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Development of the national production of personal protective equipment: Problems of control over state certification and working conditions during martial law

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Abstract

The purpose of this study was to determine the effectiveness of the mechanisms of state control over the production of personal protective equipment under martial law and to develop recommendations for their improvement to improve product quality and employee safety. The methodological framework of this study was an expert survey, systemic and structural, formal legal, and comparative legal methods. The study conducted an expert survey of managers of 7 manufacturing companies via the online platform to assess certification issues and working conditions on a five-point scale. The analysis of the study findings revealed critical problems in the field of certification: excessive financial burden, complexity of certification procedures, protracted duration of the process, lack of transparency, and low availability of information on requirements. The study found that most companies must urgently organise shelters due to the lack of protective structures, have problems with logistics and raw material supplies, and less than half of the companies faced an outflow of skilled personnel abroad. The assessment of working conditions showed an elevated level of provision of

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employees with protective equipment, but critically low readiness for evacuation. Additional security costs were found to account for an average of 15% of the companies' budgets, while labour productivity decreased by 20-30% due to frequent air raids. The study demonstrated the need to introduce simplified certification procedures for critical goods, reduce the cost of procedures through government subsidies, and create a single information portal with up-to-date information on requirements and changes in the regulatory framework. The study proposed the development of special methodological recommendations on the organisation of labour under martial law and the creation of state support mechanisms for the modernisation of production facilities and the construction of protective structures. The findings have practical implications for the development of an effective state policy in the field of personal protective equipment production in Ukraine and demonstrate the need to strike a balance between the efficiency of meeting defence needs and compliance with quality and safety standards under martial law

Keywords: product testing; cost-effectiveness; accredited laboratories; technical regulations; market surveillance; financial support

Introduction

The martial law in Ukraine and active hostilities have created an unprecedented demand for personal protective equipment (PPE) for the military and civilians. This has resulted in the rapid development of domestic PPE production and the need to ensure proper control over its quality and safety. In the context of martial law, the issue of state certification of protective equipment and control over working conditions at manufacturing enterprises is of particular relevance, as the lives and health of military personnel and civilians directly depend on it. At the same time, accelerated production rates and challenging operating conditions of enterprises create further challenges for the quality control and certification system of PPE. The problem of ensuring proper control is particularly acute in the context of decentralised production and the emergence of new manufacturers, which requires improvement of existing mechanisms of state regulation and supervision.

An analysis of the scientific literature shows that researchers pay considerable attention to various aspects of the development of production

and quality control of personal protective equipment. Q. Hu *et al.* (2023) in their review of the evolution of personal protective systems noted that modern PPE has made substantial progress in providing comprehensive protection for military personnel. The researchers emphasised the significance of the development of intelligent protection systems, which have been greatly improved over the past two decades through the introduction of advanced technologies. At the same time, the researchers emphasised the need to address the problems of ergonomics and usability of the latest protection technologies. O. Strelko and A. Horban (2023) presented a thorough historical analysis of the development of body armour, tracing the evolution of research and industrial technologies. The researchers emphasised the significance of developing uniform standards for modern protective equipment and stress the need to factor in the historical experience when developing new certification systems. They also focused on the contribution of the first developers of bulletproof vests, whose experience continues to be relevant to modern manufacturers.

R.F. Mortlock (2022) made a valuable contribution to understanding the industrial aspects of PPE production by analysing the specifics of body armour production management. The researcher emphasised the need to balance limited resources with competing priorities and highlighted the role of interaction between commercial companies and governmental control bodies. S.G. Jones (2023) presented a critical analysis of the readiness of the defence industry to meet modern challenges, focusing on the problems of production capacity and the need to rapidly increase it in the face of potential conflicts. The researcher also emphasised the significance of modernising control and regulatory systems to ensure rapid response to market needs. A.K. Mishra *et al.* (2024) analysed the technical aspects of the production of protective equipment, focusing on the use of high-strength fibres and their influence on the effectiveness of protection. The researcher's findings demonstrated the value of an integrated approach to the design of protective systems and the need to consider all components in certification.

M.J. Klausner *et al.* (2021) conducted a significant study on the effectiveness of PPE in combat, analysing injury statistics and the use of protective equipment. His findings on the most vulnerable parts of the body and the level of use of various types of protection are crucial for the development of certification standards. I.G. Crouch (2019) and S. Siengchin (2023) focused on the prospects for the use of lightweight materials in PPE production. Their research demonstrated the significance of investing in the development of new materials and the need to adapt quality control systems to the latest technological solutions. M. El Messiry (2020) presented a comprehensive analysis of testing and certification methods for protective equipment, emphasising the importance of balancing protection and comfort. The researcher's study contains valuable recommendations for improving testing and quality control systems.

Special attention was paid to the potential of additive technologies in the production of PPE.

V. Bachynskyi *et al.* (2022) and H.A. Colorado *et al.* (2023) analysed the prospects for using 3D printing in the production of protective equipment. V. Bachynskyi *et al.* (2022) emphasised that the use of additive technologies can greatly reduce the weight of body armour by optimising the use of materials and opens opportunities for the production of protective equipment in the field. H.A. Colorado *et al.* (2023) complemented this study by addressing the need to develop new standards and certification procedures for 3D printed products. Both studies emphasised the significance of adapting control systems to the latest technological challenges and the need to revise the principles of designing protective equipment to factor in the capabilities of additive technologies. The analysis of scientific studies showed that researchers have paid considerable attention to the technological aspects of PPE production, development of new materials, and evaluation of their effectiveness, but the issues of adapting state control and certification systems to martial law conditions, specifically in the context of decentralised production and the need to rapidly scale up production capacity, are still understudied. Furthermore, mechanisms for ensuring proper working conditions at PPE manufacturing enterprises in the face of increased demand and limited resources require further study.

The purpose of the present study was to identify the legal and organisational problems of the functioning of the national production of personal protective equipment under martial law and to develop ways to solve them to improve the effectiveness of state control over product quality and working conditions. The objectives of the study were as follows:

1) to establish the specific features of legal regulation and organisation of the production of personal protective equipment in Ukraine under

martial law, to identify the main problems of the industry and factors affecting its development;

2) to establish the effectiveness of the current mechanism of state certification of personal protective equipment and identify the shortcomings of the system of control over compliance with product quality standards under martial law;

3) to characterise the state of legal support and practical implementation of requirements for working conditions at enterprises producing personal protective equipment and to develop proposals for their improvement.

Materials and Methods

The methodological framework of the study is a comprehensive system of general scientific and special methods of cognition. The basic theoretical approach was based on the concept of the rule of law and the theory of administrative and legal regulation of economic relations under special legal regimes. The study was based on the fundamental provisions of the theory of public administration regarding the mechanisms for regulating economic activity in crisis conditions, as well as on the conceptual foundations of the theory of labour safety in the context of ensuring sustainable development of industrial production (Sakovskyi & Bilozorov, 2022).

The study employed a set of interrelated methods of scientific cognition. The historical method helped to explore the development of legal regulation of the production of personal protective equipment as a dynamic process that underwent substantial transformations under martial law and to identify the main contradictions between regulatory requirements and the practice of their implementation. The system-structural method was used to analyse the mechanism of state certification of PPE as an integral system of interrelated elements, including legal regulation, institutional support, and procedural aspects. The formal legal method was

applied to a detailed analysis of the provisions of the regulations governing the production of PPE and the procedure for its certification, to identify gaps and conflicts in legal regulation. Using the comparative legal method, the study compared Ukrainian legislation, specifically the Technical Regulation on Personal Protective Equipment (Resolution of the Cabinet of Ministers of Ukraine No. 761, 2008), with Regulation of the European Parliament and of the Council No. 2016/425 "On Personal Protective Equipment" (2016) in the field of technical regulation of PPE, which helped to identify areas for further harmonisation of national legislation with EU law. Furthermore, the analytical materials of the National Institute for Strategic Studies on the development of PPE production (Sobkevych *et al.*, 2024) were used, which provided up-to-date information on the state of the industry. The key source of empirical data was the results of an expert survey.

The empirical part of the study was implemented through a comprehensive analysis of working conditions and certification procedures at PPE manufacturing enterprises. The study included three interrelated components. The sample consisted of 7 enterprises from different regions of Ukraine: 2 small (up to 50 employees), 3 medium-sized (50 to 250 employees) and 2 large (over 250 employees) enterprises according to the criteria set out in Article 2 of the Law of Ukraine No. 996-XIV "On Accounting and Financial Reporting in Ukraine" (1999). Geographically, the companies are located in Kyiv (2 companies), Lviv (2 companies), Kharkiv (1 company), Dnipro (1 company), and Odesa (1 company) regions. The first component of the study consisted of an analysis of internal company documents, including permits, occupational health and safety regulations, job descriptions, orders, training and briefing materials, workplace certification documents, medical examinations, and accident records. The second component included a structured survey

and structured interviews with business managers to collect factual data on organisational changes implemented under martial law.

The study was conducted following ethical standards. All participants were informed about the purpose of the study and provided written consent to take part. The anonymity and confidentiality of the data obtained were guaranteed and used only in a generalised form. Personal data was protected following the Law of Ukraine No. 2297-VI "On Personal Data Protection" (2010). The employee survey was conducted via a secure Google Forms platform, with the average time to complete the questionnaire being 10-15 minutes.

The questionnaire for employees consisted of three parts: introductory (general information

about the respondent), assessment of certification issues, and analysis of working conditions. The respondents rated the parameters of the certification procedure on a five-point scale, including its complexity, duration, transparency of the process and financial burden. The latter included official costs according to the established tariffs: payment for the services of certification bodies (UAH 15,000-25,000), the cost of laboratory tests (UAH 20,000-40,000), and the cost of preparing technical documentation and product samples. The results of the assessment are presented in Table 1. Structured interviews with managers focused on collecting factual information on organisational changes, new security procedures, and logistical challenges under martial law.

Table 1. Five-point scale for assessing certification procedures

Parameter	Score	Content
Complexity and duration of the certification procedure	5	The procedure takes more than 6 months and requires submission of more than 15 different documents
	4	The procedure lasts 4-6 months
	3	The procedure lasts 2-4 months
	2	The average duration of certification is 1-2 months
	1	The average duration of new product certification is up to 1 month
Transparency of the certification process	5	Complete lack of information about the evaluation process and criteria
	4	Information is provided with delays and is incomplete
	3	Information is provided on time but is incomplete and contradictory
	2	Authorities provide information on time, but it is not sufficiently complete
	1	Certification bodies provide full information on the process and evaluation criteria on time
Financial burden	5	Total costs do not exceed 15,000 UAH
	4	Total costs are 15,000-30,000 UAH
	3	Total costs are 30,000-50,000 UAH
	2	Total costs are 50,000-70,000 UAH
	1	Total costs exceed 70,000 UAH
Availability of information on certification requirements	5	Information on procedures is not publicly available
	4	Access to information is severely limited and requires complex bureaucratic procedures
	3	Information is available only through official requests
	2	Procedures are available, but information about them is not sufficiently systematic.
	1	Procedures are accessible, and information about them is sufficiently systematic.

Source: developed by the author of this study

The study was conducted in three successive stages. At the first stage, a systematic analysis of the legal framework and theoretical sources was conducted to determine the specifics of legal regulation of PPE production under martial law. The second stage included the development of tools, an expert survey, and data processing to identify practical problems in the field of certification and ensuring proper working conditions. At the third stage, based on a comprehensive analysis of regulatory sources and empirical data, scientifically based proposals for improving the legal regulation of the industry were formulated.

Results

Legal regulation and organisation of production of personal protective equipment in Ukraine under martial law. In the current environment, the issue of legal regulation of the production of personal protective equipment (PPE) in Ukraine is of particular relevance, based on a comprehensive system of regulations that includes both laws and subordinate legislation. The fundamental legislative act in this area is the Law of Ukraine No. 2694-XII "On Occupational Safety" (1992). Article 8 of this Law establishes the employer's obligation to provide employees with PPE following the established standards. PPE is defined as means intended to be worn or held by an employee for protection against harmful and dangerous factors of the working environment. The Law also makes the employer responsible for the quality and prompt issuance of PPE, which creates a legal basis for quality control of the production of such equipment.

A significant element of the regulatory system is the Technical Regulations on Personal Protective Equipment approved by Resolution of the Cabinet of Ministers of Ukraine No. 761 "On Approval of the Technical Regulations on Personal Protective Equipment" (2008). This regulation sets out the safety requirements for PPE and the

procedures for assessing their compliance. The specific feature of the document is that the regulation establishes three categories of PPE depending on the degree of risk to the user: category I – for protection against minimal risks, category II – for protection against medium risks, category III – for protection against risks that may lead to extremely serious consequences. This categorisation is of practical significance as it determines distinct levels of requirements for conformity assessment procedures. For instance, for category III PPE, certification by notified bodies is mandatory, which ensures an increased level of quality control. Notably, the Technical Regulation was developed considering the Regulation of the European Parliament and of the Council No. 2016/425 "On Personal Protective Equipment" (2016). This ensures the harmonisation of Ukrainian requirements with European standards and simplifies the procedures for exporting Ukrainian products to the EU. Undoubtedly, such harmonisation of the regulatory framework facilitates Ukraine's integration into the European market and increases the competitiveness of Ukrainian producers.

The system of national standards, namely DSTU EN 13921:2017 "Personal Protective Equipment. Ergonomic Principles" (2017), which sets out critical requirements for the ergonomics of protective equipment, plays a significant role in the quality assurance of PPE. The practical significance of this standard has especially increased in the context of military operations, when the comfort of using PPE directly affects the combat capability of military personnel when worn for prolonged periods. The general legal framework for the technical regulation system is formed by the Law of Ukraine No. 124-VIII "On Technical Regulations and Conformity Assessment" (2015), which defines clear procedures for the development of technical regulations and requirements for certification bodies. The implementation of these regulatory requirements allows ensuring

an adequate level of quality control at all stages of production and certification.

Of particular note is the fact that after the introduction of martial law according to the Decree of the President of Ukraine No. 64/2022 (2022), Resolution of the Cabinet of Ministers of Ukraine No. 234 “On the Specifics of the Application of Technical Regulations and Conformity Assessment under Martial Law” (2022) was adopted. This resolution substantially simplified the PPE certification procedures, allowing the products to be placed on the market based on the manufacturer’s declaration of conformity without a full cycle of testing. Control tests within a certain time period were still mandatory. This approach enabled a rapid increase in the production of the required products, but created potential risks in terms of product quality, which could have negative consequences for PPE users.

An analysis of the structure of the PPE market in Ukraine showed substantial transformations in the industry after the outbreak of full-scale military operations. A considerable number of light industry companies have reoriented their production capacities to meet the needs of the defence sector, which has led to a dramatic change in the market structure and an increase in the number of PPE manufacturers. Admittedly, this transformation has created new challenges for the quality control system, as many companies had no previous experience in the production of specific types of PPE, including ballistic protection. In the context of the current situation, the main challenges for the industry are to ensure an adequate level of quality control under simplified certification procedures and to ensure that products meet the established standards. Notably, the absence of a full cycle of testing before products are released to the market can lead to the appearance of low-quality or dangerous PPE, which is contrary to the requirements of the Law of Ukraine No. 1023-XII “On Consumer Rights

Protection” (1991). It is vital to emphasise that the law guarantees consumers the right to product safety and makes manufacturers liable for damage caused by defective goods.

In the context of the functioning of PPE manufacturers, legal regulation of working conditions is of great significance. It was established that the intensification of production processes under martial law and the shortage of qualified personnel create prerequisites for potential violations of labour legislation. The regulatory framework for ensuring proper working conditions is provided by the provisions of the Code of Labour Laws of Ukraine (1996) and Law of Ukraine No. 2694-XII “On Occupational Safety” (1992), which establish mandatory requirements for safe working conditions and compliance with working time standards. The state policy of supporting the industry is implemented through the mechanisms stipulated by the Law of Ukraine No. 4618-VI “On Development and State Support of Small and Medium Enterprises in Ukraine” (2012), specifically through compensation of interest rates on loans for the purchase of equipment and partial reimbursement of the cost of new equipment. At the same time, according to an analytical report by the National Institute for Strategic Studies (Sobkevych *et al.*, 2024), existing state support measures do not ensure sufficient modernisation of production facilities to meet the growing demand from the defence sector and civilian population. This is conditioned by both the limited production capacity of enterprises and the logistical complications caused by the hostilities.

The legal regulation of PPE production in Ukraine needs to be further improved to ensure a balance between the efficiency of supply and product quality. In this context, it is necessary to strengthen post-certification control, introduce effective mechanisms of manufacturers’ liability for product quality, and ensure proper working conditions at enterprises. From a legal

standpoint, this can be achieved by amending the current legislation, specifically, the Law of Ukraine No. 389-VIII "On the Legal Regime of Martial Law" (2015), which will allow establishing special regulatory regimes for critical industries, including the production of PPE. Notably, a comprehensive approach to the legal regulation and organisation of PPE production under martial law is necessary to ensure the effective functioning of the industry, protect the rights of consumers and employees, and strengthen national security. It is particularly significant to understand that this involves not only improving the regulatory framework, but also active cooperation between the state and manufacturers aimed at solving the industry's current problems.

The mechanism of state certification of personal protective equipment and product quality control under martial law. The mechanism of state certification of PPE in Ukraine is based on a series of regulations, the principal of which is the Law of Ukraine No. 124-VIII (2015). This Law establishes general principles and requirements for the development, adoption, and application of technical regulations, as well as defines procedures for assessing the conformity of products with the established requirements. Technical regulations establish mandatory requirements for products or related processes or production methods, including requirements for terminology, symbols, packaging, marking, or labelling. The Technical Regulation on Personal Protective Equipment, approved by Resolution of the Cabinet of Ministers of Ukraine No. 761 (2008), which is harmonised with the relevant European standards, is in force for personal protective equipment. The procedure for state certification of PPE involves assessing the compliance of products with the established requirements by carrying out the relevant procedures specified in the technical regulations. The manufacturer is obliged to ensure that the necessary

tests are conducted, and technical documentation is drafted to confirm the conformity of the product. Conformity assessment bodies accredited following the Law of Ukraine No. 2407-III "On Accreditation of Conformity Assessment Bodies" (2001) conduct assessments and issue certificates of conformity. The accreditation of these bodies guarantees their competence and impartiality, which ensures confidence in the assessment results. Notably, accreditation is performed by the National Accreditation Agency of Ukraine (NAAU), which operates based on international standards and ensures mutual recognition of accreditation results at the international level.

PPE is tested in accredited testing laboratories to confirm that the products meet the requirements of DSTU, which are harmonised with international standards such as ISO or EN. For instance, DSTU EN 149:2017 "Personal Respiratory Protection Equipment Filtering Half Masks for Protection Against Aerosols. Requirements, Tests, Labelling" (2017). These standards define technical requirements for the design, materials, filtration efficiency, mechanical strength, and other characteristics of PPE. Testing allows ensuring that products meet the established requirements and ensure the safety of their use. The quality of PPE is monitored not only at the certification stage, but also throughout the entire product life cycle. Following the Law of Ukraine No. 2735-VI "On State Market Surveillance and Control of Non-Food Products" (2010), state market surveillance is performed to ensure that products meet the established requirements and protect consumers from dangerous products. The state market surveillance authorities, specifically the State Labour Service of Ukraine (SLSU) and the State Service of Ukraine for Food Safety and Consumer Protection (SSUFSCP), conduct inspections of business entities, take product samples for testing, take measures to withdraw unsafe products from circulation, and bring those responsible to justice.

Changes in the quality control procedures for PPE under martial law. To promptly meet the needs of defence and protection of the population, the government adopted Resolution of the Cabinet of Ministers of Ukraine No. 234 (2022). This regulation stipulates simplification of conformity assessment procedures by allowing the introduction of products into circulation based on a declaration of conformity without a full range of tests. Manufacturers can independently declare the conformity of products to the established requirements based on their technical documentation and internal quality control. However, such changes raise certain concerns regarding ensuring an adequate level of product safety and quality. Pursuant to Article 42 of the Constitution of Ukraine (1996), the state ensures the protection of consumer rights and control over the quality and safety of products. According to Article 3 of the Law of Ukraine No. 1023-XII "On Consumer Rights Protection" (1991), consumers are entitled to product safety and to receive necessary, accessible, reliable, and prompt information about products. Simplification of certification procedures may result in products that do not meet the established requirements and pose a threat to the life and health of consumers entering the market. This contradicts the basic principles of state policy in the field of consumer protection and may have negative consequences for society.

The analysis of a comprehensive study conducted at seven PPE manufacturing companies with the involvement of employees of various levels revealed systemic problems in the certification of personal protective equipment. The research methodology included both a survey of personnel and a detailed analysis of internal company documentation: permits, occupational health and safety regulations, job descriptions, orders, training and briefing materials, workplace certification documentation, medical examination materials, and accident records. According to the survey

and documentation analysis, the complexity of the certification procedure received an average score of 4.1 (29 points from seven respondents), which demonstrates that it is overly burdensome. The study showed that the procedure requires the submission and processing of more than 15 different documents, with technical requirements characterised by insufficient clarity of wording. The duration of the certification procedure also proved to be a critical issue, receiving an average score of 4.0 (28 points). An analysis of official documentation confirmed that the process can take four to six months, which, in the context of martial law and the urgent need for PPE, creates substantial obstacles to responding quickly to market needs. Delays occur both at the stage of reviewing documentation and during sample testing due to overloading of accredited laboratories.

The financial burden was the most critical parameter, receiving an average score of 4.4 (31 points). Analysis of financial documentation and survey results revealed that the total cost of certification for most companies does not exceed UAH 15,000, which suggests potential risks of insufficiently thorough product quality checks. The transparency of certification procedures received an average score of 3.7 points (26 points), suggesting substantial shortcomings in the information support of the process. Four out of seven surveyed companies noted that information is provided with a delay and is incomplete, which creates further obstacles to planning the certification process. The availability of information on certification requirements received an average score of 3.4 (24 points), which reflects some challenges in obtaining information, but is not a critical issue. An analysis of the regulatory framework for PPE certification in 2022-2024 showed three main waves of regulatory changes: in March 2022, Resolution of the Cabinet of Ministers of Ukraine No. 234 (2022) was adopted to simplify conformity assessment

procedures under martial law, in August 2023, changes were made to strengthen product quality control, and in January 2024, requirements for testing procedures were updated. Such changes were driven by the need to adapt procedures to martial law and to conform with the generally

accepted practice of regulatory updates in a crisis. To visualise the main problems of PPE certification under martial law, a diagram was created to illustrate the results of the expert survey on five key indicators that need to be addressed as a matter of priority (Fig. 1).

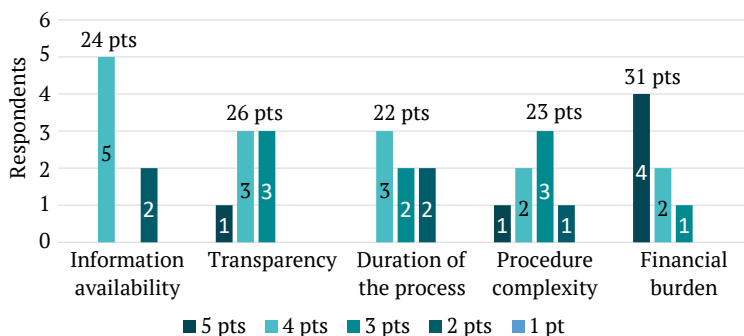


Figure 1. Distribution of assessments of PPE certification problems

Source: developed by the author of this study based on a survey of business executives

The analysis of the data obtained demonstrates systemic challenges in the field of certification of personal protective equipment under martial law, which require a differentiated approach to their solution. The most critical were the economic aspects of the certification procedure, which create a considerable burden on manufacturers and impede the development of the industry. This is primarily related to the need to pay for the services of certification bodies, laboratory testing, and preparation of technical documentation, which is especially noticeable for small and medium-sized enterprises in the context of limited financial resources in wartime. The complexity of procedures and administrative barriers form the next level of the problem, which suggests the need to optimise the regulatory framework and simplify the mechanisms of interaction between producers and certification bodies. Particular attention should be paid to the issue of the duration of procedures and their transparency, where there is a more even distribution of respondents'

assessments, indicating both positive experience and systemic shortcomings in these aspects. The issue of information accessibility, although rated relatively lower, still poses a major challenge that requires improved information and communication mechanisms and a greater level of advisory support for producers. The identified structure of problems and their gradation by the level of criticality creates the basis to develop comprehensive measures to improve the certification system, considering both the immediate needs of the industry and opportunities for its long-term development.

Based on the empirical research, the respondents formulated a set of proposals to improve the certification procedure, including simplification and acceleration of procedures, reduction of financial burden, increased transparency and accessibility of information, and stabilisation of the regulatory framework. Particular attention was paid to the need to introduce electronic systems for submitting and reviewing documents as a mechanism to reduce bureaucratic burden and expedite

processes. Furthermore, it was suggested to introduce a system of privileges or state support for Ukrainian PPE manufacturers, which is of strategic significance for the development of national production and supplying the internal market with quality products. The legal analysis of the study findings helped to draw a series of vital conclusions regarding the compliance of the existing state certification system for PPE with the fundamental principles of commercial law and constitutional guarantees. Although the system formally follows international standards, its practical implementation creates excessive regulatory barriers for manufacturers, which contradicts the principles of state policy in the field of entrepreneurship stipulated in Article 6 of the Commercial Code of Ukraine (2003), specifically, the creation of favourable conditions for business development. Furthermore, the identified problems can be regarded as a de facto restriction of the constitutional right to entrepreneurship guaranteed by Article 42 of the Constitution of Ukraine (1996). This discrepancy is particularly acute in the context of martial law, when there is an urgent need to optimise control mechanisms and adapt them to new reality.

Considering the findings of the empirical study and their legal assessment, it is recommended to implement a set of measures to improve the mechanism of state certification and quality control of PPE. Firstly, it is necessary to develop and implement simplified certification procedures for critical goods under martial law, which should be based on an analysis of international experience and best practices. Secondly, an essential area is to reduce the cost of certification procedures through state subsidies or preferential tariffs for Ukrainian producers, which will help develop national production. Thirdly, it is necessary to increase the transparency of the processes by creating a single information portal with up-to-date information on requirements, procedures, and changes in the regulatory

framework. Particular attention should be paid to optimising the regulatory framework by systemising regulations, eliminating duplications and contradictions, and minimising the frequency of changes in requirements, which will create a stable legal environment for planning production activities and investments. An essential element of the certification system reform is the introduction of a unified digital platform for submitting and reviewing documents. Implementation requires the development of specialised software with personal accounts for manufacturers, an integrated document management system, and a module for tracking the status of applications. The platform should enable the submission of documents using a qualified electronic signature, automated completeness checks, and online communication with certification bodies. Implementation of the system also requires amendments to the Technical Regulation on Personal Protective Equipment, the creation of a secure IT infrastructure, and staff training. It is equally significant to ensure that the staff of conformity assessment and market surveillance bodies have the adequate level of qualifications, and that they are provided with the necessary resources and tools to effectively perform their control functions.

Legal support and practical implementation of requirements for working conditions at enterprises producing personal protective equipment. Legal support for working conditions at personal protective equipment enterprises and its practical implementation are of particular significance under martial law, since the effective functioning of such enterprises directly affects national security and health of citizens. The regulatory framework for the regulation of working conditions is formed by a set of acts of varying legal force. The basic document is the Code of Labour Laws of Ukraine (1996), which in Article 153 enshrines the employer's obligation to ensure safe and harmless working conditions

that meet the level of technological development of production, while Article 161 establishes a mandatory requirement for briefings, training, and testing of knowledge on occupational safety and health. These provisions are detailed in the Law of Ukraine "On Occupational Safety" (1992), Article 13 of which specifies the employer's obligations to create suitable working conditions and take preventive measures. The Law of Ukraine No. 389-VIII "On the Legal Regime of Martial Law" (2015) is of particular relevance in the current environment, as Article 8 stipulates the possibility of introducing labour service and curfews, which substantially affects the organisation of production processes.

Based on a review of internal documentation and a survey of employees, an analysis of working conditions at PPE manufacturing companies revealed substantial discrepancies between regulatory requirements and their practical implementation. The issue of sheltering and evacuation of employees is particularly critical, as evidenced by the absence or non-compliance of emergency localisation and response plans with the

requirements of Article 20 of the Law of Ukraine "On Occupational Safety" (1992). A parallel study of organisational changes conducted through structured interviews with company executives (Table 2) revealed key measures implemented in response to the challenges of martial law. All the companies surveyed introduced extra security protocols and briefings. Six companies had to urgently organise shelters, which required extensive financial investments. Air raids significantly affect production processes, leading to a 20–30% reduction in productivity and the need to evacuate employees. 5 companies faced problems with logistics, raw material supplies, and increased security costs. Less acute but significant issues were the psychological state of employees and communication with government agencies (4 companies), as well as the outflow of skilled personnel and the need for technical re-equipment (3 companies). For a deeper understanding of the transformation of working conditions under martial law, a detailed analysis of changes in labour organisation was conducted, the findings of which are summarised in Table 2.

Table 2. Changes in labour organisation under martial law

Parameter	Number of enterprises (out of 7)	Comments
Need to organise shelters	6	Lack of equipped shelters; plan to equip within 3-6 months; need financial support
Continuity of production	5	Introduced shift work; moved part of the production to safer regions
Compliance with the working hours	6	The schedule was adapted to the curfew; challenges with organising night shifts
Employee safety	7	Additional briefings were held; additional PPE was purchased; emergency protocols were implemented
Problems with logistics and supply	5	Delays in the supply of raw materials; increased transport costs; instability of suppliers
Impact of air raid alarms on work	6	Frequent work stoppages; 20–30% reduction in productivity; need to evacuate employees
Psychological state of employees	4	Increased anxiety; psychological support organised; increased number of sick leaves
Outflow of qualified personnel	3	Migration of employees abroad or to safe regions; challenges in recruiting new specialists
Increased security costs	5	Additional security costs amounted to an average of 15% of the budget; need for investment in security technology

Table 2. Continued

Parameter	Number of enterprises (out of 7)	Comments
Communication with government agencies	4	Insufficient information support; complications with obtaining permits and consultations
Changes in legislation and regulations	5	Frequent changes in requirements; challenges in tracking new regulations; need for legal aid
Financial hardship and access to credit	4	Limited access to finance; lack of preferential loans; delays in payments from customers
Technical re-equipment and modernisation	3	Need to upgrade equipment; limited investment opportunities; dependence on imported components

Source: systematised by the author of this study according to the results of the answers of the executives of the enterprises to open questions

The table above describes a multi-level system of changes in labour organisation at PPE manufacturing companies that arose as a result of the introduction of martial law. The data analysis allows tracing a clear hierarchy of challenges – from critical personnel safety issues to long-term problems of enterprise development. It is worth noting the interconnectedness between various aspects of labour organisation: for instance, problems with the organisation of shelters and compliance with working hours directly affect productivity and economic efficiency. Special attention should be paid to the identified correlation between the financial capabilities of enterprises and their ability to ensure proper working conditions, which indicates the need for state support for the industry. The significance of the data presented is that they form an empirical basis for the development of concrete legal mechanisms to support enterprises and improve the labour protection system under martial law.

Based on the empirical study and the legal analysis of its results, there are systemic problems in ensuring proper working conditions at PPE enterprises under martial law. The identified problems indicate imperfect mechanisms for implementing labour law provisions and the need to adapt them to modern challenges. Specifically, the insufficient effectiveness of state control and the lack of clear instructions on how to organise

labour under martial law pose a risk of violating the constitutional right to proper, safe, and healthy working conditions guaranteed by Article 43 of the Constitution of Ukraine (1996).

To address the identified problems, a set of legal and organisational measures should be taken. Firstly, the legal framework for organising labour under martial law needs to be improved. It would be advisable to develop a special regulation – Methodological Recommendations on Labour Organisation at Critical Infrastructure Enterprises under Martial Law, which would account for the specifics of PPE production and contain clear instructions on ensuring the safety of employees. Secondly, it is necessary to strengthen state support for enterprises by amending Law of Ukraine No. 1116-IX “On State Support of Investment Projects with Significant Investments in Ukraine” (2020), making provision for separate mechanisms to support critical infrastructure enterprises to modernise production facilities and create relevant protective structures. Thirdly, it is vital to improve the system of state supervision over compliance with labour legislation by expanding the powers of the State Labour Service of Ukraine and ensuring its effective interaction with enterprises to provide methodological support. Specifically, there is a need to implement international standards in the field of labour protection, namely the recommendations of the International

Labour Organization on ensuring labour safety in emergencies. This involves not only improving national legislation but also developing practical mechanisms for its implementation through the creation of a system of training and experience exchange, the introduction of regular monitoring of working conditions and the development of emergency response plans. Implementation of the proposed measures will help to increase the level of protection of employees, ensure the sustainable operation of PPE production enterprises and, as a result, strengthen Ukraine's national security under martial law.

Discussion

The results of the study on the development of national production of personal protective equipment under martial law demonstrated systemic problems in the industry and confirmed the findings of other researchers on the critical significance of ensuring an adequate level of quality control and working conditions. The problems with PPE certification and ensuring proper working conditions identified in the study correlate with the findings of T. Guest (2024) on the need to adhere to the highest standards of testing and use of suitable materials in the production of protective equipment. This is especially relevant in the context of real combat threats faced by military personnel on the front line, particularly when using modern sniper systems and high-precision weapons. The identified problem of the lack of effectiveness of simplified certification procedures was confirmed by O.O. Chelobitchenko *et al.* (2022), who emphasised the need for full ballistics tests before certification of protective equipment. Therewith, empirical studies revealed that under martial law, an urgent need for accelerated certification arises to meet the operational needs of defence, which requires the development of exceptional quality control mechanisms under time constraints and increased demand for protective equipment.

A comprehensive analysis of working conditions at PPE manufacturing companies reveals systemic problems with employee safety. According to research by Z. Kozak *et al.* (2019), the issue of legal regulation of occupational safety and health in Ukraine is becoming more relevant under martial law, specifically, the legislative approach to the adoption of new laws should be in line with international legal standards. A. Cherep *et al.* (2023) determined the influence of the innovative potential of personnel on strengthening the economic security of Ukrainian enterprises in the post-war period, emphasising the significance of considering innovative competencies when developing programmes for the country's recovery. Particular attention was drawn to the identified problems with the organisation of shelters and evacuation of employees, which correlated with the findings of T. Arkhireyskaya *et al.* (2024) on the need to consider the transformation of threats and risks. The researchers emphasised the changing nature of emergencies, the growth of anthropogenic factors of technogenic and natural disasters, including cyberattacks, infectious pandemics, and terrorism. Based on the analysis of regulatory mechanisms, it was concluded that the legislative and law enforcement components of disaster management should factor in the transformation of their nature and stipulate strategic planning, considering the latest aspects of environmental safety, threat dynamics, and international environmental co-operation. At the same time, the findings of the study are consistent with the position of S. Zhelekhovskiy (2024), who emphasised the need to mobilise national industry and adapt civilian production to the needs of the defence sector, which in martial law requires special attention to ensuring the safety of production personnel and creating an adequate protection infrastructure. The analysis of statistical data showed that enterprises that implemented comprehensive

employee protection systems demonstrate greater labour productivity and product quality.

The findings of the study on the need to modernise production facilities correlate with the results of V.V. Sakovets and A.A. Revutskyi (2022), who substantiated the significance of introducing the latest technologies to improve the performance of protective equipment, specifically through the use of modern composite materials and innovative production technologies. Therewith, the identified problem of limited financial resources of enterprises was confirmed by E. Sheludko and M. Zavgorodnia (2022), who stressed the need for state support for high-tech industries to maintain industrial potential. The results of the study on the need to adapt protective equipment to the specific needs of users correlate with the findings of Y. Korol and Y. Lisnichenko (2022) on the significance of addressing the modern threats when developing PPE, especially in the context of protection against new types of weapons and threats. At the same time, the identified problem of insufficient standardisation was confirmed by the findings of V.V. Melkin (2022), who pointed out the lack of clear definitions of basic concepts in the field of protective equipment and the need to harmonise national standards with international requirements, which is especially significant for ensuring the export of Ukrainian products.

A particularly relevant aspect of the study is the identified problem of quality control under simplified certification procedures, which is consistent with the findings of A. Loishyn *et al.* (2022) on the need to create a comprehensive system for monitoring and controlling international assistance in the field of protective equipment. V. Chorna *et al.* (2022) also emphasised the role of ensuring that protective equipment follows international standards, specifically NATO standards, which was confirmed by the findings of the conducted study. In this context, the practices of other countries is valuable;

F. Zeng *et al.* (2019) noted that an essential aspect of the industry's development is not only technological innovation, but also ensuring the environmental friendliness of the production and disposal of protective equipment. This issue is of particular relevance in the context of European integration processes and the need for Ukrainian production to meet European environmental standards. The survey results also revealed the need to establish specialised PPE testing and certification centres, which would ensure an adequate level of product quality control even under simplified certification procedures. The identified problems with working conditions were reflected in the studies of S. Abikenova and G. Daumova (2023), who emphasised the need to factor in all harmful production factors when providing employees with protective equipment, as well as O. Fesenko *et al.* (2019), who highlighted the significance of following the regulatory requirements for providing employees with PPE and monitoring their use.

The findings of the study on the need to improve the system of state support for the industry are consistent with the findings of N. Khanyk *et al.* (2022) on the significance of international support to overcome the negative effects of war and ensure the continuity of supply of critical protective equipment. A prominent aspect is also the issue of disposal and recycling of used PPE, which was covered by N. Kathula *et al.* (2023), who proposed innovative approaches to solving this problem through the introduction of modern technologies for the processing and reuse of materials. E. Lagazzi *et al.* (2024) emphasised the value of ensuring adequate conditions for medical procedures in the field, which also requires suitable personal protective equipment and the development of specialised kits for medical staff.

Overall, the study not only confirmed the conclusions of Ukrainian and foreign researchers on the need for a systematic approach to solving the

problems of the PPE industry under martial law but also expanded the understanding of the specific challenges faced by Ukrainian manufacturers. The identified problems and proposed solutions create the basis for a comprehensive strategy for the development of the industry, which includes improving the regulatory framework, strengthening state control, ensuring adequate funding, and expanding international cooperation. The obtained findings are of practical value for the development of state policy in the field of personal protective equipment production and can be used in the formulation of programmes for the development of the industry in the post-war period. The identified trends suggest the need to create an integrated quality management system covering the entire product life cycle, from development to disposal. Another crucial aspect is the development of international cooperation in the development and implementation of new PPE production technologies, which will enable Ukrainian manufacturers to integrate into global supply chains and ensure the competitiveness of their products on the world market. Further research should be directed at developing concrete mechanisms for implementing the proposed changes, assessing their economic efficiency and social impact, and exploring the possibilities of introducing innovative technologies for the production and quality control of personal protective equipment. Particular attention should be paid to the issues of standardisation and certification of products according to international requirements, which is critical for ensuring the export potential of the industry and its further development in the context of European integration processes.

Conclusions

The study comprehensively covered the current state of legal regulation and organisation of the production of personal protective equipment in Ukraine under martial law, focusing on the

problems of state certification and ensuring proper working conditions. A systematic analysis of the regulatory framework and empirical data helped to identify the key problems of the industry and propose ways to solve them. A prominent aspect of the study was to determine the impact of simplified certification procedures on product quality and labour safety, as well as to assess the effectiveness of state control in the context of military challenges.

The study analysed the specific features of the legal regulation of PPE production, including the changes made after the introduction of martial law, and their effects on the industry. The study found that the simplification of certification procedures, while contributing to the rapid increase in production, created potential risks to product quality and user safety. An empirical study conducted by interviewing managers of PPE manufacturing enterprises revealed systemic problems in the field of certification, including excessive financial burden and complexity of procedures, which create substantial barriers to the development of the industry. The analysis of working conditions at the enterprises demonstrated critical problems with ensuring the safety of employees in the face of military threats, especially regarding the organisation of shelters and evacuation, which must be urgently addressed through government support mechanisms and improvement of the regulatory framework. The study also revealed the need to modernise production facilities and introduce modern quality control technologies to ensure the competitiveness of Ukrainian products in the international market.

The findings are of great theoretical and practical value for understanding the transformation of the PPE industry under martial law and for developing an effective state policy in this area. They demonstrate the need to find a balance between the efficiency of meeting defence needs and compliance with quality and safety standards, as well as the significance of

state support for manufacturers to modernise production and create adequate working conditions. The conceptualisation of the findings suggests the need for a systematic approach to improving the mechanisms of state regulation of the industry, which should include both optimisation of certification procedures and development of instruments of state support for producers. Of particular significance is the identified interdependence between product quality, labour conditions, and economic efficiency of enterprises, which necessitates a comprehensive approach to solving the identified problems.

Limitations of the study included the lack of complete statistical information on the production and sales of PPE under martial law, the impossibility of conducting a survey at all enterprises in the industry due to security restrictions,

and limited access to information on international practices in regulating the production of PPE in emergency situations. Promising areas for further research include the study of international practices in regulating the production of PPE in emergencies, analysis of the possibilities for introducing innovative quality control technologies, development of public-private partnership mechanisms in the field of modernising production facilities, and research into the effects of digitalisation on the efficiency of certification and quality control procedures.

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Conflict of Interest

None.

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Розвиток національного виробництва засобів індивідуального захисту: проблеми контролю за державною сертифікацією та умовами праці під час воєнного стану

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Анотація

Метою дослідження було визначення ефективності механізмів державного контролю за виробництвом засобів індивідуального захисту в умовах воєнного стану та розробка рекомендації щодо їх удосконалення для підвищення якості продукції та безпеки працівників. Методологічну основу дослідження склали експертне опитування, системно-структурний, формально-юридичний та порівняльно-правовий методи. Поза тим, було проведено експертне опитування керівників 7 підприємств-виробників через онлайн-платформу для оцінки проблем сертифікації та умов праці за п'ятибальною шкалою. Аналіз результатів дослідження виявив критичні проблеми у сфері сертифікації: надмірне фінансове навантаження, складність процедур сертифікації, тривалість процесу, недостатня прозорість та низька доступність інформації про вимоги. Встановлено, що більшість підприємств потребують термінової організації укриттів через відсутність захисних споруд, мають проблеми з логістикою та постачанням сировини, менше половини підприємств зіштовхнулися з відтоком кваліфікованих кадрів за кордон. Оцінка умов праці показала високий рівень забезпеченості працівників захисними засобами, але критично низьку готовність до евакуації. Виявлено, що додаткові витрати на безпеку склали в середньому 15% від бюджету підприємств, а продуктивність праці знизилась на 20-30% через часті повітряні тривоги. Дослідження продемонструвало необхідність впровадження спрощених процедур сертифікації для критично важливих товарів, зниження вартості процедур через механізми державного субсидування, створення єдиного інформаційного порталу з актуальною інформацією про вимоги та зміни в нормативній базі. Запропоновано розробку спеціальних методичних рекомендацій щодо організації праці в умовах воєнного стану та створення механізмів державної підтримки для модернізації виробничих потужностей і облаштування захисних споруд. Отримані результати мають практичне значення для формування ефективної державної політики у сфері виробництва засобів індивідуального захисту в Україні та демонструють необхідність пошуку балансу між оперативністю забезпечення потреб оборони та дотриманням стандартів якості й безпеки в умовах воєнного стану

Ключові слова: випробування продукції; економічна ефективність; акредитовані лабораторії; технічні регламенти; ринковий нагляд; фінансове забезпечення