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RESEARCH ARTICLE

Trends in the Development of the Global Personal Protective Equipment Market

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ABSTRACT

The occupational safety system covers many areas, one of which is the provision of workers with personal protective equipment (PPE). Increasing requirements for employee safety drive the rapid development of the PPE market, the introduction of innovations and fundamentally new technological solutions, and the integration of digital technologies. This article presents an analysis of the PPE market which made it possible to identify the general directions of innovative development, as well as the pace, scale, and institutional conditions for the implementation of new technologies. The structure of demand, the maturity level of digital infrastructure, the role of regulators and the involvement of the industrial sector in the modernization process, as well as regional specifics, were examined. An analysis of the commodity structure of the global PPE market was carried out. The study also focuses on trends in the development of the Russian PPE market, where demand for digital and 'smart' PPE is growing. General long-term development trends of this market have been identified.

INTRODUCTION

The development of the personal protective equipment (PPE) market, which represents wearable personal-use devices intended to prevent or reduce the impact on a person of harmful and/or dangerous factors, as well as to protect against contamination[1], is accompanied worldwide not only by growth in consumption volumes but also by an evolving technological transformation. Under intensifying competition, stricter regulatory requirements and the spread of the sustainable development agenda, the key driver becomes the introduction of innovative solutions — from 'smart' devices to environmentally friendly and adaptive materials. With expanded functionality and updated modifications, such PPE can account for various parameters of the labor process, analyze the physical condition and location of a worker using sensor devices, and record work results (Marilov et al., 2024).

The application of digital technologies can simplify managerial functions in the provision of PPE, reduce the level of industrial injuries and enhance occupational safety by controlling compliance with PPE usage rules by workers (Petrova et al., 2024; Veer and Sharma, 2025). Multifunctional innovative PPE with combined properties can provide protection against chemical, biological, radiological and other hazards (Borisov, 2024; Masih et al., 2025; Mansoor et al., 2025; Fatima et al., 2025), increase labor productivity, reduce the risk of occupational diseases, reduce the number of workers involved in the labor process, and also enable public budget savings (Monakova and Turkova, 2023; Jam et al., 2025). At present, the PPE market is undergoing changes characterized by both global trends and the specificities of national economies.

[1] Technical Regulation of the Customs Union "On the Safety of Personal Protective Equipment" (TR CU 019/2011). https://eec.eaeunion.org/comission/department/deptexreg/tr/bezopSIZ.php

MATERIALS AND METHODS

This study implements a qualitative methodological approach based on document analysis as the sole method of data collection. The empirical base was formed exclusively of secondary (documentary) sources. The documentary method was chosen due to the analytical nature of the work, which involves the synthesis of existing knowledge and data about the market. The research structure includes two levels of analysis — global and Russian. Accordingly, source selection was carried out according to the criterion of geographic coverage: materials reflecting global tendencies (global level) and national specifics (Russian level) were included.

The source base of the study comprises diverse types of documents. These include scientific publications (in Russian and English), regulatory legal acts (for example, technical regulations on PPE safety), analytical reports of international consulting and research organizations, data from specialized digital platforms with market analytics, as well as official statistics (for example, published indicators of market size and occupational safety). Such a diversity of sources allowed for a comprehensive coverage of the research problem and the comparison of different viewpoints.

Thematic analysis was used to interpret the collected data, which made it possible to structure information and identify the key directions of the study. During the document analysis, the following main themes were identified: innovations in the PPE field (including the development of 'smart' protective devices and the integration of digital technologies), processes of digitalization of occupational safety systems, changes in regulatory requirements and the normative base, the sectoral structure of demand for PPE, product segmentation of the market, as well as regional characteristics of industry development.

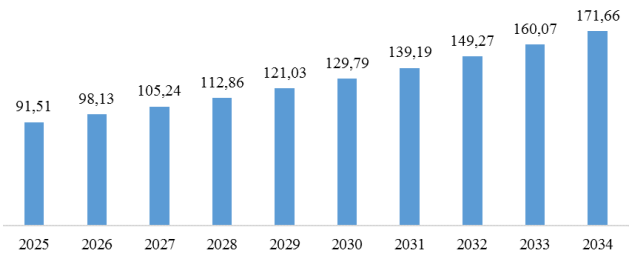
The processing of information was of a comparative-analytical nature. The authors compared data and conclusions related to the global and Russian levels of analysis. To improve the reliability of the results, the principle of triangulation was used: key indicators and facts were cross-checked across several independent sources. This approach made it possible to identify both common patterns and specific features of market development. Recurring themes noted in various sources were treated as manifestations of stable tendencies. In addition, the generalization of regional tendencies was carried out to understand differences and similarities in the PPE market dynamics between countries and regions.

A key limitation of the study is the incompleteness of data for a number of countries and narrow market segments of PPE. This is due both to the commercial secrecy of some industry information and to the insufficient availability of systematic statistics in open sources for certain regions.

RESULTS AND DISCUSSION

Analysis of the global PPE market

According to forecast data for 2023, the global PPE market volume could reach USD 171.66 billion by 2034 with an average annual growth rate ranging between 7.24% and 7.76% according to various estimates[2,3].



[2] P IMARC Group. Personal Protective Equipment Market Size, Share, Trends and Forecast by Equipment Type, End Use Industry, and Region, 2025-2033 https://www.imarcgroup.com/personal-protective-equipment-market

[3] Grand View Research. Personal Protective Equipment (PPE) Market Report, 2024–2030 https://www.grandviewresearch.com/industry-analysis/personal-protective-equipment-ppe-market

Figure 1. Forecasted Volume of the Global PPE Market

In fact, the global PPE market volume reached USD 84.55 billion in 2024[4]. Growth in this segment is explained by increasing attention to ensuring worker safety, which stimulates demand for PPE and forms steady institutional and behavioral changes on the part of employers and regulators. Notable expansion is demonstrated by countries in the Asia-Pacific region, primarily China, India and Southeast Asian states. Here there is a rise in investment in construction, the food and chemical industries, and pharmaceutical production, which results in an expanding consumer base and increased demand for modern protective equipment. Additional drivers of growth include industrialization, active state support for infrastructure projects and a high level of industrial risks in the mentioned sectors.

The COVID-19 pandemic had a significant impact on the development of the global PPE market. During 2020–2022, a sharp surge in demand for protective products was recorded in both the medical and the industrial segments. The need for PPE was especially acute in healthcare, where the use of masks, gloves, protective gowns and goggles became a mandatory element of anti-epidemic measures (Lam et al., 2020; Zhang et al., 2022; Wan et al., 2023; Liu et al., 2025). This experience stimulated sustainable changes in production and consumer practices and contributed to the strengthening of regulatory requirements[5].

In the USA, the consequences of the pandemic led to a significant tightening of regulatory requirements. Strengthened sanitary oversight and revisions to approaches to the prevention of infectious diseases affected not only PPE procurement volumes but also requirements for their quality characteristics. A stringent regulatory environment (including actions by bodies such as OSHA, NIOSH and the FDA) became one of the key factors shaping manufacturers' competitive strategies focused on innovation, reliability and regulatory compliance.

The introduction of high-tech solutions into the field of PPE design and production is another significant vector of development. Manufacturers focus on creating light, ergonomic, aesthetically appealing and at the same time highly effective protective products that integrate modern materials and digital technologies (thermo-adaptive fibers, sensors, wearable electronics) (Mazurina et al., 2022; Trubetskov et al., 2023; Pigilova et al., 2025).

The intelligent PPE is one of the latest trends in the global PPE market, using technologies to increase safety and productivity. For example, smart helmets and gloves equipped with sensors that transmit data in real time are gradually finding applications in industries such as construction and manufacturing. These complex tools not only improve worker safety by monitoring the work environment and health parameters, but also predict necessary precautionary measures and warn about violations of safety requirements (Choi et al., 2017; Rajendram et al., 2020; Flor-Unda et al., 2023; Aksüt et al., 2024; Blocher et al., 2025; Gazziro et al., 2025; Sidorenko et al., 2025).

This trend indicates a shift toward more intelligent and networked safety systems, which implies substantial industry development. Such features become factors of product differentiation in a saturated and competitive market.

Additionally, increased employer expenditures on compensation for industrial injuries and the tightening of corporate occupational safety standards create a stable motivation to expand investments in PPE. Against this background, complex solutions aimed not only at regulatory compliance but also at improving the overall culture of occupational safety are gaining importance[6].

Industry analysis points to high activity in research and development and experimental design work aimed at raising the technological level of products.

Leading manufacturers' key strategic priorities include expanding product ranges, entering new geographic markets, strengthening distribution networks, and introducing customized solutions —

[4] Grand View Research. Personal Protective Equipment (PPE) Market Report, 2024–2030 https://www.grandviewresearch.com/industry-analysis/personal-protective-equipment-ppe-market

[5] Personal Protective Equipment (PPE) Market Size, Share, and Growth Analysis. Personal Protective Equipment (PPE) Market By Product (Head Protection, Eye Protection), By End Use (Construction, Manufacturing), By Region - Industry Forecast 2025-2032. https://www.skyquestt.com/report/personal-protective-equipment-market

[6] Grand View Research. Personal Protective Equipment (PPE) Market Report, 2024–2030 https://www.grandviewresearch.com/industry-analysis/personal-protective-equipment-ppe-market

including contract manufacturing to distributor specifications. The latter is especially relevant for developed economies (USA, Western European countries).

Regional analysis of the global PPE market demonstrates uneven growth rates and consumption volumes depending on the level of industrialization, regulatory environment and sectoral structure of the economy. The highest aggregate revenue in 2023 was recorded in Europe. This is due to the high maturity level of the manufacturing sector, the systemic integration of PPE into occupational safety processes, and strict requirements on the part of national and supranational regulators. In particular, regulatory acts in the European Union provide for significant fines for non-compliance with occupational safety requirements, which stimulates widespread and systematic use of certified PPE across enterprises in various sectors.

The Asia-Pacific region is becoming increasingly important in the global industry structure. Major production sites include China, India, Thailand, South Korea and Japan. Capacity growth in these countries is due to several factors:

— Availability of a skilled but relatively inexpensive workforce;

— Proximity to raw material bases;

— Attractiveness of the region for multinational corporations investing in the construction of modern ppe and protective workwear production facilities.

Analysis of the commodity structure of the global PPE market indicates the dominance of the hand protection segment. This segment is primarily composed of various types of protective gloves intended to prevent injuries caused by mechanical impacts (cuts, abrasions, burns) as well as chemical contamination. Demand growth in this segment directly correlates with increased industrial production volumes, the complexity of technological processes and the need to comply with stricter occupational safety standards in sectors such as construction, food and oil and gas industries, healthcare and metalworking.

The next most significant position is taken by protective clothing. This segment includes items designed for various operating conditions: suits resistant to chemical agents, high temperatures and open flame, as well as mechanically robust workwear and products for 'cleanrooms'. Sustainable growth in this segment is driven by an increase in the number of accidents, including severe and fatal cases, which intensifies regulatory pressure on employers and creates demand for products with high performance characteristics — strength, wear resistance, thermal stability and comfort during prolonged wear.

The head protection shows substantial growth potential, especially in developing countries where helmet and hard-hat provision remains low. High rates of fatal head injuries at worksites stimulate interest in these products from regulators, manifested in tighter national safety standards and mandatory PPE use in certain types of operations[7] [8] [9].

Moreover, an important factor contributing to demand growth across PPE categories is the global strengthening of requirements related to sustainable development. Regulators in a number of countries — in particular the USA — intensify control over compliance with occupational safety norms through the actions of institutions such as OSHA, NIOSH and EPA, which directly affects corporate PPE procurement volumes.

Analysis of PPE consumption distribution by sector indicates the dominant role of manufacturing, which in 2023 held leading positions by purchase volume. Enterprises in this sector actively implement innovative solutions in occupational safety systems, including integration of wearable electronics, sensors and intelligent monitoring systems. Such measures allow real-time tracking of

[7] Business Research Insights. PPE market overview.
https://www.businessresearchinsights.com/market-reports/ppe-market-115976

[8] Grand View Research. Personal Protective Equipment (PPE) Market Report, 2024–2030
https://www.grandviewresearch.com/industry-analysis/personal-protective-equipment-ppe-market

[9] Personal Protective Equipment (PPE) Market
https://www.fortunebusinessinsights.com/personal-protective-equipment-ppe-market-102015

environmental parameters, workers' health status and the identification of potential production risks, significantly improving the efficiency of production control and injury prevention systems.

Significant increases in PPE demand are expected in the construction sector, especially in countries with high rates of industrial and infrastructure building such as China and India. Primary determinants of growth are high levels of occupational risk associated with accidents and fatal injuries on construction sites, as well as tightening of national occupational safety standards. The Asia-Pacific region as a whole shows positive dynamics due to a combination of demographic pressure, active urbanization and increased attention to regulatory policy in the field of occupational safety.

The food industry is also a key consumer of PPE. Demand increases are driven by the need for strict compliance with sanitary and hygienic requirements in the production process, especially in operations involving direct contact of personnel with food products (cutting, mixing, packaging, storage). Violations of sanitary norms can lead to product contamination, which increases the importance of applying appropriate protective measures and strengthens normative regulation in this area.

At the national level, such as in the USA, systemic efforts are being made to strengthen PPE supply chain resilience. This includes ramping up domestic production, forming strategic reserves and creating digital systems for monitoring logistics flows. Additionally, in the medium term, an increase in consumption of medical PPE is expected, aided by the adoption of regulatory measures aimed at ensuring stable access for healthcare workers to PPE. In particular, the U.S. Food and Drug Administration (FDA) implements measures to remove barriers for healthcare institutions in the procurement and distribution of PPE, including masks, gloves and protective gowns.

In the Middle East and African countries, the oil and gas industry remains the main driver of the PPE market development. Large-scale projects for the development of major fields, in particular Ghawar and Shaybah in Saudi Arabia, as well as active introduction of modern extraction methods such as enhanced oil recovery (EOR), create stable demand for high-level professional PPE[10].

Sectoral distribution of PPE demand is shaped by the specifics of occupational risks, the level of regulatory pressure and the readiness of enterprises to introduce innovative and digital solutions into occupational safety systems. The regional landscape of the global PPE market demonstrates differentiation in the maturity of occupational safety systems, the degree of regulatory pressure and investment activity. At the same time, under conditions of globalization and unification of occupational safety requirements, there is a convergence of trends in terms of standardization, digitalization and functional adaptation of PPE to the conditions of specific productions[11].

Analysis of the Russian PPE Market

Against the background of global growth, the Russian segment is strengthening its position on the global stage. Russia ranks fourth in the world by PPE sales volume, trailing only the USA, China and Germany — and accounts for more than 4% of the global market volume[12]. These indicators are accompanied by steady growth rates: the average annual growth of the Russian market is about 13%, which is almost twice the global average estimated at about 6.7% per year[13].

The reasons for Russia's outpacing growth rates are multifaceted. Firstly, they reflect internal institutional and technological changes: active development of the production base, tightening of occupational safety requirements and a shift toward risk-based regulation. Secondly, external economic factors: after 2022 the market underwent structural transformation caused by a reduction in import share and an increase in local production[14].

[10] Technavio. Personal Protective Equipment Market Analysis, Size, and Forecast 2025-2029: North America (US and Canada), Europe (France, Germany, and UK), APAC (Australia, China, India, Japan, and South Korea), and Rest of World (ROW) https://www.technavio.com/report/personal-protective-equipment-market-industry-analysis

[11] Grand View Research. Personal Protective Equipment (PPE) Market Report, 2024–2030. https://www.grandviewresearch.com/industry-analysis/personal-protective-equipment-ppe-market

[12] Securika Moscow. The Russian market for personal protective equipment and workwear grew by 18% to reach 330 billion rubles. https://securika-moscow.ru/ru/about/news/2024/october/15/siz-2024/

[13] PPE market: all doors are open for growth. Industrial pages. https://indpages.ru/safe/rinok-seez/

[14] Analysis of the Russian and global PPE market. New trends and developments. Industry pages

A comparative analysis with global forecasts emphasizes the potential of the Russian market, which demonstrates accelerated expansion of production and distribution infrastructure, indicating high investment attractiveness and recovery capacity.

Key factors contributing to growth include development of manufacturing and extractive industries, as well as the adaptation of Russian manufacturers to domestic demand while taking into account industry, climatic and technological peculiarities[15] [16]. Currently, about 16 million workers in Russia are provided with personal protective equipment, which constitutes a significant part of the working-age population employed in high-risk sectors[17]. On average, the cost of an individual PPE kit ranges between 15,000 and 18,000 rubles per employee, depending on the level of professional risk and industry specifics[18].

The development of the Russian PPE market in 2024–2025 is driven by transformation of the normative and legal framework. Updating technical regulations, strengthening state control and the spread of a risk-oriented approach are forming a new agenda in the occupational safety system and directly influence demand structure and product quality standards.

The risk-oriented approach implies a personalized selection of protective equipment depending on the level, nature and source of risk, creating prerequisites for enhancing the employer's competence in providing workers with PPE, including revising approaches to processes of needs assessment, worker training in PPE use, organization of control over issuance and correct use, and disposal.

The development of the Russian PPE market occurs against the backdrop of a steady increase in enterprises' total spending on occupational safety. This dynamic underlines the strategic importance of occupational safety as one of the key factors in ensuring business resilience and preventing production risks[19].

Positive dynamics are also observed over a broader time span: investments in occupational safety have grown — from 2017 to 2023, PPE procurement volumes increased from 100 to 181 billion rubles. At the same time, expenses on compensation and sanitary-hygienic measures rose by 53% — from 237.2 to 363.4 billion rubles. This growth is explained not only by inflationary factors but also by increased employer awareness of the importance of systematic prevention and compliance with working condition requirements.

The structure of PPE consumption in Russia is shaped by both regulatory requirements and real production risks. The most mass purchases remain basic categories of PPE — workwear, safety footwear, respirators, protective goggles, gloves and helmets. These items are traditionally applied in construction, industry, transport and the energy sector.

At the same time, there is steady growth of interest in specialized categories such as noise-cancelling earmuffs, fall protection equipment, disposable kits and items with a high degree of protection against thermal, chemical and biological impacts. This trend is largely due to the tightening of regulatory requirements and increased supervisory activity, as well as the spread of a risk-oriented approach[20].

A noteworthy recent shift is toward individualized selection of PPE. Large companies increasingly abandon universal solutions in favor of targeted product selection depending on the specifics of technological processes and professional risk assessment. This approach not only ensures a higher

https://indpages.ru/safe/analeez-rosseeyiskogo-ee-meerovogo-rinka-seez/

[15] PPE market: all doors are open for growth. Industrial pages. https://indpages.ru/safe/rinok-seez/

[16] Analysis of the Russian and global PPE market. New trends and developments. Industrial pages. https://indpages.ru/safe/analeez-rosseeyiskogo-ee-meerovogo-rinka-seez/

[17] Securika Moscow. The Russian market for personal protective equipment and workwear grew by 18% to reach 330 billion rubles. https://securika-moscow.ru/ru/about/news/2024/october/15/siz-2024/

[18] Analysis of the Russian and global PPE market. New trends and developments. Industrial pages. https://indpages.ru/safe/analeez-rosseeyiskogo-ee-meerovogo-rinka-seez/

[19] Analysis of the Russian and global PPE market. New trends and developments. Industrial pages. https://indpages.ru/safe/analeez-rosseeyiskogo-ee-meerovogo-rinka-seez/

[20] Analysis of the Russian and global PPE market. Industrial pages. https://indpages.ru/safe/analeez-rosseeyiskogo-ee-meerovogo-rinka-seez/

level of worker protection but also increases the economic efficiency of occupational safety investments by reducing expenses on ineffective or excessive protective equipment.

In addition to technical product characteristics, consumers have raised demands for ergonomics, design, durability and compliance with new standards.

By industry breakdown, main consumers of PPE in Russia remain: manufacturing, construction, transport, the agricultural sector, as well as the medical, pharmaceutical and food industries. The latter impose special sanitary-hygienic requirements on products. Analysis also shows increasing interest in PPE from small and medium-sized businesses, partly due to expanded practices of outsourcing occupational safety and digitalization of procurement activities[21].

The contemporary PPE market is undergoing a qualitative transformation associated with the introduction of new technological solutions, the complication of consumer demand, and the shift from single-function items to more universal, adaptive and sustainable products. Emphasis shifts from mere compliance with safety requirements toward creating innovative and ergonomic products that provide a higher level of protection and comfort.

One of the key development directions has become the production of multifunctional PPE that combines protection against several factors at once (e.g., chemical, thermal, mechanical and biological). Such products are in demand in high-risk sectors including oil and gas, metallurgy, fertilizer production and waste processing. Alongside this, requirements for ergonomics and wearability increase: the weight of items decreases, material flexibility and breathability increase, and antistatic and moisture-absorbing components are integrated. Demand for digital and 'smart' PPE is growing, and the issue of environmental friendliness comes to the fore (secondary recycling technologies and biodegradable materials, reduction of toxicity of dyes and treatments). Interest in environmentally friendly PPE is especially relevant for multinational companies and enterprises operating within sustainable development strategies.

A separate block in industry forecasts highlights the development of dermatological and bioprotective PPE, including gloves, creams, masks and goggles with antimicrobial coatings and barrier technologies. Demand for such products is particularly high in the food industry, healthcare and laboratory practice[22].

In recent years, the structure of PPE distribution channels in Russia has undergone significant changes, reflecting both technological shifts in logistics and trade and transformations in consumer behavior. One of the key development vectors is the active adoption of online platforms and marketplaces, which affects not only producers but also regulators.

Online sales allow suppliers to expand geographic coverage, increase brand recognition and reduce transaction costs by direct access to customers. However, along with distribution expansion, there is a serious threat of the spread of non-certified and openly counterfeit products.

Despite the mentioned risks, online channels increasingly play an important role in popularizing products among retail consumers. The development of online sales, on the one hand, expands product accessibility and, on the other hand, requires stricter control and joint efforts to combat counterfeiting.

The evolution of consumer preferences, driven by the complication of production processes and the expansion of functional and adaptive PPE requirements, has created objective preconditions for the active promotion of innovative solutions in the field of individual protection[23].

Innovative PPE is becoming an integral part of overall market development (Glebova, Peskova, 2025). Their prevalence and diversity reflect not only manufacturers' pursuit of technological leadership but also enterprises' practical need for effective, multifunctional and personalized occupational safety solutions. The innovative PPE segment is forming as a strategically promising

[21] Analysis of the Russian and global PPE market. Industrial pages. https://indpages.ru/safe/analeez-rosseeyiskogo-ee-meerovogo-rinka-seez/

[22] Analysis of the Russian and global PPE market. New trends and developments. Industrial pages. https://indpages.ru/safe/analeez-rosseeyiskogo-ee-meerovogo-rinka-seez/

[23] PPE market: all doors are open for growth. Industrial pages. https://indpages.ru/safe/rinok-seez/

direction capable of enhancing safety levels, reducing production risks and complying with international standards.

Currently, innovative PPE in Russia is at the formation stage. Despite growing interest in smart solutions and eco-friendly materials, mass distribution of such products is constrained by their high cost, low maturity of digital infrastructure at enterprises, limited availability of electronic components and the absence of practices for assessing the economic efficiency of innovative PPE.

CONCLUSION

The global PPE market in 2024–2030 is characterized by sustainable growth rates, strengthened regulatory oversight, technological innovations and expansion of consumer segments. Dominant factors shaping the industry's development vector include digitalization, the formation of new occupational safety standards, environmental and ergonomic requirements, and the growing role of personalized solutions integrating smart technologies and the Internet of Things. The COVID-19 pandemic acted as a catalyst for systemic shifts, leading to expanded scale of PPE production and increased requirements for innovative, medical, tactical and industrial protective solutions. In the post-pandemic recovery context and accelerated technological development, the global PPE market is characterized by increased competition, greater product complexity and active adoption of innovative solutions, requiring participants to be flexible and to strategically reassess production and distribution models.

There is an objective need to improve PPE and to use innovations in their production, which is becoming a global trend in PPE market development. The Russian segment of this market evolves in close alignment with global trends; it can be characterized as an actively developing segment showing signs of steady consolidation, moving toward technological maturity and professionalization. Expanding assortments, higher product quality requirements and the formation of a consumer culture in occupational safety are signs of maturation in this strategically important sector.

The structure of PPE consumption in Russia is becoming increasingly complex and flexible, reflecting the general trend toward a shift from regulatory compliance to risk management based on assessment of working conditions and individual worker needs. Innovative solutions are becoming an indispensable element in enhancing industrial safety and technological sovereignty.

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