Formation of a Model of Internal Control over Compliance with the Production Technology of Wineries

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Abstract: - The purpose of this study is to justify approaches to developing a model of internal control that ensures compliance with technological processes at winemaking enterprises. The results show that internal control is based on the accounting system as a key tool for ensuring its effectiveness in management. The main components of internal control include operational and financial control, which have the greatest impact on compliance with technological parameters. A model for implementing internal control has been developed that covers all stages of the production process. It ensures the efficient use of resources, improved product quality, compliance with regulatory requirements, and financial stability. The study confirms the key role of internal control in improving managerial decision-making and maintaining product quality.

Key-Words: - control, accounting, winemaking, functions, product quality, activities, production technology.

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1 Introduction

The wine industry is one of the key components of the agro-industrial complex, providing high-quality products with unique taste properties. In conditions of dynamic change and constant risk, the control function in the management system of wine-producing enterprises is becoming increasingly important. It manifests through managerial control, a management function within the management system of any business entity. In modern economic conditions, managers at various levels exercise control on an ongoing basis, enabling them to respond promptly to current changes and make operational and strategic

decisions to ensure the enterprise's effectiveness. In the current conditions of globalization and growing consumer demands for product quality, internal control over compliance with production technology is becoming particularly important.

It is precisely because of effective internal control in wine-producing enterprises that the following occurs: 1) product quality assurance, since internal control prevents deviations from standards that could affect the taste, aroma, and safety of wine; 2) compliance with regulatory requirements, which in many countries regulate wine products with strict standards (e.g., DSTU, HACCP, ISO), and violations of the technological process can lead to sanctions or loss of license; 3) economic efficiency is ensured by control over the use of raw materials and resources and allows optimizing production costs and reducing the risk of defects; 4) increased competitiveness of wine products, which are evaluated on the international market according to quality criteria, and systematic control guarantees stable performance; 5) environmental and ethical aspects, which are ensured by compliance with technologies, allow minimizing the negative impact on the environment and complying with the principles of sustainable development.

Control is such a complex concept that it remains a subject of study for lawyers, sociologists, and economists, and is characterized by scholars as a function, a principle, or a form of activity. Of particular relevance is the study of the place and role of control in the management system, which remains under-researched. The theory and methodology of control have been studied in the works of [1], [2], [3], [4], [5], [6], [7]. [8] evaluates approaches to the formation of accounting theory and areas of disagreement. Other authors [9] revealed the peculiarities of controlling the formation of prices for wine products on the world market, considering their qualification categories.

Some researchers [10] considered sustainable wine assessment tools to enhance the sustainability of the wine industry, where sustainability indicators met strict criteria for accuracy and reliability, and the assessment system promoted transparency and accountability. Previous studies [11] note in their work that knowledge-based control systematic monitoring of wine production processes; however, their practical application is limited by insufficient digitalization, a shortage of qualified specialists, high implementation costs, and weak control over counterfeit products.

Thus, improving internal control in the wine industry requires a comprehensive approach, including the introduction of modern information technologies, staff training, and harmonization of the regulatory framework with international standards.

2 Problem Formulation

The study is empirical in nature, as it was based on a combined approach to the specifics of forming an internal control model while adhering to the production technology of wine-making enterprises. The primary materials of the study are scientific publications, in particular [8], [10], and [11], which studied the tools for assessing the quality of wine products and the mechanisms of internal control in the management system of enterprises.

The study outlined the features of internal control at each stage of the production process to ensure the quality of the wine as the final product. To ensure the high efficiency of internal control in wine-producing enterprises, specific research methods were used, in particular: laboratory tests, automated monitoring systems, organoleptic testing, and documentary control. Specific attention is paid to identifying risks at different stages of production.

The research covers methodological approaches to internal control of compliance with international regulatory requirements for wine quality, in particular, the analysis of raw material compliance, control of the technological process, verification of storage conditions, etc. The study examined the environmental and ethical aspects ensured by compliance with technologies. Internal control is ensured through the following methods: automated monitoring systems, regular environmental audits, compliance with sustainable production standards, training personnel on environmental risks, and efficient resource use. The study's result is a model of internal control over compliance with production technologies at wine-producing enterprises, aimed at achieving management objectives.

3 Problem Solution

Control is a complex, under-researched scientific concept, as its meaning lacks a clear, universally accepted definition. At the same time, on a practical level, control is an integral part of the activities of any enterprise and the daily life of every person. No sphere of human activity can exist without the process of control, especially in professional management. Managers carry out their activities within the general management cycle, which includes planning, organizing, motivating, and controlling. While the first three components have been thoroughly researched in management theory

and successfully implemented in practice, control is often not covered in sufficient detail and remains less structured in scientific approaches.

We agree with most authors that control theory should be studied within the framework of cognitive theory and a systematic approach. According to modern systems theory, there are eight levels: linguistic; theoretical-multiple; abstract-logical; topological; logical-mathematical; theoretical-informational; dynamic; heuristic, [12].

Control is a process that ensures the object of management functions in accordance with the management decisions made and is aimed at achieving the set goal. Among the existing types of economic control, scientists highlight the special role and functions of internal economic control in the management system of economic entities. This research is the subject of works by foreign and Ukrainian scientists, in particular: [13], [14], [15], [16], [17], [18], [19], and others.

Accounting is the primary tool for ensuring the effectiveness and performance of internal control functions, as it provides management personnel at all levels with reliable information.

Internal control is an integral part of managing a wine-producing enterprise. Its primary purpose is to ensure the effective use of resources and compliance with technological and quality standards for finished products, thereby increasing their competitiveness.

Internal control performs its functions in the management system of a wine-producing enterprise with the help of the following components: - operational control – ensures the quality of finished products; - financial and economic control – ensures cost optimization and improves the financial results of the enterprise; - control of compliance with regulatory and environmental requirements – ensures consistency and compliance with standards; - control of material and technical support – ensures optimization of production processes; - personnel control – increases productivity and occupational safety; - innovative control – contributes to the modernization and environmental friendliness of production.

The purpose, actions, and results of each of the listed components of internal control are shown in Figure 1 (Appendix). Due to the effectiveness of the internal control system, the winery can increase production efficiency, guarantee stable wine quality, and successfully compete in domestic and international markets.

A survey of 61 enterprises allowed us to summarise the results of assessing the effectiveness of control components on a Likert scale (1-5), where 1 indicates very low effectiveness, 2 low, 3 average, 4 high, and 5 very high effectiveness (Table 1).

Table 1. Results of the assessment of the effectiveness of control components in the grape and wine industry (n=61)

Control components	Mean value (Mean)	Standard deviation (SD)	Frequency of observations (n)
Operational control	4,20	0,68	61
Financial and economic control	4,60	0,55	61
Control over compliance with regulatory requirements	4,40	0,62	61
Control over material resources	3,70	0,81	61
Control over personnel	3,90	0,74	61
Control over innovations	3,20	0,89	61

Source: created by the authors

An analysis of the results of a survey of 61 grape and wine-producing enterprises showed that financial and economic control is characterised not only by the highest average value (4.60), but also by the smallest standard deviation (SD=0.55). This indicates a high degree of consistency in the respondents' assessments and a relatively uniform level of financial and economic control development in the industry. Operational control and regulatory compliance have high average values (4.20 and 4.40, respectively) with moderate standard deviations, indicating the stability of technological process control and regulatory compliance practices, driven by industry standards in winemaking.

At the same time, control of material resources (SD=0.8) and control of personnel (SD=0.74) show increased variability in assessments. This means that the effectiveness of these components varies significantly across enterprises, which can be explained by seasonality in production, different levels of mechanisation, and dependence on temporary labour. The highest standard deviation is observed for innovation control (SD=0.89), indicating the absence of a unified approach to managing innovation activities. Some enterprises actively implement technologies, while others limit themselves to traditional production methods.

The results of empirical research are presented, combining descriptive statistics, correlation analysis, and multiple regression modelling to assess the impact of internal control system components on the enterprise's key performance indicators.

The results of the descriptive analysis show that the overall level of development of the internal control system in the grape and wine industry is relatively high, but uneven across individual components (Table 2, Appendix).

According to the study's results, the highest average value was recorded for financial and economic control (Mean=4.6; SD=0.55), reflecting the industry's capital-intensive nature and the critical importance of financial discipline. High average scores were also obtained for operational control (Mean=4.20; SD=0.68) and regulatory compliance control (Mean=4.40; SD =0.62), which is due to strict technological standards and regulatory requirements in winemaking. Innovation control is characterised by the lowest mean value (Mean=3.20; SD=0.89) and the largest standard deviation, which indicates significant differentiation among enterprises in their approaches to managing innovation activities.

Spearman's correlation coefficient was used to assess the relationships between the components of the control system and performance indicators. The results confirm the existence of statistically significant correlations ($p<0.05$) between most of the variables studied. The models' explanatory power (generalisation) is shown in Table 3.

Table 3. Explanatory power of models (generalisation)

Dependent variable	R^2	Adj.R^2	F(p-value)
Product quality	0,62	0,58	p < 0,001
Production costs	0,68	0,64	p < 0,001
Compliance with regulatory requirements	0,71	0,68	p < 0,001
Financial results	0,74	0,71	p < 0,001

Source: created by the authors

Operational control demonstrates a strong direct correlation with product quality (r=0.62) and a strong inverse correlation with the defect rate (r=-0.58), underscoring the key role of technological discipline in ensuring the stable quality of wine products.

Financial control shows the strongest negative correlation with production costs (r=-0.67) and the strongest positive correlation with financial results (r=0.71), confirming its systemic role in ensuring the economic efficiency of enterprises.

Control over compliance with regulatory requirements is characterised by a very strong correlation with the level of regulatory responsibility (r=0.78), confirming the validity of this control component in a highly regulated industry. At the same time, innovation control correlates significantly with product quality (r=0.65) and financial results (r=0.63), indicating the importance of innovation for the formation of competitive advantages.

To determine the net impact of the control system components on the key performance indicator (Yi), a general model was formed, and a series of multiple linear regression (OLS) models with standard coefficients were constructed.

General model:

$$Y_i = \beta_0 + \beta_1 OC_i + \beta_2 FC_i + \beta_3 CC_i + \beta_4 MC_i + \beta_5 HC_i + \beta_6 IC_i + \varepsilon_i \quad (1),$$

In equation (1), Yi is the key performance indicator.
OC – operational control;
FC – financial and economic control;
CC – regulatory control;
MC – material control;
HC – human control;
IC – innovation control.

The regression model, in which product quality is the dependent variable, has a sufficiently high explanatory power (R2=0.62; p < 0.001). Statistically significant predictors are innovation control (β=0.35; p = 0.001), operational control (β=0.31; p =0.004) and personnel control (β=0.27; p = 0.008). This indicates the crucial importance of combining technological control and human capital management to ensure high product quality. In the production cost model (R2=0.68; p < 0.001), financial and economic control (β= - 0.41; p =0.001) and material supply control (β= - 0.33; p =0.001) have the strongest influence, confirming their key role in the rational use of resources and cost optimisation. The regulatory compliance model is characterised by the highest coefficient of determination (R2=0.71; p < 0.001). The dominant factor is control over compliance with regulatory requirements (β= - 0.52; p < 0.001), while operational and personnel controls have a moderate but statistically significant impact. This corresponds to the specifics of the grape and wine industry as a highly regulated field of activity. The regression model of financial results demonstrates high explanatory power (R2=0.74; p < 0.001). The most significant determinants of financial performance are financial control (β= 0.46; p < 0.001), innovation control (β= 0.34; p < 0.001), and personnel control (β= 0.26; p = 0.006), which indicates the synergistic effect of financial discipline, innovative development, and effective human resource management.

Let us consider each component that ensures the specific features of internal control over the production of high-quality wine, step by step.

1) ensuring product quality, since internal control allows avoiding deviations from standards that may affect the taste, aroma, and safety of wine;

To ensure high efficiency of internal control, wine-producing enterprises use specific methods:

- laboratory tests are used to perform chemical

and microbiological analyses;

- automated monitoring systems provide temperature sensors and CO2 level determination, automated fermenters;
- Organoleptic testing is used for tasting control by professional winemakers.
- documentary control ensures the registration of parameters at each stage of winemaking to track the analysis of possible deviations.

Using Table 4 (Appendix), we will characterize the risks affecting the quality of wine products.

The main task of a wine-producing enterprise is to implement an internal control system that will minimize risks, stabilize product quality, and ensure that the quality characteristics of wine comply with international standards.

2) compliance with regulatory requirements, which in many countries regulate wine products with strict standards (e.g., DSTU, HACCP, ISO), and violations of the technological process can lead to sanctions or loss of license;

The production of wine products in Ukraine is regulated by strict requirements aimed at ensuring product quality and safety. Internal control in wine-producing enterprises is a key mechanism that not only helps prevent violations but also enhances product competitiveness.

Scientific research on the development and implementation of the HACCP management system was carried out by foreign and domestic scientists, in particular: [20], [21], [22], [23], [24], [25], [26], [27], [28] and others.

Hazard Analysis and Critical Control Point (HACCP) is a science-based system for identifying hazards and critical control points to ensure food safety throughout the entire production chain, "from farm to table", [29]. Dr. Deming made a significant contribution to the development of the Total Quality Management (TQM) system, emphasizing a comprehensive, systematic approach to production that can improve quality while reducing costs, [30], [31]. The quality of wine products in Ukraine is ensured by compliance with international standards, in particular: ISO 22 000; ISO 9001; OIV (International Organization of Vine and Wine).

Ensuring the compliance of wine products with established quality and safety standards is impossible without strict adherence to applicable regulatory requirements. It is the regulatory framework governing the production, accounting, storage, and sale of wine products, defining the key requirements for organizing processes within the enterprise. The regulation of wine products in selected countries that are world leaders in the wine industry is shown in Table 5 (Appendix).

Internal control at Ukrainian wine-producing enterprises is an integral part of ensuring that products comply with strict national and international standards. Compliance with HACCP, DSTU, and ISO requirements helps prevent violations and avoid sanctions. At the same time, violations of the technological process can lead to significant fines, product recalls, and even loss of licenses.

3) Economic efficiency is ensured by controlling the use of raw materials and resources, allowing for the optimization of production costs and the reduction of defect risks.

Internal control of raw materials and resources is a strategic tool for ensuring the economic efficiency of wine production. Thanks to careful control of each stage—from grape reception to bottling of the finished product—wineries can significantly reduce production costs, minimize the risk of defects, and improve product quality. This, in turn, allows them to remain competitive in the market and ensure stable profits.

4) increasing the competitiveness of wine products, which are evaluated on the international market according to quality criteria, and systematic control guarantees stable performance;

On the international market, wine is evaluated according to relevant quality criteria, which cover both organoleptic characteristics (taste, aroma, color) and physical and chemical parameters. Internal control at a winery allows for high product quality by ensuring:

- Stability of chemical composition and taste characteristics, in particular compliance with production standards and consumer expectations;
- Compliance with international certificates (ISO 22000, HACCP, OIV, organic certification);
- Minimization of the risk of defects and ensuring a high level of product safety;
- Consumer trust is built on high wine quality, which increases brand loyalty.
- Economic efficiency through reduced losses and waste due to strict control of technological parameters.

This allows companies to retain customer loyalty, increase export opportunities, and strengthen their position in the wine industry.

5) Environmental and ethical aspects, which are ensured by compliance with technologies, allow for minimizing the negative impact on the environment and complying with the principles of sustainable development.

Compliance with winemaking technologies is essential not only for economic efficiency and product quality, but also for ensuring environmental safety and compliance with ethical production standards. Contemporary winemaking increasingly aligns with sustainable resource conservation,

pollution reduction, and responsible labor and social standards.

Summarizing the above, we will develop a model of internal control over compliance with production technology in wine-producing enterprises (Figure 2 Appendix).

The developed model of internal control over compliance with production technology at wine-producing enterprises is aimed at achieving management objectives, in particular the efficient use of resources, by controlling the use of materials, energy supply, labor, and reducing losses from defects; improving product quality (compliance with technological standards, minimizing the risks of deviation from norms); compliance with regulatory requirements (ensuring compliance with international standards, preventing environmental and technological violations); financial stability of the enterprise (reducing costs, increasing profitability, introducing modern technologies to optimize processes). All measures are aimed at achieving the business entity's goals to improve financial results.

4 Conclusion

The development of a model of internal control over compliance with production technology at wine-producing enterprises is an integral key element of the management system of wine-producing enterprises. The study confirms that the implementation of control functions in the activities of wine-producing enterprises occurs in conjunction with the management system, which helps managers at various levels of management to assess the compliance of production processes with established standards, prevent losses from defective finished products, increase economic efficiency and rational use of resources, ensure compliance with regulatory and environmental requirements and international standards for wine quality. The study outlines the components of internal control (operational control, financial and economic control, control of compliance with regulatory and environmental requirements, control of material and technical support, personnel control, innovation control) that ensure the implementation of the above functions, defining their purpose, actions, and results aimed at improving the performance of wine-producing enterprises.

The empirical study is based on a questionnaire survey of 61 grape and wine-producing enterprises, ensuring sufficient representativeness of the sample for analysing the state of internal control in the industry. The results obtained indicate a statistically significant multilevel dependence between the effectiveness of control system components and the key performance indicators of grape and wine production enterprises. Correlation analysis confirms the existence of stable relationships ($|r| = 0.32 – 0.78$), and regression models demonstrate high explanatory power ($R2 = 0.62$-0.74). The financial, operational, and innovative components of control play a particularly significant role, shaping both the short-term effectiveness and long-term competitiveness of the industry.

The study's results confirm that the internal control system has a multidimensional, statistically significant impact on the key performance indicators of wine-producing enterprises. Financial and economic control, and regulatory control, ensure stability and compliance with regulatory requirements, while operational, human resources, and innovation control form the basis for improving product quality and the industry's long-term competitiveness. The high R2 value in all models confirms the adequacy of the constructed regression models and the reliability of the empirical conclusions obtained.

In general, the control system in the industry is characterised by an organisation focused on financial stability and regulatory responsibility, while the innovation component requires further development.

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Contribution of Individual Authors to the Creation of a Scientific Article (Ghostwriting Policy)

The authors equally contributed in the present research, at all stages from the formulation of the problem to the final findings and solution.

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Conflict of Interest

The authors have no conflicts of interest to declare that are relevant to the content of this article

APPENDIX

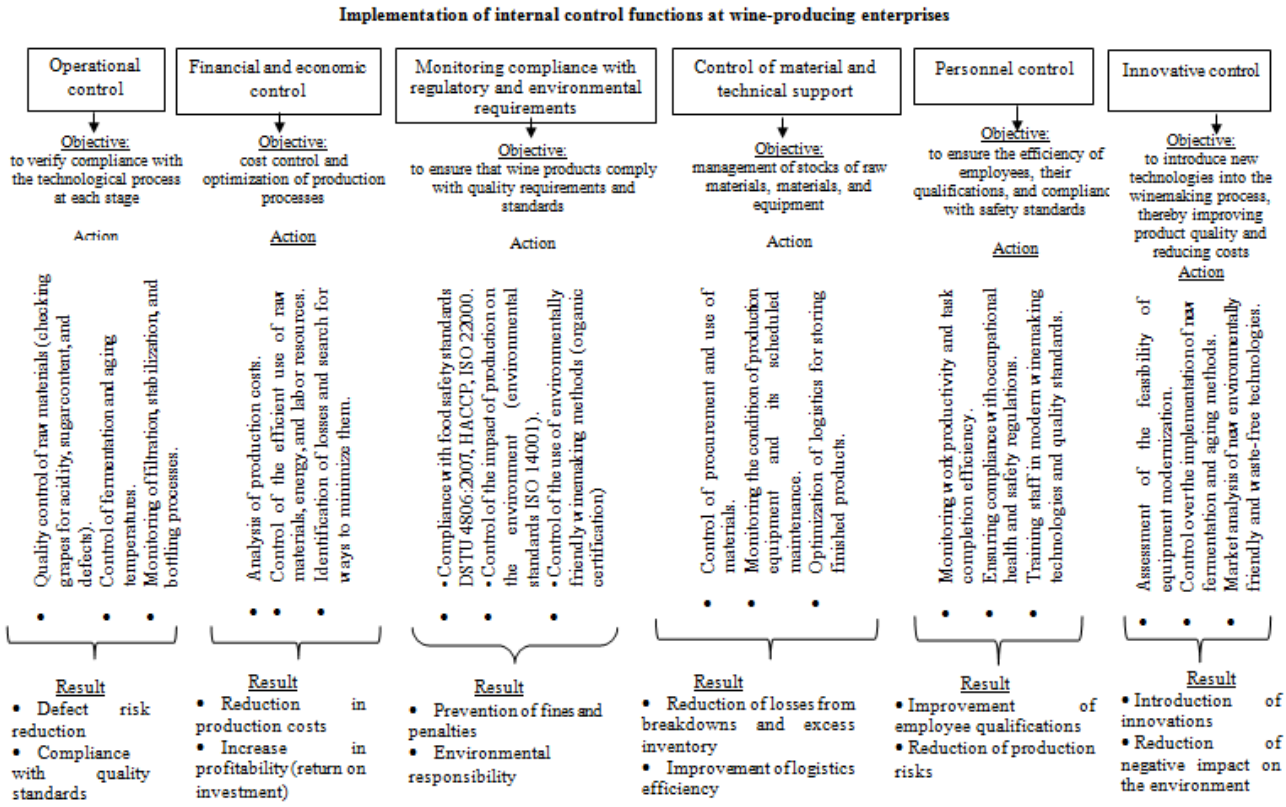

Fig. 1: Model for implementing internal control functions in the management system of wine-producing enterprises

Source: compiled by the author

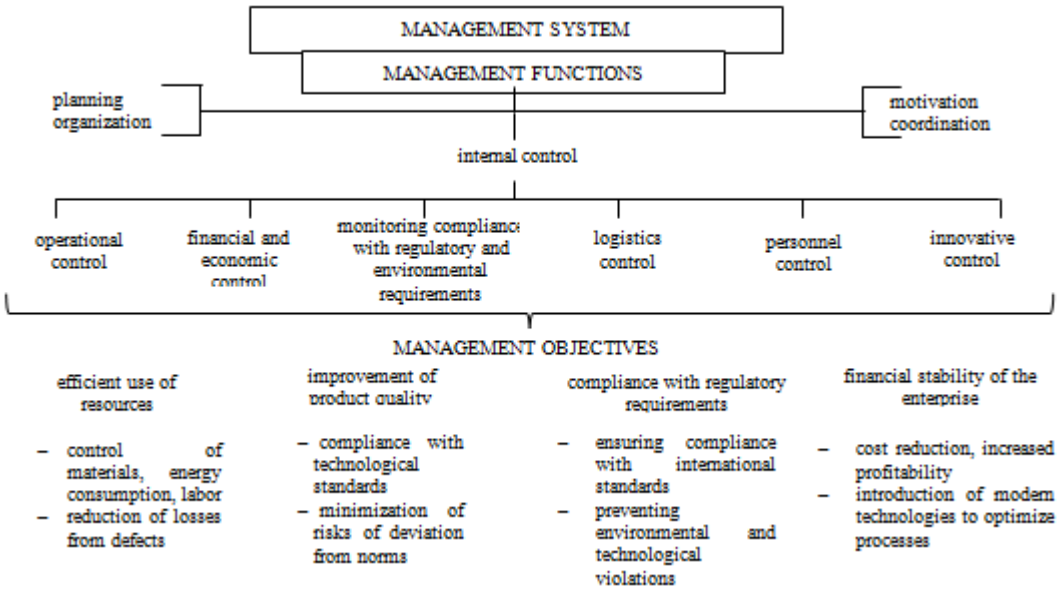

Fig. 2: Model of internal control over compliance with production technology at wine-producing enterprises

Source: created by the authors

Table 2. Generalised results of empirical research (n=61, Likert scale 1-5)

Control system component	Mean	SD	Product quality	Production costs	Compliance with standards	Financial results
Operational control	4,20	0,68	r=0,62*** β=0,31*** CI [0,11;0,51]	r=0,41** β=-0,22* CI [-0,41; -0,03]	r=0,49*** β=0,19* CI [0,01;0,37]	r=0,53*** β=0,24* CI [0,06;0,42]
Financial and economic control	4,60	0,55	r=0,48*** β=0,18 (n.s.)	r=-0,67*** β=-0,41*** CI [-0,60; -0,22]	r=0,0,45*** β=0,16 (n.s.)	r=0,71*** β=0,46*** CI [0,28;0,64]
Control over compliance with regulatory requirements	4,40	0,62	r=0,55*** β=0,21* CI [0,02;0,40]	r=-0,32*** β=-0,12 (n.s.)	r=0,78*** β=0,52*** CI [0,34;0,70]	r=0,50*** β=0,18* CI [0,01;0,35]
Control over material resources	3.70	0,81	r=0,46*** β=0,14 (n.s.)	r=-0,59*** β=-0,33*** CI [-0,52; -0,14]	r=0,38** β=0,11 (n.s.)	r=0,47*** β=0,21* CI [0,03;0,39]
Control over personnel	3,90	0,74	r=0,57*** β=0,27** CI [0,08;0,46]	r=-0,43*** β=-0,19* CI [-0,37; -0,01]	r=0,42*** β=0,17* CI [0,01;0,33]	r=0,56*** β=0,26*** CI [0,09;0,43]
Control over innovations	3,20	0,89	r=0,65*** β=0,35*** CI [0,15;0,55]	r=-0,35*** β=-0,15 (n.s.)	r=0,41*** β=0,13 (n.s.)	r=0,63*** β=0,34*** CI [0,17;0,51]

Note: - Spearman's correlation coefficient;
- CI – 95% confidence interval;
- standardised regression coefficient (OLS)
*- ***p < 0.001; **p < 0.01; *p << 0.05; n.s. – statistically insignificant.*
Source: created by the authors

Table 4. Characteristics of risks affecting the quality of wine products

Risk group	Risk components	Risk characteristics
Agrometeorological risks	Climate change	Higher average annual temperatures and lower rainfall can affect the sugar content and acidity of grapes.
	Droughts or excessive precipitation	Insufficient moisture leads to lower yields, while excessive moisture leads to berry rot.
	Hail, frost, abnormal temperatures	They can destroy the crop or impair its quality.
	Grape diseases (powdery mildew, downy mildew, gray rot)	They spread under unfavorable weather conditions and negatively affect the productivity of grapevines
Technological risks	Fermentation instability	If the fermentation temperature is too high or too low, the yeast may not work properly, which will affect the taste.
	Wine oxidation	This occurs due to contact with oxygen at various stages of production (e.g., during racking or bottling). This can lead to changes in color, taste, and aroma.
	Aging defects	Improper storage conditions in barrels or tanks can cause unwanted aromas or loss of fruitiness.
	Filtration and stabilization issues	Insufficient filtration can leave yeast and bacteria in the wine, causing it to spoil, while excessive filtration can lead to a loss of organoleptic properties.
	Incorrect sulfur dioxide (SO2) control	A lack of oxygen can lead to bacterial contamination of the wine, while an excess can lead to a deterioration in taste.
Microbiological risks	Contamination with wild yeast and bacteria	May cause unwanted fermentation processes.
	Acetic acid fermentation	Caused by Acetobacter bacteria, which form acetic acid when in contact with oxygen.
	Lactic acid fermentation	Caused by lactobacilli, which can alter the taste of wine.
	Brettanomyces contamination	These yeasts can cause unpleasant aromas.
Environmental	Soil and water pollution	The use of pesticides, herbicides, and chemical fertilizers can leave toxic residues in wine.
	Air pollution	Industrial areas near vineyards can affect the condition of grapes.
	Waste accumulation	Grape pomace, wastewater, and plastic packaging can cause environmental problems.
Economic risks	Fluctuations in raw material prices	Prices for grapes and other materials can vary significantly depending on crop yields.
	Insufficient funding for production modernization	Outdated equipment and technology can negatively affect wine quality.
	Logistics risks	Improper transportation of wine can lead to spoilage (e.g., prolonged storage at high temperatures)
Regulatory risks	Non-compliance with HACCP, ISO 22000	May result in product recalls or fines
	Non-compliance with labeling requirements	Incorrectly labeled information may result in product bans in export markets.
	Presence of counterfeit products	Counterfeiting of wine brands may reduce consumer confidence.

Source: created by the authors

Table 5. Characteristics of the regulation of various types of wine quality control in countries around the world

Country	Regulatory control	Characteristics of regulation
France	AOC – Appellation d'Origine Contrôlée	Strict control of grape origin; Regulation of production technology (permitted varieties, fermentation methods, aging); Penalties for violations – product recall, fines, sales ban
Italy	DOCG – Denominazione di Origine Controllata e Garantita	Strict verification of grape variety composition Mandatory laboratory and organoleptic tests; Violations are punishable by revocation of DOCG status and fines.
The USA	TBB – Alcohol and Tobacco Tax and Trade Bureau	Requirements for product labeling and safety; Control over alcohol content and additives; License revocation in case of serious violations
European Union	PDO – Protected Designation of Origin	Regulation (EU) No. 1308/2013 on grape wine; Control of production methods and geographical origin; High fines and export bans in case of non-compliance with standards

Source: created by the authors