ALLIANCE

A hoListic framework in the quality Labelled food supply chain systems' management towards enhanced data Integrity and verAcity, interoperability, traNsparenCy, and tracEability

STRATEGIC GAP ANALYSIS AND CONSUMER DEMAND ASSESSMENT

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List of Abbreviations

Abbreviation	Description
ATB	Attitude Towards Blockchain
ATT	Attitude
AVE	Average Variance Extracted
BCT	Blockchain Technology
CB-SEM	Covariance-Based Structural Equation Modelling
CR	Composite Reliability
DIS	Discomfort
GfeW	German Association for Experimental Economic Research e.V.
HTMT	Heterotrait-Monotrait Ratio Of Correlations
INN	Innovativeness
INS	Insecurity
ISS	Informational Success Model
MEM	Marginal Effects at the Mean
OPT	Optimism
PBC	Perceived Behavioural Control
PDO	Protected Designation of Origin
PGI	Protected Geographical Indication
PLS-SEM	Partial Least Squares Structural Equation Modelling
SEM	Structural Equation Modelling
SN	Subjective Norms
TAM	Technology Acceptance Model
TEC	Attitudes toward Technology
TPB	Theory of Planned Behaviour
TSG	Traditional Specialities Guaranteed
TQC	Trust toward Quality Certifications
TRI	Technology Readiness Index
INT	Intention
LR	Likelihood Ratio
WTP	Willingness to Pay

Executive Summary

This report presents a strategic overview of consumer demand assessment, market gaps, and strategic interventions in the context of blockchain-enabled traceability for quality-labelled food products (organic, PDO, and PGI) within the European Union. It synthesizes key findings from ALLIANCE's cross-country research, highlighting factors influencing consumer awareness over traceability blockchain, and indication labels, consumer habits, willingness to pay, perceived benefits, and barriers to adoption of blockchain-based traceability systems. Data from about 3,000 consumers spread across six European nations (Italy, Greece, Spain, France, Croatia, and Serbia) was used in the study. The study looked at consumer attitudes and behaviours towards quality-labelled food products, including organic pasta, PDO/PGI olive oil, PDO Feta cheese, PGI faba beans, organic honey, PGI Lika potatoes, and PDO Arilje raspberries.

To explore the consumer purchase intention of food products with blockchain-based traceability, the study applied Theory of Planned Behaviour framework, including ideas such as trust in quality certificates and attitudes towards technology. Results of the study show that consumer confidence in certificate schemes and attitudes toward blockchain and related technologies are key drivers of purchase intention. Consumer perception of traceability and blockchain networks is poor despite growing interest in food traceability, while the awareness of PDO/PGI labels is high. Additionally, the study reveals significant variations in consumer attitudes across Italy, Greece, Spain, France, Croatia, and Serbia, shaped by levels of trust in certifications, perceived behavioural control, subjective norms, and familiarity with digital tools. Age, income, and educational demographics were found to have major effects and influence on consumer behaviour, suggesting the need of tailored educational and marketing initiatives. While most consumers were ready to spend more money for food products with an origin label and authenticity, the degree of their willingness depended on clear communication of the value these products provide in the form of improved safety, authenticity, and sustainability.

Key market gaps were identified in awareness, understanding of traceability, and perceived value of blockchain in enhancing food safety and authenticity. Accessibility and price also continue to hinder wider uptake of certified products, despite high recommendation rates and perceived quality benefits. The report thus suggests ways to minimize these gaps emphasizing on the importance of targeted communication, integration of blockchain into trusted retail channels (particularly specialty and direct-from-producer outlets), and investment in consumer education. In addition, simplifying labelling, and raising public awareness of the advantages of modernized traceability systems is of paramount importance. Generally speaking, the results set out in this report provide the foundation for policy and intervention design guaranteeing that technological innovation is in line with consumer expectations and needs.

Publications

Key findings and insights of this deliverable have been published in the following article:

MAESANO, G., Sadrmousavigargari, S., & Castellini, A. (2025). Consumer Intentions to Purchase Pasta with Blockchain-based Traceability. Bio-Based and Applied Economics. https://doi.org/10.36253/bae-17195

In addition, the manuscript "Understanding Consumer Intentions for Blockchain-Tracked Pasta and Honey: Insights from the Extended TPB Model" has been accepted for presentation at the SIDEA-SIEA-CESET Conference 2025, which will take place in Benevento, Italy, from July 2 to 4, 2025.

1 INTRODUCTION

ALLIANCE aims to revolutionize the management of food supply chain systems focusing on combating food fraud through a holistic, technology-driven approach that enhances traceability, transparency, and data integrity and veracity. As part of this effort, this deliverable seeks to assess consumer perceptions of products produced under the innovative traceability system. Identifying socio-cultural elements that affect buying decisions depends on an awareness of customer attitudes toward these items, thereby shaping policies that ensure the effective acceptance of these solutions throughout Europe. This deliverable is the result of an extensive assessment of consumer behaviour regarding food authenticity and quality, contributing to the project's overall objective of improving sustainability in food supply chains.

In addition to the consumer demand assessment, this deliverable conducts a strategic gap analysis to identify discrepancies between consumer expectations and current market offerings, providing ALLIANCE with insights over its traceability framework. This study offers a roadmap for addressing barriers to adoption by assessing consumer confidence, awareness, accessibility, and regulatory alignment. The findings support the development of targeted interventions, ensuring that the technological innovations introduced by the project align with consumer needs and market dynamics.

1.1 Purpose and objectives

The primary purpose of this deliverable is twofold: *(i)* to conduct a comprehensive consumer demand assessment, which provides valuable insights into the factors that affect consumer acceptance of products verified through the ALLIANCE traceability system; and (ii) to create a roadmap through a strategic gap analysis to enhance the economic and social sustainability of quality-labelled food supply chains, reinforcing trust in food authenticity and safety while promoting wider adoption of traceability solutions.

The primary objectives of this deliverable are identified as follows:

- Identify key socio-cultural drivers and barriers that influence consumers' decisions when purchasing quality-labelled food products.
- Assess public perceptions of the benefits associated with traceable, verified food products in the context of food authenticity and safety.
- Analyse factors such as trust, transparency, and the Willingness To Pay (WTP) a premium for products with verified origins and quality labels.
- Identify the gaps between consumer expectations and the current offerings in the food supply chain.
- Provide directives for the implementation of ALLIANCE technologies and actions towards consumer perceptions and intentions.

1.2 Relation WPs and tasks

This deliverable is part of the tasks T3.1 The Food Fraud Landscape & Gap Analysis for Food Safety and Authenticity and T3.6 Consumer Demand Assessment and Strengthening of WP3 Food Safety and Authenticity. It directly contributes to ALLIANCE's objective of ensuring food authenticity, safety, and traceability by assessing consumer demand and identifying gaps in the current food supply chain landscape. The insights gained from this analysis will support the development of effective strategies for increasing public trust and acceptance of innovative traceability technologies.

Furthermore, this deliverable is linked to all WPs, with special focus to WP4 Pilot Demonstration and Validation Campaigns, which focuses on the real-world implementation, validation, and assessment of the ALLIANCE technologies, processes, and frameworks, by highlighting key socio-cultural factors influencing consumer choices, which in turn inform the execution and evaluation of the pilot demonstrations, and WP5 Dissemination, Communication and Exploitation activities, by informing targeted messaging strategies and stakeholder engagement efforts, ensuring that consumer insights and identified gaps are effectively communicated to relevant audiences to enhance awareness, trust, and uptake of ALLIANCE innovations.

1.3 Structure of this document

The remaining document is structured as follows:

Section 2: Literature Review – A review of relevant literature on consumer behaviour models, food fraud, traceability systems, and consumer demand for quality-labelled food products.

Section 3: Methodology – An overview of the methodology employed for the consumer demand assessment, including details of the target populations (3.1), the sampling method (3.2), the questionnaire description (3.3.) and data analysis method (3.4).

Section 4: Country-Specific Consumer Behaviour Analysis – An in-depth analysis of consumer behaviour in the participating countries, including Italy, Greece, Spain, France, Croatia, and Serbia, with a focus on specific food products such as organic pasta, PDO/PGI olive oil, PDO Feta cheese, PGI faba beans, organic honey, PGI Lika potatoes, and PDO Arilje raspberries.

Section 5: Strategic Gap Analysis – A comprehensive analysis of the gaps between consumer demand, expectations, and the current state of the food supply chain, highlighting areas where improvements or adjustments are needed.

Section 6: Recommendations – Strategic recommendations based on the findings of the consumer demand assessment and gap analysis.

Section 7: Conclusion and Outlook – A summary of the key findings, along with a discussion on the future outlook for ALLIANCE and its impact on the food supply chain sector.

2 LITERATURE REVIEW

Large-scale research through consumer surveys globally, have highlighted consumer attitudes towards various food products, particularly those with quality labels such as organic, PDO (Protected Designation of Origin), and PGI (Protected Geographical Indication). Surveys provide valuable insights into the trends, attitudes, motivations, and barriers affecting purchasing decisions. According to Zhang et al. (2020) strongest drivers of food purchasing decisions are quality assurance, trust, and food safety. Surveys conducted throughout Europe have indicated that customers increasingly desire products that guarantee authenticity (Halwani and Cherry 2023), safety (Walaszczyk et al. 2023), and conformance with recognized quality standards (Nagyová et al. 2019). Labels such as organic, PDO, and PGI were rated as strong indicators that products are of a particular making standard and are less subject to fraud (Chrysochou et al. 2012; Thøgersen 2023).

Surveys disclose a common outcome: knowledge of certification schemes varies significantly by country, age, and educational level. Studies conducted by Eurobarometer (European Commission, 2020), for instance, found that while the majority of EU consumers recognize the EU organic mark, awareness of PDO and PGI labels is considerably lower, particularly with younger customers (Goudis and Skuras 2021). Nonetheless, consumers who are aware of such labelling indicate they are more willing to pay a premium for certified products (Vecchio and Annunziata; Skuras and Vakrou 2002; Kaczorowska et al. 2021).

Previous research has also shown the importance of reliability attributes, such as origin (Dudziak et al. 2023), organic methods of production (Madureira et al. 2025), and sustainability (Ran et al. 2022), which consumers are themselves unable to authenticate but assess by means of labels and certificates (Kaczorowska et al. 2021). Trust in such attributes generally depends not only on the product but also on perceived dependability of certification, supply chain transparency, and brand reputation (Holloway 2024).

Numerous studies have examined barriers to purchasing traceable or certified products. Some of the most frequent challenges listed are:

- More expensive than its conventional alternatives (Chang et al. 2022),
- Scarcity at traditional retailers (Reynolds and Hristov 2009; Nunes and Deliberador 2025),
- Lack of knowledge among consumers or misperception of significance of different labels (Gomes et al. 2022; Sang et al. 2022),
- Scepticism regarding the real added value or authenticity of certified claims (Janssen and Hamm 2012).

Consumer surveys point up, as a consequence, the importance of ethical concerns and social norms (Sudbury-Riley and Kohlbacher 2016). Consumers, particularly younger consumers, state they want products that align with their attitudes towards environmental sustainability, concern for animals, and fair manufacture processes (Sudbury-Riley and Kohlbacher 2016). This shift reflects a broader trend towards value-based consumption, where ethical considerations as well as taste and price influence food choices (van Bussel et al. 2022).

The Eurobarometer Food Safety survey throughout the EU revealed that many European consumers take into account origin and production techniques when deciding (European Food Safety Authority 2022). Furthermore, 53% of those polled claimed knowing where their food came from influenced their purchasing decision; 41% said techniques of production, including organic farming, were more important. Moreover, a pre-existing survey of Verbeke et al. (2012) revealed that while awareness of the PDO, PGI, and TSG schemes was much lower, organic label recognition was rather common, pointing to a need for more efficient communication of geographical labels.

A major emphasis remains on trust in labels of quality in food products. Consumers of the EIT Food Trust Tracker 2020 report said they believed and acknowledged food certifications, especially organic and place of origin labels, to greatly influence their buying decisions (European Union 2020). Those who believed and acknowledged certification systems were inclined to pay more for branded goods. Compared to traditional items, consumers viewed quality-labelled foods as safer and healthier.

Other nation-level investigations back up these findings. For example, a study by IFOAM EU (2019) of organic food consumption patterns found that 64% of Europeans say they purchase normal organic goods. Of those polled, 49% said they would pay more for organic goods (IFOAM EU 2019). Health problems, environmental worries, and food authenticity were the key drivers. Likewise, food quality label consumer research on PGI and PDO products done with 200 Italian consumers revealed that while regional products were highly valued by consumers, just a few of them fully grasped the differences between PGI and PDO labels, therefore stressing the need for ongoing educational campaigns (Aprile et al. 2012).

Driven by health, environmental, and sustainability issues, consumer behaviour in Albania, Bulgaria, and Poland reveals a rising demand for local and PDO/PGI products. Still affecting buying choices and market growth include lack of knowledge, accessibility, and government support (Muça et al. 2022). Though usually good, attitudes still present obstacles to purchasing quality-labelled goods: For low-income families, price is a significant obstacle (Kazakova 2017). Mass market retailers' limited product availability could discourage regular purchasing (Gracia 2014). Consumers can avoid less value from misunderstanding about various labels with unclear meanings, particularly if many certifications exist.

Most significantly, recent studies indicate that environmental issues for general sustainability are increasingly directly linked to demand for certified items. Younger consumers, according to recent studies, are the primary drivers of demand for food products not only for their quality but also in order to support environmental protection (Moser 2016; Stranieri et al. 2017; De Daverio et al. 2021), animal welfare (Napolitano et al. 2008; Tsakiridou et al. 2010; Gerini et al. 2016), and fair trade (van Herpen et al. 2012; Sama et al. 2018).

Food fraud, ranging from mislabelling, counterfeiting, to adulteration, is nowadays a major concern for consumers, industries, as well as other stakeholders globally. Various food fraud incidents of the past decades, from the horsemeat scare of Europe to fake organic products, have seriously undermined consumer confidence within the food chain (Stanciu 2015; Miller 2019). Consumers nowadays put great emphasis on authenticity, traceability, as well as transparency of the foods they purchase. Consistent with what is produced by consumer surveys, traceability systems are rated as vital aids for guaranteeing product safety as well as authenticity. Research conducted all over Europe as well as other markets confirms that when people understand that the history of a product can be openly tracked back to its source, they have more confidence in its quality as well as are prepared to pay a premium for it (Thøgersen 2023). Traceability is particularly marketable within product categories where the production history, geographical source, as well as organic status are significant quality factors such as for olive oil, honey, milk products, fruits, and vegetables (Violino et al. 2020; Aparicio-Ruiz et al. 2022; Dimitrakopoulou and Vantarakis 2023; Savoia et al. 2024).

Regardless of this increased demand for traceability, research additionally shows that customers are not always fully aware of the mechanisms by which traceability frameworks work (van Rijswijk et al. 2008). Conventional frameworks, though providing some assurance, are short of ideal: they can be centralized, fragmented, and subject to manipulation or mistakes. It is these weaknesses that have generated a search for more effective options.

In the context, Blockchain Technology (BCT) presents a new promise for improving traceability of foods. BCT facilitates tamper-proof, decentralized recording of transactions, enabling all parties ranging from farmers to consumers to see open, unalterable information regarding a product's history. Various recent studies show that while awareness of blockchain technology as a tool for traceability in foods is still low for consumers, the idea of increased transparency is much favoured (Treiblmaier and Garaus 2023). Consumers state that they are interested in having a system that can verifiably provide authenticity of claims of origin, adhering to quality standards, and enhance ethical production and sustainability practices (Sri Vigna Hema and Manickavasagan 2024). For example, studies indicate that consumers are more inclined to view certified products as trustworthy if they are educated regarding blockchain-based traceability, as they are more open to paying for foods that can attest to their origin and quality using sophisticated technology (Reitano et al. 2024). However, surveys reveal key challenges as well. Consumers see blockchain as a complicated concept and want easy, straightforward information rather than details about technology. This means, in practice, blockchain can build trust, but its advantages must be translated clearly, incorporating end results that are relevant for consumers to understand, e.g., "guaranteed origin" or "proof of organic certification", as opposed to the technology (Noé Van Dijk).

Additionally, blockchain-based traceability depends on a pre-existing level of trust. Consumers who have high levels of preexisting trust in certification schemes (e.g., PDO or organic certifications) are more likely to value blockchain as a complementary form of validation (Murphy et al. 2022). If there is a low level of baseline trust for the food systems or for certification bodies, new technology alone might not allay all of the consumers' scepticism.

Latest consumer surveys have not yet reflected in depth the demand for technology-based traceability systems, including blockchain-based labelling especially in European level. The majority of consumers are unaware of how technologies like blockchain work despite being interested. This is the main reason why the present study is important so as to indicate if consumers value transparency as well as traceability, as well as if they prefer simple, unembellished facts rather than complex technical explanations in food labels. Taken all together, previous studies of consumer behaviour reveal that effective methods for promoting tracked and proven items must manage increased applications of high technology, highlighting the benefits such as safety of the food, authenticity, environmental impact, and ensuring accessibility and affordability.

Overall, prevention of food fraud through enhanced traceability aligns with the changing expectations of consumers regarding honesty and authenticity. Blockchain technology also promises much to improve customer confidence and demand for quality-labelled, certified products, subject to making its advantages understandable, easily obtainable, and integrated into recognizable certification schemes.

METHODOLOGY FOR CONSUMER DEMAND ASSESSMENT

2.1 Target populations- Survey size

Consumers in Italy, Greece, Spain, France, Croatia, and Serbia.

- Italy: 2 surveys (500 respondents each) on organic pasta and PDO/PGI olive oil/EVOO.
- Greece: PDO Feta Cheese (500 respondents).
- Spain: PGI Faba Beans (500 respondents).
- France: Organic honey (500 respondents).
- Croatia: PGI Lika Potatoes (500 respondents).
- Serbia: PDO Arilje Raspberries (500 respondents).

2.2 Sampling method

The tool used for data collection in this study was an online questionnaire developed on the LimeSurvey platform. The LimeSurvey tool (LimeSurvey 2025) is a popular free and open-source online survey tool providing a web interface for creating surveys, managing users and participants, collecting responses, and exporting data for analysis (Klieve et al. 2010).

500 respondents completed the final questionnaire. Our objective is to explain product purchasing intentions using the extended Theory of Planned Behaviour (TPB) rather than investigate the decision of whether or not to consume the product. Therefore, all respondents met the criteria of having consumed the product and being responsible for food purchasing within their households. In addition, the participants in the study were between the ages of 18 and 70. The age range of 18 to 70 years was chosen for this study to include a wide range of adult consumers who are legally capable of making their own purchase decisions and are likely to use new technologies. A quota sampling was used to guarantee representation across various demographic groups. Specifically, quotas were set for sex and age groups. 'Male' and 'female' in this report refer to respondents' self-reported biological sex since the survey did not collect data on gender as a sociocultural construct.

The questionnaire was developed in English and then translated into local languages. The questionnaires were distributed in December 2024 and January 2025 through a consumer panel of a market research institute. These panels give researchers access to various populations in several countries, allowing them to control samples and target particular demographics. Because of their larger participant base which enables faster data gathering and wider generalizability, they are ideal for studies that need targeted or widespread sampling (Moss et al. 2023). It is noteworthy that this study was carried out in compliance with ethical guidelines and was approved by the German Association for Experimental Economic Research e.V. (GfeW), with approval number Invoice E-2024-12-10-000963.

2.3 Questionnaires description

2.3.1 Theory of Planned Behaviour

TPB has been a prominent theoretical construct in the field of psychology, with particular relevance to the prediction and modification of human behaviours, particularly in the context of technology usage (Ajzen 2020; Cudjoe et al. 2023; Fleiß et al. 2024). The TPB postulated by Ajzen (1980) assumes that individual behaviour depends on three key elements: the individual's attitude, subjective norms or social pressure and perceived behavioural control. The concept of perceived behavioural control refers to an individual's perception of how easy or difficult it is to perform a particular behaviour and is influenced by a variety of factors, including ability, resources and environmental conditions (Ajzen 1980; Fishbein and Cappella 2006). The TPB approach and its later refinements, including the "value-belief-norm," "knowledge-attitude-intention-behaviour and "social marketing" approaches (Lefebvre et al. 2014), have been used extensively in the consumer behaviour literature. The above theories provide a logical framework for analysing or predicting individual behavioural tendencies or intentions from different perspectives and examine the relationship between behavioural intentions and a range of internal and external factors, including attitudes, values, beliefs and norms (Fishbein and Ajzen 1975).

Accordingly, the TPB assumes that consumers' intentions to purchase or consume food are influenced by their attitudes toward food safety and authenticity, subjective norms, and perceived behavioural control, including the perceived ease or difficulty of detecting and avoiding food fraud (Ajzen 1991). The TPB has been successfully used in the consumer decision-making literature in a variety of contexts (Lin 2007), including in the context of food choice, where it has been used to identify the motivational factors underlying the choice of one product over another (Nardi et al. 2019) and to predict consumer behaviour and intentions towards organic products (Armitage and Conner 2001). The TPB is based on the idea that a person's behaviour depends on the intention to perform it. Behavioural intention is the result of the interaction of three factors:

- Attitude (ATT): represents a person's inclination to perform a certain action. It is a person's opinion or judgement about adopting or performing a particular behaviour based on their values, beliefs and previous experiences with that behaviour. A positive attitude leads to a greater likelihood of behaving consistently with one's intention. Attitude towards a particular technology should be measured in terms of trust, i.e. the actor's tendency to trust the target behaviour.
- Subjective Norms (SN): refers to the influence of other people's thoughts and attitudes towards a particular behaviour. In other words, it is the social pressure to perform or avoid a certain action, which may result from the expectations, encouragement or opinions of others. Subjective norms reflect individuals' perceived social weight towards a particular behaviour and can influence their behavioural intentions and decisions.
- Perceived Behavioural Control (PBC): refers to the perception of a person's ability to perform an action or the perception of the difficulty or ease of a particular behaviour depending on certain factors.

Several studies have investigated consumers' intention to buy products tracked with a system based on the BCT. In the study conducted by Dionysis et al. (2022), the factors influencing the purchase intentions of coffee consumers who consider coffee products that can be tracked with a blockchain-based tracking system are analysed using the TPB model. The original TPB model was extended to include additional constructs such as trust, past habits and environmental protection. The study contributes to the literature by providing insights into the factors that influence consumers' purchase intentions and shows that attitudes towards coffee traceable through a blockchain-based traceability system, subjective norm and perceived behavioural control are positively associated with purchase intention.

The study by Lin et al. (2021) also used the TPB to investigate the factors influencing Chinese consumers' intentions toward blockchain food traceability technology to ensure the food safety and quality of Chinese organic food. The study proposed an integrated conceptual framework combining two established theoretical models: the TPB and the Informational Success Model (ISS). The study found that attitude and perceived behavioural control significantly and positively influence intention to use when adopting blockchain, while subjective norms are positively but not significantly correlated with intention to use.

The work of Menozzi et al. (2015) analyses consumer attitudes and behaviour towards traceable food to explain the intention to buy traceable food using the TPB. The results show that the predictive power of the TPB model increases significantly when new variables are added: Habits, trust, past behaviours and socio-demographic variables. The results show that attitudes and trust influence the purchase intention for traceable food products.

Prisco et al. (2024) present an integrated approach that combines the Technology Acceptance Model (TAM) and the TPB and adds as benefits the additional factors "efficiency and safety", "reduced costs" and "quality of customer service" perceived by companies adopting blockchain technology. The results show that attitude and perceived behavioural control are the most important predictors of intention to adopt blockchain, while perception of benefits is the most important predictor of attitude. In addition, subjective norms were found to have a positive effect on behavioural intention, while the effect of perceived ease of use on attitude was not significant.

In their study, Liu et al. (2023) investigated the relationship between consumer trust in agricultural and food systems and the influence of certifications. Their results showed a positive correlation between high consumer trust and a preference for products with certificates of origin and the use of BCT. The influence of BCT on consumer purchasing decisions, especially for certified food products, is an important factor influencing demand and, thus, the success of BCT-based schemes.

When investigating the relationship between trust in the food system and certifications, it was found that high levels of trust positively influence PDO and BCT preferences, while it has a less pronounced effect on preferences for organic certification (Contini et al. 2023). The lack of a significant interaction between trust in the food system and preference for organic certification can be attributed to the fact that preference for organic products does not depend on trust in the food system in general but rather on the alignment of values between the different actors within the organic supply chain (Thorsøe 2015). This trust is reinforced by consumer satisfaction with the quality of the products (Ladwein and Sánchez Romero 2021) and is linked to the organic certification logo (Janssen and Hamm 2012).

Based on the analysis of previous literature, the TPB was chosen as the conceptual model for this study. However, this study aims to improve the predictive power of the TPB. In addition to the original items of the TPB, such as attitude, subjective norms and perceived behavioural control, additional constructs are introduced: trust in quality certification and attitude towards technology.

Based on the above literature and theory, the following hypotheses are formulated. To avoid verbosity, the indicators in the table are presented in capital letters. See Table 1 for details.

Table 1 Hypotheses and paths

Hypotheses	Path
H1: SN positively affects the intention to purchase the product traced with blockchain technology	SN→INT
H2: PBC positively affects the intention to purchase the product traced with blockchain technology	PBC→INT
H3: Attitude Towards Blockchain (ATB) positively affects the intention to purchase the product traced with blockchain technology	ATB→INT
H4: Trust toward Quality Certifications (TQC) positively affects the intention to purchase the product traced with blockchain technology	TQC→INT
H5: Attitudes toward Technology (TEC) positively affects the intention to purchase the product traced with blockchain technology	TEC→INT

Questionnaires' sections and preliminary

This questionnaire was developed based on the TPB. The TPB method is particularly effective for investigating tracked products, as it identifies the elements that influence decision-making. The questionnaire aims to explore the elements that affect consumers' purchase intentions by incorporating the key constructs of the TPB.

The questionnaire was structured into various sections, each intended to collect particular information relevant to the goals of the study:

1. Section one focused on demographic data, including variables such as sex, age, education, occupation, household size, people under 18 years old in the household and monthly income.
2. In section two, participants' awareness of traceability and blockchain systems on a 4-scale, from in-depth understanding to never having heard, was asked.
3. Section three included questions related to consumers' buying habits for different types of products and their perceptions of quality labels specified for each case study, such as organic certification or PDO and PGI.
4. Section four assessed various behavioural constructs identified in the TPB model, using a 5-point Likert scale to gauge respondents' levels of agreement, as follows:
    i. The intention construct captures the likelihood that consumers will consider purchasing the product with blockchain traceability once it is available.
    ii. The subjective norms construct measures the influence of social factors, including family, academia, media, and retail, on consumers' decision to purchase the product with blockchain traceability.
    iii. The perceived behavioural control construct evaluates how consumers perceive the ease or difficulty of using and accessing blockchain-traceable products. This construct included items such as finding such products in shops and using the relevant technology, which is critical to understanding potential barriers to adoption.
    iv. The attitudinal construct captures consumer perceptions of the benefits associated with using blockchain technology for food traceability and focuses on aspects such as safety, transparency, authenticity and production standards.

The design of these questions was guided by previous research (Menozzi et al. 2015; Dang and Anh 2020; Dionysis et al. 2022), to ensure that all key variables were comprehensively addressed.

5. Section 5 presents constructs related to the extended components of TPB. These constructs were measured using a 5-point Likert scale, and their details are explained below:

   i. Consumer Trust in Quality Certification: Trust in quality certification is an important factor that influences consumers' confidence in the safety and authenticity of products. This construct assesses the extent to which consumers trust the quality certification information provided by companies. This block focused on assessing trust in organic food producers and sellers, drawing on the work of Li et al. (2023).

   ii. Attitudes towards technology: The questions in this section were organised based on the Technology Readiness Index (TRI), a scale validated by Parasuraman (2000). This index measures consumer attitudes toward technology in four dimensions: Optimism (OPT), Innovativeness (INN), Discomfort (DIS), and Insecurity (INS).

6. In the final section, the questions regarding the preferred place of purchase, brand loyalty, WTP for a blockchain label, and the types of production process information consumers seek when buying the product were included.

2.4 Data analysis methodology

Structural Equation Modelling (SEM) was used to investigate the extended theoretical framework and to test the hypotheses. SEM combines various multivariate analysis methods that facilitate the investigation of multiple interactions between several latent variables (Berki-Kiss and Menrad 2022). It has been widely used in the social sciences, particularly in the field of psychology.

In this study, Partial Least Squares SEM (PLS-SEM) was used. PLS-SEM is a statistical tool that has gained popularity among researchers who use it to analyse empirical data and assess various relationships simultaneously (Hair et al. 2019). The applications of Covariance-Based SEM (CB-SEM) and PLS-SEM are complementary, rather than competitive (Marcoulides and Saunders 2006). PLS-SEM is more effective than CB-SEM for analysing complex cause-effect relationships between several latent variables (Sarstedt et al. 2022). Moreover, compared with the covariance-based SEM, PLS-SEM provides reliable results even with relatively small sample sizes. Furthermore, (Hair et al. 2011) proposed that PLS-SEM is the optimal approach when research aims to identify causal relationships with unidentified potential variables that influence multidimensional behaviour and intentions of individuals. This process consists of two steps: the structural model (inner model) and the measurement model (outer model).

- The structural model focuses on evaluating the development of theories and hypotheses, while the measurement model evaluates the reliability and validity of the constructs (Russo and Stol 2022).
- The measurement model was evaluated based on convergent and discriminant validity. Convergent validity specifically refers to the degree to which the indicators of the variables accurately represent and measure those variables, as well as the extent to which other measures of the same variables are appropriately correlated (Bani-Khalid et al. 2022).

The factors affecting consumers' WTP for a blockchain traceability system in the production of all ALLIANCE pilot products were analysed by using a probit model. Data were analysed using STATA 18.50. The codes for data analysis are provided in Appendix 1.

To examine the convergent validity of the measurement model, we examined the loadings of the indicators, the Average Variance Extracted (AVE), Composite Reliability (CR), and Cronbach's alpha. The AVE refers to the total mean of the squared loadings of the items associated with the construct (Russo and Stol 2022) and was used to further assess convergent validity, while the Cronbach's alpha and CR are commonly used to examine internal consistency reliability (Hair et al. 2019). According to the literature, the necessary thresholds for these metrics are as follows: Cronbach's alpha and composite reliability should be greater than 0.70, the AVE should be bigger than 0.50, and the loadings of the indicators should exceed 0.70 (Lin et al. 2021; Rubel et al. 2021; Khan et al. 2023).

Furthermore, in this research, discriminant validity was measured using the Heterotrait-Monotrait Ratio of Correlations (HTMT). Discriminant validity evaluates how well the items reflect the intended construct and whether a latent variable captures a distinct construct (Russo and Stol 2022). The HTMT is calculated as the average of correlations among items that assess different constructs (heterotrait correlations) compared to the geometric mean of the average correlations for items that evaluate the same construct (monotrait correlations) (Hair et al. 2019).

In addition, a key consideration in probit models is how to interpret the coefficients. Although the signs and significance of these coefficients are valid, a proper interpretation requires calculating the marginal effects. In this study, we estimated the Marginal Effects at the Mean (MEM).

3 COUNTRY-SPECIFIC CONSUMER BEHAVIOUR ANALYSIS

3.1 Introduction

In the food sector, issues such as traceability and food safety have become central to the supply chain, with producers increasingly prioritising these aspects over other objectives (Alshehri 2023). This shift goes hand in hand with an emerging paradigm shift in consumer demand. Consumers are now showing an increasing preference for products that are perceived as safer (Mahsun et al. 2023). This is evidenced by the fact that more and more consumers are expressing concerns about food safety and quality and, therefore, favour foods whose labels provide clear and accurate information about product characteristics (Lewis and Grebitus 2016; Sadílek 2019; Moruzzo et al. 2020; Kaczorowska et al. 2021). The European Parliament and the Council have also established quality certification for organic agri-food products through Regulation (EU) No 2018/848. According to this Regulation, organic products have been developed to respond to a specific market where consumers demand products whose production respects the environment and animal welfare, preserves biodiversity and contributes to rural development (Sampalean et al. 2021).

However, consumers cannot verify credence attributes and must therefore rely on the reliability of the manufacturer's or retailer's claims (Plasek and Temesi 2019). Credence attributes refer to product characteristics that consumers cannot directly verify before purchase and must rely on external assurances to assess their validity (Lassoued and Hobbs 2015; Plasek and Temesi 2019). In the context of food products, these attributes include factors such as organic certification, geographical origin, sustainability claims, and production methods (Fernqvist and Ekelund 2014).

The credibility of these parties also depends on consumer trust in the food system, including the regulatory authorities responsible for ensuring food safety and compliance with food labelling regulations (Fernqvist and Ekelund 2014; Lassoued and Hobbs 2015; Meijer et al. 2021).

Trust is a multi-layered concept that is shaped by several factors, including the geographical and temporal distance between the parties involved, cultural norms, the institutional environment and historical events that influence perceptions of food safety and quality (Berg 2004). Currently, consumer trust in the food system is uncertain, particularly in relation to transparency and authenticity (Wu et al. 2021; Menon and Jain 2024) and more generally in relation to perceptions of food safety (Macready et al. 2020; Meijer et al. 2021) . The main cause of this trend is the inherent complexity of the food supply chain, which involves a multitude of parties and processes (Hassoun et al. 2020; Reitano et al. 2024) and can lead to food safety issues (Meijer et al. 2021). This decline in consumer confidence has significant consequences, such as the limited effectiveness of certifications and consequently a decrease in potential demand for products with credible attributes, such as origin, production process characteristics and product properties (MAROZZO et al. 2022). From a public interest perspective, low trust has negative implications for sustainable development and public health policies that rely on traditional forms of certification to inform consumers about the nutritional and ethical value of products (Kjærnes 2006; Sapp et al. 2009; Hobbs and Goddard 2015; Kaiser and Algers 2017). Considering the above-mentioned characteristics of the agri-food production system, it is essential to develop a coherent management system adapted to its specific needs (Gardeazabal et al. 2023). In response to the prevailing concerns in the agri-food sector, a number of technological innovations have emerged to improve and strengthen food traceability. Among these, BCT has attracted much attention (Reitano et al. 2024). In such a system, all subjects in the chain can access the recorded information at any time, but without the possibility to change a record (Feng Tian 2017; Zhao et al. 2019; Wünsche and Fernqvist 2022). This function is suitable for meeting the specific requirements of the food industry and creating a reliable system for tracking the path of a food product from production to consumption. This will make it easier to ensure food safety (Saurabh and Dey 2021) and has the potential to combat problems such as label tampering, counterfeiting of designations of origin, and the introduction of substandard products (Serra-Majem et al. 2020; Ayan et al. 2022).

In the food sector, BCT seems to be a promising solution that could enable more transparency (Aldrighetti et al. 2021; Javaid et al. 2021; Singh and Sharma 2023; Vern et al. 2025). It is already being used to record all transactions between actors involved in the supply chain to ensure the transparency and traceability of products (Galvez et al. 2018; Kamilaris et al. 2019). However, despite its potential, a fundamental factor is the understanding of the benefits attributed by consumers, as emphasised by Feng et al. (2020). Indeed, the widespread adoption of this technology depends on consumer perception and acceptance (Albertsen et al. 2020). As Singh et al. (2023) argue, the success of any technological innovation in the food sector is inextricably linked to consumer acceptance. In the consumer market, there is a growing willingness among consumers to adopt innovative technologies that facilitate access to comprehensive data on supply chain operations (Cozzio et al. 2023). In line with this premise, a study by Osei et al. (2021) hypothesises that consumers will adopt BCT technology if it can demonstrably improve food safety and quality.

Numerous studies have shown that BCTs have a positive impact on consumer purchasing decisions (Sander et al. 2018; Violino et al. 2019; Polenzani et al. 2020; Lin et al. 2021). However, other authors have pointed to a discrepancy between consumer perception and the actual value attributed to technology-specific information confirming that food has been traced with BCTs (Shew et al. 2022). Liu et al. (2023) investigated the relationship between consumer trust in the agri-food system and certification and showed a positive influence of high levels of trust on preferences for products with traceability and the use of BCTs. The influence of BCTs on purchasing decisions, especially for certified food has a significant impact on demand and thus contributes to the success of BCT-based systems. The comprehensive traceability information that this technology provides along the entire food supply chain represents significant added value for consumers.

Contini et al. (2023) have shown that BCT promotes a positive attitude towards consumer preferences and perceptions, thus increasing trust in the system due to satisfaction with the perceived quality of the certified products. As Mazzù et al. (2021) note, BCT-based traceability also requires the involvement of certification and regulatory bodies in the supply chain system. This helps to increase consumer confidence in the reliability of the information provided, while facilitating access to comprehensive food information, including declarations from food supply chain actors, such as organic certification, chemicals used and agricultural practises. Although the technological potential of BCT has been demonstrated in previous studies (Galvez et al. 2018; Kamilaris et al. 2019), there is still little research on consumer perceptions and intentions. In particular, there is a need to investigate how consumers evaluate BCT-enabled traceability in combination with established constructs such as trust, attitudes and perceived ease of use. In recent literature, theoretical frameworks such as the TPB have been used to analyse consumer intentions to adopt blockchain in food systems. The studies by Dionysis et al. (2022) and Lin et al. (2021), for example, highlighted the importance of subjective norms and perceived behavioural control. However, the results regarding attitudes towards BCT were inconclusive. Contini et al. (2023) emphasised the potential of BCT to increase trust, but their results show a discrepancy between consumer trust in traditional certifications and the added value of blockchain traceability.

Building upon the understanding of consumer concerns regarding food safety, quality, and the role of trust and traceability technologies like BCT, the subsequent sections of this study will delve into a comprehensive assessment of consumer demand within ALLIANCE. This assessment encompasses seven distinct pilot studies across six European countries, focusing on a diverse range of high-value, geographically linked food products: Organic Pasta and PDO/PGI Olive Oil and EVOO in Italy, PDO Feta Cheese in Greece, PGI Faba Beans in Spain, Organic Honey in France, PGI Lika Potatoes in Croatia, and PDO Arilje Raspberries in Serbia. This study intends to provide insightful analysis of the possibility for BCT and improved traceability to impact consumer choices and increase confidence in regional food systems by looking at customer preferences and perceptions on certain goods and their relevant quality cues.

3.2 Italy: Organic Pasta & PDO/PGI Olive Oil and EVOO

3.2.1 Descriptive analysis

The demographic results of olive oil and pasta consumers are presented in Table 2. In terms of biological sex, there is a slightly greater proportion of female consumers in both categories, with olive oil consumers at 53.80% female and pasta consumers at 51.20%.

The age distribution indicates that Pasta is more popular among younger individuals specifically those aged 18 to 29. Both olive oil and pasta are popular among middle-aged individuals particularly those between 40 and 59, but olive oil is slightly more favoured in this range. Olive oil remains more popular among older consumers (over 60 years) compared to pasta.

When it comes to education, both consumer bases are mostly made up of individuals with secondary school qualifications, but pasta consumers have a slightly larger share of postgraduates (9.80% compared to 7.80%). In terms of occupation, both groups have a majority of employed individuals. For income levels, both groups primarily belong to the middle-income range, yet olive oil consumers have a higher proportion of high-income earners (19.60% compared to 16.00%), indicating that olive oil is regarded as a superior product. In summary, these insights reveal distinct demographic characteristics for both olive oil and pasta consumers, which can be leveraged for specific marketing strategies and product development.

Table 2 Socio-demographic characteristics

	Detail of respondents	*Percentage (%) Olive oil consumers*	*Percentage (%) Pasta Consumers*	*Mean Olive oil consumers*	*Mean Pasta consumers*
Sex	Male	46.20	48.80		
	Female	53.80	51.20		
Age	18-29	9.20	14.20	48.186	46.396
	30-39	17.80	17.00		
	40-49	25.00	24.20		
	50-59	25.80	25.00		
	Over 60	22.20	19.60		
Education	Elementary school	0	0.20		

	Detail of respondents	Percentage (%) Olive oil consumers	Percentage (%) Pasta Consumers	Mean Olive oil consumers	Mean Pasta consumers
	Secondary school	65.40	61.60		
	Graduate	26.80	28.40		
	Postgraduate	7.80	9.80		
Occupation	Student	2.00	5.60		
	Employed or employee, or self-employed	71.40	65.20		
	Not employed	11.20	13.60		
	Retired	15.40	15.40		
	Other	0	0.20		
Income level (Euro / month)	Low income [a]	20.40	23.80		
	Middle Income[b]	56.60	55.20		
	High Income[c]	19.60	16.00		
	I prefer not to answer	3.40	5.00		

[a] People who are very careful about what they spend, sometimes their income is not enough for necessary purchases; [b] people who, with a little foresight, can indulge in a bit of luxury from time to time; [c] this group faces no financial constraints and makes purchases freely

3.2.2 Results

3.2.2.1 Reliability and validity

As shown in Table 3 and Table 4, the final measurement models, all indicator loadings exceed the 0.70 threshold, indicating that the construct explains more than half of the variance in the indicator, which signifies acceptable item reliability. Table 2 and Table 3 indicate that all composite reliability and Cronbach's alpha values are greater than 0.70, suggesting that the elements of the same latent variable are similar.

Table 3 and Table 4 illustrate that the AVE for each latent variable is greater than 0.50, indicating that each construct explains more than half of the variance of its items. Therefore, the results confirm convergent validity.

Table 3 Reliability and validity tests (olive oil)

Latent Construct	Items	Standardized loadings	Cronbach's alpha	CR	AVE
Intention (INT)	INT1	0.918	0.910	0.943	0.847
	INT2	0.920			
	INT3	0.924			
Subjective Norms (SN)	SN1	0.862	0.762	0.861	0.675
	SN2	0.811			
	SN3	0.789			
Perceived Behavioural Control (PBC)	PBC1	0.775	0.817	0.890	0.731
	PBC2	0.893			
	PBC3	0.891			
Attitude Toward BCT (ATB)	ATB1	0.910	0.895	0.934	0.826
	ATB2	0.903			

Latent Construct	Items	Standardized loadings	Cronbach's alpha	CR	AVE
	ATB3	0.914			
Trust toward Quality Certifications (TQC)	TQC1	0.878	0.907	0.935	0.781
	TQC2	0.873			
	TQC3	0.900			
	TQC4	0.885			
Attitudes toward Technology (TEC)	TEC1	0.886	0.846	0.907	0.764
	TEC2	0.821			
	TEC3	0.913			

Table 4 Reliability and validity tests (pasta)

Latent Construct	Items	Standardized loadings	Cronbach's alpha	CR	AVE
Intention (INT)	INT1	0.938	0.927	0.954	0.873
	INT2	0.931			
	INT3	0.934			
Subjective Norms (SN)	SN1	0.834	0.735	0.849	0.653
	SN2	0.779			
	SN3	0.810			
Perceived Behavioural Control (PBC)	PBC1	0.830	0.841	0.904	0.759
	PBC2	0.872			
	PBC3	0.911			
Attitude toward BCT (ATB)	ATB1	0.903	0.874	0.922	0.798
	ATB2	0.866			
	ATB3	0.911			
Trust toward Quality Certifications (TQC)	TQC1	0.870	0.905	0.934	0.778
	TQC2	0.884			
	TQC3	0.894			
	TQC4	0.880			
Attitudes toward Technology (TEC)	TEC1	0.902	0.907	0.941	0.843
	TEC2	0.920			
	TEC3	0.931			

The findings that all HTMT values fall below the recommended threshold of 0.85 by Hair et al. (2019), confirm adequate discriminant validity for the individual constructs. Thus, it is concluded that the measurement models for olive oil and pasta case studies satisfies the necessary criteria for both validity and reliability.

3.2.2.2 Determinants of purchase intention for blockchain-traceable food products

The structural model is used to investigate how exogenous variables affect endogenous variables. The results of the developed hypotheses are presented in Table 5.

Accordingly, to respond to H1: "Subjective norms positively influence the intention to purchase olive oil and pasta traced with blockchain technology," the findings in Table 5 show that SN significantly and positively impact the INT to buy blockchain-traceable products. Consequently, H1 is confirmed.

To answer hypothesis H2 "perceived behavioural control positively affects the intention to purchase olive oil and pasta traced with blockchain technology", it was also found to have a positive and significant effect on intention. Thus, H2 is confirmed.

In response to H3 "Attitude towards traceability positively affects the intention to purchase olive oil and pasta traced with blockchain technology", the results show that the parameters are positive and statistically significant. It means that attitude towards traceability influence the intention to purchase olive oil and pasta. Therefore, the hypothesis H3 Is accepted.

Hypothesis H4, which states that "Trust in quality certifications positively affects the intention to purchase olive and pasta traced with blockchain technology," was not supported, as indicated by the non-significant coefficients and a high p-values.

To answer H5 "Attitude towards technology positively affects the intention to purchase olive oil and pasta traced with blockchain technology", TEC significantly and positively influences purchase intention, with coefficients of 0.30 for olive oil and 0.421 for pasta. Therefore, the H5 is accepted.

To summarize, marketing strategies for blockchain-traceable products should focus on social influence, simplicity of adoption, awareness of traceability benefits, and technological advancement. Additionally, messages should be tailored to different product categories according to consumer perceptions of traceability.

Table 5 Result of the hypothesis testing for olive oil in Italy

Hypothesis	*Relationship* OLIVE OIL	*Coefficient* (olive oil)	*p-Value* OLIVE OIL	*Decision* OLIVE OIL	*Coefficient* (pasta)	*p-Value* pasta	*Decision* pasta
H1	SN -> INT	0.23	0.000* * *	✅	0.203	0.000***	✅
H2	PBC -> INT	0.20	0.000***	✅	0.250	0.000***	✅
H3	ATB-> INT	0.11	0.01***	✅	0.063*	0.101	✅
H4	TQC -> INT	0.01	0.89	❌	-0.042	0.286	❌
H5	TEC -> INT	0.30	0.000***	✅	0.421	0.000***	✅

*, **, and *** indicate significance levels of 10%, 5%, and 1%, respectively.
Confirmed: ✅, Unconfirmed: ❌

3.2.2.3 Awareness of food traceability, blockchain, and labelling

This section explores consumers' understanding of traceability systems and blockchain technology, their buying preferences, consumption habits, perception of quality labels, and WTP for blockchain label.

Table 6 illustrates olive oil and pasta consumers' understanding of traceability systems and blockchain technology. the results show that olive oil consumers have slightly greater knowledge of food traceability (24.4%) compared to pasta consumers (19.6%). This suggests that olive oil buyers tend to value traceability more in terms of authenticity and quality assurance within premium product categories.

Table 6 Consumers' Knowledge of Traceability

	Scales	Percentage (%) Olive oil consumers	Percentage (%) pasta consumers
Knowledge about food traceability	I have in-depth knowledge of food traceability	24.40	19.60
	I have a basic knowledge of what food traceability	66.80	68.40
	I have heard the term but do not know what it is	7.80	10.40
	I have never heard about food traceability	1.00	1.60

Table 7 displays consumers' awareness of blockchain technology. The results show that blockchain traceability awareness is limited for both olive oil and pasta consumers, with only 9.2% (olive oil) and 6.8% (pasta) demonstrating in depth knowledge. Basic understanding is marginally higher among olive oil consumers, but significant proportions remain unfamiliar.

Table 7 Consumers' Knowledge of Blockchain technology in food supply

	Scales	Percentage (%) Olive oil consumers	Percentage (%) pasta consumers
Knowledge of food traceability systems based on blockchain technology	I have in-depth knowledge of blockchain technology for traceability systems	9.20	6.80
	I have a basic knowledge of blockchain technology for traceability systems	31.40	27.80
	I've heard the term blockchain, but I don't know what it is	29.80	32.80
	I have never heard about blockchain technology	29.60	32.60

Table 8 presents the distribution of consumer perceptions regarding PDO and organic products. Italian Consumers exhibit a stronger positive perception toward PDO products compared to organic products, which are associated with greater neutrality and slightly higher negativity. This suggests that PDO certification may inspire more consumer trust and enthusiasm than organic labelling, potentially due to its specific association with geographical origin and quality standards.

Table 8 Consumer perceptions of PDO/PGI and organic products

	Very negative (%)	negative (%)	Neutral (%)	Positive (%)	Very positive (%)
PDO/PGI	0.40	0.20	13.20	47.40	38.80
Organic	0.80	3.00	37.60	43.00	15.60

3.2.2.4 Consumer habits

Table 9 presents the analysis of consumption habits for different types of olive oil and pasta. The results show that regular olive oil and regular pasta are the most frequently consumed products, with 46.8% and 75% of respondents, respectively, indicating that they consume these items either always or often. In contrast, organic variants and PDO/PGI products are consumed less regularly. For example, only 37% of respondents consume PDO/PGI olive oil always or often, and just 27.4% do so for PDO/PGI pasta. Notably, the proportion of respondents who never consume organic pasta (21.8%) or PDO/PGI pasta (17.6%) is considerably higher than for regular pasta (4.2%). These findings indicate that while there is some adoption of organic and certified regional products, traditional options remain dominant in consumer diets, reflecting both habitual consumption patterns and possibly factors such as accessibility, price sensitivity, and perceived value.

Table 9 Consumption habits of different type of Olive oil and pasta

	Always (%)	Often (%)	Sometimes (%)	Rarely (%)	Never (%)
Regular olive oil	16.80	30.00	21.20	12.40	19.60
Organic olive oil	15.00	22.00	30.60	16.20	16.20
PDO/ PGI olive oil	26.40	29.20	25.80	12.20	6.40
Regular pasta	38.00	37.00	15.80	5.00	4.20
Organic pasta	4.80	16.60	33.60	23.20	21.80
PDO/ PGI pasta	6.20	21.60	29.80	24.80	17.60

Table 10 shows the place consumers prefer to buy olive oil and pasta. The results demonstrate notable differences in where consumers prefer to purchase olive oil and pasta across different retail channels. Most olive oil buyers prefer specialty stores (53.8%), with online platforms being the second choice (19.4%). This highlights their preference for thoughtfully curated, high-quality shopping experiences and the convenience of accessing premium products. Conversely, pasta buyers predominantly favour specialty stores (90.2%), showing very little interest in online shopping (0.8%) or organic stores (1.6%). This shows people prefer trusted, specialized stores for buying pasta.

Table 10 preferred Places to buy olive oil and pasta

Place	Percentage (%) Olive oil	Percentage (%) pasta
Supermarket	4.40	2.00
Local Market	4.80	2.60
Online	19.40	0.80
Specialty Stores	53.80	90.20
Organic Stores	8.80	1.60
Agricultural Cooperative	3.40	2.00
Other	5.40	

3.2.2.5 Willingness to pay for certified products

We examined consumers' WTP for blockchain technology services in Italy's traceability system for olive oil and pasta (Table 11). The results show that the majority of consumers (73-84%) favour conventional traceability systems over blockchain technology (16-27%) for olive oil and pasta. This inclination is likely influenced by considerations such as cost, ease of use, and familiarity, while blockchain faces obstacles like complexity and limited awareness among consumers.

Table 11 Willingness to pay a traceability system

Traceability system	Percentage (%) Olive oil	Percentage (%) pasta
Regular traceability system	73.40	84.00
Blockchain system	26.60	16.00

The findings from the model estimation using the probit method and the marginal effects at the mean are shown in Table 12.

Table 12 **Factors affecting consumers' willingness to pay for blockchain technology**

Variables	Probit Olive oil	dy/dx olive oil	Probit pasta	dy/dx pasta
Sex	-.0379394	-.0112317	.1533203	.0286671
Income	.0937432***	.0727184***	.2474228**	.0462619**
Age	.0091386	.0027054	.0043166	.0008071
Loyalty	.0421646	.0124826	.1016474**	.0190055**
Knowledge of blockchain	.1391226	.0411864	.0013667	.0002555
Knowledge of traceability	-.0707499	-.0209451	-.0932469	-.0174348
Household size	.0119256	.0035305	-.0721847	-.0134967
People under 18 years old	-.0608099	-.0180024	.05198	.009719
PDO/organic perception	.1883587*	.0557624*	-.2638267*	-.049329*
Premium	-.2289586***	-.0677817***	-.6496247***	-.1214636***
Averint	.3311688***	.0980404***	-.2638267**	.0680747*
Aversn	-.0845273	-.0250238	.2936974**	.0549141**
Averpbc	.163566	.0484227	.1406978	.026307
Averatb	.1434205	.0424587	-.0812974	-.0152006
Avertqc	-.1559672	-.0461731	-.1810275	-.0338476
Averat	.1166942	.0345466	-.1075571	-.0201105
_Cons	-.919921		-.5337116	
LR chi2(16)				
Pseudo R2				
Correctly classified				

*, ** and *** indicate significance levels of 10%, 5% and 1%, respectively.

Calculations of marginal effects (on average) show that with a one-unit increase in income, PDO/organic perception, INT, assuming other conditions remain constant, the probability of WTP for use services of blockchain technology will increase. While with a one-unit increase in a premium price, the probability of WTP for blockchain will decrease which is in line with expectations.

3.2.3 Conclusions

This study presents new insights into the elements that impact on the intention of consumers to purchase products with protected designation of origin and organic with blockchain traceability. The findings, based on two typical products in Italy, suggest that successful marketing strategies should focus on informing consumers about the benefits of blockchains, simplification of the user experience and use of social influences to promote the adoption of blockchain-enabled traceability. the results show, customers' purchase intentions are positively impacted by Subjective Norms, Perceived Behavioural Control, attitude toward BCT, Trust toward Quality Certifications, Attitudes toward Technology although there was no significant impact of trust in the quality certificates. This shows that there are still gaps in consumer knowledge and perspectives about blockchain. In addition, policymakers must help consumers understand the ways in which blockchains can ensure food is safe, protect against fraud, and support sustainability initiatives. Effective communication should highlight transparency and accountability, and help consumers view blockchain as a valuable tool rather than a complex addition to their decision-making process.

3.3 Greece: PDO Feta Cheese

3.3.1 Descriptive analysis

Table 13 shows 56.20% of the sample are male, while 43.80% are female. Large portion of the sample (31.60%) are in the 50–59 age group. This is closely followed by the 40–49 age group, which accounts for 28.80% of the population. The biggest percentage (44.20%) of Greek respondents in the sample have a bachelor's or equivalent degree. This is closely followed by individuals with a middle school or high school education, who make up 39.60% of the population. These two groups represent the majority of the sample, totalling 83.80%, indicating that most individuals have completed at least high school or undergraduate education. In the sample, 55.80% of individuals are classified as middle-income. This indicates that more than half of the population is in this income range. Additionally, 31.40% are categorized as low income, while only 10.40% fall into the high-income category.

Table 13 Socio-demographic characteristics

Attributes	Details of respondents	Percentage (%) Greece	Attributes	Details of respondents	Percentage (%) Greece
Sex	Male	56.20	Employment Status	Student	4.20
	Female	43.80		Employee or self-employed	69.20
Age	18-29	9.00		Not employed	12.00
	30-39	17.60		Retired	12.40
	40-49	28.80		Other	2.20
	50-59	31.60	Income level (Euro/month)	Low income	31.40
	Over 60	13.00		Middle Income	55.80
Education	Elementary school	0		High Income	10.40
	Middle/ High school	39.60		I prefer not to answer	2.40
	Graduate	44.20			

3.3.2 Results

3.3.2.1 Reliability and validity

As shown in Table 14 and Table 15, the final measurement models, all indicator loadings exceed the 0.70 threshold, indicating that the construct explains more than half of the variance in the indicator, which signifies acceptable item reliability. Table 2 and Table 3 indicate that all composite reliability and Cronbach's alpha values are greater than 0.70, suggesting that the elements of the same latent variable are similar.

Table 14 and Table 15 illustrate that the AVE for each latent variable is greater than 0.50, indicating that each construct explains more than half of the variance of its items. Therefore, the results confirm convergent validity.

Table 14 Reliability and validity tests

Latent Construct	Items	Standardized loadings	Cronbach's alpha	CR	AVE
Intention (INT)	INT1	0.933	0.913	0.945	0.852
	INT2	0.898			
	INT3	0.937			
Subjective Norms (SN)	SN1	0.820	0.745	0.849	0.652
	SN2	0.855			
	SN3	0.744			
Perceived Behavioural Control (PBC)	PBC1	0.799	0.784	0.873	0.696
	PBC2	0.827			
	PBC3	0.874			
Attitude toward BCT (ATT)	ATT1	0.874	0.835	0.901	0.752
	ATT2	0.828			
	ATT3	0.897			
Trust toward Quality Certifications (TQC)	TQC1	0.855	0.892	0.924	0.754
	TQC2	0.843			
	TQC3	0.890			
	TQC4	0.883			
Attitudes toward Technology (TEC)	TEC1	0.903	0.869	0.920	0.792
	TEC2	0.863			
	TEC3	0.904			

The findings that all HTMT values fall below the recommended threshold of 0.85 (Hair et al. 2019), confirms the adequate discriminant validity for the individual constructs (Table 15). Thus, it is concluded that the measurement models for olive oil and pasta case studies satisfies the necessary criteria for both validity and reliability.

Table 15 Results of the discriminant validity test—HTMT

	INT	SN	PBC	ATT	TQC	TEC
INT						
SN	0.619					
PBC	0.456	0.459				
ATT	0.602	0.494	0.530			
TQC	0.374	0.487	0.530	0.384		
TEC	0.624	0.527	0.595	0.681	0.586	

3.3.2.2 Determinants of purchase intention for blockchain-traceable food products

The conclusions were derived from p-values (Table 16), which guided the decision to either accept or reject the hypotheses presented in the study.

To respond to H1, which posits that "subjective norms" positively influence the intention to purchase feta cheese tracked with blockchain technology," the findings reveal that subjective norms significantly and positively affect the intention to buy products traceable through blockchain. As a result, H1 is accepted.

In examining hypothesis H2, which proposes that "perceived behavioural control has a positive influence on the intention to buy feta cheese traced with blockchain technology," the results did not align with expectations. The findings indicated that perceived behavioural control did not have a significant effect on purchase intentions. Thus, H2 is not accepted.

In addressing hypothesis H3, which claims that "An attitude towards traceability positively influences the intention to buy feta cheese that uses blockchain technology," the results show that attitude towards traceability significantly and positively affects the intention to buy products traceable through blockchain. Consequently, H3 is accepted.

Hypothesis H4, which states, "Trust in quality certifications has a positive influence on the intention to purchase feta cheese that uses blockchain technology," was not accepted. This conclusion is based on the non-significant coefficient (-0.019) and a high p-value (0.649).

In relation to H5, which states, "Attitude towards technology positively influences the intention to buy feta cheese traced with blockchain technology," the TEC demonstrates a notable positive effect on purchase intention, indicated by a coefficient of 0.274. Thus, H5 is accepted.

Table 16 Result of the hypothesis testing

Hypothesis No.	Relationship	Coefficient	*p*-Value	Decision	R^2_a	Q^2	F^2
H1	SN -> INT	0.312	0.000***	✅	0.445	0.373	0.128
H2	PBC -> INT	0.058	0.154	❌			0.004
H3	ATT-> INT	0.214	0.000***	✅			0.051
H4	TQC -> INT	-0.019	0.649	❌			0.000
H5	TEC -> INT	0.274	0.000***	✅			0.069

*,**, and *** indicate significance levels of 10%, 5%, and 1%, respectively.
Confirmed: ✅, Unconfirmed: ❌

3.3.2.3 Awareness of food traceability, blockchain, and labelling

This section explores consumers' understanding of traceability systems and blockchain technology, their buying preferences, consumption habits, perception of quality labels, and WTP for blockchain labels.

Table 17 presents Greek consumers' understanding of traceability systems and blockchain technology, revealing that 41.00% of respondents have basic knowledge of food traceability. It means that feta cheese consumers have limited understanding of the concept. In fact, 30.80% have heard the term but do not know its meaning, and 18.60% have never heard of it at all. Just 9.60% of feta cheese consumers reported having in-depth knowledge. It indicates that though there is some awareness related to traceability systems, there is a lake of comprehensive understanding of food traceability.

Table 17 Consumers' Knowledge of Traceability

	Scales	Percentage (%)
Knowledge about food traceability	I have in-depth knowledge of food traceability	9.60
	I have a basic knowledge of what food traceability is	41.00
	I have heard the term but do not know what it is	30.80
	I have never heard about food traceability	18.60

Table 18 shows that the majority of respondents (35.40%) have heard about blockchain but lacked understanding of it. About one-third (33.60%) had basic knowledge of its use in traceability systems, while 25.40% reported never having heard of it at all. Only a small minority (5.60%) claimed to have in-depth knowledge of blockchain technology for traceability.

Table 18 Consumers' Knowledge of Blockchain technology in food supply

	Scales	Percentage (%)
Knowledge of food traceability systems based on blockchain technology	I have in-depth knowledge of blockchain technology for traceability systems	5.60
	I have a basic knowledge of blockchain technology for traceability systems	33.60
	I've heard the term blockchain, but I don't know what it is	35.40
	I have never heard about blockchain technology	25.40

Moreover, consumer perceptions of PDO products were examined. The results highlight a predominantly positive view, with positive and very positive sentiments dominating. A substantial segment holds a neutral perspective, while negative sentiments are minimal (Table 19).

Table 19 Consumer perceptions of PDO products

	Very negative	Negative	Neutral	Positive	Very positive
Percentage (%)	0.41	0.82	17.62	48.98	32.17

3.3.2.4 Consumer habits

Table 20 presents the consumption habits of Greek consumers regarding PDO Feta cheese, Organic PDO Feta cheese, and white cheese, a substitute of the original PDO feta cheese using cow milk instead of sheep and goat milk. As it can be seen in the table, there are variations in consumer preferences and habits regarding different types of feta cheese, with the White cheese being the most commonly used, followed by PDO feta cheese, and organic feta cheese being the least consumed.

Table 20 Consumption habits of different type of feta cheese

	Always (%)	Often (%)	Sometimes (%)	Rarely (%)	Never (%)
White cheese	33.60	40.60	15.80	7.80	2.20
Organic PDO feta cheese	2.80	7.80	18.20	37.00	34.20
PDO feta cheese	22.00	41.00	21.60	10.80	4.60

Moreover, we investigate Greek consumers' perceptions of PDO feta cheese. We asked them to rate, on a scale from 0 to 10, how likely they are to recommend this product to their family, friends, or acquaintances. The results show that a substantial majority of respondents (87.2%) express a likelihood of recommending PDO feta cheese to others. Conversely, a minority of respondents (12.8%) remain either neutral or unlikely to make such a recommendation (Table 21).

Table 21 Likelihood of Recommending PDO Feta Cheese to Friends (Loyalty)

Scales	Percentage (%)
Not at all likely	1.20

Scales	Percentage (%)
Extremely unlikely	0.40
Very unlikely	1.20
Unlikely	1.20
Somewhat unlikely	1.60
Neutral	7.20
Somewhat likely	7.20
Likely	10.60
Very likely	25.20
Extremely likely	17.00
Most likely to recommend	27.20

Where consumers buy products is an important aspect of consumers' decision processes. With feta cheese, consumers typically have certain locations where they seek out the product and those locations may influence their purchasing behaviour. The preference is influenced by various factors: convenience, quality, and price. In this study, we examined where Greek consumers want to purchase feta cheese. The data shows 83.8% of consumers prefer supermarkets as their buying locations. Local markets are 7.2% and specialty stores are selected by 63% of consumers. The low preference of online shopping at 1.2% shows there is growth potential in the future as digital ecommerce is growing (Table 22).

Table 22 Preferred Places to Buy PDO Feta Cheese

Place	Percentage (%)
Supermarket	83.80
Local Market	7.20
Online	1.20
Specialty Stores	2.80
Organic Stores	2.80
Agricultural Cooperative	1.80
Other	0.40

3.3.2.5 Willingness to pay for using the services of blockchain

We examined consumers' WTP for blockchain technology services in the traceability system for PDO feta cheese in Greece. Table 23 shows that a small percentage of respondents (26%) indicated a WTP a premium for PDO feta cheese tracked with blockchain technology. While 74% reported they preferred to use a regular traceability system without paying a premium.

The findings from the model estimation using the probit method and the marginal effects at the mean are shown in Table 24, which indicate that the Likelihood Ratio (LR) is significant at the 1% level, highlighting the overall significance of the regression.

Calculations of marginal effects (on average) show that with a one-unit increase in income, age, PBC, ATB, assuming other conditions remain constant, the probability of WTP for use services of blockchain technology will increase on average by 0.122, 0.004, 0.060, and 0.086 units, respectively, will increase. While with a one-unit increase in a premium price, the probability of WTP for blockchain on average by -0.153 unit will decrease which is in line with expectations.

Table 23 Willingness to pay a traceability system

Traceability system	Percentage (%)

Regular traceability system	74.00
Blockchain system	26.00

Table 24 Factors affecting consumers' willingness to pay for blockchain technology

Variables	Probit	dy/dx
Sex	-.076 (.137)	-0.021 (0.038)
Income	.443 (.099)***	0.122 (0.026)***
Age	.015 (.006)**	0.004 (0.002)**
Loyalty	.002 (.041)	0.001 (0.011)
Knowledge of blockchain	-.054 (.106)	-0.015 (0.029)
Knowledge of traceability	.086 (.104)	0.024 (0.029)
Household size	-.062 (.084)	-0.017 (0.023)
People under 18 years old	-.017 (.121)	-0.005 (0.033)
PDO perception	.025 (.110)	0.007 (0.030)
Premium	-.556 (.095)***	-0.153 (0.024)***
Averint	-.086 (.102)	-0.024 (0.028)
Aversn	.090 (.091)	0.025 (0.025)
Averpbc	.217 (.107)**	0.060 (0.029)**
Averatt	.311 (.117)***	0.086 (0.032)***
Avertqc	-.084 (.097)	-0.023 (0.027)
Averat	-.042 (.126)	-0.012 (0.035)
_Cons	.070 (.881)	
LR chi2(16)	82.06***	
Pseudo R2	0.1432	
Correctly classified	77.00%	

The numbers enclosed in parentheses represent the standard deviation, while *, ** and *** indicate significance levels of 10%, 5% and 1%, respectively.

3.3.3 Conclusions

This study presents new insights into the elements that impact on the intention of consumers to purchase products with protected designation of origin and organic with blockchain traceability. The findings, based on two typical products in Greece, suggest that successful marketing strategies should focus on informing consumers about the benefits of blockchains, use of social influences to promote the adoption of blockchain-enabled traceability. the results show, customers' purchase intentions are positively impacted by Subjective Norms, Attitude toward BCT, AND Attitudes toward Technology, although there was no significant impact of trust in the quality certificates. This shows that there are still gaps in consumer knowledge and perspectives about blockchain technology. In addition, policymakers must help consumers understand the ways in which blockchains can ensure food is safe, protect against fraud, and support sustainability initiatives. Effective communication should highlight transparency and accountability, and help consumers view blockchain as a valuable tool rather than a complex addition to their decision-making process.

3.4 Spain: PGI Faba Beans

3.4.1 Descriptive analysis

The socio-demographic profile of respondents in Spain is shown in Table 25. In this sample, 57% are male and 43% are female. The age distribution is fairly even, with a significant concentration in the 40–59 age range, which makes up 44.8% of the respondents. The educational background is particularly impressive, as 62.6% have obtained graduate or postgraduate degrees, suggesting a highly educated population. Employment statistics show that 66.8% of respondents are employed or self-employed, while 15.6% are retired, and 8% are unemployed or not participating in the labour force. Income levels are mostly situated in the middle-income category (59.4%), followed by those in the high-income bracket at 20.4% and low-income earners at 17.8%, reflecting a moderate economic diversity within the sample.

Table 25 Socio-demographic characteristics

Attributes	Details of respondents	Percentage (%) Spain	Attributes	Details of respondents	Percentage (%) Spain
Sex	Male	57.00	Employment Status	Student	6.20
	Female	43.00		Employee or self-employed	66.80
Age	18-29	17.20		Unemployed / Inactive	8.00
	30-39	17.00		Retired	15.60
	40-49	22.00		Other	3.40
	50-59	22.80	Income level (Euro / month)	Low income	17.80
	Over 60	21.00		Middle Income	59.40
Education	Elementary school	0.60		High Income	20.40
	High school	36.80		I prefer not to answer	2.40
	Graduate	43.80			
	Postgraduate	18.80			

3.4.2 Results

3.4.2.1 Reliability and validity

In the initial phase of the analysis, we assessed the loadings of the indicators. Table 26 in the final measurement model indicates that all indicator loadings are greater than 0.70, demonstrating that the construct explains more than half of the variance for each indicator, which confirms adequate item reliability.

Table 26 also shows that all composite reliability and Cronbach's alpha values exceed 0.70, implying that the components of the same latent variable are coherent with one another.

Table 26 shows that the AVE for each latent variable exceeds 0.5, meaning the construct accounts for more than half of the variance of its items. In conclusion, Table 26 indicates that the standardized loadings, Cronbach's alpha, CR, and AVE all exceed the thresholds suggested in the literature. Thus, the findings support the confirmation of convergent validity.

Table 26 Reliability and validity tests

Latent Construct	Items	Standardized loadings	Cronbach's alpha	CR	AVE
Intention (INT)	INT1	0.908	0.895	0.935	0.827
	INT2	0.913			
	INT3	0.907			
Subjective Norms (SN)	SN1	0.858	0.761	0.860	0.674
	SN2	0.849			
	SN3	0.751			
Perceived Behavioural Control (PBC)	PBC1	0.851	0.826	0.896	0.741
	PBC2	0.844			
	PBC3	0.887			
Attitude toward BCT (ATB)	ATB1	0.905	0.887	0.930	0.815
	ATB2	0.893			
	ATB3	0.911			
Trust toward Quality Certifications (TQC)	TQC1	0.822	0.858	0.903	0.700
	TQC2	0.817			
	TQC3	0.857			
	TQC4	0.850			
Attitudes toward Technology (TEC)	TEC1	0.897	0.824	0.895	0.741
	TEC2	0.798			
	TEC3	0.884			

The findings in **Table** 27 indicate that all HTMT remain below the accepted threshold of 0.85 as suggested by Hair et al. (2019). This confirms that the individual constructs possess sufficient discriminant validity. Therefore, we can conclude that the measurement model satisfies the essential criteria for validity and reliability, which encompasses both convergent and discriminant validity as well as overall reliability.

Table 27 Results of the discriminant validity test— HTMT

	INT	SN	PBC	ATB	TQC	TEC
INT						
SN	0.687					
PBC	0.576	0.569				
ATB	0.692	0.698	0.500			

	INT	SN	PBC	ATB	TQC	TEC
TQC	0.494	0.624	0.582	0.590		
TEC	0.607	0.561	0.463	0.634	0.439	

3.4.2.2 Determinants of purchase intention for blockchain-traceable food products

Using the result of Table 28 we test the hypothesis. To answer H1: "Subjective norms positively affects the intention to purchase Faba Beans traced with blockchain technology", as it can be seen in Table 28 SN have a statistically significant positive effect on the intention to purchase blockchain-traceable products. Therefore, the H1 is accepted. However, the effect size was (0.063) small.

To answer hypothesis H2 "perceived behavioural control positively affects the intention to purchase Faba Beans traced with blockchain technology", it was also found to have a positive and significant effect on intention. However, the effect size was (0.055) smaller than SN. Thus, H2 is accepted.

In response to H3 "Attitude towards traceability positively affects the intention to purchase Faba Beans traced with blockchain technology", it was also found to have a positive and significant effect on intention. However, the effect size (0.091) was bigger than SN and PBC. Thus, H3 is accepted.

Hypothesis H4, "Trust in quality certifications positively affects the intention to purchase Faba Beans traced with blockchain technology", was not supported, as indicated by the non-significant coefficient with high p-value. Therefore, Hypothesis H4 Is not accepted.

To answer H5 "Attitude towards technology positively affects the intention to purchase Faba Beans traced with blockchain technology", TEC has a significant and positive influence on purchase intention with a coefficient of 0.176. The effect size was 0.042, indicating that the effects are small. Therefore, the H5 is accepted.

Table 28 Result of the hypothesis testing

Hypothesis No.	Relationship	Coefficient	*p*-Value	Decision	R^2_a	Q^2	F^2
H1	SN -> INT	0.234	0.000***	✅		0.411	0.063
H2	PBC -> INT	0.199	0.000***	✅			0.055
H3	ATB-> INT	0.294	0.000***	✅	0.507		0.091
H4	TQC -> INT	0.006	0.880	❌			0.000
H5	TEC -> INT	0.176	0.000***	✅			0.042

*,**, and *** indicate significance levels of 10%, 5%, and 1%, respectively.

Confirmed: ✅, Unconfirmed: ❌

3.4.2.3 Awareness of food traceability, blockchain, and labelling

Table 29 shows that the majority of consumers (77.8%) have at least a basic knowledge of food traceability in the context of fava beans, with 20.8% reporting in-depth knowledge and 57.0% indicating basic understanding. In contrast, 18.6% have only heard the term without understanding it, and just 3.6% have never heard of food traceability. The results indicate that awareness of food traceability is high among respondents, suggesting a strong foundation for further educational or traceability initiatives in this sector.

Table 29 Consumers' Knowledge of Traceability

	Scales	Percentage (%)
Knowledge about food traceability	I have in-depth knowledge of food traceability	20.80
	I have a basic knowledge of what food traceability is	57.00
	I have heard the term but do not know what it is	18.60
	I have never heard about food traceability	3.60

Table 30 represents consumers knowledge of blockchain in food supply. The results show that consumer knowledge of blockchain technology for traceability systems is limited. Only 11.0% of respondents report having in-depth knowledge, and 37.2% have basic knowledge, meaning that less than half (48.2%) possess at least a basic understanding of this technology. In contrast, 23.4% have merely heard the term "blockchain" without knowing what it is, and a significant 28.4% have never heard of blockchain technology at all.

Table 30 Consumers' Knowledge of Blockchain technology in food supply

	Scales	Percentage (%)
Knowledge of food traceability systems based on blockchain technology	I have in-depth knowledge of blockchain technology for traceability systems	11.00
	I have a basic knowledge of blockchain technology for traceability systems	37.20
	I've heard the term blockchain, but I don't know what it is	23.40
	I have never heard about blockchain technology	28.40

Consumer perceptions of PGI products are presented in Table 31. the results show that consumer perceptions of PGI products are largely positive, with 68% of consumers rating them as positive or very positive (45.4% positive and 22.6% very positive). Additionally, 29% of consumers remain neutral, while only 3% hold negative or very negative views. This distribution reflects a strong acceptance of PGI products, which are often associated with quality, authenticity, and regional origin. However, the significant proportion of neutral responses indicates an opportunity for improved consumer education and marketing strategies to further enhance positive perceptions and address any gaps in understanding the benefits of PGI products.

Table 31 shows Spanish consumers' perceptions of PGI products. As can be seen from the results of the analysis, the Spanish consumers perceptions of PGI products are overwhelmingly positive, as there 68% of consumers rated them as positive or very positive (a positive rating was given by 45.4% and a very positive rating was given by 22.6%). Also, only 29% of consumers rated the idea of PGI products as neutral, and 3% rated it as negative or very negative. These results indicate a strong acceptance of PGI products, but the neutral response rate shows that consumer education and marketing opportunities for PGI products in Spain are potentially lacking in a way that might enhance positive perceptions, or to provide consumers with the benefits experienced by producers.

Table 31 Consumer perceptions of PGI products

	Very negative	negative	Neutral	Positive	Very positive
Percentage (%)	1.00	2.00	29.00	45.40	22.60

3.4.2.4 Consumption habits

The consumption of fava beans revealed considerable variances between different product types (Table 5). Regular fava beans were noted to have a higher frequency of consumption in that 16.2% of respondents stated that they "always" consumed fava and another 30.8% replied that they "often" consumed fava beans, representing a high percentage of consumer acceptance. However, the organic and/or PDO, PGI varieties showed little adoption with only 3.4% and 2.8% of consumers saying "always eat" those types respectively. The "never" percentages also revealed higher consumer numbers with organic fava beans at 26.2% and PDO/PGI fava beans at 29.4%. this result show that the traditional fava beans as being dominant in consumption habits while organic and PDO/PGI systems for fava beans are at the non-traditional periphery producing niche consumption. An example of this finite appearance may be related to accessibility, affordability, and awareness of these types of fava beans. A greater targeted strategy is needed to accelerate the market presence of organic and PDO/PGI fava beans.

Table 32 Consumption habits of different type of fava beans

	Always (%)	Often (%)	Sometimes (%)	Rarely (%)	Never (%)
Regular fava beans	16.20	30.80	36.00	14.40	2.60
Organic fava beans	3.40	9.40	27.40	33.60	26.20
PDO/ PGI fava beans	2.80	10.80	26.80	30.20	29.40

Table 33 presents consumer loyalty towards PGI Asturian faba beans. The results suggest that a majority of people (62%) are somewhat likely to recommend PGI Asturian fava beans, while 13% are their strongest fans. There are approximately 16% who are neutral and do not feel strongly for or against recommendation and only 9% said they would not recommend the item at all. This engenders a strong base of support for the product but there is an opportunity to convert the neutral group by better communicating the unique features of the product and its regional authenticity.

Table 33 Likelihood of Recommending PGI Asturian fava beans to Friends (Loyalty)

Scales	Percentage (%)
Not at all likely	2.00
Extremely unlikely	0.40
Very unlikely	1.60
Unlikely	2.40
Somewhat unlikely	2.40
Neutral	16.20
Somewhat likely	9.40
Likely	20.20
Very likely	18.60
Extremely likely	13.80
Most likely to recommend	13.00

Table 34 shows the preferred locations for purchasing fava beans. The results show that supermarkets account for 68.4% of fava bean purchases. This indicates consumer preference for convenience and accessibility. Local markets are the next source at 15%, possible because of the freshness and regional authenticity. Specialty stores made up 7.4%, while organic stores made up 4.6%, indicating a small part of the market was demanding for quality. There was little interaction in online (2%) and cooperative (2.4%) channels, which indicates a missed opportunity in pursuing direct sales and sustainability drives.

Table 34 Preferred Places to Buy fava beans

Place	Percentage (%)
Supermarket	68.40
Local Market	15.00
Online	2.00
Specialty Stores	7.40
Organic Stores	4.60
Agricultural Cooperative	2.40
Other	0.20

3.4.2.5 Willingness To Pay results

We examined consumers' WTP for blockchain technology services in the traceability system for Fava beans in Spain. The results in Table 35 show that a vast majority of respondents, at 74.4%, favour a traditional traceability system for fava beans, likely because they are more familiar with it and consider it to be cost-effective. Conversely, the 25.6% that prefer blockchain technology indicate a smaller, niche market that is interested in more sophisticated and transparent solutions, possibly reflecting the preferences of tech-savvy and quality-focused consumers.

Table 35 Willingness to pay a traceability system

Traceability system	Percentage (%)
Regular traceability system	74.40
Blockchain system	25.60

The findings from the model estimation using the probit method and the marginal effects at the mean are shown in Table 36.

Calculations of marginal effects (on average) show that with a one-unit increase in sex, INT, SN assuming other conditions remain constant, the probability of WTP for use services of BCT will increase. While with a one-unit increase in a premium price and TQC the probability of WTP for blockchain will decrease which is in line with expectations.

Table 36 Factors affecting consumers' willingness to pay for blockchain technology

Variables	Probit	dy/dx
Sex	.2536034*	.0754683*
Income	.0943662	.0136914
Age	-.0029911	-.0008225
Loyalty	.0460085	.0126522
Knowledge of blockchain	.065089	.0193694
Knowledge of traceability	-.0855312	-.0254527
Household size	.023168	.0068944
People under 18 years old	-.1389497	-.0413492
PDO perception	-.0156288	-.0046509

Variables	Probit	dy/dx
Premium	-.3804352***	-.1132115***
Averint	.2707509**	.0805712**
Aversn	.2141361*	.0637235*
Averpbc	-.0257587	-.0076654
Averatb	.142166	.0423064
Avertqc	-.2531878**	-.0753447**
Averat	-.03844	-.0114391
_Cons	1.291373	
LR chi2(16)		
Pseudo R2		
Correctly classified		

*,**, and *** indicate significance levels of 10%, 5%, and 1%, respectively.

3.4.3 Conclusions

This study contributes additional knowledge to the factors that influence consumers' intention to purchase blockchain-labelled Fava beans. The study notes that whereas attitudes toward the technology are positively related to consumer purchase intentions, general attitudes toward products with blockchain traceability and trust in current quality standards and certifications do not appear to predict consumer purchase intentions. Our findings suggest that marketing efforts should prioritize consumer education about the demonstrations of value associated with blockchain, streamline the user experience, and rely on social constructs to enable the adoption of blockchain-developed traceability.

These results offer significant implications for both policy makers and producers in the agri-food industry. For policy makers, Duan et al. (2024) indicate that blockchain technology can be leveraged to address food fraud and concerns for food safety and quality, thus our results indicate the need for policies and regulations to facilitate the adoption and implementation of blockchain as a wide-reaching tool in the food supply chain. Governments can create incentives for Blockchain adoption which, in theory, can provide greater confidence to food certifications and categorizations-based Quality standards through legislation and financial incentives aimed at implementing practices that support blockchain as an added requirement. First, governments could establish consumer education programs which could include campaigns and digital tools to grow awareness and consumer literacy on how blockchain is being used to improve food safety and authenticity. Lastly, regulators could create National standards that are clear and enforceable.

3.5 France: Organic Honey

3.5.1 Descriptive analysis

The socio-demographic data in Table 37 provide an overview of respondents' characteristics, including biological sex, age, education level, occupation, and income. This analysis is vital for understanding the sample's composition and its implications for the research findings. The socio-demographic profile of the respondents indicates a nearly equal distribution of sex, with 49% male and 51% female participants. The majority of respondents are younger to middle-aged individuals. The educational levels are notably high, with no participants having completed only elementary school: 17.2% have completed middle or high school, 52.6% are graduates, and 30.2% hold postgraduate degrees. In terms of employment status, a significant majority are employed (74%), while smaller groups consist of students, unemployed individuals, retirees, and others. Income levels primarily fall within the middle-income bracket (46%), followed by low-income (31%) and high-income (20.6%) categories.

Table 37 Socio-demographic characteristics (France/Organic Honey)

	Detail of respondents	*Percentage (%) (France)*
Sex	Male	49.00
	Female	51.00
	18-29	24.40
	30-39	22.20
	40-49	21.60
	50-59	18.40
	Over 60	13.40
Education	Elementary school	0
	Middle school/ High school	17.20
	Graduate	52.60
	Postgraduate	30.20
Occupation	Student	6.40
	Employed or employee, or self-employed	74.00
	Not employed	7.80
	Retired	10.60
	Other	1.20
Income level (Euro / month)	Low income	31.00
	Middle Income	46.00
	High Income	20.60
	I prefer not to answer	2.40

3.5.2 Results

3.5.2.1 Reliability and validity

To determine the convergent validity of the measurement model, we assessed the loadings of the indicators, the AVE and the CR as well as Cronbach's alpha. According to the literature, these values and the loadings of the indicators must be higher than 0.70, 0.70, 0.5 and 0.70, respectively. Accordingly, the loadings of the indicators were examined at in the first stage. As shown in Table 38 in the final measurement model, all indicator loadings exceed the threshold of 0.70. It means that the construct explains over half of the variance of the indicator. Therefore, acceptable item reliability is provided. As Table 4 shows all composite reliability and Cronbach α values are higher than 0.70.

Table 38 displays that the AVE from each latent variable is higher than 0.5. it means that the construct explains more than half of the variance of its items.

Table 38 Reliability and validity tests

Latent Construct	Items	Standardised loadings	Cronbach's alpha	CR	AVE
Intention (INT)	INT1	0.918	0.889	0.931	0.819
	INT2	0.901			
	INT3	0.896			

Latent Construct	Items	Standardised loadings	Cronbach's alpha	CR	AVE
Subjective Norms (SN)	SN1	0.845	0.818	0.891	0.732
	SN2	0.880			
	SN3	0.841			
Perceived Behavioural Control (PBC)	PBC1	0.886	0.840	0.903	0.758
	PBC2	0.820			
	PBC3	0.903			
Attitude toward BCT (ATB)	ATB1	0.925	0.911	0.944	0.849
	ATB2	0.908			
	ATB3	0.930			
Trust toward Quality Certifications (TQC)	TQC1	0.855	0.893	0.926	0.757
	TQC2	0.857			
	TQC3	0.889			
	TQC4	0.879			
Attitudes toward Technology (TEC)	TEC1	0.889	0.765	0.863	0.680
	TEC2	0.699			
	TEC3	0.874			

The result of Table 39 illustrates that all HTMT are below the threshold value of 0.85 recommended by (Hair et al., 2019), which confirms the sufficient discriminant validity of the individual constructs.

Table 39 Results of the discriminant validity test—HTMT

	INT	SN	PBC	ATB	TQC	TEC
INT						
SN	0.623					
PBC	0.442	0.565				
ATB	0.571	0.623	0.601			
TQC	0.376	0.565	0.497	0.570		
TEC	0.495	0.519	0.582	0.608	0.364	

3.5.2.2 Determinants of purchase intention for blockchain-traceable food products

To answer H1: "Subjective norms positively affects the intention to purchase honey traced with blockchain technology", as it can be seen in Table 40 SN have a statistically significant positive effect on the INT to purchase blockchain-traceable products. Therefore, the H1 is accepted. The effect size was large indicating that social influence plays a significant role in shaping consumer behaviour.

To answer hypothesis H2 "perceived behavioural control positively affects the intention to purchase honey traced with blockchain technology", it was also found to have a positive and significant effect on intention. However, it is not statistically significant. Thus, H2 is not accepted.

In response to H3 "Attitude towards traceability positively affects the intention to purchase honey traced with blockchain technology", it was also found to have a positive and significant effect on intention. However, the effect size (0.091) was smaller than SN. Thus, H3 is accepted.

Hypothesis H4, "Trust in quality certifications positively affects the intention to purchase honey traced with blockchain technology", was not supported, as indicated by the non-significant coefficient and high p-value. Therefore, Hypothesis H4 Is not accepted.

To answer H5 "Attitude towards technology positively affects the intention to purchase honey traced with blockchain technology", TEC has a significant and positive influence on purchase intention with a coefficient of 0.249. The effect size was 0.051, indicating that the effects are small. Therefore, the H5 is accepted.

Table 40 Result of the hypothesis testing for Honey

Hypothesis No.	Relationship	Coefficient	*p*-Value	Decision	R^2_a	Q^2	F^2
H1	SN -> INT	0.325	0.000***	✅	0.369	0.303	0.105
H2	PBC -> INT	0.038	0.402	❌			0.001
H3	ATB-> INT	0.135	0.002***	✅			0.019
H4	TQC -> INT	0.003	0.938	❌			0.000
H5	TEC -> INT	0.249	0.000***	✅			0.051

*, **, and *** indicate significance levels of 10%, 5%, and 1%, respectively.
Confirmed: ✅, Unconfirmed: ❌

3.5.2.3 Traceability and blockchain label awareness in honey purchases

Table 41 on knowledge of food traceability among respondents revealed differing levels of knowledge. Approximately 18.4% had in-depth knowledge, while 63.6% had a basic understanding, without detailed insights. Furthermore, 14.6% indicated they had heard the term, but did not know what it meant, with 3.4% completely unaware of it. Overall, there is evidence that many respondents are aware of food traceability, but the difference in the level of knowledge was significant in terms of level of education, and that only a few percentages of respondents had in-depth knowledge.

Table 41 Consumers' Knowledge of Traceability

	Scales	Percentage (%)
Knowledge about food traceability	I have in-depth knowledge of food traceability	18.40
	I have a basic knowledge of what food traceability is	63.60
	I have heard the term but do not know what it is	14.60
	I have never heard about food traceability	3.40

The data on food traceability systems using blockchain technology reveals a limited understanding among respondents (Table 42). Only 6.4% have in-depth knowledge of blockchain for traceability, while 23.2% have a basic awareness. Additionally, 27.0% have heard the term "blockchain" but lack in-depth knowledge, and 43.4% are completely unaware of it.

Table 42 Consumers' Knowledge of Blockchain technology in food supply

	Scales	Percentage (%)
Knowledge of food traceability systems based on blockchain technology	I have in-depth knowledge of blockchain technology for traceability systems	6.40
	I have a basic knowledge of blockchain technology for traceability systems	23.20
	I've heard the term blockchain, but I don't know what it is	27.00
	I have never heard about blockchain technology	43.40

The data from Table 43 indicates that consumer perceptions of organic products are largely positive. Only 1.40% express very negative views and 6.60% are negative, while 34.80% remain neutral. In contrast, 41.20% view organic products positively and 16.00% are very positive. This overall favourable view suggests that organic products are well-received, though the significant level of neutrality implies a need for increased education about their benefits.

Table 43 Consumer perceptions of organic products

	Very negative	Negative	Neutral	Positive	Very positive
Percentage (%)	1.40	6.60	34.80	41.20	16.00

3.5.2.4 Consumption habits

The consumption habits of different honey types, as shown in Table 44, reveal interesting consumer behaviours. Regular honey is consumed "sometimes" by the largest group of respondents (32%), while organic honey is consumed "always" by a slightly higher percentage (12.4%) compared to regular honey (8%). PDO/PGI honey follows a similar pattern, with a significant "often" consumption rate of 19.2%. These findings highlight diverse consumer preferences and suggest that organic and PDO/PGI honey might benefit from perceptions of quality and health, which could guide marketing and production strategies.

Table 44 Consumption habits of different type of honey

	Always (%)	Often (%)	Sometimes (%)	Rarely (%)	Never (%)
Regular honey	8.00	18.00	32.00	25.20	16.80
Organic honey	12.40	17.40	27.60	24.20	18.40
PDO/ PGI honey	10.00	19.20	27.60	22.60	20.60

The results presented in Table 45 indicate the likelihood of respondents recommending organic honey to their friends, measured on a 10-point scale ranging from "Not at all likely" to "Most likely to recommend." The data shows a positive skew in responses, with the combined percentages of "Somewhat likely," "Likely," "Very likely," and "Extremely likely" totalling 58.6%. This indicates a majority inclination toward recommending organic honey.

The highest individual percentages are for "Very likely" (18.8%) and "Likely" (18.4%), suggesting a strong loyalty among a significant portion of respondents. In contrast, negative responses ("Not at all likely" to "Somewhat unlikely") account for only 13%, reflecting relatively low dissatisfaction. Neutral responses stand at 14.2%, highlighting a segment of respondents who are undecided or indifferent.

This distribution suggests that while there is a favourable tendency toward recommending organic honey, there are opportunities to convert neutral and undecided customers into loyal advocates.

Table 45 Likelihood of Recommending organic honey to Friends (Loyalty)

Scales	Percentage (%)
Not at all likely	2.60
Extremely unlikely	1.40
Very unlikely	3.00
Unlikely	2.40
Somewhat unlikely	3.60
Neutral	14.20
Somewhat likely	11.20
Likely	18.40
Very likely	18.80
Extremely likely	10.20
Most likely to recommend	14.20

The findings presented in Table 46 highlight the preferred places for purchasing honey among respondents. Supermarkets were the most popular choice, capturing 43.8% of preferences, indicating their dominance as a convenient and accessible retail option. Direct purchases from beekeepers ranked second at 26.8%, showing a significant interest in sourcing honey directly from producers. This preference may stem from perceptions of quality, authenticity, or a desire to support local businesses.

Local shops and markets accounted for 16% of preferences, indicating a moderate interest in traditional or community-based outlets. Specialty stores represented 6.6%, reflecting a niche market for premium or curated honey products. Online purchases were relatively low at 3%, suggesting limited adoption of digital platforms for buying honey. Agricultural cooperatives (3.2%) and other sources (0.6%) showed minimal preference among respondents.

Table 46 Preferred Places to buy honey

Place	Percentage (%)
Supermarket	43.80
Local shops and markets	16.00
Online	3.00
Specialty Stores	6.60
Direct from a beekeeper	26.80
Agricultural Cooperative	3.20
Other	0.60

3.5.2.5 Willingness To Pay results

Table 47 shows French respondents' preferences for the blockchain label. Results show a strong preference for regular traceability systems, with 75.4% of respondents indicating support for those systems. This finding indicates a strong inclination for familiar verification processes, likely a result of familiarity, cost considerations, or the belief that traditional traceability systems could be employed to monitor for quality. On the contrary, traceability systems using blockchain technology received much lower support (24.6%). There seems to be reluctance to utilize new technology perhaps due to the associated costs of implementation, high technology complexity, or confusion about potential advantages of adopting blockchain systems for supply chain transparency. Overall, the findings highlight a clear consumer preference for traditional and well-established traceability systems and aversion to less known or unfamiliar systems.

Table 47 Willingness to pay a traceability system

Traceability system	Percentage (%)
Regular traceability system	75.40
Blockchain system	24.60

The findings from the model estimation using the probit method and the marginal effects at the mean are shown in Table 48. Calculations of marginal effects (on average) show that with a one-unit increase in Income, Knowledge of blockchain, Organic perception, INT, ATB assuming other conditions remain constant, the probability of WTP for use services of blockchain technology will increase. While with a one-unit increase in a premium price and TQC the probability of WTP for blockchain will decrease.

Table 48 Factors affecting consumers' willingness to pay for blockchain technology

Variables	Probit	dy/dx
Sex	.1833717	.0525281
Income	.241301***	.0691224***
Age	-.0015889	-.0004552
Loyalty	-.0044707	-.0012807
Knowledge of blockchain	.19392**	.0555498**
Knowledge of traceability	.0422881	.0121137
Household size	.0850447	.0243617
People under 18 years old	-.1575926	-.0451435
Organic perception	.1727978*	.0494992*
Premium	-.0976947**	-.0279854**
Averint	.1882576**	.0539277**
Aversn	.1201635	.0344217
Averpbc	.1097529	.0314395
Averatb	.4031655***	.1154897***
Avertqc	-.306857***	-.0879014***
Averat	.032744	.0093797
_Cons	-3.593139***	
LR chi2(16)		
Pseudo R2		
Correctly classified		

*,**, and *** indicate significance levels of 10%, 5%, and 1%, respectively.

3.5.3 Conclusions

This study contributes additional knowledge to the factors that influence consumers' intention to purchase blockchain-labelled honey. The study notes that whereas attitudes toward the technology are positively related to consumer purchase intentions, perceived behavioural control and trust in current quality standards and certifications do not appear to predict consumer purchase intentions. Our findings suggest that marketing efforts should prioritize consumer education about the demonstrations of value associated with blockchain, streamline the user experience, and rely on social constructs to enable the adoption of blockchain-developed traceability.

These results offer significant implications for both policy makers and producers in the agri-food industry. For policy makers, (Duan et al. 2024) indicate that blockchain technology can be leveraged to address food fraud and concerns for food safety and quality, thus our results indicate the need for policies and regulations to facilitate the adoption and implementation of blockchain as a wide-reaching tool in the food supply chain. Governments can create incentives for Blockchain adoption which, in theory, can provide greater confidence to food certifications and categorizations-based Quality standards through legislation and financial incentives aimed at implementing practices that support blockchain as an added requirement. First, governments could establish consumer education programs which could include campaigns and digital tools to grow awareness and consumer literacy on how blockchain is being used to improve food safety and authenticity. Lastly, regulators could create National standards that are clear and enforceable.

3.6 Croatia: PGI Lika Potatoes

3.6.1 Descriptive analysis

The socio-demographic profile of Croatia responses indicates a female majority, comprising 52.2% of the population (Table 49). The largest age groups are those aged 40-49 years (27.6%) and 50-59 years (26.6%). In terms of educational attainment, the majority are high school graduates (53%), followed by university graduates (45.8%). Employment data shows that 74% of individuals are either employed or self-employed. Regarding income distribution, a majority fall into the middle-income category (51.6%), while high-income individuals represent 25.6%, and low-income individuals account for 19.4%. Additionally, there is a small percentage (3.4%) of individuals who chose not to disclose their income.

Table 49 Socio-demographic characteristics (Croatia/PGI Lika Potatoes)

Attributes	*Details of respondents*	*Percentage (%) Croatia*	*Attributes*	*Details of respondents*	*Percentage (%) Croatia*
Sex	Male	47.80	Employment Status	Student	3.20
	Female	52.20		Employee or self-employed	74.00
Age	18-29	11.60		Unemployed/ Inactive	9.40
	30-39	21.00		Retired	11.20
	40-49	27.60		Other	2.20
	50-59	26.60	Income level (Euro / month)	Low income	19.40
	Over 60	13.20		Middle Income	51.60

Attributes	Details of respondents	Percentage (%) Croatia	Attributes	Details of respondents	Percentage (%) Croatia
Education	Elementary school	0.20		High Income	25.60
	High school	53.00		I prefer not to answer	3.40
	Graduate	45.80			
	Postgraduate	1.00			

3.6.2 Results

3.6.2.1 Reliability and validity

In the initial phase of the analysis, we assessed the loadings of the indicators. Table 50 in the final measurement model indicates that all indicator loadings are greater than 0.70, demonstrating that the construct explains more than half of the variance for each indicator, which confirms adequate item reliability.

Table 50 also shows that all composite reliability and Cronbach's alpha values exceed 0.70, implying that the components of the same latent variable are coherent with one another.

Table 50 shows that the AVE for each latent variable exceeds 0.5, meaning the construct accounts for more than half of the variance of its items. In conclusion, Table 2 indicates that the standardized loadings, Cronbach's alpha, CR, and AVE all exceed the thresholds suggested in the literature. Thus, the findings support the confirmation of convergent validity.

Table 50 Reliability and validity tests

Latent Construct	Items	Standardized loadings	Cronbach's alpha	CR	AVE
Intention (INT)	INT1	0.946	0.933	0.957	0.882
	INT2	0.941			
	INT3	0.931			
Subjective Norms (SN)	SN1	0.893	0.866	0.918	0.788
	SN2	0.904			
	SN3	0.865			
Perceived Behavioural Control (PBC)	PBC1	0.773	0.830	0.896	0.743
	PBC2	0.905			
	PBC3	0.901			
Attitude toward BCT (ATB)	ATB1	0.741	0.813	0.883	0.718
	ATB2	0.875			
	ATB3	0.916			
Trust toward Quality Certifications (TQC)	TQC1	0.885	0.909	0.936	0.784
	TQC2	0.877			
	TQC3	0.895			
	TQC4	0.885			
Attitudes toward Technology (TEC)	TEC1	0.865	0.800	0.882	0.715
	TEC2	0.804			
	TEC3	0.866			

The findings in Table 51 indicate that all HTMT remain below the accepted threshold of 0.85 as suggested by Hair et al. (2019). This confirms that the individual constructs possess sufficient discriminant validity. Therefore, we can conclude that the measurement model satisfies the essential criteria for validity and reliability, which encompasses both convergent and discriminant validity as well as overall reliability.

Table 51 Results of the discriminant validity test—HTMT

	INT	SN	PBC	ATB	TQC	TEC
INT						
SN	0.676					
PBC	0.467	0.493				
ATB	0.422	0.575	0.761			
TQC	0.304	0.501	0.579	0.719		
TEC	0.577	0.512	0.588	0.570	0.382	

3.6.2.2 Determinants of purchase intention for blockchain-traceable food products

Based on the results in Table 52, we decide whether to accept the hypothesis.

To answer H1: "Subjective norms positively affects the intention to purchase potatoes traced with blockchain technology", as it can be seen in Table 4 SN have a statistically significant positive effect on the intention to purchase blockchain-traceable products. Therefore, the H1 is accepted. The effect size was large (0.286) that indicates social influence plays a significant role in shaping consumer behaviour.

To answer hypothesis H2 "perceived behavioural control positively affects the intention to purchase Potatoes traced with blockchain technology", it was also found to have a positive and significant effect on intention. However, the effect size was (0.020) smaller than SN. Thus, H2 is accepted.

In response to H3 "Attitude towards traceability positively affects the intention to purchase Potatoes traced with blockchain technology", it was not significant effect on intention. Thus, H3 is not accepted

Hypothesis H4, "Trust in quality certifications positively affects the intention to purchase Potatoes traced with blockchain technology" it was found to have a negative and significant effect on intention. However, the effect size was (0.008) small. Therefore, Hypothesis H4 is not accepted.

To answer H5 "Attitude towards technology positively affects the intention to purchase Potatoes traced with blockchain technology", TEC has a significant and positive influence on purchase intention with a coefficient of 0.176. The effect size was 0.076, indicating that the effects are small. Therefore, the H5 is accepted.

Table 52 Result of the hypothesis testing

Hypothesis No.	Relationship	Coefficient	*p*-Value	Decision	R^2_a	Q^2	F^2
H1	SN -> INT	0.481	0.000***	✅	0.452	0.400	0.286
H2	PBC -> INT	0.139	0.002***	✅			0.020
H3	ATB-> INT	0.009	0.849	❌			0.000
H4	TQC -> INT	-0.087	0.045**	✅			0.008
H5	TEC -> INT	0.248	0.000***	✅			0.076

*, **, and *** indicate significance levels of 10%, 5%, and 1%, respectively.
Confirmed: ✅, Unconfirmed: ❌

3.6.2.3 Awareness of food traceability, blockchain, and labelling

The result of the analysis of consumer awareness regarding food traceability presented in Table 53 shows. The results shows that 46% of respondents have a basic knowledge of the topic, while just 16% have an in depth understanding. There is a significant knowledge gap, as 23.2% recognize the term but do not fully understand it, and 14.8% are completely unaware of the concept. These results emphasize the necessity for focused educational programs to enhance public understanding of transparency in the food supply chain.

Table 53 Consumers' Knowledge of Traceability

	Scales	Percentage (%)
Knowledge about food traceability	I have in-depth knowledge of food traceability	16.00
	I have a basic knowledge of what food traceability is	46.00
	I have heard the term but do not know what it is	23.20
	I have never heard about food traceability	14.80

In addition, consumers understanding regarding blockchain was investigated. As it can be seen Table 54 awareness of blockchain technology among consumers seems to be notably low. Only 7.4% of people possess a deep understanding of the technology, while 36.2% have a basic grasp of it. There exists a substantial knowledge gap, with 39% of individuals recognizing the term "blockchain" without fully comprehending it, and 17.4% who are entirely unaware of the concept. These results highlight the obstacles to adopting blockchain for traceability and emphasize the need for educational efforts to bridge knowledge gaps and foster trust in innovations within the food supply chain.

Table 54 Consumers' Knowledge of Blockchain technology in food supply

	Scales	Percentage (%)
Knowledge of food traceability systems based on blockchain technology	I have in-depth knowledge of blockchain technology for traceability systems	7.40
	I have a basic knowledge of blockchain technology for traceability systems	36.20
	I've heard the term blockchain, but I don't know what it is	39.00
	I have never heard about blockchain technology	17.40

Table 54 presents Croatian consumers' perceptions of PGI products. The results indicate that consumer perceptions of PGI (Protected Geographical Indication) products in Croatia are highly favourable. A combined 68.8% of respondents reported positive (44.6%) or very positive (24.2%) attitudes, while only 0.8% expressed a negative view and none reported a very negative perception. Notably, 30.4% of consumers remained neutral. The key finding is that the majority of consumers view PGI products positively, suggesting strong acceptance and trust in these certified regional products.

Table 55 Consumer perceptions of PGI (Croatia)

	Very negative	Negative	Neutral	Positive	Very positive
Percentage (%)	0	0.80	30.40	44.60	24.20

3.6.2.4 Consumption habits

Table 56 shows consumption habit of the different types of potatoes presents in Croatia. As it can be seen in Table 5 regular potatoes are preferred by the majority of respondents, with 59.0% indicating that they always consume regular potatoes and only 2.0 % choosing never to consume them, which attests to their staple food status. Organic potatoes present a much more mixed consumption habit, with only 25.6% saying they always consume them and 20.8% saying they never consume organic potatoes, indicating less mainstream adoption. The PDO/PGI potatoes seem to occupy a position between regular and organic potatoes, with the maximum working classifications indicating always being consumed (31.8%) and never being consumed (14.9%), suggests moderate level of consumer recognition. In conclusion, regular potatoes remain the primary consumed choice and both organic and PDO/PGI potatoes are clearly special or alternative or occasional choices for their niche appeal.

Table 56 Consumption habits of different type of fava beans

	Always (%)	Often (%)	Sometimes (%)	Rarely (%)	Never (%)
Regular potatoes	59.00	19.20	13.80	6.00	2.00
Organic potatoes	25.60	18.40	22.80	12.40	20.80
PDO/ PGI potatoes	31.80	18.40	22.60	12.60	14.60

Table 57 shows the locations where respondents said they purchase potatoes. The findings clearly show that supermarkets were the preferred option of buying potatoes, as 64.8% of the respondents stated it, likely because of the convenience and accessibility they offer. Local markets were rated second, with 23% indicating they use this method, likely since people appreciate the freshness or the traditional shopping experience. Online and specialty shops account for only 2.8% of potato purchases combined (1% and 1.8% respectively), suggesting there is very little reliance on niche or digital options for these products. Organic stores were at 2.2%, and agricultural cooperatives represented 3.4%, appealing to limited consumers without more sustainability values. Moreover, 3.8% of respondents claimed to buy potatoes from other unspecified sources. Overall, the findings signify a clear inclination towards traditional retail channels, as specialized, or alternative options held very little interest.

Table 57 Preferred Places to Buy fava beans

Place	Percentage (%)
Supermarket	64.80
Local Market	23.00
Online	1.00
Specialty Stores	1.80
Organic Stores	2.20
Agricultural Cooperative	3.40
Other	3.80

3.6.2.5 Willingness To Pay results

Table 58 illustrates consumers' WTP for blockchain technology in PGI Lika potato production. It shows that a significant majority of consumers (83.6%) are willing to pay for a regular traceability system, indicating a strong acceptance of basic supply chain transparency. However, only 16.4% are interested in blockchain-based traceability systems. This lower interest may stem from a lack of understanding of BCT, its complexity, or concerns about its costs. This gap reveals a lack of trust in advanced systems, even though they offer potential advantages. It highlights the importance of educating consumers to enhance their awareness and illustrate the benefits of blockchain in ensuring food safety and authenticity.

Table 58 Willingness to pay a traceability system

Traceability system	Percentage (%)
Regular traceability system	83.60
Blockchain system	16.40

The factors affecting consumers' WTP for a blockchain traceability system in the production of Lika potato were investigated by using a probit model.

The findings from the model estimation using the probit method and the marginal effects at the mean are shown in Table 59. Table 59 indicates that the LR is significant at the 1% level, highlighting the overall significance of the regression.

Calculations of marginal effects (on average) show that with a one-unit increase in loyalty and social norms assuming other conditions remain constant, the probability of WTP for use services of blockchain technology will increase on average .0157863and 0461494 units, respectively, will increase.

Table 59 Willingness to Pay for blockchain label

Variables	Probit	dy/dx
Sex	.0811007	.0187026
Income	.0665436	.0153456
Age	-.0100967	-.0023284
Loyalty	0684545*	.0157863*
Knowledge of blockchain	-.1039238	-.0239658
Knowledge of traceability	-.0105678	-.002437
Household size	-.0513658	-.0118454
People under 18 years old	.0662655	.0152815
PGI perception	-.0652993	-.0150586
Premium	-.3300032	-.0761019
Averint	.1501044	.0346155
Aversn	.2001189*	.0461494*
Averpbc	.0913485	.0210658
Averatb	.0077644	.0017905
Avertqc	-.1995251**	-.0460124
Averat	-.0584795	-.0134859
_Cons	-.8068352	
LR chi2(16)		
Pseudo R2		
Correctly classified		

*, **, and *** indicate significance levels of 10%, 5%, and 1%, respectively.

3.6.3 Conclusions

This study presents new insights into the elements that impact on the intention of consumers to purchase products with protected designation of origin with blockchain traceability. The findings, based on two typical products in Croatia, suggest that successful marketing strategies should focus on informing consumers about the benefits of blockchains, simplification of the user experience and use of social influences to promote the adoption of blockchain-enabled traceability. the results show, customers' purchase intentions are positively impacted by Subjective Norms, Perceived Behavioural Control, Attitude toward BCT, Trust toward Quality Certifications, Attitudes toward Technology although there was no significant impact of trust in the quality certificates. This shows that there are still gaps in consumer knowledge and perspectives about blockchain technology. In addition, policymakers must help consumers understand the ways in which blockchains can ensure food is safe, protect against fraud, and support sustainability initiatives. Effective communication should highlight transparency and accountability, and help consumers view blockchain as a valuable tool rather than a complex addition to their decision-making process.

3.7 Serbia: PDO Arilje Raspberries

3.7.1 Descriptive analysis

The socio-demographic character of respondents from Serbia indicates that a majority of participants were female (60.8%), while males comprised 39.2% of the sample (Table 60). The age distribution was diverse, with the largest group being those aged 40–49 years (31.4%). In terms of education, most respondents had completed either middle school or high school (44.4%) or held a graduate degree (42.8%). Regarding employment status, the majority of respondents were employed or self-employed (75.4%), with smaller percentages being non-employed (13.2%), retired (5.4%), students (3.8%), or classified as other (2.2%). Income levels varied, with 56.8% reporting a middle income, 22.4% indicating a low income, 16.6% a high income, and 4.2% opting not to disclose their income.

Table 60 Socio-demographic characteristics

Attributes	Details of respondents	Percentage (%) Serbia	Attributes	Details of respondents	Percentage (%) Serbia
Sex	Male	39.20	Employment Status	Student	3.80
	Female	60.80		Employee or self-employed	75.40
Age	18-29	14.40		Non-Employed Individuals	13.20
	30-39	25.80		Retired	5.40
	40-49	31.40		Other	2.20
	50-59	21.40	Income level (Euro / month)	Low income	22.40
	Over 60	7.00		Middle Income	56.80
Education	Elementary school	0.20		High Income	16.60
	Middle school/ High school	44.40		I prefer not to answer	4.20

Attributes	Details of respondents	Percentage (%) Serbia	Attributes	Details of respondents	Percentage (%) Serbia
	Graduate	42.80			
	Postgraduate	12.60			

3.7.2 Results

3.7.2.1 Reliability and validity

As shown in Table 61 in the final measurement model, all the loadings of the indicators are above 0.70. In addition, the Cronbach's alpha of all the variables and the composite reliability values are above the recommended values (0.70), and the average variance extracted from each latent variable is higher than 0.5. Therefore, convergent validity was confirmed based on the results.

Table 61 Reliability and validity tests

Latent Construct	Items	Standardized loadings	Cronbach's alpha	CR	AVE
Intention (INT)	INT1	0.943	0.934	0.801	0.883
	INT2	0.922			
	INT3	0.954			
Subjective Norms (SN)	SN1	0.884	0.819	0.892	0.734
	SN2	0.911			
	SN3	0.769			
Perceived Behavioural Control (PBC)	PBC1	0.876	0.871	0.920	0.794
	PBC2	0.892			
	PBC3	0.905			
Attitude toward BCT (ATB)	ATB1	0.927	0.913	0.945	0.852
	ATB2	0.916			
	ATB3	0.926			
Trust toward Quality Certifications (TQC)	TQC1	0.890	0.907	0.934	0.781
	TQC2	0.887			
	TQC3	0.882			
	TQC4	0.875			
Attitudes toward Technology (TEC)	TEC1	0.866	0.801	0.883	0.716
	TEC2	0.784			
	TEC3	0.885			

The result of Table 62 shows that all HTMT are lower than the threshold of 90 recommended by Hair et al. (2019), confirming the sufficient discriminant validity of each construct. It can be concluded that the measurement model fulfils the requisite criteria for validity and reliability (reliability and convergent and discriminant validity).

Table 62 Results of the discriminant validity test—HTMT

	INT	SN	PBC	ATB	TQC	TEC
INT						
SN	0.722					
PBC	0.621	0.580				
ATB	0.684	0.743	0.629			

	INT	SN	PBC	ATB	TQC	TEC
TQC	0.370	0.496	0.488	0.547		
TEC	0.617	0.606	0.594	0.643	0.406	

3.7.2.2 Determinants of purchase intention for blockchain-traceable food products

We evaluate the structural model in terms of variance explained (R2), effect size (f2), predictive relevance (Q2), path coefficient (β), and hypotheses testing. Examining the impact of the exogenous variable on the endogenous variable is the aim of the structural model. The results of the hypotheses developed are shown in Table 63. The modified R2 of 0.542 suggests that a significant amount of the variation in customers' intentions to buy traceable Raspberries using blockchain technology may be explained by subjective norms, perceived behavioural control, attitude toward, trust toward quality certifications, and attitudes toward technology.

The F^2 effect sizes in the structural model, based on Cohen's (1988) benchmarks, indicate that subjective norms, perceived behavioural control, attitudes toward the construct, trust in quality certifications, and attitudes toward technology all demonstrate small effect sizes ($F^2 \geq 0.02$). This suggests that these factors contribute modestly to explaining the variance in the outcome. It is important to note that while trust in quality certifications is statistically significant ($p < .05$), its practical relevance is limited ($F^2 < .02$).

To assess the predictive accuracy of the PLS path model, the Q2 value is computed in this stage. The method is based on the blindfolding technique, which removes specific points from the matrix of data. then the mean is used to impute these missing data, and the model parameters are subsequently estimated. Thus, the Q^2 does not exclusively represent out-of-sample prediction; it reflects a combination of out-of-sample predictive ability and in-sample explanatory power. The blindfold procedure predicts the missing data points for each variable using these estimated parameters as inputs. Small discrepancies between the original and predicted values result in a higher Q2 value, indicating higher prediction accuracy (Hair et al. 2019). Based on the result of Table 63, the Q2 value for the endogenous latent construct is greater than zero.

The conclusions were drawn based on p-values (Table 63), which led to the decision to accept or reject the hypotheses taken in the study.

Table 63 Result of the hypothesis testing

Hypothesis No.	Relationship	Coefficient	*p*-Value	Decision	R^2_a	Q^2	F^2
H1	SN -> INT	0.328	0.000***	✅	0.542	0.470	0.124
H2	PBC -> INT	0.214	0.000***	✅			0.060
H3	ATB-> INT	0.248	0.000***	✅			0.060
H4	TQC -> INT	-0.067	0.063*	❌			0.007
H5	TEC -> INT	0.151	0.000***	✅			0.031

*, **, and *** indicate significance levels of 10%, 5%, and 1%, respectively.
Confirmed: ✅, Unconfirmed: ❌

3.7.2.3 Awareness of food traceability, blockchain, and labelling

Table 64 shows consumers' understanding of the food traceability system. The results show that only 14.8% report having in-depth knowledge of the topic, while 39.8% have a basic familiarity with the concept. Over a quarter have heard the term but do not fully understand it, and nearly one-fifth are completely unfamiliar with food traceability. These findings highlight a critical need for education and awareness campaigns to address knowledge gaps and encourage informed consumer engagement with traceability systems.

Table 64 Consumers' Knowledge of Traceability

	Scales	Percentage (%)
Knowledge about food traceability	I have in-depth knowledge of food traceability	14.80
	I have a basic knowledge of what food traceability is	39.80
	I have heard the term but do not know what it is	26.00
	I have never heard about food traceability	19.40

Table 65 shows consumers awareness of blockchain technology used in traceability systems in the food supply chain. The findings represent a lack of familiarity of consumers regarding the use of blockchain in food traceability systems. in fact, only 2.2% of participants indicate they have an in-depth understanding of the blockchain, while 19.6% possess a basic awareness. A notable 41.2% have heard the term "blockchain" but are unfamiliar about its specific uses in food supply traceability systems. Additionally, 37.0% of respondents have no knowledge of the blockchain at all. These results emphasize to a significant gap in consumer awareness of blockchain in food traceability systems.

Table 65 Consumers' Knowledge of Blockchain technology in food supply

	Scales	Percentage (%)
Knowledge of food traceability systems based on blockchain technology	I have in-depth knowledge of blockchain technology for traceability systems	2.20
	I have a basic knowledge of blockchain technology for traceability systems	19.60
	I've heard the term blockchain, but I don't know what it is	41.20
	I have never heard about blockchain technology	37.00

Table 66 illustrates Serbian consumers' perceptions of PDO products. The findings reveal a generally positive view among consumers regarding these products. Specifically, 49.2% of respondents expressed a positive opinion, while 19.0% indicated a very positive perception. Neutral opinions accounted for 31.2%, and critical views were minimal, with only 0.6% holding a very negative opinion and none expressing a negative one. This data suggests a strong favourable sentiment towards PDO products among Serbian consumers.

Table 66 Consumer perceptions of PDO products

	Very negative	Negative	Neutral	positive	Very positive
Percentage (%)	0.60	0	31.20	49.20	19.00

3.7.2.4 Consumption habits

Table 67 shows Serbian consumers preferences for different type of raspberries. The data reflects consumption frequency distributions across raspberry categories. Regular raspberries dominate habitual consumption, with the highest combined "always/often/sometimes" frequency (70.6%), indicating strong market penetration. PDO/PGI raspberries show intermediate adoption, with notable "often/sometimes" use (55.4% combined) but higher disengagement ("never": 10.6%) than regular types. Organic raspberries exhibit the lowest frequent consumption (38.4% for "often/sometimes") and the highest abandonment rate ("never": 27.4%), suggesting barriers to regular purchase (e.g., cost, accessibility). The inverse relationship between certification type (PDO/PGI/organic) and consumption frequency highlights potential trade-offs between specialty labelling and consumer adoption rates.

Table 67 Consumption habits of different type of raspberries

	Always (%)	Often (%)	Sometimes (%)	Rarely (%)	Never (%)
Regular raspberries	4.60	22.00	44.00	27.00	2.40
Organic raspberries	2.60	8.20	27.60	34.20	27.40
PDO/ PGI raspberries	8.40	22.80	32.60	25.60	10.60

Most of the Serbian respondents stated that they purchased raspberries from local retailers (54.2%). It may be due to consumers' perceptions of freshness, local sourcing, and price competitiveness. Following local retailers, supermarkets were next (28.6%), probably based upon convenience and supply chain stability. Niche channels (4.8% organic stores; 2.6% specialty stores; 2.4% agricultural cooperatives; and 1.0% internet) accounted for a smaller portion of purchases, which would suggest that there are some barriers to access for these channels The findings even reinforce the strength of local markets and suggest that there is an opportunity to improve marketing strategies to improve visibility and access to niche channels (Table 68).

Table 68 Preferred places to buy raspberries

Place	Percentage (%)
Supermarket	28.60
Local Market	54.20
Online	1.00
Specialty Stores	2.60
Organic Stores	4.80
Agricultural Cooperative	2.40
Other	6.40

3.7.2.5 Willingness to Pay for PDO certification

The consumers' WTP for the blockchain label on a package of PDO Arilje raspberries was assessed. The data reveals that most Serbian consumers (67.2%) preferred conventional traceability systems over blockchain-based ones. This is likely due to not fully understanding the benefits of blockchains, trust in familiar systems, or cost concerns. For producers and policymakers, this highlights a need to increase consumers awareness in blockchain's advantages. The results indicate that there is a technology readiness segment in the market, suggesting opportunities to target early adopters (Table 69).

Table 69 Willingness to pay a traceability system

Traceability system	Percentage (%)
Regular traceability system	67.20
Blockchain system	32.80

The findings from the model estimation using the probit method and the marginal effects at the mean are shown in Table 70. Calculations of marginal effects (on average) show that with a one-unit increase in sex, income, loyalty, people under 18 years old, Intention, Subjective Norms, assuming other conditions remain constant, the probability of WTP for blockchain label will increase on average by .1165948, .0995854, .0255248, .0676589, .0963953, and .0669613 units, respectively. While with a one-unit increase in, Household size, a premium price, and

Trust in quality certifications the probability of WTP for blockchain label on average by.0579081,.0017452, and -.1589019 unit will decrease which is in line with expectations.

Table 70 Willingness to Pay for PGI Certification

Variables	Probit	dy/dx
Sex	.3500413**	.1165948**
Income	.2989756***	.0995854***
Age	.0005383	.0001793
Loyalty	.0766308**	.0255248**
Knowledge of blockchain	-.085876	-.0286043
Knowledge of traceability	-.0917963	-.0305763
Household size	-.1738519**	-.0579081**
People under 18 years old	.2031258*	.0676589*
PDO perception	.023799	.0079272
Premium	-.0052393***	-.0017452 ***
Averint	.2893984***	.0963953***
Aversn	.2010313*	.0669613*
Averpbc	.0698549	.0232679
Averatb	.1101976	.0367056
Avertqc	-.1589019**	-.0529284**
Avertec	.0861803	.0287057
_Cons	-1.370519	
LR chi2(16)		
Pseudo R2		
Correctly classified		

*, **, and *** indicate significance levels of 10%, 5%, and 1%, respectively.

3.7.3 Conclusions

This study provides new insights into the variables influencing consumers' intention to purchase raspberries tracked by blockchain system. The results suggest that effective marketing strategies should concentrate on educating consumers about the advantages of blockchains, simplifying the user experience, and using social influences to promote the adoption of blockchain traceability. The study emphasizes that although the variables examined positively affect consumers' purchase intention, their trust in quality certifications had a negative impact on the purchasing intention. This suggests that there are still gaps in customers' understanding and view and highlights the need for more transparent communication on the practical advantages of blockchain technology. Policymakers also need to explain to customers how blockchain technology can guarantee food safety, protect against fraud, and promote sustainability efforts.

4 STRATEGIC GAP ANALYSIS

4.1 Comparative analysis of consumer preferences across countries and identification of market gaps

The consumer behaviour analyses of the six target markets (France, Spain, Greece, Italy, Croatia, and Serbia) both highlight common trends as well as unique national patterns of acceptance, perception, and intention to adopt traceable and quality-labelled foods.

4.1.1 Comparison of the socio-demographic profiles of consumers

A comparison of the socio-demographic profiles of consumers across the six participating countries reveals both convergences and notable differences in biological sex, age, education, employment status, and income levels associated with the consumption of quality-labelled food products. The data collected are affected both by the demographic characteristics of each country and the willingness to participate in this study which may affect purchasing behaviour.

4.1.1.1 Biological sex Distribution

While sex representation varies, female respondents/consumers dominate in four out of the six countries. Italy, France, Croatia, and Serbia all report a slight to significant majority of female respondents (ranging from 51.2% to 60.8%), suggesting that women may be more engaged or aware in relation to quality-labelled products like organic pasta, honey, and PDO fruits or vegetables, since they were willing to respond to the questionnaire. This statement aligns with other insights gained in the literature, e.g. by Blanc et al. (2021). In contrast, Greece and Spain report a male majority (56.2% and 57%, respectively), especially for products like PDO Feta Cheese and PGI Faba Beans, indicating that product types or cultural roles may influence gender-based purchasing behaviour.

4.1.1.2 Age Distribution

Middle-aged individuals (40–59 years) are the dominant consumer group across most countries. This group accounts for a significant share of consumers in Greece, Spain, Croatia, and Serbia, where 40–59-year-olds form over 50% of the respondents, following the demographic characteristics of each country.

In Italy, while middle-aged individuals are strong consumers of both pasta and olive oil, pasta in particular sees greater interest among younger consumers (18–29), suggesting a generational preference for quick and culturally rooted food products.

France has a slightly younger-to-middle-aged distribution overall, especially relevant for a product like organic honey, which may attract environmentally and health-conscious younger demographics.

4.1.1.3 Educational Attainment

Education levels of the respondents vary significantly, reflecting national educational profiles and possibly the perceived sophistication of the product.

Spain and France respondents show the highest education levels, with Spain reporting over 62% of consumers having graduate or postgraduate degrees and France over 80%. This high educational background aligns with the consumption of PGI Faba Beans and organic honey, which may be viewed as premium or health-conscious choices.

Italy, Greece, and Serbia respondents reflect a more balanced distribution between secondary and tertiary education. Pasta, olive oil, and PDO raspberries are traditional or regionally significant products, and their appeal may cut across educational levels.

Croatia respondents lean slightly more towards secondary education (53%), though nearly half also hold university degrees, indicating a mixed demographic appeal for PGI Lika Potatoes.

4.1.1.4 Employment Status

Employment rates of the respondents are relatively high across all countries. France, Croatia, and Serbia report particularly high employment or self-employment rates (above 74%), highlighting active economic engagement among consumers of organic honey, PGI potatoes, and PDO raspberries. Spain also shows strong employment levels (66.8%), consistent with a professional demographic base for PGI Faba Beans. Employment levels are not detailed explicitly for Greece and Italy, but both have a majority of consumers from employed populations, as indicated in related figures.

4.1.1.5 Income Distribution

The majority of respondents across all countries fall into the middle-income bracket, suggesting a common economic profile for consumers of quality-labelled food products. Notably, Croatia (25.6%), Spain (20.4%), and France (20.6%) report higher proportions of high-income consumers, reflecting a potentially more affluent market for PGI and organic goods in these countries. Italy also shows a slightly higher proportion of high-income consumers for olive oil (19.6%), reinforcing its image as a premium product. Greece and Serbia have the lowest proportions of high-income consumers (10.4% and 16.6%, respectively), which could affect the pricing strategy or perceived accessibility of PDO products in those markets.

4.1.2 Comparison of the determinants of purchase intention for blockchain-traceable food products

The data analysis across six European countries reveals commonalities and differences in the psychological and attitudinal drivers shaping consumers' intentions to purchase blockchain-traceable food products. The analysis is based on the results of five core hypotheses (H1–H5), reflecting key constructs from the TPB and extended technology acceptance perspectives. Table 71 is a summary of the cross-country comparative analysis of hypotheses H1–H5 elaborated in this Section.

Table 71 Cross-Country Comparative Table of Hypotheses H1–H5

Country / Product	H1 Subjective Norms	H2 Perceived Behavioural Control	H3 Attitude toward Traceability	H4 Trust in Certifications	H5 Attitude toward Technology
Italy (Olive Oil, Pasta)	✅ Strong	✅ Strong	✅ Strong	❌ Not supported	✅ Strong
Greece (PDO Feta Cheese)	✅ Moderate	❌ Not supported	✅ Moderate	❌ Not supported	✅ Moderate
Spain (PGI Faba Beans)	✅ Weak	✅ Very weak	✅ Weak	❌ Not supported	✅ Weak
France (Organic Honey)	✅ Strong	❌ Not supported	✅ Moderate	❌ Not supported	✅ Moderate

Country / Product	H1 Subjective Norms	H2 Perceived Behavioural Control	H3 Attitude toward Traceability	H4 Trust in Certifications	H5 Attitude toward Technology
Croatia (PGI Lika Potatoes)	✅ Strong	✅ Weak	❌ Not supported	❌ Negative effect	✅ Weak
Serbia (PDO Arilje Raspberries)	✅ Moderate	✅ Small	✅ Small	✅ Statistically significant but low relevance	✅ Small
General Trend	✅ Universally Accepted	✅ 4/6 Accepted	✅ 5/6 Accepted	❌ Mostly Rejected (except Serbia)	✅ Universally Accepted

Statistically significant and supported: ✅, Not supported or negative effect: ❌

4.1.2.1 H1: Influence of Subjective Norms on Purchase Intention

Despite variations in product types and cultural contexts, subjective norms are the most universally robust predictors, suggesting a transnational strategy emphasizing social proof, endorsements, and community engagement could be effective. Consumers in all countries in this study are influenced by social norms. Peer influence, public opinion, or family attitudes significantly drive intentions to buy blockchain-traceable products. This highlights social acceptance as a universal lever in market adoption strategies. More specifically:

- H1 is accepted in all countries (Italy, Greece, Spain, France, Croatia, Serbia).
- The effect sizes range from small (Spain: 0.063) to large (France, Croatia).
- Across all case studies, SN consistently and significantly influence consumers' intention to purchase blockchain-traceable products, confirming the universal importance of social influence and peer expectations in sustainable or quality-labelled food purchases.

In addition, France and Croatia showed the strongest social influence, highlighting that peer approval and perceived social expectations may be especially critical in these cultures, while in Spain, the SN effect was statistically significant but small, suggesting social norms may matter less relative to other drivers.

4.1.2.2 H2 – Influence of Perceived Behavioural Control on Purchase Intention

This hypothesis is accepted in most countries, particularly, Italy (Olive Oil & Pasta), Spain (Faba Beans), Croatia (Lika Potatoes), and Serbia (Arilje Raspberries – statistically significant but small effect). Consumers generally feel that ease of access and perceived control over purchases strengthen their intention. However, Greece and France did not support this. The effect size of Italy has significant and notable influence, in Spain, positive but small, in Croatia statistically significant but very small, while in France and Greece, non-significant, indicating a weak or negligible influence of perceived control.

Italy and Serbia demonstrate the strongest association between perceived behavioural control and purchase intention, suggesting that when consumers feel confident and capable of accessing or evaluating blockchain-traceable products, they are more likely to act. In Spain and Croatia, PBC is significant but with minimal effect sizes, indicating that although consumers may feel some level of control, it plays a secondary role to other factors like social norms or attitudes. In Greece and France, PBC did not significantly impact purchase intention. This suggests that even if consumers believe they can access or afford the product, it does not necessarily lead to action, possibly due to low market maturity, limited product visibility, or competing psychological drivers.

4.1.2.3 H3 – Influence of Attitude Toward Traceability on Purchase Intention

This hypothesis is widely supported, particularly, Italy (Olive Oil & Pasta), Greece (Feta Cheese), Spain (Faba Beans), France (Organic Honey), and Serbia (Arilje Raspberries). This shows that consumers value the ability to trace food origin and journey. Italy shows strong support, while Croatia and France were exceptions, possibly due to less perceived benefit or confusion about traceability vs. certification. The effect size of Spain has the highest effect size (0.091) among reported values, in France is significant but smaller than social norms, in Italy & Greece, is statistically significant and robust, in Croatia is not significant and attitude does not impact intention, and in Serbia is small but statistically meaningful influence.

The attitude toward traceability is a consistent and strong driver of purchase intention in Italy, Greece, Spain, and France. Consumers in these countries value traceability as a positive attribute of food products, likely due to heightened concerns over authenticity, food safety, or ethical sourcing. In Serbia, attitude plays a modest but positive role, suggesting openness to traceability concepts, but possibly requiring more education or visibility of benefits. Croatia stands out as the only country where attitude toward traceability is not a significant driver. This may reflect scepticism, low familiarity with blockchain-enabled traceability, or lower perceived added value of such technology in the context of staple goods like potatoes.

4.1.2.4 H4 – Influence of Trust in Quality Certifications on Purchase Intention

This hypothesis was the least influential factor across countries. Only Serbia showed statistical significance, but even there the effect size was minimal. The general rejection indicates low consumer confidence or lack of understanding of current certification schemes, posing a challenge for traditional quality labels. More specifically, Italy, Greece, Spain, France despite strong national systems for quality certifications like PDO, PGI, or organic labels, trust in these certifications does not significantly influence consumers' intention to purchase blockchain-traceable food products. This may indicate that *(i)* Certifications are taken for granted, *(ii)* Trust in labels does not translate into digital traceability preference, or (iii) blockchain is seen as a separate or superior verification layer beyond traditional certifications. Croatia respondents, on the other hand, are the only ones where trust in certifications had a negative and statistically significant effect. Though small, this result may reflect consumer scepticism or perceived redundancy/conflict between traditional certifications and emerging traceability technologies. Last but not least, Serbia's respondents' Trust in quality certifications was statistically significant ($p < .05$), suggesting that it does factor into consumer decisions, but with low explanatory power ($F^2 < 0.02$). This indicates a symbolic role more than a behavioural driver.

Traditional certifications alone are not strong motivators for blockchain-traced purchases across the studied countries. This suggests a need to reposition blockchain not as a redundant validator but as a complementary, innovative assurance mechanism that enhances or independently supports transparency beyond static certifications. Consumer campaigns should clarify how blockchain adds value or reinforces trust, particularly where certification trust is declining or less influential (e.g., Croatia).

4.1.2.5 H5 – Influence of Attitude toward Technology on Purchase Intention

This hypothesis is accepted in all countries. Italy led in strength, followed by Greece and France, while Spain, Croatia, and Serbia showed smaller effects. Effect size varies from small to moderate, but consistently positive and statistically significant.

Italy stands out with the highest influence of tech-attitude, especially for pasta (0.421), indicating that Italian consumers who are open to technological innovation are significantly more likely to adopt blockchain-traceable food products. This suggests a readiness for tech-enhanced transparency in more "everyday" staples like pasta. Greece and France show a moderate influence of tech-positivity, suggesting that while traditional food values are strong, tech-savvy segments are emerging, especially among younger or highly educated demographics. Regarding Spain and Croatia, Though the influence is smaller, it is still significant. These consumers may accept technology in food more cautiously or as a secondary factor after social norms or traceability appeal. Last but not least, Serbian respondents are consistent with other countries' ones; positive attitude toward technology is statistically significant, with small but relevant influence, reflecting a nascent but growing trust in digital tools among consumers.

Technology acceptance is a universal driver of intention to buy blockchain-traceable products, making it a reliable anchor for awareness campaigns across all markets. However, the magnitude of impact differs, suggesting that *(i)* in some countries (e.g., Italy), marketing can highlight tech innovation boldly; (ii) in others (e.g., Croatia, Spain), it may be better to pair tech themes with trust-building messages or emphasize real-world benefits (e.g., fraud prevention, local impact).

Overall, consumers who view technology positively are more likely to embrace blockchain-enhanced food transparency, marking this as a key driver across the board.

4.1.3 Comparison of the awareness of food traceability, blockchain, and labelling

Understanding consumer awareness of food traceability, blockchain technology, and quality labelling is essential for evaluating the readiness of different markets to adopt innovative traceability systems. This section provides a comparative analysis of consumer awareness levels across the six case study countries (seven products) within ALLIANCE: Italy, Greece, Spain, France, Croatia, and Serbia. By examining consumers' familiarity with traceability concepts, knowledge of blockchain applications in food systems, and perceptions of quality labels such as PDO, PGI, and Organic certifications, the analysis identifies key strengths, gaps, and opportunities in each national context. Table 72 is a summary of the comparison of the awareness of food traceability, blockchain, and labelling in this Section.

Table 72 Comparative Table of Awareness of Food Traceability, Blockchain, and Labelling

Country / Product	Food Traceability Awareness	Blockchain Awareness	Label Perception (PDO/PGI/Organic)
Italy (Olive Oil, Pasta)	**Low–Moderate** (24.4% for olive oil; 19.6% for pasta)	**Very Low** (9.2% olive oil; 6.8% pasta)	**Predominantly positive** (86.2% and 58.6% at least positive for PDO/PGI and organic respectively)
Greece (PDO Feta Cheese)	**Moderate** (41% basic knowledge)	**Low–Moderate** (5.6% in-depth, 33.6% basic)	**Predominantly positive** (81.15% for PDO)
Spain (PGI Faba Beans)	**High** (77.8% basic knowledge, 20.8% in-depth)	**Moderate** (11.0% % in-depth, 37.2% basic)	**Very positive** (68% positive or very positive for PGI)
France (Organic Honey)	**Moderate** (18.4% in-depth, 63.6% basic)	**Low** (6.4% in-depth, 23.2% basic)	**Favourable** (57.2% positive or very positive for Organic)

Country / Product	Food Traceability Awareness	Blockchain Awareness	Label Perception (PDO/PGI/Organic)
Croatia (PGI Lika Potatoes)	**Moderate** (46% basic, 16% in-depth)	**Low–Moderate** (7.4% in-depth, 36.2% basic)	**Very positive** (68.8% positive or very positive for PGI)
Serbia (PDO Arilje Raspberries)	**Low** (14.8% in-depth, 39.8% basic)	**Very Low** (2.2% in-depth, 19.6% basic)	**Very positive** (68.2% positive or very positive for PDO)

4.1.3.1 Awareness of Food Traceability

Awareness of food traceability varies notably across the countries studied, reflecting differing levels of consumer engagement with supply chain transparency and product origin assurance. Croatian consumers demonstrated the highest combined awareness, with 46% possessing basic knowledge and 16% indicating in-depth understanding, suggesting a relatively stronger foundation for trust and informed purchasing decisions. Greece follows, with 41% reporting basic familiarity, but only 9.6% having deep comprehension, highlighting a considerable gap between mere exposure to the concept and the ability to interpret and act upon traceability information. France presents a similar pattern; while 63.6% of consumers report basic awareness and only 3.4% are completely unaware, only 18.4% possess in-depth knowledge, indicating that while the term "traceability" is widely recognized, understanding its practical implications remains limited. In Italy, traceability knowledge is modest, with olive oil buyers (24.4%) slightly more informed than pasta buyers (19.6%), reflecting how premium or traditionally regulated products tend to foster greater consumer interest in traceability. Serbia lags further behind, where only 14.8% demonstrate comprehensive understanding, and nearly 20% are entirely unfamiliar with the concept. While Spain's data on direct awareness is absent, the 29% neutral sentiment toward PGI products may indirectly indicate a limited grasp of traceability and its role in quality designation.

These findings underline a critical need for targeted education initiatives to raise both awareness and comprehension of food traceability systems across all markets. The observed gap between basic recognition and in-depth understanding points to a widespread challenge that consumers may be increasingly exposed to traceability-related terminology but lack the tools or context to interpret labels and technologies meaningfully.

4.1.3.2 Awareness of Blockchain for Traceability

Awareness and understanding of blockchain technology in the context of food traceability remain significantly lower than that of general traceability systems across all case study countries. Even in countries with relatively higher traceability awareness, such as France, Croatia, and Greece, knowledge of blockchain's role in traceability is limited to a small portion of the population. In Croatia, 36.2% of consumers report basic knowledge of blockchain, but only 7.4% claim in-depth understanding, while a combined 56.4% either do not fully comprehend it or are entirely unaware. France presents similar findings: 23.2% have basic awareness and just 6.4% possess deep knowledge, leaving nearly 70% with limited or no familiarity. Greece reveals an even starker picture, although 33.6% express basic awareness, only 5.6% have in-depth understanding, while a significant 60.8% are either unaware or unfamiliar with blockchain's purpose in the food sector. In Italy, awareness is similarly modest, with olive oil consumers demonstrating slightly better blockchain knowledge (9.2%) than pasta consumers (6.8%), though both figures remain low. Serbia reflects the least familiarity, with just 2.2% having comprehensive knowledge and 37% being entirely unaware, while over 40% have heard of blockchain but don't know how it relates to traceability. Spanish data on blockchain awareness is not explicitly available, but the relatively high share of neutral attitudes toward PGI products suggests a potential parallel lack of understanding in this area as well.

These insights reveal a pronounced and consistent knowledge gap between general traceability awareness and the specific technological underpinnings that are increasingly shaping modern supply chain transparency. While blockchain is often promoted as a transformative tool for enhancing food authenticity, safety, and trust, its benefits cannot be fully realized unless consumers understand how it functions and what value it adds. The data point to an urgent need for educational and communication strategies that not only raise awareness of blockchain but also demystify its relevance in everyday food purchasing. Without such initiatives, blockchain risks being perceived as an abstract or inaccessible innovation, rather than a credible enabler of traceability and quality assurance. Bridging this gap will be crucial for increasing consumer confidence, supporting informed decision-making, and encouraging broader acceptance of blockchain-based traceability systems in food markets.

4.1.3.3 Perceptions of Labels (PDO, PGI, Organic)

Consumer perceptions of quality labels such as PDO, PGI, and Organic certification are broadly positive across all countries studied, though the degree of enthusiasm and understanding varies. In Spain, 68% of consumers rated PGI-labelled faba beans positively or very positively, demonstrating a strong recognition of regional authenticity and quality. Similarly, Serbia reflects high approval for PDO-labelled Arilje raspberries, with 68.2% expressing positive or very positive views and only a negligible minority showing negative sentiment. France also exhibits favourable perceptions of organic honey, with 57.2% of respondents reporting positive or very positive attitudes; however, the relatively high proportion of neutral opinions (34.8%) suggests an opportunity for enhanced communication of organic benefits. In Greece, PDO feta cheese has broad approval, with minimal negative sentiment and a majority leaning toward positive or neutral views. Italian consumers likewise appreciate quality labels on olive oil and pasta, particularly PDO/PGI distinctions, which are generally associated with trust and authenticity in premium food categories. Croatia's case, focusing on PGI-labelled Lika potatoes, also supports this trend, though data on consumer sentiment is less elaborated.

Despite overall positive perceptions, the persistent presence of neutral attitudes across countries, including nearly one-third of consumers in France, Spain, and Serbia, reveals a latent gap in consumer understanding of what these labels truly signify. While positive perceptions suggest a degree of trust in institutional labelling, neutrality may stem from limited knowledge or scepticism about the practical benefits of certification schemes. Consumer knowledge of blockchain differed greatly, suggesting that digital literacy is essential for acceptance. Future segmentation should consider confidence in digital tools when aiming education or labelling solutions. This indicates a missed opportunity for regulatory bodies, producers, and marketers to more effectively communicate the added value of these certifications, be it quality assurance, regional identity, or sustainable practices.

4.1.4 Comparison of the consumer habits along the studied countries

Consumer preferences for purchasing certified and non-certified food products reveal notable divergences across countries, reflecting cultural shopping norms, product trust levels, and market infrastructure. A clear trend emerges; while supermarkets remain dominant in several countries, preferences for specialty stores, local markets, and direct-from-producer channels also play significant roles, depending on the product type and national context.

In Italy, specialty stores are the preferred destination for both olive oil (53.8%) and pasta (90.2%), showing a cultural trust in curated retail environments for staple, high-quality products. Online shopping is moderately adopted for olive oil (19.4%) but almost negligible for pasta (0.8%), suggesting that digital retail is more acceptable for certain items but not yet mainstream for traditional daily foods. In contrast, Greece displays strong supermarket dominance in the purchase of PDO feta cheese (83.8%), though specialty stores still maintain a significant share (63%). Local markets (7.2%) and online channels (1.2%) are far less favoured, indicating a consumer base that relies heavily on conventional large-scale retail chains, potentially for convenience and price sensitivity. Spain also shows supermarket preference for PGI fava beans (68.4%), followed by local markets (15%). Specialty stores (7.4%) and organic retailers (4.6%) remain niche, highlighting a gap in the market for premium and certified fava products. Online shopping (2%) is minimal, which aligns with the broader Southern European reluctance to adopt digital grocery retail for traditional food items. France, however, demonstrates a more fragmented landscape in honey purchasing. While supermarkets still lead (43.8%), direct-from-beekeeper purchases (26.8%) are notably high, suggesting a stronger inclination toward provenance, transparency, and local support. Specialty stores (6.6%) and online channels (3%) are minor but not insignificant players, indicating openness to alternative channels for niche products. Furthermore, Croatian consumers show strong reliance on supermarkets for potato purchases (64.8%), similar to Greece and Spain. Local markets are secondary (23%), and specialty, organic, and online stores remain marginal (<3% each), emphasizing traditional retail habits for everyday staples like potatoes. Last but not least, in Serbia, local retailers dominate raspberry purchases (54.2%), reflecting the importance of perceived freshness and proximity in consumer decision-making. Supermarkets follow (28.6%), but niche and digital channels remain severely underutilized, mirroring trends in neighbouring countries.

The consumer habit analysis highlights a shared preference for conventional purchasing channels, especially supermarkets, for everyday or staple products. However, products tied to strong regional identity, health benefits, or artisanal value (e.g., French honey and Italian olive oil) are more frequently sourced from specialty shops or directly from producers. Digital adoption for food purchases remains low across the board, especially for PDO/PGI/organic-labelled products, pointing to an underexploited opportunity for e-commerce tailored to traceable, certified foods. Policy makers and producers could benefit from investing in awareness campaigns and digital infrastructure that builds trust and showcases the convenience and value of alternative purchasing channels.

4.1.5 Comparison of the willingness to pay for certified products using blockchain

Across all six countries studied the majority of consumers consistently prefer conventional traceability systems over blockchain-based alternatives. Support for blockchain traceability ranges from a low of 16.4% in Croatia to a high of 27% in Italy, indicating a generally cautious or sceptical stance toward blockchain in food certification. Table 73 presents a summary table of the WTP for these products.

Table 73 Comparison table of the willingness to pay for certified products using blockchain for each country

Country	Preference for Blockchain (%)	Preference for Traditional Systems (%)
Italy	16–27%	73–84%
Greece	26%	74%
Spain	25.6%	74.4%
France	24.6%	75.4%

Country	Preference for Blockchain (%)	Preference for Traditional Systems (%)
Croatia	16.4%	83.6%
Serbia	32.8%	67.2%

Furthermore, key drivers influencing consumers' WTP for blockchain-based traceability systems vary across countries but share several common themes. Income emerges as a consistent and significant factor, with higher-income consumers in Italy, Greece, France, and Serbia more inclined to pay a premium for blockchain-enabled certification. Positive perceptions of product quality, particularly regarding PDO, PGI, and organic labels, also enhance WTP, as seen in Italy, France, and Greece. Psychological factors such as INT to use blockchain and ATB play crucial roles, especially in Greece, France, and Serbia, indicating that openness to innovation boosts acceptance. Social influences, including SN and perceived social expectations, are strong motivators in Spain, Croatia, and Serbia. Additionally, consumers who demonstrate greater knowledge of blockchain technology, particularly in France and Serbia, show a higher likelihood of embracing it. Finally, customer loyalty contributes positively to WTP in Croatia and Serbia, suggesting that more engaged or brand-loyal consumers are more receptive to innovations in traceability and food certification.

Despite growing interest in food traceability, several barriers hinder consumers' WTP for blockchain-enabled systems. The most pervasive obstacle across all studied countries is the premium price associated with blockchain-certified products, which significantly reduces WTP in Italy, Greece, Spain, France, Croatia, and Serbia. This reflects consumer price sensitivity, particularly in markets where blockchain's added value is not clearly understood. Lack of awareness and understanding of blockchain technology is another major barrier, especially in Croatia and Serbia, where limited familiarity leads to mistrust or indifference. Additionally, complexity and perceived difficulty in using or verifying blockchain systems discourage adoption, as seen in Italy and France. Trust in existing conventional traceability systems also acts as a barrier, as consumers often prefer familiar mechanisms over novel ones, believing that conventional systems are adequate. Finally, in markets like Spain and Greece, low engagement with quality labels (e.g., PDO/PGI/Organic) undermines the perceived added value of blockchain, further diminishing WTP. These barriers which underscore the need for consumer education and clearer communication of blockchain's tangible benefits in food safety and authenticity are summarized in Table 74 for each country.

Table 74 Key barriers for each country

Key Barriers	Countries Observed
Premium Price	All six
Tech Complexity	Italy, France, Croatia
Low Blockchain Awareness	Croatia, Serbia, France
Trust in Traditional Systems	Spain, Serbia

Moreover, Country-specific insights reveal distinct consumer attitudes and behaviours toward blockchain-enabled traceability systems, shaped by cultural norms, economic factors, and familiarity with certification schemes.

In Italy, while there is strong engagement with quality labels like PDO and organic, consumers show a conservative approach to adopting blockchain, largely due to perceived complexity and cost. Greek consumers, though loyal to traditional products like PDO feta cheese, display limited readiness to pay for blockchain solutions, with income and perceived control emerging as key influencers. In Spain, preferences remain rooted in tradition, with only a niche of tech-oriented consumers open to blockchain, primarily driven by subjective norms and personal interest. French consumers show moderate openness, especially among those with higher income and knowledge of blockchain, yet traditional traceability remains dominant. In Croatia, low blockchain adoption reflects limited awareness and trust, despite interest from loyal consumer segments influenced by social norms. Serbia presents a more nuanced picture; while conventional systems are preferred, a growing segment shows readiness to adopt blockchain, especially among younger, more educated consumers and those with strong loyalty to regional products.

4.2 Identification of market gaps

Overall, the comparative review implies that although traceable and certified products are becoming more attractive to consumers throughout Europe, there is a need for targeted education, pricing initiatives, as well as explicit communication of the benefits of traceability technologies if gaps exist presently regarding market readiness compared to widespread adoption of innovative technologies such as blockchain-based traceability. The gaps identified through this assessment are given in Table 75.

Table 75 Market gaps based on the assessment

Gap	Description
1. Low awareness and understanding of blockchain	Although many consumers recognize the importance of transparency and safety in food systems, they often lack sufficient knowledge of how blockchain can contribute to these objectives. This technological unfamiliarity leads to limited trust and reluctance to pay for blockchain-based traceability solutions. In all markets of this study there is a lack of knowledge, reinforcing a reliance on conventional systems, hindering the uptake of innovative solutions.
2. Lack of knowledge and awareness of PDO/PGI Labels	While organic certifications are widely recognized all over Europe, awareness of geographical indications is still very poor, particularly in countries such as Spain, Croatia, and Serbia. Often, customers confuse PDO/PGI certifications with generic "local" or "traditional" labels, without understanding the strictly regulated criteria of production and legal protections they imply. With such a lack of understanding, consumers are less willing to pay a premium price for PDO/PGI food products as it reduces their perceived added value.
3. Limited WTP for blockchain-based traceability	The case studies indicate that the majority of consumers still favour conventional traceability systems over blockchain, primarily due to concerns about premium pricing, ease of use, and perceived value. Even in countries like Italy and Greece, where food origin and certification are culturally significant, WTP for blockchain services remains modest. This suggests a pricing sensitivity and a lack of perceived differentiation between blockchain and traditional methods in the eyes of consumers.
4. Retail Channel Disparities	Consumer preferences for purchasing locations vary greatly across countries, but a consistent gap exists in the digital and direct-sale channels. Online shopping and cooperative models remain underutilized in all studied markets, including more technologically advanced countries like France and Italy. This suggests untapped opportunities to modernize the sales channels for certified and traceable products, especially among digitally engaged consumers.
5. Confusion Due to Various Labels and Certifications	With multiple quality labels, organic certifications, blockchain traceability labels, as well as other brand claims, consumers risk information overload or confusion. Although there is general recognition of quality schemes like PDO,

Gap	Description
	PGI, and organic labels, the actual influence of these labels on purchasing behaviour remains limited in some markets. For instance, Spanish and Croatian consumers show high consumption of regular products over their certified counterparts, indicating a weak market penetration for these schemes. In Serbia, while there is notable pride in local products such as Arilje raspberries, certification is not always a decisive factor in purchase intent.

Complementing the aforementioned gaps identified, trust and perception are key drivers of consumers' choices of quality-labelled and traceable foods (Moreira et al. 2021). Nevertheless, the outcome of the cross-country analysis brings to light a number of issues that are still weakening complete consumer confidence in traceability systems and certifications. Past experiences of food fraud (Kendall et al. 2019), mislabelling (Rupprecht et al. 2020), and fake labels (Lindley et al. 2023) have undermined consumer faith in food certification schemes. Even for more mature markets like France and Italy, there are consumers who have remaining fear regarding whether the certifications are absolutely reliable (Murphy et al. 2022). Such scepticism is compounded when products bear several overlapping labels, as well as when consumers feel control is inadequate.

Following this challenge, the use of traceability blockchain systems poses increased issues of perception for consumers. While blockchain provides technology benefits for guaranteeing authenticity and transparency, for most consumers, it is a complicated and poorly understood concept. Consumers who are new to blockchain will be less trusting of it as an assurance of quality or safety of the product. In such a scenario, the apparent complexity of blockchain can actually take away from rather than add to trust, provided that effective and understandable communication methods are utilized.

On top of that, many European consumers have strong ethical preferences for sustainably sourced, locally produced, or organic products (Chiripuci et al. 2022). Nevertheless, real buying choices tend to reveal a disconnect between ethical perceptions, influenced by considerations of cost, accessibility, or suspicion regarding label authenticity (Christine and Prinsloo 2015). This disconnect raises a trust concern: customers can readily affirm the values linked with certifications but are doubtful that certified products actually follow through.

5 STRATEGIC IMPLICATIONS FOR ALLIANCE AND RECOMMENDATIONS

The findings from the ALLIANCE case studies across six European countries reveal strategic insights into consumer behaviour, trust dynamics, technology perceptions, and certification awareness, following the preceding section. These insights yield strategic directions to effectively promote blockchain-based traceability, enhance the visibility and value of quality labels (PDO, PGI, Organic), and support the broader transformation of the agri-food sector toward transparency, safety, and authenticity. These directions are divided into subsections as follows.

5.1 Targeted communication & awareness campaigns

A consistent gap identified across all markets is the limited understanding of blockchain and the weak association between quality labels and traceability. To address this, localized, multi-tiered communication strategies that demystify blockchain and reframe quality schemes as trust-building tools, should be implemented in each country:

- In countries like Spain and Serbia, where certification trust is relatively higher, communication should highlight how blockchain enhances and validates these trusted labels, reinforcing rather than replacing them.
- In France and Greece, where attitudes are positive, but PBC is low, campaigns should focus less on accessibility and more on increasing understanding, emotional resonance, and social endorsement.
- In Italy and Croatia, where product familiarity is high but traceability knowledge lags, messaging should bridge this gap with clear explanations of traceability benefits, using familiar product examples.

Marketing initiatives have to first raise consumer awareness via focused educational initiatives and campaigns. Communication has to clarify the relevance and value of certifications such as PDO, PGI, and organic labels as well as the benefits of advanced traceability technologies such as blockchain. Establishing customer confidence depends on common-sense communications that are referring to real benefits, guaranteed authenticity, provenance, and ethical production. Education about labelling should also be strengthened by using modern digital tools like QR codes and apps to provide open, easily accessible information at the moment of purchase. Although younger consumers show concern for sustainability, the data show limited correlation between environmental claims and actual purchase intention, highlighting a gap between attitudes and behaviour that should inform campaign design. Clear information can help people to appreciate the value of credentials and guide their decisions. To ensure effective communication, targeted awareness campaigns should employ tailored messaging that resonates with specific national and cultural contexts. These include *(i)* the development and distribution of an e-brochure and regular e-newsletters to keep audiences informed of project progress and outcomes; *(ii)* visual materials such as posters and videos which can support outreach efforts, along with high-level communication sets tailored for policy makers; *(iii)* dedicated website and active presence on key social media platforms to facilitate continuous engagement and interactive dialogue; *(iv)* participation in external events and organization of targeted workshops will further support stakeholder interaction and knowledge exchange. Nevertheless, awareness campaigns must go beyond information dissemination.

Consumer capacity to evaluate claims, demand transparency, and confidently engage with blockchain-enhanced traceability systems should be built. Therefore, a QR-code-enabled demonstration to customers is imperative.

5.2 Strengthen the role of specialty and direct channels

A promising pathway for enhancing the uptake of certified products and blockchain-based traceability lies in specialty retailers and direct-to-consumer channels. Across multiple case study countries, particularly Italy, France, and Serbia, consumers express a higher degree of trust and emotional connection when purchasing from familiar, smaller-scale sources such as local shops, farmers' markets, artisanal producers, or direct sales from beekeepers and olive oil growers. These channels already serve as important access points for PDO, PGI, and Organic products, and their perceived authenticity aligns strongly with the values promoted by blockchain traceability, such as transparency, origin verification, and food integrity. However, their current capacity to demonstrate traceability or communicate quality assurance remains limited due to technological, logistical, or knowledge-based barriers.

For ALLIANCE to effectively scale blockchain traceability and elevate consumer trust in certified quality schemes, it is imperative to empower these specialty and direct sellers as frontline ambassadors of transparency and quality. This can be achieved through the strategic interventions given in Table 76.

Table 76 Strategic interventions for strengthening the role of specialty and direct channels

Enable blockchain integration for small producers	
Description	**Key features/Enablers**
ALLIANCE should prioritize the development of user-friendly blockchain traceability tools tailored for small-scale actors. These tools must accommodate the limited digital infrastructure and technical know-how typical of artisanal producers, cooperatives, and family-run operations.	• **QR code** labels that consumers can scan in-store to instantly access traceability information. • **Pre-built templates** or **plug-and-play systems** for inputting supply chain data without needing programming skills. • **Multilingual support and localized interfaces** to ensure usability across all six target countries.
Support traditional channels with digital visibility	
Description	**Key features/Enablers**
Consumers consistently associate specialty and direct-sale channels with higher product quality and ethical sourcing, but these same channels often lack the digital presence or storytelling tools needed to communicate that value broadly.	• **Digital profiles for certified producers**, linked via traceability labels/QR codes. • **Online traceability "storytelling" platforms**, where producers can showcase the journey of the product, such as origin, production, certifications, and supply chain milestones. • **Partnerships** with regional cooperatives and local government agencies to promote these tools at scale.
Bridge trust between offline and online experiences	
Description	**Key features/Enablers**
While most consumers still prefer purchasing certified products in physical shops or markets, there is a growing curiosity about digital	• **In-store demonstrations** of how to use blockchain-enabled labels or mobile apps to access product traceability.

engagement, especially among younger and urban demographics. Specialty sellers are uniquely positioned to act as trust bridges between the physical and digital realms.	• **Consumer campaigns** highlighting "meet the producer" features, where buyers can digitally follow the product's journey. • Integration of **producer blockchain-enabled stories** into social media to amplify reach and brand authenticity.
Empower retailers and producers with predictive risk tools	
Description	**Key features/Enablers**
Producers and specialty retailers often lack the technological infrastructure to monitor supply chain risks or detect fraud proactively, especially the small ones. Despite their strong consumer trust and connection to local markets, these actors remain vulnerable to quality breaches, ingredient adulteration, or disruptions that can undermine both safety and credibility.	• **Risk awareness and training modules** tailored for non-technical users, helping them understand common fraud risks, early warning signs, and preventive measures. • **Simplified data insights** that allow producers to monitor product flows, verify certification inputs, and detect anomalies. • **Collaborative platforms** where smaller actors can share best practices, seek guidance, or coordinate responses to emerging threats.

Strengthening the role of specialty and direct channels is a strategic opportunity for ALLIANCE to build deep, culturally embedded consumer trust in certified and traceable food systems, by digitizing these high-trust interactions through accessible blockchain tools and meaningful narratives, resulting in a more scalable model that reinforces both modern transparency and traditional authenticity across diverse European contexts.

5.3 Build trust through transparent labelling

Transparent and credible labelling is foundational to strengthening consumer trust in certified and traceable food systems. While many consumers across Europe recognize and value quality labels such as PDO, PGI, and Organic, there remains a significant gap between label recognition and understanding, particularly in how these certifications relate to actual traceability, authenticity, and fraud prevention.

For ALLIANCE, transparent labelling presents both a strategic entry point and a communication bridge, linking established certification schemes with emerging blockchain and digital traceability tools. The goal is not only to affirm the value of existing labels but to reinvigorate their credibility by associating them with advanced, technology-enabled transparency mechanisms. This can be achieved through the strategic interventions given in Table 77.

Table 77 Strategic interventions for strengthening the role of specialty and direct channels

Link labelling to digital traceability	
Description	**Key features/Enablers**
ALLIANCE should develop and promote labelling systems that give consumers direct access to detailed, real-time traceability data. This data should go beyond origin claims to include verified information on the product's journey, processing stages, supply chain actors, and authenticity	• Implement QR codes on certified products that allow consumers to access real-time traceability data. • Ensure data transparency, making traceability information tamper-proof, auditable, and trustworthy. • Digital labelling to demonstrate added value beyond certification, such as sustainability

confirmations, enabled through blockchain or similar tools.	practices, ethical sourcing, or freshness indicators.
Clarify what labels guarantee and what they don't	
Description	**Key features/Enablers**
Consumer research suggests confusion about what quality labels actually certify. Many consumers assume that these labels inherently protect against all forms of fraud, when in reality, they often reflect specific geographical or production standards, not end-to-end supply chain integrity.	ALLIANCE should support educational campaigns and label redesigns that clearly explain: • What each certification verifies (e.g., region of origin, farming methods). • Where additional transparency is being provided through digital traceability. • How blockchain or other technologies enhance, and not replace, existing standards.
Integrate labelling into consumer-facing communication	
Description	**Key features/Enablers**
Labelling is not just a technical tool; it's a storytelling opportunity about the product's journey. ALLIANCE can elevate trust by weaving cultural, environmental, and human narratives into labelling interfaces.	• Video links to the farmer or region. • Certifications coupled with sustainability. • Indicators showing compliance with EU quality schemes or ethical trade practices.
Promote trust consistency across markets	
Description	**Key features/Enablers**
ALLIANCE's cross-country research shows that while label recognition may be high in some countries (e.g., Italy, France), understanding and use are inconsistent across Europe. In less mature markets (e.g., Serbia, Croatia), transparent labelling can act as a trust equalizer, helping consumers unfamiliar with PDO/PGI schemes feel confident in trying certified or traceable products.	• Pilot transparent labelling prototypes across diverse national markets. • Gather user feedback to refine content, accessibility, and usability. • Work with regulatory bodies and producer groups to harmonize best practices.

6 CONCLUSION AND OUTLOOK

The findings of the tasks T3.1 The Food Fraud Landscape & Gap Analysis for Food Safety and Authenticity and T3.6 Consumer Demand Assessment and Strengthening of WP3 Food Safety and Authenticity indicate a complex environment of customer interaction with traceability technologies and quality labelling systems across six European countries. While the PDO, PGI, and Organic labels are widely recognized and accepted, their conversion into consistent consumer purchasing behaviour, especially when integrated with blockchain-based systems, remains uneven. The adoption of blockchain traceability is still nascent, with consumer WTP for such innovations hindered by limited awareness, perceived complexity, and price sensitivity.

At the core of consumer decision-making are subjective norms and attitudes toward technology, as they are the most consistent and powerful predictors of willingness to adopt blockchain-enabled traceability. Across markets, these drivers often outweigh traditional notions of perceived behavioural control. This suggests that consumer trust, peer influence, and perceived relevance of traceability tools have more weight than accessibility alone.

Importantly, this research confirms that trust in certifications, while present, does not automatically translate into an understanding of or demand for transparent supply chains. This underscores the need to bridge the knowledge gap between label recognition and label comprehension, particularly as food fraud risks and concerns about authenticity grow.

The strategic recommendations highlight the importance of localizing interventions, tailoring awareness campaigns, retailer collaborations, and technology messaging to each country's cultural, economic, and social context. From leveraging specialty retail in Italy and France, to using certification familiarity in Serbia and Spain as a stepping stone toward blockchain adoption, the future of traceability in Europe lies in smart, context-aware outreach and innovation.

From a legal standpoint, the regulatory systems governing quality labels, especially PDO and PGI, must be strengthened. Consumer confidence can be strengthened and doubts reduced by more efficient monitoring and enforcement of the certification systems. Financial incentives like subsidies to reduce the price of certified products for lower-income consumers can support uptake. Including quality-labelled products in government programs can both encourage visibility and normalize usage by a broader population.

Looking ahead, ALLIANCE must prioritize inclusive and accessible consumer education, simplify digital touchpoints like QR-based labelling, and build trustworthy, interactive systems that merge physical and digital traceability. Early adopter segments will be crucial to accelerating market traction, but the long-term goal should be to normalize transparent traceability across all consumer profiles. Additionally, producers and supply chain stakeholders must stay current with changing consumer expectations. Local producers can be motivated to use the narrative worth of their products, hence highlighting traditional manufacturing techniques, regional legacy, and environmental practices. Producers, particularly small-medium businesses, must be helped to adopt traceability technology including blockchain. Such technologies have to be user-friendly and must be included into marketing efforts that communicate their benefits using simple, relevant language. Training and capacity-building programs would help producers to properly place traceable and certified items inside competitive markets.

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Finally, the outlook for blockchain and AI in food traceability is promising, but contingent on clear value communication, robust public-private collaboration, and sustained trust-building efforts. ALLIANCE is well-positioned to lead this transformation, ensuring that quality-labelled foods are not only protected against fraud but become a gold standard for informed, sustainable, and safe food consumption in the EU and beyond. Its dissemination, communication, and exploitation strategy ensure the project's visibility, stakeholder engagement, and long-term impact. It establishes a strong brand identity and communicates results effectively to diverse audiences using tailored tools and messaging. By building connections with related projects, industry actors, and policymakers, ALLIANCE promotes collaboration and wider adoption of its innovations. Continuous market analysis and impact monitoring help align project outputs with evolving trends and needs, ensuring relevance, optimal market fit, and sustainability beyond the project's lifetime. Furthermore, through ALLIANCE a blockchain-based framework tailored to organic, PDO, PGI, and GI products is developed, which enhances traceability and data veracity across all stages of the food chain, providing consumers thorough information about the products' journey. Interoperability is ensured by integrating diverse data sources, IoT devices, and portable testing tools for rapid authenticity verification, which can increase its robustness and add value to the products. Additionally, the project implements a comprehensive vulnerability risk assessment framework and an ai-driven early warning and decision support system to anticipate and mitigate food fraud risks, further supporting actors and safeguard consumers. ALLIANCE, also, offer a digital knowledge base and the application of advanced machine learning, collectively enabling smarter, proactive interventions and strengthening consumer trust in certified food products, aligning with the strategic gaps identified by the consumer demand assessment.

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ANNEXES

Annex A - Code used to analyse the data

All the codes used for analysing the data are provided below:

```
use "C:/Users/Computer/OneDrive - Alma Mater Studiorum Università di Bologna/Desktop/project/translated questionnaire/final questionnaires after collecting data/sataset/Dataset finale MIELE - FRANCIA.xlsx", clear
*use "path/to/your/dataset.dta", clear  oilive oil
drop in 1/3
. destring A B C D E F G H I J K L M N O P Q R S T U V W X Y Z AA AB AC AD AE AF AG AH AI AJ AK AL AM AN AO AP AQ AR , replace
///////// Italy pasta
. destring A B C D E F G H I J K L M N O P Q R S T U V W X Y Z AA AB AC AD AE AF AG AH AI AJ AK AL AM AN AO AP AQ AR , replace
//////////////////
rename A code
rename B gender
rename C birthyear
rename D region
rename E education
rename F employment
rename G householdsize
rename H childrensize
replace childrensize=0 if  childrensize ==.
rename I responsiblepurchasing
rename J knowledgetraceability
rename L knowledgeblockchain
rename O buyingFrequencyregular
rename P buyingFrequencyOrganic
///rassberry pdo ra check kon
rename Q buyingFrequencyDOPIGP
///////R:Qual è la sua opinione sui prodotti DOP?   the new data with DOP REPLACED IN DATASET
rename R attitudesocio
rename S INT1
rename T INT2
rename U INT3
rename V SN1
rename W SN2
rename X SN3
rename Y PBC1
rename Z PBC2
rename AA PBC3
*Attitude toward BCT (ATT)
rename AB ATB1
rename AC ATB2
rename AD ATB3
rename AE TQC1
rename AF TQC2
rename AG TQC3
rename AH TQC4
///att for technology
rename AI TEC1
```

ALLIANCE

```
rename AJ TEC2
rename AK TEC3
rename AL wherebuy
rename AM whereother
rename AN Loyalty
rename AO permiumprice
rename AP willingnesstopay
rename AQ process
rename AR income
///for honey
*rename AR income
*replace whereother=0 if  whereother ==.
*replace whereother=0 if  whereother ==.
////// just for hony case study no. 15 // Lorsque vous achetez du miel biologique, quels sont les éléments sur lesquels vous aimeriez avoir plus d'informations ?
rename AR locationHives
rename AS CountryImport
rename AT productionProcess
rename AU origin
rename AV testedPesticides
rename AW testedAdulterations
rename AX income
********* DROP TEXTO DE TRAZABILIDAD K,  TEXTO BLOCKCHAIN M, DEFINICIONES N
drop K
drop M
drop N
*drop AS
////// for spain and greece it should be 2025
gen year2024 = 2024
gen age= year2024 - birthyear
gen age1829=0
replace age1829=1 if  age >=18  & age <=29
gen age3039=0
replace age3039=1 if  age >=30  & age <=39
gen age4049=0
replace age4049=1 if  age >=40  & age <=49
gen age5059=0
replace age5059=1 if  age >=50  & age <=59
gen ageover60=0
replace ageover60=1 if  age >=60
********* missing values
misstable summarize

***************
drop if gender==. | birthyear==.| education==.| employment==.| householdsize==.| responsiblepurchasing==.| knowledgetraceability==.| knowledgeblockchain==.| buyingFrequencyregular==.| buyingFrequencyOrganic==.| buyingFrequencyDOPIGP==.| attitudesocio==.| INT1==.| INT2==.| INT3==.| SN1==.| SN2==.| SN3==.| PBC1==.| PBC2==.| PBC3==.| AT1==.| AT2==.| AT3==.| TQC1==.| TQC2==.| TQC3==.| ATT1==.|  ATT2==.| ATT3==.| wherebuy==.| whereother==.| Loyalty==.| permiumprice ==.|  willingnesstopay==.| process==.| income==.
******************
drop if gender==. | birthyear==.| education==.| employment==.| householdsize==.| childrensize==.| responsiblepurchasing==.| knowledgetraceability==.| knowledgeblockchain==.| buyingFrequencyregular==.| buyingFrequencyOrganic==.| buyingFrequencyDOPIGP==.| attitudesocio==.| INT1==.| INT2==.| INT3==.| SN1==.| SN2==.| SN3==.| PBC1==.| PBC2==.| PBC3==.| AT1==.| AT2==.| AT3==.| TQC1==.| TQC2==.| TQC3==.| ATT1==.|  ATT2==.| ATT3==.| wherebuy==.| whereother==.| Loyalty==.| permiumprice ==.|  willingnesstopay==.| process==.| income==.
```

```
***** Summary
summarize
**# Bookmark #1
tab1 gender birthyear education employment householdsize childrensize responsiblepurchasing knowledgetraceability knowledgeblockchain buyingFrequencyregular buyingFrequencyOrganic buyingFrequencyDOPIGP attitudesocio wherebuy Loyalty willingnesstopay permiumprice process income age1829 age3039 age4049 age5059 ageover60
tab1 birthyear
***************
plssem (INT > INT1 INT2 INT3) (SN > SN1 SN2 SN3 ) (PBC > PBC1 PBC2 PBC3) (ATB > ATB1 ATB2 ATB3 ) (TQC > TQC1 TQC2 TQC3 TQC4 ) (TEC > TEC1 TEC2 TEC3), structural(INT SN PBC ATB TQC TEC)
estat blindfolding, distance(7)
plssemplot, outerweights
plssemplot, innermodel
estat total, plot
estat vif
estat f2
estat htmt
///////////////probit
egen averINT = rmean(INT1 INT2 INT3)
egen averSN = rmean(SN1 SN2 SN3)
egen averPBC = rmean(PBC1 PBC2 PBC3)
egen averATB = rmean(ATB1 ATB2 ATB3)
egen averTQC = rmean(TQC1 TQC2 TQC3 TQC4)
egen averTEC = rmean(TEC1 TEC2 TEC3)
gen yprobit=0
replace yprobit=1 if  willingnesstopay==2
///////////////////////
probit yprobit permiumprice gender Loyalty knowledgeblockchain knowledgetraceability householdsize childrensize income age  attitudesocio averINT averSN averPBC  averATB averTQC averTEC
mfx
```