UDC 338.48:663.2:330.341.1:502.131.1

FOODTECH INNOVATIONS AND ESG IN THE TRANSFORMATION OF TRADITIONAL WINEMAKING INTO SMART WINE TOURISM DESTINATIONS

https://doi.org/10.15673/fst.v20i3.3598
ISSN-print: 2073-8684
ISSN-online: 2409-7004

Correspondence:
A. Chernykhivska
E-mail: chernykhivska.av@knutd.edu.ua

Cite as Vancouver style citation

Akhmedova O, Chernykhivska A. Foodtech innovations and ESG in the transformation of traditional winemaking into smart wine tourism destinations. Food Science and Technology. 2026;20(3):140-155
doi: https://doi.org/10.15673/fst.v20i3.3598

Цитування згідно ДСТУ 8302:2015

Akhmedova O., Chernykhivska A. Foodtech innovations and ESG in the transformation of traditional winemaking into smart wine tourism destinations // Food Science and Technology. 2026. Vol. 20, Issue 3. P. 140-155
doi: https://doi.org/10.15673/fst.v20i3.3598

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O. Akhmedova, D.Sc in Public Administration, Professor
https://orcid.org/0000-0003-1573-7710
A. Chernykhivska, Candidate of Economic Sciences, Associate Professor
E-mail: chernykhivska.av@knutd.edu.ua
https://orcid.org/0000-0001-9642-8471
Department of Tourism, Hotel and Restaurant Business
Kyiv National University of Technologies and Design
2 Mala Shyyanivska Street, Kyiv, 01011

Abstract. The paper examines the roles of FoodTech innovation and ESG in transforming contemporary wine tourism systems from traditional winemaking models to smart, sustainable destinations. Particular attention is given to the interaction between technological modernisation in viticulture and winemaking, sustainability-oriented management practices and the creation of competitive wine tourism experiences. The study examines how precision viticulture, digital terroir management, traceability platforms, artificial intelligence, craft winemaking innovations and indigenous grape varieties contribute to the development of modern wine tourism ecosystems. The research substantiates that FoodTech extends beyond technological improvements in wine production and functions as an integrated mechanism that connects vineyard management, wine quality, destination branding, visitor engagement, and sustainability objectives. Special emphasis is placed on the role of terroir-based differentiation, alternative vinification methods and the growing importance of craft wineries in strengthening the authenticity and attractiveness of wine-producing territories. The study employs a comparative analytical approach and a KPI framework comprising five dimensions. The comparative assessment covers France, Italy, Portugal, Spain and Ukraine. The article proposes an integrated analytical framework for evaluating FoodTech-driven transformation in wine tourism. It confirms that the long-term competitiveness of wine-producing territories increasingly depends on the ability to combine technological innovation, sustainability principles, local identity and visitor-centred value creation.

Keywords: FoodTech, ESG, wine tourism, craft winemaking, innovations, digital transformation, sustainability, artificial intelligence, destination competitiveness.

Introduction. Formulation of the problem

The contemporary transformation of wine tourism increasingly reflects the convergence of technological innovation, sustainability governance and destination-based value creation. Traditionally interpreted as a niche segment of gastronomic tourism centred on vineyard visits and wine-tasting experiences, wine tourism has evolved into a multidimensional socio-economic ecosystem integrating agricultural production, hospitality services, regional branding, cultural heritage preservation, and digital experience management.

This transformation is largely driven by the accelerated diffusion of FoodTech innovations and the institutionalisation of Environmental, Social and Governance (ESG) principles across agri-food and tourism systems. Within wine tourism destinations, digital technologies no longer serve an auxiliary operational function; rather, they constitute a strategic infrastructure that shapes transparency in production, visitor interaction, territorial competitiveness, and long-term destination resilience. Precision viticulture, blockchain-enabled traceability systems, artificial intelligence-based visitor personalisation, and smart supply-chain platforms increasingly determine the capacity of wine destinations to generate integrated value across production and tourism ecosystems.

At the same time, ESG has emerged as a structural framework redefining the strategic orientation of wine tourism development. Environmental accountability, social inclusiveness, and governance transparency are increasingly becoming decisive determinants of investment attractiveness, regulatory legitimacy, and international market positioning. In technologically mature wine regions, ESG implementation is increasingly operationalised through data-driven monitoring systems that quantify

environmental performance, optimise resource consumption, and ensure continuous compliance with sustainability standards.

Despite the growing body of scholarship addressing digitalisation, sustainability and destination management in wine tourism, existing studies remain largely fragmented. Current research predominantly examines isolated dimensions of technological modernisation, ecological adaptation, or territorial branding without conceptualising their systemic interdependence. In particular, insufficient attention has been devoted to understanding FoodTech innovation as an integrated infrastructural mechanism through which ESG reshapes destination competitiveness.

This research addresses that analytical gap by proposing a comparative framework for evaluating FoodTech maturity and ESG integration across leading European wine tourism destinations, including France, Italy, Spain, Portugal and Ukraine as an emerging transformational case.

The relevance of the Ukrainian case is particularly significant. Unlike mature European wine tourism systems characterised by path-dependent institutional structures, Ukraine possesses the opportunity to embed advanced digital and sustainability-oriented solutions directly into post-war reconstruction processes. This creates a unique strategic context for leapfrogging toward technologically integrated and ESG-compliant destination development.

Analysis of recent research and publications

Recent scholarship demonstrates a profound transformation in the conceptualization of wine tourism. Rather than being regarded merely as a niche tourism product, wine tourism is increasingly understood as a multidimensional development mechanism capable of generating economic value, preserving cultural heritage, supporting environmental sustainability and facilitating digital transformation. Contemporary academic discourse therefore positions wine tourism at the intersection of sustainable destination management, innovation ecosystems and ESG-oriented governance.

A substantial body of research investigates the relationship between wine tourism and sustainability-driven innovation within the wine industry. Studies by Toribio-Gómez [1], Gazzola [2], Martínez-Falcó [3; 4] and García-Cortijo et al. [5] demonstrate that sustainability has become a strategic determinant of competitiveness and long-term organizational resilience. These authors argue that the growing demand for environmentally responsible tourism experiences stimulates wineries to adopt green technologies, improve resource efficiency, implement sustainability reporting systems and integrate circular economy principles into business operations. From this perspective, wine tourism functions not only as a tourism activity but also as a catalyst for environmental modernization and responsible business transformation.

Another important research stream focuses on the territorial and socio-cultural dimensions of wine tourism development. Jezierska-Thöle [6], Pechko [16], Nahurna and Kurylenko [17] emphasize the capacity of wine tourism to preserve cultural landscapes, strengthen regional identity and diversify local economies. Their findings suggest that wine routes and wine-related experiences contribute to heritage conservation while simultaneously creating new opportunities for investment attraction, destination branding and community development. Such studies reinforce the notion that wine tourism represents an effective mechanism for balancing economic growth with the protection of cultural and environmental assets.

Consumer behavior and value creation have also become central themes within contemporary wine tourism research. Dias [7] demonstrates that environmental awareness increasingly influences tourists' destination preferences, participation in wine-related activities and perceptions of winery brands. Similar conclusions are presented by Liu, Thanh and Fang [8], who highlight the role of transparency, authenticity and responsible business practices in building consumer trust and enhancing brand value. Collectively, these studies indicate that sustainability-related attributes have evolved from optional marketing instruments into critical determinants of consumer decision-making and destination competitiveness.

The rapid digitalization of tourism and hospitality systems has generated another influential research direction. Trigo [9], Festa [10], Castillo et al. [11], Kim et al. [12] and Kalinichenko, Hrybinyk and Avriata [18] explore how digital technologies reshape tourism experiences and organizational management processes. Their findings demonstrate that artificial intelligence, big data analytics, digital platforms, service automation and advanced customer interfaces improve operational efficiency, facilitate visitor management and support more personalized tourism experiences. Digital transformation is therefore increasingly viewed as an essential prerequisite for the sustainable development of wine tourism destinations and hospitality ecosystems.

The convergence of sustainability and digital transformation is particularly evident within the emerging literature on ESG implementation. Wang et al. [13], Kim et al. [12] and Martínez-Falcó [3] argue that ESG principles generate the greatest value when embedded within organizational strategy rather than implemented as isolated initiatives. These studies reveal that the integration of environmental responsibility, social engagement and transparent governance enhances adaptive capacity, strengthens stakeholder relationships and contributes to long-term competitiveness. Consequently, ESG orientation has become an increasingly important analytical framework for evaluating the future development trajectories of tourism and hospitality organizations.

Marco-Lajara et al. [14] identify a significant expansion of wine tourism and reveal several dominant thematic clusters, including sustainability, digital transformation, destination management, consumer behavior and regional development. Their analysis illustrates the interdisciplinary nature of wine tourism and confirms its increasing relevance across tourism studies, environmental management, business research and innovation scholarship.

The spatial and territorial dimensions of sustainable wine tourism have also received considerable attention. Using the Douro Wine Region in Portugal as a case study, Jezierska-Thöle [6] argues that wine tourism contributes to the preservation of cultural landscapes by supporting traditional land-use practices, safeguarding cultural heritage and generating economic opportunities for local communities. This perspective reinforces the view that wine tourism can function as a strategic instrument for balancing economic growth with heritage conservation.

Castillo et al. [11] show that foodtech solutions, service automation and digital customer interfaces played a crucial role in the post-pandemic recovery of Spain's restaurant industry, demonstrating the transformative potential of technological innovation within hospitality ecosystems.

Within the Ukrainian academic context, systematic research on wine tourism has intensified during the last decade, particularly in response to the need for economic diversification, regional revitalization and tourism recovery. Existing studies primarily examine strategic development models, regional competitiveness, destination branding, infrastructure modernization and digital transformation processes.

Ukrainian scholars Bondar [15], Pechko [16], Nahurna and Kurylenko [17], Kalinichenko, Hrybinyk and Avriata [18] have generated important insights into the economic and managerial dimensions of wine tourism development and have highlighted the significant potential of wine-producing regions for strengthening tourism attractiveness and territorial competitiveness.

Although the Ukrainian literature on wine tourism continues to expand, most studies focus primarily on economic, infrastructural or managerial dimensions of the sector. Considerably less attention has been devoted to the integration of ESG principles, the digital transformation of wine destinations and the adaptation of international sustainability practices to the realities of Ukraine's post-war recovery.

Consequently, contemporary scholarly discourse provides a robust theoretical basis for understanding wine tourism as a mechanism of territorial competitiveness, rural diversification and sustainable destination development. Nevertheless, a substantial research gap persists concerning the interrelationship between FoodTech innovation, ESG-oriented transformation, craft winemaking and wine tourism development, particularly within emerging wine destinations. This gap is especially evident in the Ukrainian context, where the modernization of viticulture and wine tourism is increasingly associated with indigenous grape varieties, terroir-based differentiation, digital transformation and post-war reconstruction processes.

Addressing this gap is essential for advancing theoretical perspectives on innovation-driven wine tourism systems and for supporting evidence-based policy and strategic decision-making aimed at strengthening the long-term sustainability and international competitiveness of wine destinations.

The purpose of this study is to investigate the role of FoodTech innovations and ESG in the transformation of contemporary wine tourism systems and to identify comparative development models that enhance the competitiveness, sustainability and experiential value of wine destinations.

Research objectives:

– To conceptualise FoodTech infrastructure as a multidimensional driver of innovation in viticulture, winemaking, and wine tourism development;

– To examine the role of terroir digitalisation, indigenous grape varieties and craft winemaking practices in shaping destination competitiveness;

– To evaluate comparative differences in FoodTech adoption, ESG integration and wine tourism innovation across selected European wine-producing countries;

– To assess the contribution of alternative vinification methods, traceability systems and sustainability-oriented production models to contemporary wine tourism experiences;

– To identify strategic directions for the modernisation of Ukrainian wine tourism through the integration of FoodTech solutions, indigenous varietal resources, craft wine production and ESG principles within the broader framework of European integration and post-war reconstruction.

The scientific contribution of this study lies in the development of an integrated analytical framework that combines FoodTech innovation, craft winemaking development, terroir-based differentiation, and ESG for the comparative assessment of wine tourism destinations. Unlike conventional approaches that examine technological innovation primarily from a production perspective, the proposed framework conceptualises FoodTech as a systemic mechanism linking vineyard management, winemaking practices, destination experiences, sustainability performance, and territorial competitiveness

Materials and methods.

This study employs a comparative conceptual approach combined with qualitative expert assessment to analyse the integration of FoodTech innovations and ESG in contemporary wine tourism development. The research design integrates systematic literature

synthesis, cross-country comparative analysis and a structured indicator-based evaluation framework.

The analysis draws upon an extensive review of peer-reviewed academic literature [1–18], reports from international organizations (such as the International Organization of Vine and Wine – OIV), EU policy documents, national wine industry strategies and destination management publications covering the period 2020–2026 [19–33; 35; 41]. This synthesis served as the primary basis for identifying key dimensions of FoodTech and ESG integration in wine tourism systems.

Five European countries were selected for comparative analysis: France, Italy, Spain and Portugal as mature wine tourism destinations with established innovation ecosystems and Ukraine as an emerging destination undergoing significant regulatory and technological transformation. The selection was based on their representativeness of different development models within the European context.

To enable structured comparison, a five-dimensional indicator framework was developed based on recurrent themes in the literature. The dimensions include:

1. Smart Terroir Management,
2. Alternative Vinification Technologies,
3. Wine Traceability and Authenticity,
4. ESG Integration in Wineries,
5. Wine Tourism Product Innovation.

Each indicator was evaluated using a standardised 10-point scale (1 = very low development; 10 = highly advanced/mature implementation). The scores were assigned through comparative evidence synthesis rather than statistical measurement. For each country, the evaluation was based on the documented level of implementation, consistency of adoption and institutional maturity identified across multiple independent sources, including peer-reviewed publications, international reports and official policy documents. Individual scores reflected the cumulative weight of available evidence rather than isolated examples or individual initiatives. The same evaluation criteria were applied consistently across all countries to ensure methodological comparability and transparency. France was chosen as the benchmarking reference due to its internationally recognized leadership in precision viticulture, terroir protection, traceability systems and premium wine tourism.

To ensure transparency and reproducibility, a structured scoring rubric was applied. Each indicator was evaluated according to the following descriptors, with France used as the international benchmark (10 points):

1–3 (Very low): Negligible or fragmented implementation with minimal institutional support.

4–5 (Low/Emerging): Initial policy frameworks and pilot projects exist, but adoption remains limited in scale and systemic integration (e.g., Ukraine's environmental ESG component scored 4.5, reflecting recent regulatory alignment and emerging initiatives, while still facing constraints in resource efficiency and decarbonisation).

6–7 (Moderate): Systematic adoption in key regions with moderate integration between production and tourism.

8–9 (High): Advanced implementation with strong stakeholder coordination and measurable outcomes.

10 (Mature/Leading): Comprehensive ecosystem integration representing global best practice.

Composite scores for overall FoodTech integration and ESG maturity were calculated as the arithmetic mean of the respective indicators. This methodological approach does not claim statistical precision or generalisability but aims to provide a transparent, replicable visualization of relative maturity levels and strategic differences across the selected countries.

Results of the research and their discussion

The modern development of wine tourism is inseparable from the evolution of modern winemaking. While wine routes, tasting experiences and destination branding remain visible components of tourism products, the primary motivation for visiting wine regions continues to be the wine itself. The quality, authenticity and uniqueness of wine determine the attractiveness of vineyards, wineries and wine destinations. Consequently, FoodTech innovations acquire strategic importance because they directly influence the characteristics of wines that form the foundation of wine tourism experiences.

From a theoretical perspective, FoodTech infrastructure can be defined as a multidimensional technological environment consisting of digital platforms, intelligent monitoring systems, data-driven management tools and innovation-based service solutions that facilitate the efficient production, distribution and consumption of food and beverage products. Within wine tourism, this infrastructure extends beyond the physical boundaries of wineries and encompasses the entire visitor experience, from vineyard cultivation and wine production to gastronomic interpretation, destination marketing and post-visit consumer interaction [3; 4; 11].

The emergence of FoodTech infrastructure reflects broader transformations associated with the Fourth Industrial Revolution and the digitalization of agri-food systems. Contemporary wine tourism increasingly operates within the framework of Agriculture 4.0 and Tourism 4.0, where real-time data collection, predictive analytics, artificial intelligence and interconnected digital platforms support decision-making processes at multiple organizational levels. Consequently, wineries are evolving from traditional agricultural enterprises into technologically sophisticated organizations capable of generating value through both physical products and digital experiences.

In modern viticulture and enology, technological innovation is increasingly focused on preserving and enhancing terroir expression rather than replacing traditional winemaking practices. Terroir remains one of the most influential concepts in global wine culture, referring to the interaction of soil composition, climate conditions, topography, biodiversity and human expertise that collectively shape wine identity. Contemporary FoodTech solutions allow winemakers to better understand these interactions and to preserve regional distinctiveness while improving production efficiency and environmental sustainability [10; 28]

The relationship between terroir and tourism is particularly evident in Europe's leading wine regions. Visitors travel to Bordeaux not simply to consume wine but to experience the specific environmental and cultural conditions that produce Cabernet Sauvignon and Merlot-based blends. Similarly, tourists visiting Tuscany seek wines derived from Sangiovese grapes because these wines represent centuries of interaction between local landscapes, agricultural traditions and regional identity. In Rioja, Tempranillo serves not only as a grape variety but also as a cultural symbol embedded in the tourism image of the region. Comparable relationships can be observed in Portugal's Douro Valley through Touriga Nacional and in Ukrainian wine regions through Odesa Black and Telti Kuruk [20; 21; 41].

The growing emphasis on terroir authenticity has encouraged wineries to adopt technologies that support more precise vineyard management and grape quality assessment. FoodTech systems enable producers to monitor vineyard conditions throughout the growing season and identify factors influencing grape development. Such technologies contribute to greater consistency in fruit quality and allow wineries to produce wines that more accurately reflect local environmental conditions. As a result, wine tourists encounter products with stronger geographical identity and more distinctive sensory characteristics.

The preservation and promotion of indigenous grape varieties represent another important dimension of FoodTech-driven wine tourism development. Global wine markets have long been dominated by international cultivars such as Cabernet Sauvignon, Merlot, Chardonnay and Sauvignon Blanc. However, contemporary consumers increasingly seek wines associated with regional uniqueness and cultural authenticity. This trend has stimulated renewed interest in local grape varieties that embody specific territorial identities.

In France, varieties such as Pinot Noir, Cabernet Franc and Chenin Blanc remain closely linked to the cultural landscapes of Burgundy and the Loire Valley. Italy continues to strengthen its international reputation through Sangiovese, Nebbiolo and Nero d'Avola. Spain increasingly promotes Tempranillo, Garnacha and Albariño as distinctive components of regional wine tourism experiences. Portugal has successfully positioned Touriga Nacional, Tinta Roriz and Alvarinho within premium wine tourism markets. Ukraine likewise possesses significant potential through indigenous and locally adapted varieties including Odesa Black, Sukholymanskyi White and Telti Kuruk [25].

FoodTech innovations facilitate the preservation of these varieties through advanced genetic analysis, vineyard monitoring systems and climate adaptation strategies. This is particularly important under contemporary climate change conditions, where many traditional wine regions face increasing environmental pressures. Technologies supporting varietal adaptation contribute not only to agricultural resilience but also to the preservation of cultural and tourism resources that differentiate wine destinations from global competitors.

Modern winemaking technologies have also transformed the fermentation stage, which remains one of the most critical processes influencing wine quality. Fermentation management systems enable precise control of temperature, oxygen exposure and microbial activity. Such control contributes to greater aromatic complexity, improved flavour stability and enhanced consistency across vintages. Rather than standardizing wine styles, contemporary enological technologies increasingly support the expression of terroir-specific characteristics by minimizing production faults and preserving desirable sensory attributes [19; 22].

Biotechnological innovations have further expanded opportunities for quality enhancement. Research on indigenous yeast populations has demonstrated that microbial communities play a significant role in shaping regional wine identity. The concept of microbial terroir has emerged as an important area of contemporary wine science, suggesting that naturally occurring microorganisms contribute to the distinctive sensory profiles associated with specific wine regions. For wine tourism destinations, this scientific perspective strengthens authenticity narratives by providing evidence that local environmental conditions influence wine characteristics at multiple biological levels [6; 33]

The growing popularity of organic, biodynamic and low-intervention wines represents another major trend connecting FoodTech, sustainability and tourism development. Contemporary wine tourists increasingly associate wine quality with environmental responsibility and ethical production practices. Consequently, wineries are adopting innovative technologies that reduce chemical inputs, optimize resource consumption and support biodiversity conservation.

Organic and biodynamic wines have become particularly important tourism assets in regions where sustainability forms part of destination branding strategies. Wine tourists often perceive environmentally responsible wineries as more authentic and culturally meaningful. This perception enhances destination attractiveness and supports the development of premium

tourism experiences linked to environmental stewardship and local food systems [45].

Within this context, ESG principles have become increasingly influential in shaping winery development strategies. Environmental dimensions focus on carbon reduction, water efficiency, biodiversity conservation and climate adaptation. Social dimensions emphasise support for local communities, preservation of cultural heritage and responsible employment practices. Governance dimensions address transparency, accountability and traceability throughout the wine value chain. FoodTech innovations provide wineries with practical tools for implementing and measuring ESG performance, thereby strengthening both sustainability outcomes and destination reputation [24; 33].

Digital traceability systems have become particularly significant in premium wine tourism markets. Consumers increasingly seek information regarding grape origin, vineyard location, production methods and sustainability practices. Technologies such as blockchain-based traceability platforms allow wineries to document every stage of production from vineyard to bottle. This transparency reinforces consumer trust and enhances the perceived authenticity of wine tourism experiences [28; 29].

Wine tourism is therefore evolving from a simple tasting activity into a comprehensive educational and cultural experience centred on wine production, terroir interpretation and sustainability values. Visitors increasingly seek to understand why wines from Bordeaux differ from those produced in Tuscany, Rioja, Douro or Southern Ukraine. FoodTech innovations support this process by providing scientific insights into viticulture and winemaking while preserving the regional identities that constitute the essence of wine tourism.

Ultimately, the future competitiveness of wine tourism destinations will depend on their ability to integrate technological innovation with terroir preservation, indigenous grape varieties, sustainable production practices and authentic cultural narratives. In this regard, FoodTech should not be viewed as a substitute for tradition but as a mechanism that enables wineries to preserve authenticity, improve wine quality and create more meaningful tourism experiences within an increasingly competitive global market.

The comparative analysis demonstrates that FoodTech adoption in wine tourism follows different developmental trajectories across European wine-producing countries. Although all studied destinations integrate digital and sustainable innovations into viticulture and enology, their strategic priorities differ substantially. France emphasizes technological enhancement of terroir expression and premium wine authenticity, Italy integrates FoodTech into gastronomic destination ecosystems, Portugal utilizes innovation to strengthen territorial connectivity and wine-route management, Spain focuses on data-driven personalization of visitor experiences, whereas Ukraine represents an emerging model characterized by significant transformational potential and opportunities for technological leapfrogging.

The French model demonstrates that technological innovation does not necessarily lead to the standardization of wine production. Instead, FoodTech is primarily employed to reinforce terroir differentiation, preserve appellation identity and increase the experiential value of premium wines. This approach is particularly visible in Bordeaux, Burgundy and Champagne, where technological modernization is closely linked to the protection of geographical origin and types of wine [21; 23].

The most significant innovation concerns the digitalization of terroir management. Precision viticulture enables producers to identify micro-zones within vineyards and to adapt cultivation practices according to specific soil, climatic and topographical characteristics. As a result, wineries achieve a more precise expression of terroir in the final product. For wine tourists, this creates opportunities to experience wines that embody highly localized environmental conditions rather than standardized production styles.

French wineries increasingly transform terroir from an abstract concept into a tangible tourism asset. Visitors are offered guided experiences explaining the relationship between vineyard geology, microclimate, grape development and sensory characteristics of wines. Consequently, FoodTech contributes not only to production quality but also to the interpretation and commercialization of territorial identity.

A distinctive feature of the French model is the integration of digital traceability into luxury wine tourism. Premium visitors increasingly demand information regarding vineyard origin, vintage conditions, cultivation practices and sustainability performance. Digital wine passports and blockchain-supported authentication systems strengthen trust while simultaneously enhancing the educational dimension of winery visits. The result is a tourism product where technological transparency reinforces perceptions of exclusivity and authenticity [29].

Unlike France, where innovation primarily supports terroir differentiation, Italy utilizes FoodTech to strengthen the relationship between wine, gastronomy and cultural heritage. The analysis indicates that Italian wine tourism is characterized by a high degree of experiential integration, particularly in Tuscany and Piedmont where wine consumption is inseparable from local food traditions and rural landscapes [20; 23].

FoodTech innovations in Italy are directed toward creating seamless gastronomic ecosystems rather than focusing exclusively on vineyard productivity. Digital platforms connect wineries, restaurants, agritourism facilities, olive oil producers and artisanal food enterprises into coordinated tourism networks. As a result, wine becomes part of a broader

multisensory experience that extends beyond the winery itself.

An important competitive advantage of the Italian model is the use of artificial intelligence for gastronomic personalization. Wine tourists increasingly receive customized recommendations based on taste preferences, culinary interests and previous travel behaviour. Such systems generate individualized food-and-wine pairing experiences that strengthen visitor engagement and increase tourism expenditure across local supply chains [25; 34].

Another notable feature is the integration of sustainability-oriented production methods with tourism storytelling. Organic and biodynamic vineyards are not presented merely as agricultural practices but as experiential resources that communicate environmental values and local identity. Consequently, FoodTech serves as a bridge connecting sustainable wine production with experiential consumption.

The Italian model illustrates that innovation creates the greatest tourism value when technological solutions support the broader cultural ecosystem surrounding wine rather than focusing solely on production efficiency.

Portugal demonstrates a distinct development trajectory centred on the modernization of heroic viticulture landscapes. Unlike France and Italy, where innovation primarily enhances product differentiation and gastronomic integration, Portuguese wineries increasingly employ FoodTech to address structural challenges associated with vineyard cultivation under extreme environmental conditions.

The Douro Valley provides a particularly significant example. Viticulture in this region is characterized by steep terraced slopes, fragmented vineyard structures and growing climate-related pressures. As a result, technological innovation focuses heavily on adaptive vineyard management, water-use efficiency and climate resilience [9].

FoodTech solutions enable producers to monitor heat stress, optimize irrigation practices and preserve grape quality under increasingly variable climatic conditions. This has become especially important for maintaining the quality of indigenous Portuguese varieties such as Touriga Nacional, Touriga Franca and Tinta Roriz, which constitute the foundation of both wine production and destination identity [21].

The tourism implications of this model are substantial. Climate adaptation has become part of the destination narrative itself. Visitors increasingly encounter wine landscapes presented not only as cultural heritage assets but also as examples of sustainable agricultural adaptation. Consequently, Portuguese wine tourism derives competitive advantage from demonstrating how traditional wine regions can remain viable under changing environmental conditions.

Spain represents the most advanced example of artificial intelligence integration within wine tourism experiences. While technological innovations are also present in vineyard management and wine production, the distinguishing characteristic of the Spanish model is the application of data analytics to visitor personalization.

Wine regions such as Rioja and Ribera del Duero increasingly utilize consumer data to design individualized tourism experiences. This includes customized tasting programs, personalized winery itineraries and adaptive recommendation systems capable of responding to visitor preferences in real time [11].

The analysis suggests that Spain is moving toward a model of hyper-personalized wine tourism in which each visitor receives a unique combination of wines, gastronomic experiences and cultural activities. Such personalization increases perceived value and strengthens emotional attachment to destinations.

An additional innovation concerns the use of digital twins and predictive analytics in destination management. By simulating visitor behaviour and spatial movement patterns, destination managers can optimize tourism flows and improve service quality. This contributes to enhanced operational efficiency while maintaining high levels of visitor satisfaction.

Spanish wineries also demonstrate strong integration between FoodTech innovations and circular economy principles. Wine tourism experiences increasingly incorporate narratives related to waste reduction, resource efficiency and sustainable production practices. This alignment between technological innovation and environmental responsibility strengthens destination competitiveness in sustainability-conscious tourism markets.

Ukraine occupies a distinct position within the European wine tourism landscape. Unlike established wine destinations with mature innovation ecosystems, Ukrainian wine tourism remains in a formative stage characterized by significant opportunities for structural modernization.

The analysis indicates that Ukraine's competitive advantage does not lie in replicating existing European models but in combining indigenous grape varieties, emerging wine regions and modern FoodTech solutions within a new development framework. Local varieties such as Odesa Black, Telti Kuruk and Sukholymanskyi White provide a foundation for destination differentiation, particularly in international markets increasingly interested in unique and authentic wine experiences [17; 35].

FoodTech innovations could play a decisive role in strengthening the visibility and market positioning of these varieties. Digital terroir mapping, traceability systems and sustainability certification tools would enable wineries to communicate the distinctiveness of Ukrainian wines more effectively to international visitors.

Another important opportunity concerns post-war reconstruction. The renewal of tourism

infrastructure creates favourable conditions for the implementation of smart destination principles from the earliest stages of development. Unlike many mature destinations constrained by outdated systems, Ukrainian wine regions possess the possibility to integrate digital visitor management, ESG-oriented production practices and intelligent wine-route development simultaneously [38; 39].

The findings suggest that Ukraine has the potential to develop a hybrid model combining European sustainability standards, indigenous viticultural heritage and advanced FoodTech innovations. Such a model could strengthen both tourism competitiveness and regional economic resilience while positioning Ukrainian wine tourism within emerging international premium markets.

Overall, the comparative analysis demonstrates that the strategic role of FoodTech extends far beyond technological modernization. In each country, innovation serves different tourism functions: strengthening terroir authenticity in France, enhancing gastronomic integration in Italy, improving territorial connectivity in Portugal, enabling personalization in Spain and creating opportunities for accelerated modernization in Ukraine. These differences confirm that FoodTech should be understood not as a universal technological toolkit but as a flexible mechanism through which wine destinations create distinctive forms of tourism value and competitive advantage.

One of the most significant structural transformations observed across contemporary wine tourism destinations is the rapid expansion of craft and boutique winemaking. Although large commercial wineries continue to dominate global wine production, the tourism value of wine regions is increasingly generated by small-scale, family-owned and terroir-driven producers that operate within niche market segments. As a result, craft winemaking has evolved from a marginal production model into a strategic component of wine tourism development.

From an economic perspective, craft wineries differ fundamentally from industrial producers. Their competitive advantage is not based on production volume, standardization or mass-market distribution. Instead, they create value through limited production, strong territorial identity, experimental vinification practices and direct interaction with consumers. Consequently, wine tourism has become one of the most important channels through which craft wineries commercialize their products and communicate their unique narratives [26; 40; 42].

The rise of craft winemaking is closely associated with broader transformations in consumer behaviour. Contemporary wine tourists increasingly seek authenticity, provenance and sensory uniqueness rather than internationally standardized wine styles. This shift has encouraged producers to focus on local grape varieties, micro-terroirs and distinctive production methods capable of differentiating wines from globally distributed commercial brands. In this context, FoodTech innovations support not the industrialization of wine production but the preservation and enhancement of wine individuality.

The evaluation and synthesis reveal that craft winemaking performs different strategic functions across European wine tourism destinations. In France, the craft segment is primarily associated with the valorisation of micro-terroirs. Small producers in Burgundy, Alsace and the Loire Valley increasingly utilize precision viticulture and digital terroir mapping to demonstrate subtle environmental variations between adjacent vineyard parcels. Rather than pursuing technological standardization, French boutique wineries employ FoodTech solutions to strengthen the expression of place. Consequently, visitors are offered highly differentiated tasting experiences centred on specific vineyard sites, individual vintages and limited-production wines [22].

In Italy, craft wineries function as anchors of regional gastronomic ecosystems. Unlike the French emphasis on parcel-level terroir differentiation, Italian boutique producers integrate wine with broader culinary traditions and rural lifestyles. Family-owned wineries in Tuscany, Piedmont and Sicily increasingly combine small-batch wine production with agritourism, local gastronomy and cultural heritage experiences. FoodTech innovations facilitate this integration by connecting wineries with regional food networks, digital reservation systems and personalized visitor services. As a result, the tourism product extends beyond wine itself and encompasses a comprehensive food-and-wine experience rooted in local identity [20].

Portugal demonstrates a different pattern in which craft winemaking contributes to the preservation of heroic viticulture. Small wineries in the Douro Valley play a critical role in maintaining steep terraced vineyards that are difficult to mechanize and economically challenging to manage. FoodTech innovations enable these producers to improve vineyard monitoring, climate adaptation and resource efficiency while preserving traditional cultivation practices. Within wine tourism, these vineyards represent highly attractive cultural landscapes where visitors encounter a combination of historical continuity and technological adaptation [26].

In Spain, the growth of craft winemaking has stimulated experimentation with alternative wine styles and innovative visitor experiences. Boutique wineries in regions such as Priorat, Rioja and Bierzo increasingly produce limited-edition wines, single-vineyard bottlings and experimental blends designed for niche consumer segments. This diversification is supported by advanced fermentation monitoring systems, sensory analytics and consumer preference research. Wine tourism experiences are consequently structured around discovery, innovation and direct interaction with winemakers rather than conventional tasting formats [20; 22].

Ukraine represents one of the most dynamic emerging environments for craft winemaking development. Unlike Western European countries where the craft segment evolved gradually over several decades, Ukrainian boutique wineries have become important agents of adaptation and innovation during periods of economic and geopolitical instability. Small producers have demonstrated considerable flexibility in responding to market disruptions through direct-to-consumer sales, experiential tourism products and digital communication strategies.

A defining characteristic of the Ukrainian craft sector is the growing emphasis on indigenous and locally adapted grape varieties. Odesa Black, Telti Kuruk, Sukholymanskyi White, Zahrei and Furmint increasingly serve as markers of territorial identity and destination differentiation. These varieties provide wineries with opportunities to create tourism experiences unavailable in competing destinations, thereby strengthening the international positioning of Ukrainian wine regions [36; 41].

The technological paradigm of contemporary craft winemaking also differs substantially from industrial production models. While large-scale wineries often prioritize consistency and standardization, craft producers increasingly adopt minimal-intervention approaches that emphasize vintage variation and terroir expression. Such practices include spontaneous fermentation using indigenous yeasts, reduced filtration, limited sulfur additions and small-batch vinification.

The growing popularity of natural wines, orange wines, pétillant naturel (pet-nat) sparkling wines and amphora-aged wines illustrates this shift. These products are not merely alternative wine styles but components of a broader experiential economy in which consumers actively seek authenticity, craftsmanship and production transparency. Their tourism appeal lies in the possibility of engaging directly with production processes and understanding the cultural and environmental factors that shape wine identity.

Particularly important is the revival of traditional fermentation and aging techniques. Amphora vinification, qvevri fermentation and other heritage-based practices are increasingly combined with contemporary monitoring technologies that ensure quality control while preserving traditional production methods. This convergence demonstrates that FoodTech and craft winemaking should not be viewed as opposing concepts. On the contrary, technological innovation increasingly functions as a mechanism for safeguarding artisanal production and enhancing the market visibility of niche wines.

The findings indicate that craft wineries generate disproportionate tourism value relative to their production scale. Although their contribution to total wine output remains modest, they play a central role in destination differentiation, visitor engagement and place branding. Their ability to connect terroir, local grape varieties, gastronomy and cultural heritage creates highly immersive tourism experiences that are difficult for large industrial producers to replicate (Table 1).

Table 1 – Craft Winemaking Technologies as Drivers of Wine Tourism Experiences

Craft winemaking innovation	Technological characteristics	Influence on wine profile	Contribution to wine tourism
Amphora aging	Wine maturation in ceramic vessels without oak influence; controlled micro-oxygenation	Enhanced minerality, purity of fruit expression, complex texture and preservation of terroir characteristics	Creates authentic heritage-based experiences and attracts tourists interested in traditional winemaking practices
Qvevri winemaking	Fermentation and aging in underground clay vessels following ancient Georgian traditions	Greater structural complexity, tannin integration, natural stabilization and distinctive sensory profiles	Strengthens cultural storytelling and experiential tourism centred on historical wine traditions
Spontaneous fermentation with indigenous yeasts	Fermentation driven by naturally occurring vineyard and winery microflora	Unique aromatic complexity, vintage variability and stronger terroir expression	Enhances authenticity and educational value of winery visits focused on natural winemaking
Pétillant Naturel (Pet-Nat)	Ancestral sparkling wine method with a single fermentation completed in bottle	Fresh, vibrant and less standardized sparkling wines with natural effervescence	Appeals to younger wine tourists seeking innovative and artisanal wine styles
Orange wines	White grapes fermented with extended skin contact	Increased tannin structure, amber colour, complex aromas and	Attracts niche wine tourists seeking authentic and distinctive wine experiences

Therefore, the expansion of craft winemaking should be interpreted not simply as a trend within the wine sector but as a structural transformation of wine tourism itself. Across France, Italy, Portugal, Spain and Ukraine, boutique wineries increasingly function as laboratories of innovation where FoodTech solutions, sustainability principles and terroir-driven production models converge to create new forms of tourism value within contemporary wine destinations.

The analytical assessment of FoodTech integration in wine tourism destinations is based on a structured expert evaluation approach combined with secondary data analysis. Given the absence of unified global statistical indicators for FoodTech development in wine tourism, a composite indicator system was developed to ensure comparability across countries [19–33; 35; 41].

The KPI framework was constructed around five analytical dimensions reflecting the functional role of FoodTech in wine tourism systems:

(1) Smart terroir management;

(2) Indigenous grape utilization;

(3) Craft and experimental winemaking development;

(4) ESG and sustainability integration;

(5) Wine tourism experience innovation.

Each indicator was evaluated using a normalized 10-point, where 1 represents very low level of development and 10 represents advanced or mature implementation.

To reduce subjectivity, the evaluation followed a relative benchmarking principle. France was used as a reference benchmark due to its globally recognized leadership in precision viticulture, appellation systems and terroir-based wine tourism development. Other countries were assessed in relation to this benchmark according to the observed intensity of FoodTech adoption, diversity of wine tourism products and level of integration between production systems and tourism experiences.

The indicator "Smart Terroir Management" reflects the degree of integration of precision viticulture technologies, digital terroir mapping and environmental monitoring systems in vineyard management.

"Indigenous Grape Utilization" measures the extent to which countries actively preserve and commercially promote autochthonous grape varieties within wine tourism experiences.

"Craft Wine Innovation" captures the presence of al ternative vinification techniques such as spontaneous fermentation, amphora aging, pétillant naturel production and low-intervention winemaking practices.

"ESG and Sustainability Integration" reflects the implementation of environmental and governance-oriented practices in wine production and tourism management. "Wine Tourism Experience Innovation" evaluates the diversification and digital enhancement of visitor experiences, including sensory, educational and interactive components.

The overall composite score was calculated as an arithmetic mean of the five indicators for each country, ensuring equal weighting across all dimensions. This approach allows for balanced comparison without overemphasizing any single technological or institutional factor.

Although the scoring is semi-quantitative in nature, it is grounded in systematic qualitative evidence synthesis, making it suitable for exploratory comparative analysis in emerging interdisciplinary fields such as FoodTech-enabled wine tourism development (Table 2).

The KPI assessment demonstrates a differentiated pattern of FoodTech integration across European wine tourism destinations. France obtained the highest composite score (9.2), confirming its status as the most advanced ecosystem in terms of technological innovation, institutional support, sustainability implementation and tourism value creation. The 3.2-point difference between France and Ukraine highlights a substantial gap in the deployment of precision viticulture, digital traceability systems, smart vineyard management and innovation-driven tourism products.

Table 2 – Comparative Assessment of FoodTech-Driven Wine Tourism Development (1–10 Scale)

Country	Smart Terroir Management	Alternative Vinification Technologies	Wine Traceability and Authenticity	ESG Integration in Wineries	Wine Tourism Product Innovation	Overall Score
France	10.0	8.0	9.5	9.5	9.0	9.2
Italy	8.5	8.5	8.5	8.5	9.5	8.7
Portugal	8.0	7.5	8.0	8.5	8.5	8.1
Spain	8.0	9.0	8.0	8.0	9.5	8.5
Ukraine	5.0	9.0	4.5	5.0	6.5	6.0

Note: Scores were derived using the comparative evaluation framework described in the Research materials and methods section. The assessment was informed by the systematic synthesis of peer-reviewed literature, OIV reports, European Commission policy documents and national strategic sources [19–33; 35; 41]. France served as the benchmark country, and the overall score was calculated as the arithmetic mean of the five analytical dimensions

Nevertheless, the relatively small differences among the leading European destinations indicate that technological leadership is no longer concentrated in a single country. Italy (8.7) and Spain (8.5) exhibit nearly equivalent levels of FoodTech maturity despite relying on distinct strategic models. Italy benefits from the close integration of wine production, gastronomy and destination branding, while Spain has strengthened its position through digital personalization, visitor experience design and consumer-oriented innovation. Portugal, with a score of 8.1, remains highly competitive and demonstrates a strong capacity to combine technological modernization with sustainable destination management.

Ukraine recorded the lowest composite score (6.0), yet the results reflect a stage of ongoing transformation rather than technological stagnation. The gap of 2.1 points relative to Portugal and 2.7 points relative to Italy suggests the presence of modernization challenges alongside considerable development opportunities (Fig. 1).

Emerging FoodTech applications, growing interest in craft winemaking and increasing attention to sustainability principles indicate that the foundations for future advancement are already being established. From a strategic perspective, the comparatively moderate distance separating Ukraine from the leading European wine tourism destinations suggests favourable conditions for accelerated convergence.

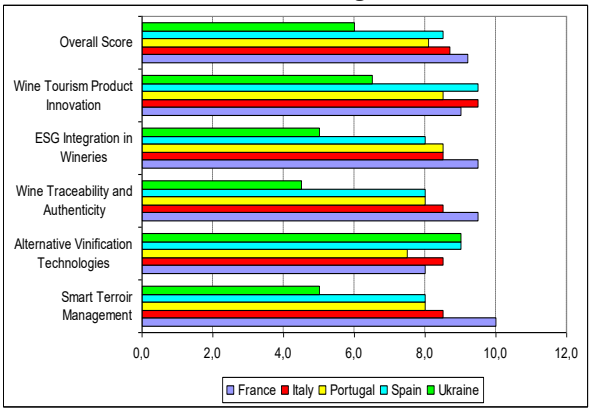


Fig. 1. Comparative Assessment of FoodTech-Driven Wine Tourism Development

Thus, the findings support the argument that future competitiveness in wine tourism will depend not only on the scale of technological adoption but also on the ability of destinations to transform local viticultural resources into distinctive and innovation-driven tourism products.

The integration of Environmental, Social and Governance (ESG) principles has become a defining structural component of contemporary wine tourism development, particularly in destinations where FoodTech technologies are actively reshaping production systems and visitor experiences. ESG should no longer be interpreted as a supplementary corporate reporting tool; instead, it functions as a systemic governance framework that determines how technological innovation is embedded into environmental management, territorial development and stakeholder relations. Within wine tourism ecosystems, ESG integration directly influences investment attractiveness, brand credibility, regulatory compliance and long-term destination resilience [24; 32; 33].

From a FoodTech perspective, ESG implementation is increasingly operationalized through digital monitoring systems, precision agriculture technologies, carbon accounting tools and blockchain-based transparency mechanisms. These instruments enable wineries and destination managers to quantify environmental impact, optimize resource consumption and demonstrate compliance with sustainability standards in real time. As a result, ESG is evolving into a data-driven management paradigm where environmental and social performance is continuously measured rather than periodically reported. However, the level of ESG maturity remains highly uneven across European wine tourism destinations, reflecting differences in institutional capacity, innovation ecosystems and strategic priorities.

The comparative analysis demonstrates that ESG integration in wine tourism is not merely an environmental policy instrument but a fundamental component of FoodTech-driven transformation. Countries with higher levels of ESG maturity exhibit stronger resilience, higher destination competitiveness and more stable long-term growth trajectories. Conversely, emerging destinations such as Ukraine have the opportunity to accelerate their development through strategic alignment with ESG principles and digital sustainability technologies.

Table 3 presents a comparative assessment of the structural components of ESG integration across leading European wine tourism destinations and Ukraine. The analysis focuses on four key dimensions: environmental certification systems, resource efficiency and circular economy practices, carbon reduction strategies, and social-territorial responsibility mechanisms. These indicators were selected to reflect the multidimensional nature of ESG implementation within FoodTech-enabled wine tourism ecosystems.

Table 4 presents the integrated ESG Maturity Index, which aggregates environmental, social, and governance performance indicators into a composite quantitative measure on a 10-point scale. This index enables cross-country comparison of overall ESG development levels within wine tourism systems, providing a synthesized view of sustainability maturity beyond individual component indicators.

Table 3 – ESG Structural Indicators in Wine Tourism Destinations

Country	Environmental Certification Systems	Resource Efficiency & Circular Economy	Carbon Reduction Practices	Social & Territorial Responsibility
France	AOC system, Vignobles & Découvertes, organic/biodynamic labels	High integration of renewable energy and precision agriculture	Advanced decarbonisation strategies	Strong heritage protection and governance
Italy	VIVA program, regional sustainability standards	Integrated agri-food ecosystems, biodiversity focus	Moderate-to-advanced reduction policies	Strong community-based tourism model
Spain	EU-aligned regional ESG frameworks	Highly developed circular economy practices	Strong renewable energy adoption	Regional development integration
Portugal	RNCSV certification, UNESCO-linked policies	Improving water and land management efficiency	Moderate low-carbon transition	Cultural landscape protection focus
Ukraine	Emerging ESG frameworks	Limited circular economy implementation	Early-stage decarbonisation	Fragmented social responsibility initiatives

Table 4 - Integrated ESG Maturity Index in Wine Tourism (1–10 Scale)

Country	ESG Environmental	ESG Social	ESG Governance	Overall Score Integrated ESG Index
France	9.5	9.0	9.0	**9.2**
Italy	8.7	9.2	8.0	**8.6**
Spain	8.8	8.5	8.7	**8.7**
Portugal	7.8	8.0	7.6	**7.8**
Ukraine	4.5	4.2	4.3	**4.3**

Note: ESG scores were derived using the comparative evaluation framework described in the Research materials and methods section. The assessment was informed by the systematic synthesis of peer-reviewed literature, international sustainability reports, European Union policy documents and national strategic sources [19–33; 35; 41]. France served as the benchmark country. The Integrated ESG Maturity Index was calculated as the arithmetic mean of the environmental, social and governance dimensions.

The ESG assessment reveals considerable differences in sustainability maturity among the analyzed wine tourism destinations. The environmental dimension shows the widest variation, with France achieving the highest score (9.5), followed by Spain (8.8), Italy (8.7) and Portugal (7.8). These results indicate the extensive adoption of sustainable viticulture practices, climate adaptation measures, biodiversity protection initiatives and resource-efficient technologies across leading European wine regions. In the social dimension, Italy recorded the highest score (9.2), demonstrating a strong capacity to integrate local communities, preserve cultural heritage and generate regional economic benefits through wine tourism. France (9.0), Spain (8.5) and Portugal (8.0) also achieved high levels of social sustainability, reflecting the importance of stakeholder engagement and community-oriented development within their tourism systems.

The governance dimension confirms the critical role of institutional effectiveness in supporting sustainable wine tourism development. France and Spain demonstrated the strongest governance performance with scores of 9.0 and 8.7 respectively, while Italy (8.0) and Portugal (7.6) maintained relatively mature governance structures characterized by strategic planning and sustainability-oriented management. Ukraine obtained significantly lower scores across all ESG components, recording 4.5 in the environmental dimension, 4.2 in the social dimension and 4.3 in governance. These results indicate that sustainability practices remain at an early stage of institutionalization. At the same time, the relatively balanced distribution of scores suggests that future progress should focus on the simultaneous strengthening of environmental modernization, stakeholder participation and governance mechanisms to ensure a comprehensive and sustainable transformation of the Ukrainian wine tourism sector (Fig. 2).

The findings reveal a clear stratification of ESG maturity across European wine tourism destinations. France achieves the highest score (9.2), confirming its position as a benchmark system where ESG principles are deeply embedded in regulatory frameworks, territorial governance, and FoodTech-driven innovation processes. Spain (8.7) and Italy (8.6) form a second

high-performance cluster, albeit with differing structural orientations: Spain emphasizes circular economy and resource efficiency, while Italy integrates ESG within cultural, gastronomic, and community-based tourism systems.

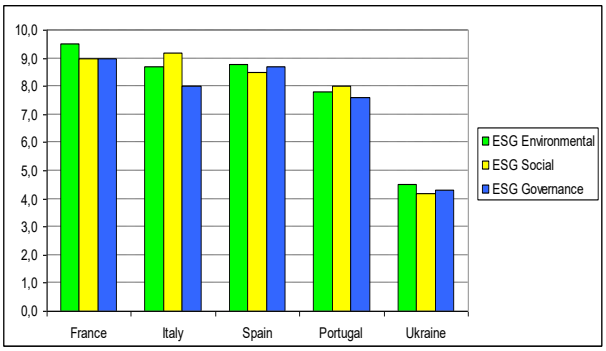


Fig. 2. Integrated ESG Maturity Index in Wine Tourism

Portugal (7.8) represents a moderate but steadily evolving ESG model, characterized by strong environmental protection mechanisms but comparatively limited governance integration at the systemic level. Ukraine (4.3) remains significantly below European benchmarks, reflecting early-stage development of ESG frameworks and limited institutional capacity. However, the observed gap also indicates substantial convergence potential, particularly if ESG integration is embedded within reconstruction strategies aligned with EU sustainability policies and digital transformation agendas (Fig. 3).

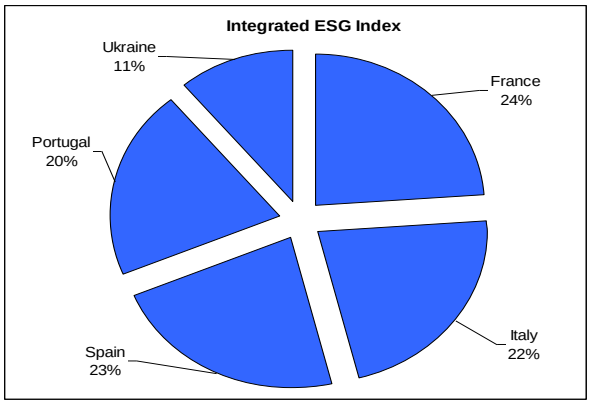


Fig. 3. Overall Score Integrated ESG Index

Overall, the index confirms that ESG maturity in wine tourism is strongly correlated with the level of FoodTech development, institutional support, and the degree of integration between technological innovation and territorial governance systems.

The modernization of wine tourism in Ukraine is increasingly shaped by the convergence of institutional reform, digital transformation and the gradual integration of FoodTech and ESG-oriented development strategies. A key milestone in this process is the adoption of the new Law of Ukraine "On Grapes, Wine and Products of Viticulture" (2026), which aligns national regulatory standards with the European Union framework. Beyond legal harmonization, this reform represents a structural shift toward a governance model in which quality regulation, territorial identity and sustainability principles are becoming interlinked components of wine sector development [43].

A central feature of the new regulatory system is the introduction of geographical indications (PDO/PGI), which serve as a bridge between product authenticity, territorial branding and sustainability governance. Within the ESG framework, these instruments enhance environmental transparency through traceable origin systems (E), strengthen socio-economic inclusion of regional producers and rural communities (S), and improve institutional accountability in quality certification and market regulation (G). From a FoodTech perspective, geographical indications also create the foundation for digital traceability systems, enabling data-driven verification of origin, production methods and environmental compliance.

The PDO model ensures that all stages of production occur within a defined geographical area, reinforcing the concept of terroir as both a cultural and environmental determinant of quality. PGI certification introduces a more flexible structure, allowing partial localization of production processes while maintaining regional identity. This dual system is particularly relevant for Ukraine, as it supports both established wineries and emerging small-scale producers, facilitating inclusive participation in wine tourism value chains.

From an ESG-driven tourism perspective, geographical indications significantly enhance destination competitiveness. They increase consumer trust, strengthen regional wine branding and elevate the experiential value of wine tourism by linking consumption with verified territorial narratives. Regions such as Odesa, Zakarpattia, Mykolaiv, Bessarabia and Podillia are emerging as strategic territories for ESG-based wine tourism development due to their agro-climatic potential and growing tourism infrastructure.

In parallel with regulatory transformation, Ukraine is undergoing a rapid emergence of FoodTech-enabled digital ecosystems within the wine sector. Historically fragmented, small and medium-sized wineries are gradually being integrated into platform-based systems that connect production, distribution and tourism services. The digital platform "Sertsevyna" illustrates this transition, functioning as an early-stage FoodTech infrastructure that redefines sectoral coordination through data integration and digital intermediation [44].

From a FoodTech perspective, such platforms introduce three interconnected layers of value creation. The informational layer enhances transparency by providing structured data on wineries, terroirs and production processes, thereby enabling informed tourism decision-

making and route optimization. The economic layer functions as a digital marketplace that reduces intermediary dependencies, strengthens producer profitability and improves market accessibility for small wineries. The socio-cultural layer fosters collective identity formation by linking producers and consumers within a unified narrative of Ukrainian wine, thereby contributing to destination branding and cultural differentiation.

From an ESG standpoint, these digital systems play a transformative role in improving governance transparency, supporting local economic development and enabling environmentally informed decision-making. Data-driven platforms reduce information asymmetry, strengthen stakeholder trust and facilitate the integration of sustainability indicators into tourism and production management systems.

Geographically, Ukraine demonstrates a high degree of spatial differentiation in its emerging wine tourism structure. Southern regions, particularly Odesa and Mykolaiv, are characterized by large-scale terroir-based estates oriented toward premium and heritage tourism. Western regions such as Zakarpattia and Lviv are developing small-scale, community-driven wine tourism models that integrate gastronomy, culture and rural development. Central and northern regions are increasingly oriented toward experimental and educational wine tourism formats, including interactive tastings and innovation-driven visitor experiences.

Rather than representing fragmentation, this spatial heterogeneity constitutes a strategic advantage, enabling the development of differentiated ESG and FoodTech models tailored to regional capacities. Digital platforms act as catalysts of territorial specialization, allowing regions to articulate distinct competitive identities within a unified national wine tourism ecosystem.

Thus, the Ukrainian case demonstrates that the future of wine tourism development lies in the integration of FoodTech systems and ESG frameworks rather than in production modernization alone. The alignment of EU regulatory standards, the implementation of geographical indication systems and the emergence of digital platforms collectively establish the foundations for a hybrid development model that combines sustainability, digitalization and territorial branding.

From a strategic perspective, Ukraine can be interpreted not merely as a converging market but as a potential experimental environment for next-generation FoodTech–ESG wine tourism systems. The effectiveness of this transformation will depend on the ability to consolidate fragmented initiatives into a coherent national strategy that integrates digital infrastructure, sustainability governance and territorial tourism development into a unified policy framework.

Conclusion

This study demonstrates that FoodTech integration in wine tourism represents a systemic transformation rather than a purely technological upgrade. Its influence extends beyond production efficiency and directly affects the structure of wine tourism territories, including how value is created, how authenticity is communicated, and how visitors engage with wine-producing regions. The findings confirm that FoodTech operates as a connecting mechanism between viticulture and winemaking practices and tourism experience design.

The comparative analysis shows that the development of wine tourism is increasingly determined by the degree of integration between technological innovation, terroir-based production systems, and sustainability-oriented governance. Territories with higher levels of coordination between these dimensions tend to demonstrate stronger competitiveness in premium and niche tourism segments. In such cases, innovation is not isolated within wineries but is embedded across the entire regional ecosystem, including vineyard management, production processes, logistics, and visitor services.

At the same time, the results indicate that wine tourism development follows different structural pathways rather than a single model of modernisation. Some countries rely primarily on institutionalised quality systems and terroir protection, others emphasise gastronomic and cultural integration, while others focus on digital personalisation of visitor experiences or adaptation to environmental constraints. These differences suggest that FoodTech should be understood as a flexible framework that adapts to national conditions rather than a standardised technological solution.

The study also highlights the growing importance of craft and alternative winemaking practices within contemporary wine tourism. Small scale production indigenous grape varieties and low intervention vinification methods increasingly contribute to regional identity and differentiation. These elements strengthen the link between wine production and tourism by offering more authentic and experience driven products that cannot be easily replicated in industrial systems.

ESG principles are an integral component of contemporary wine tourism development linking environmental efficiency social responsibility and governance quality across production and visitor experience systems Environmental aspects include resource efficiency climate adaptation and reduced chemical use in viticulture Social dimensions involve support for local producers preservation of wine heritage and community based tourism development Governance is reflected in transparency traceability and compliance with quality standards Together these elements function as a unified framework that enhances sustainability competitiveness and long term resilience of wine tourism territories

Finally, the study provides implications for future development strategies in emerging wine tourism territories. Sustainable competitiveness is likely to

depend on the ability to combine technological tools with local identity resources, particularly indigenous grape varieties and craft production systems. This is especially relevant for countries undergoing structural transformation, where modernisation opportunities are closely linked to the reconfiguration of agricultural and tourism systems. In this sense FoodTech should be viewed as a long-term development instrument that shapes both the economic and cultural evolution of wine tourism regions.

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FOODTECH-ІННОВАЦІЇ ТА ESG У ТРАНСФОРМАЦІЇ ТРАДИЦІЙНОГО ВИНОРОБСТВА В СМАРТ-ДЕСТИНАЦІЇ ВИННОГО ТУРИЗМУ

О.О. Ахмедова, доктор наук з державного управління, професор, *E-mail:* akhmedova.oo@knutd.edu.ua
https://orcid.org/0000-0003-1573-7710
А. В. Чернихівська, кандидат економічних наук, доцент, *E-mail:* chernykhivska.av@knutd.edu.ua
https://orcid.org/0000-0001-9642-8471
кафедра туризму та готельно-ресторанного бізнесу
Київський національний університет технологій та дизайну
вул. Мала Шияновська, 2, Київ, 01011

Анотація. У статті досліджено значення інновацій FoodTech та ESG у трансформації сучасних систем винного туризму від традиційних моделей виноробства до концепції розумних і сталих дестинацій. Особливу увагу приділено взаємозв'язку між технологічною модернізацією виноградарства та виноробства, практиками управління, орієнтованими на принципи сталого розвитку, а також формуванням конкурентоспроможного туристичного продукту. Проаналізовано вплив точного виноградарства, цифрового управління теруаром, систем походження продукції, штучного інтелекту, інновацій крафтового виноробства та використання автохтонних сортів винограду на розвиток сучасних екосистем винного туризму. Обґрунтовано, що FoodTech виходить за межі суто технологічної модернізації виробництва вина та функціонує як інтегрований механізм, що поєднує управління виноградниками, забезпечення якості винної продукції, брендинг виноробних територій, формування туристичного досвіду та досягнення цілей сталого розвитку. Визначено значення теруарної диференціації, альтернативних методів вініфікації та крафтового виноробства як важливих чинників підвищення автентичності й туристичної привабливості виноробних регіонів. Дослідження базується на порівняльному аналітичному підході та системі KPI-показників, що дозволило здійснити оцінювання рівня інтеграції FoodTech у винному туризмі Франції, Італії, Португалії, Іспанії та України. Результати дослідження засвідчили наявність різних траєкторій розвитку європейських систем винного туризму, зумовлених особливостями технологічного розвитку, інституційного середовища, теруарної спеціалізації та практик сталого управління. Доведено, що довгострокова конкурентоспроможність виноробних територій дедалі більше залежить від здатності поєднувати технологічні інновації, принципи ESG, локальну винну ідентичність та клієнтоорієнтовані туристичні практики в межах єдиної системи сталого розвитку.

Ключові слова: FoodTech, ESG, винний туризм, крафтове виноробство, інновації, цифрова трансформація, сталий розвиток, штучний інтелект, конкурентоспроможність дестинацій.

Received 10.06.2026 **Approved 29.09.2026**
Revised 22.06.2026 **Available in Internet 12.10.2026**