically distinct (Henseler et al., 2015) and supporting the robustness of the measurement model.

The structural model results presented in Fig. 3 and Table 4 provide a detailed examination and empirical support for the relationships proposed in the conceptual model, revealing how external stimuli, emotional engagement, BCT knowledge and perceived risks interact to affect consumers' adoption of BFTS in the wine sector. Fig. 3 presents the structural model results from PLS-SEM, illustrating the hypothesised relationships among constructs derived from the SOR and TPR frameworks, displaying the standardised β , 95 % CI, and f^2 for each path. Solid arrows denote significant and supported relationships, whereas dotted arrows denote unsupported hypotheses. The R^2 values for endogenous constructs indicate the proportion of variance explained by their predictors, with the model demonstrating strong explanatory power ($R^2 = 0.681$ for Purchase Intention).

The results revealed that Transparency and Traceability contribute to Perceived Value ($\beta = 0.209, p < 0.001$), supporting hypothesis H1a and reinforcing the notion that verifiable product information enhances consumers' perception of product value. Indeed, Reitano et al. (2024) examined consumers' purchase intentions for BCT-traced agri-food products and found that BCT-supported transparency and traceability influenced perceptions of product value and drove purchase intention. Diagnosticity exerted the most significant influence on Perceived Value ($\beta = 0.522, p < 0.001$, explained variance [EV] = 37 %). This finding supports H1b, explaining the role of diagnosticity in generating perceived product value and suggesting that consumers attribute greater value to wines when they can confidently assess product quality and authenticity through information accessibility. This observation aligns with Yuan et al. (2020), who indicated that consumers tend to assign greater value to products when the diagnosticity is high.

The model indicated no significant correlation between Subjective Norms and Perceived Trust, refuting hypothesis H2a. Lin et al. (2021)

Table 3 Measurement model. Discriminant validity (HTMT).

	Diagnosticity	Facilitating conditions	Hedonic Perception	IT/BC Knowledge	Perceived Usefulness	Perceived risk	Perceived value	Purchase intention	Subjective norms
Facilitating conditions	0.625								
Hedonic Perception	0.663	0.584							
BCT Knowledge	0.119	0.222	0.304						
Perceived Usefulness	0.812	0.685	0.804	0.213					
Perceived risk	0.052	0.106	0.098	0.181	0.038				
Perceived value	0.800	0.631	0.811	0.252	0.855	0.138			
Purchase intention	0.614	0.532	0.839	0.368	0.735	0.166	0.774		
Subjective norms	0.422	0.470	0.665	0.391	0.485	0.252	0.590	0.739	
Traceability & Transparency	0.878	0.623	0.515	0.106	0.755	0.030	0.702	0.442	0.269

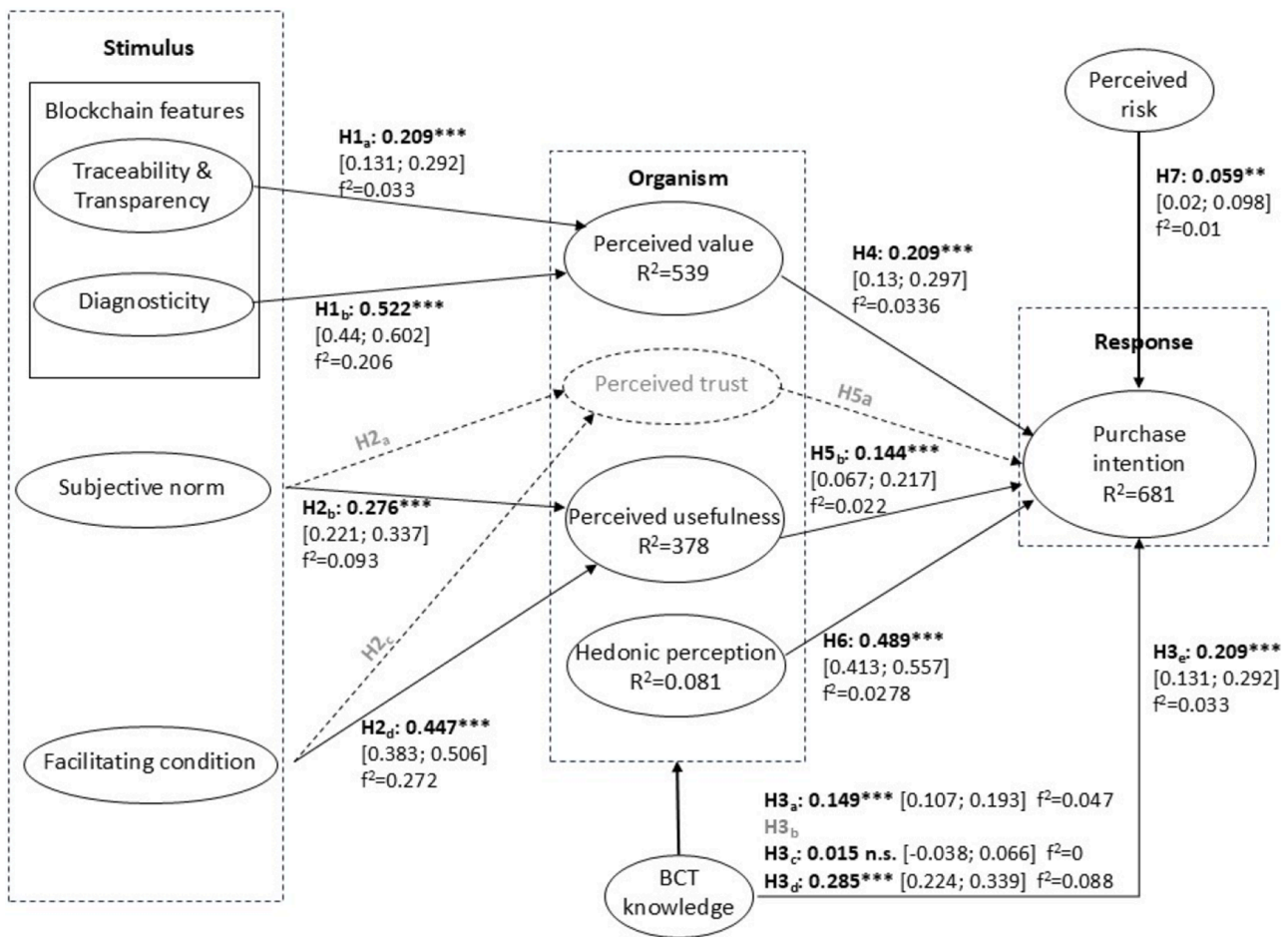


Fig. 3. Assessment of the structural model.

Table 4
Effects on the endogenous variables.

	Direct Effect	t-Value	p-Value	CI	Support	Explained Variance	f ² /Q ² Predict
Perceived Value						53.9 %	0.535
H1a: Transparency & Traceability	0.209	5.080	0.000	[0.131; 0.292]	Yes	13.5 %	0.033
H1b: Diagnosticsity	0.522	12.692	0.000	[0.44; 0.602]	Yes	37.0 %	0.206
H3a: BCT Knowledge	0.149	6.837	0.000	[0.107; 0.193]	Yes	3.4 %	0.047
Perceived Usefulness						37.8 %	0.373
H2b: Subjective norms	0.276	9.283	0.000	[0.221; 0.337]	Yes	12.6 %	0.093
H2d: Facilitating conditions	0.447	14.177	0.000	[0.383; 0.506]	Yes	24.9 %	0.272
H3c: BCT Knowledge	0.015	0.573	0.566	[-0.038; 0.066]	No	0.3 %	0.000
Hedonic Perception						8.1 %	0.078
H3d: BCT Knowledge	0.285	9.762	0.000	[0.224; 0.339]	Yes	8.1 %	0.088
Purchase intention						68.1 %	0.321
H3e: BCT Knowledge	0.113	5.586	0.000	[0.074; 0.153]	Yes	3.8 %	0.036
H4: Perceived Value	0.209	4.903	0.000	[0.13; 0.297]	Yes	14.9 %	0.047
H5b: Perceived Usefulness	0.144	3.811	0.000	[0.067; 0.217]	Yes	9.9 %	0.022
H6: Hedonic Perception	0.489	13.206	0.000	[0.413; 0.557]	Yes	38.5 %	0.278
H7: Perceived risk	0.059	2.963	0.003	[0.02; 0.098]	Yes	0.9 %	0.010

Note: CI: Bias corrected Percentile confidence interval. Bootstrapping based on n = 5000 subsamples. Hypothesized effects are assessed by applying a one-tailed test for a t Student distribution (CI 90 %).

reported a similar outcome when examining determinants of BCT adoption in the context of organic food purchases among Chinese consumers. Based on 300 valid face-to-face interviews, they argued that, contrary to earlier studies suggesting that subjective norms define consumers' purchase intention, this does not appear to hold for BFTS. Similarly, the model indicated no significant relationship between Facilitating Conditions and Perceived Trust, refuting hypothesis H2c. This finding contrasts with Lu et al. (2005) and Ratnasingam (2004). For

example, Ratnasingam (2004) posited that facilitating conditions help build initial trust in technology, which subsequently evolves into the trusted relationships in the marketplace. Similarly, in a study involving 357 Chinese students pursuing a master's degree in business administration, Lu et al. (2005) found that facilitating conditions positively influenced trust in new technologies, which in turn shaped consumers' intentions to adopt them.

However, the model indicated that Subjective Norms ($\beta = 0.276, p <$

0.001, $EV = 24.9\%$) and Facilitating Conditions ($\beta = 0.447, p < 0.001, EV = 24.9\%$) enhance Perceived Usefulness, supporting hypotheses H2b and H2d. Thus, subjective norms and facilitating conditions shape consumers' perception of the technology's usefulness. Consumers are more likely to perceive BFTS as useful when external support mechanisms, such as easy access to relevant information, user-friendly interfaces and peer recommendations, are present. This finding is consistent with previous studies (e.g. Alam et al., 2024; Higgins et al., 2014; Hu et al., 2020). For instance, Lin and Wu (2021) demonstrated that subjective norms play a crucial role in shaping consumers' perceptions of the usefulness of QR codes and BCT, as social influences contribute to a more favourable view of their functionality. Additionally, Peñarroja et al. (2019) highlighted the critical role of facilitating conditions in shaping consumers' perceptions of technology usefulness and its subsequent adoption.

The model indicated a relatively modest effect of BCT Knowledge on Perceived Value ($\beta = 0.149, p < 0.001$), suggesting that while familiarity with BCT may enhance trust, it is not necessarily a primary driver of perceived worth. This finding provides very weak support for hypothesis H3a and partially aligns with previous studies' findings. For instance, Hu et al. (2021) found that consumers with low BCT expertise were unwilling to use BCT to verify product information, which negatively influenced their perception of product value. Similarly, Duong et al. (2024) argued that familiarity with BCT's features directly affects consumers' perceptions of product value, which, in turn, determines their purchase intention of BCT-traced products.

The model indicated no correlation between BCT Knowledge and Perceived Trust, refuting hypothesis H3b and contrasting with the findings of Hu et al. (2021) and Duong et al. (2024), who argued that consumers' awareness of BCT determines their trust. Similarly, the model indicated no significant relationship between BCT Knowledge and Perceived Usefulness ($\beta = 0.015, p > 0.05$), refuting hypothesis H3c and contrasting with the findings of Bassellier et al. (2003), who argued that technology knowledge directly correlates with consumers' perception of its usefulness and advantages. However, it further reinforces the notion that usability perceptions are shaped more by contextual and social factors than by individual technological expertise. Thus, this finding challenges earlier assumptions that familiarity with BCT directly enhances perceived functionality, as argued by Hu et al. (2021) and Duong et al. (2024), suggesting instead that perceived usefulness is driven by the accessibility and integration of the BFTS within consumers' purchasing routines (Lin & Wu, 2021).

The non-significant results for hypotheses H3b and H3c suggest that consumers' familiarity with BCT does not necessarily translate into higher trust or perceived usefulness. Although consumers may have heard of BCT, their understanding often remains superficial, limiting appreciation of its benefits in wine traceability. Since BCT operates mainly in the background of product information tools (e.g. via QR codes), users tend to perceive its utility as system-embedded rather than dependent on personal expertise. Thus, perceived usefulness and trust appear to stem more from contextual cues and the quality of digital interaction than from individual technological knowledge.

In contrast, the model indicated a positive correlation between BCT Knowledge and Hedonic Perception ($\beta = 0.285, p < 0.001, EV = 8.1\%$), supporting hypothesis H3d. This finding is consistent with Bureen et al. (2025), who suggested that consumers' awareness of innovative technologies, especially their potential to improve product attributes, is positively associated with greater satisfaction and enjoyment, which ultimately influences their intention to adopt these technologies during purchasing. One interesting observation is the relatively modest effect of BCT Knowledge on Purchase Intention ($\beta = 0.113, p < 0.001, EV = 3.8\%$), partially supporting hypothesis H3e. While some studies have suggested that technological familiarity enhances trust and adoption, our findings indicate that technical literacy is not a primary determinant of consumers' purchasing behaviour. Thus, our finding suggests that consumers do not necessarily need a deep understanding of BCT to

recognise its benefits, provided the BFTS is intuitive and effectively communicates the value of traceability.

However, this finding does not fully align with the previous research on digital consumer behaviour, which highlights the importance of increasing awareness of technology to encourage broader adoption (Wang et al., 2024). Indeed, Manos & Manikas (2010) claimed that consumers' education in new technology would hasten its adoption. Similarly, in a study examining Greek consumers' willingness to adopt BCT in their purchasing habits, Tran et al. (2024) demonstrated that consumers' low interest in adopting BCT despite their demand for detailed product information could be explained by a lack of knowledge about BCT. Indeed, other studies have reported a positive correlation between technology knowledge and its adoption intention (Duong et al., 2024; Hu et al., 2021).

The model indicates that Perceived Value positively influences Purchase Intention ($\beta = 0.209, p < 0.001, EV = 14.9\%$), supporting hypothesis H4. This finding aligns with previous research indicating that consumers are more likely to purchase a product when they can verify its value (Choe et al., 2009). Similarly, in a study of Chinese consumers' food purchase intention through traceability systems, Yuan et al. (2020) found that product diagnosticity determined consumers' perception of product value, which, in turn, positively influenced their purchase intention.

The model indicated no significant influence of Perceived Trust on Purchase Intention, refuting hypothesis H5a. This finding contrasts with those of Bandinelli et al. (2023) and Shahzad et al. (2024), who identified trust as a crucial factor in technology adoption. In contrast, the model indicated that Perceived Usefulness significantly influences Purchase Intention ($\beta = 0.144, p < 0.001, EV = 9.9\%$), supporting hypothesis H5b. This finding aligns with previous studies that collectively illustrate the importance of perceived usefulness in the adoption of traceability technologies (Esfahbodi et al., 2022; Higgins et al., 2014; Martinelli & De Canio, 2023). For instance, Martinelli and De Canio (2023) studied consumers' food purchase behaviour and showed that perceived usefulness shapes consumers' attitudes towards using BCT, which, in turn, shapes their intention to use BCT in their purchase decisions.

Overall, the model explained 68.1% of the variance in Purchase Intention, demonstrating a strong explanatory capability (Hair et al., 2011). Among the strongest predictors of Purchase Intention, Hedonic Perception emerged as particularly influential ($\beta = 0.489, p < 0.001, EV = 38.5\%$), reinforcing the notion that consumers are not solely motivated by functional benefits but also by the enjoyment derived from interacting with digital traceability systems. This finding supports hypothesis H6 and suggests that BFTS for wine should not only be designed to enhance transparency and security but also to create an engaging user experience. This conclusion is consistent with existing literature, emphasising the role of user enjoyment in technology adoption, particularly in contexts where consumers' engagement with digital tools influences their purchasing behaviour. For instance, Alam et al. (2024) highlighted that the enjoyment experienced while using a technology can strongly impact users' intention to adopt it. Therefore, rather than solely emphasising functionality, developers should also enhance the user experience by making the technology more engaging. Incorporating features such as gamification, personalisation and appealing design into the purchase process could increase consumers' satisfaction and encourage their use of novel technologies.

Notably, the model indicated that Perceived Risk had a modest but significant influence on Purchase Intention ($\beta = 0.059, p = 0.003, EV = 3.8\%$), partially supporting hypothesis H7. Concerns about privacy and data security have been frequently identified as barriers to the adoption of digital technologies (Anic et al., 2019; Inman & Nikolova, 2017; Lebo, 2013). However, the evidence suggests that consumers may already trust BCT-enabled security measures. While Anic et al. (2019) and Eastlick et al. (2006) emphasised that privacy concerns negatively impact consumers' readiness to adopt new digital technologies, as

growing data collection by organisations has raised consumers' fears about the misuse of their personal information (Inman & Nikolova, 2017; Lebo, 2013), our findings demonstrate that Italian wine consumers do not exhibit high anxiety regarding misuse of their personal information by adopting BFTS in their purchasing behaviour. They align with White (2004), indicating that while privacy concerns are present, they do not necessarily deter technology adoption when its perceived benefits outweigh its potential risks. Thus, consumers appear more inclined to adopt new technologies when they feel the benefits outweigh the potential risks to their privacy.

Conclusions

Our study reinforces the notion that consumers' adoption of BFTS is influenced by a combination of rational evaluations and experiential factors. Our findings confirm the key roles of perceived value, usefulness, hedonic perception and diagnosticity in shaping purchase intention, while revealing that trust and BCT knowledge have more limited or indirect effects. Emotional engagement (hedonic perception) emerged as the strongest predictor of purchase intention, indicating that user enjoyment significantly drives consumer acceptance. Although perceived risks exhibited a minor effect, their presence still highlights the importance of addressing security concerns. Moreover, our findings highlight the significance of social influence and external support systems in shaping perceived usefulness and subsequently driving purchase intention, suggesting that marketing strategies should emphasise the ease of use and social validation of traceable wine products. Overall, the model demonstrated a high explanatory power, accounting for 68.1 % of the variance in purchase intention.

Our study provides valuable insights into the factors driving consumer adoption of BFTS for wine, offering both theoretical contributions and actionable strategies for companies. By leveraging the interplay between transparency, perceived value, social influence and consumer engagement, companies can enhance the adoption and success of digital traceability systems in the wine industry.

Theoretical implications

Our study contributes to theoretical advancements in consumer behaviour research by reinforcing the applicability of established models, such as the SOR and TPR, within the context of BFTS for wine. This integration enriches the understanding of consumer decision-making by capturing the dual nature of technology perception – balancing trust and risk – as a determinant of behavioural outcomes. Unlike prior research, which has predominantly adopted a company-centric perspective, our study offers a consumer-focused approach grounded in robust theoretical foundations and addresses the psychological and emotional mechanisms that drive the adoption of traceability systems for wine. Compared to traditional cognitive models such as the TPB and TAM, which focus on rational determinants (attitudes, usefulness and control), the SOR approach captures the affective and experiential dimensions of consumers' responses, emphasising the role of trust, emotion and engagement. By integrating perceived risk, our study offers a more comprehensive understanding of how both cognitive and emotional processes jointly shape consumers' acceptance of digital transparency technologies in the wine sector. Indeed, our findings confirm that external stimuli, such as transparency, traceability, diagnosticity, facilitating conditions and social influence, shape consumers' psychological responses, including perceived value, usefulness and enjoyment, which, in turn, drive their purchasing behaviour. One additional theoretical contribution of our study is the application of these behavioural models specifically to the wine sector, where credence attributes play a critical role in consumer decision-making – a dimension often overlooked in broader agri-food research.

By empirically validating the conceptual model, our findings provide a deeper understanding of how factors such as hedonic perception,

perceived value and perceived usefulness influence consumers' purchase intentions for traceable wines. In particular, our findings demonstrate that beyond cognitive evaluations of usefulness and value, emotional and experiential responses play key roles in shaping behavioural intentions. This observation highlights the importance of considering both rational and affective pathways in understanding technology-driven consumption experiences, especially in hedonic and authenticity-oriented markets such as wine.

Practical and managerial implications

From a practical perspective, our findings suggest several key considerations for companies seeking to enhance consumers' adoption of BFTS. One of the most important insights is that the functional transparency of a BFTS must be complemented by an engaging user experience. While the ability to verify product authenticity and quality remains important, companies should also focus on making traceability interactions enjoyable, intuitive and interactive. For instance, this could be achieved through strategies such as digital testimonials or storytelling from winemakers integrated into QR code content to build emotional connection and authenticity; multimedia storytelling about wine origins, such as developing virtual vineyard tours that allow consumers to explore production sites through immersive videos or augmented reality experiences; and gamification elements that enhance consumer involvement, such as reward points or collectable digital labels, can enhance users' enjoyment and repeat engagement. By integrating these features, companies can increase the likelihood that consumers will actively engage with traceability systems rather than perceiving them as mere informational tools.

Additionally, our findings emphasise the importance of social influence in driving adoption. Given that subjective norms significantly impact perceived usefulness, marketing strategies should highlight peer recommendations, endorsements from wine experts and social proof mechanisms that reinforce the value of traceable wines. Encouraging user-generated content and reviews on traceability features can strengthen consumers' trust and stimulate word-of-mouth adoption. Communications should emphasise not only the transparency provided by BCT and QR codes but also the emotional and experiential benefits, such as authenticity and connection to terroir. Finally, designing interactive digital experiences can further engage consumers, enhance hedonic perception, and foster loyalty.

Moreover, our findings suggest that technological facilitation should be prioritised: facilitating conditions, such as good mobile integration and simplified scanning processes, enhance perceived ease of use and overall system accessibility. This observation has important implications for both technology developers and marketers, as it suggests that consumers' engagement with traceability features can be enhanced through interactive and visually appealing interfaces. For managers and technology developers, our findings indicate that privacy concerns, while relevant, should not be overemphasised at the expense of promoting the benefits of BFTS. While ensuring robust security measures remains essential, marketing communications should focus more on the transparency, trust and value that traceability systems provide. The relatively minor impact of privacy concerns suggests that consumers are more focused on the advantages of traceability than on potential data security risks. Finally, our findings offer guidance on targeting different consumer segments. Given that BCT knowledge was not a major predictor of perceived usefulness or purchase intention, companies should avoid overly technical explanations of BCT and instead emphasise its practical benefits, such as traceability. Messaging should focus on how the BFTS enhances wine selection, quality assurance and overall purchasing confidence rather than delving into the complexities of BCT infrastructure. By tailoring communications to highlight the tangible advantages of traceability, companies can appeal to a broader consumer base, including those who may be less technologically inclined.

Limitations and future research directions

Despite its contributions, our study had several limitations that should be acknowledged. Firstly, its geographical scope was limited to Italy, which restricts the generalizability of our findings to other cultural or sectoral contexts. Thus, comparative studies across multiple countries could provide deeper insights into how cultural values influence consumers' trust and technology acceptance.

Secondly, the technological context is rapidly evolving, with BCT, QR codes and digital traceability interfaces continuously evolving. Thus, future research should explore how emerging technologies, such as artificial intelligence, augmented reality and internet-of-things integration, may further enhance traceability experiences and influence consumer behaviour.

Thirdly, because our study collected data via an online questionnaire, reliance on self-reported data must be considered, which may not accurately reflect actual purchasing behaviour due to the intention-behavior gap. In addition, social desirability bias could have influenced responses, leading respondents to overstate their willingness to engage with traceability solutions. Since consumers' perceptions and intentions were measured at a single time point, the study design limits causal inference. Therefore, future research should address these limitations by adopting longitudinal or experimental study designs to capture dynamic changes in behaviour and actual purchase decisions over time. In addition, conducting field or observational studies in real purchasing contexts would provide a more accurate understanding of how consumers interact with BFTS. Finally, estimating the price premium consumers are willing to pay for traceable wine would provide valuable insights into their economic commitment to transparency.

CRediT authorship contribution statement

Ángel Peiró-Signes: Writing – original draft, Validation, Methodology, Formal analysis, Data curation. **Nino Adamashvili:** Writing – original draft, Visualization, Validation, Data curation. **Magdaléna Tupá:** Writing – original draft, Visualization, Validation. **Antonino Galati:** Writing – original draft, Validation, Supervision, Methodology, Funding acquisition, Data curation, Conceptualization.

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Supplementary materials

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