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**Book**

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Edited by  
Oksana Chernega, Yuliia Bocharova

# CHALLENGES AND PARADIGM OF NATIONAL AND INTERNATIONAL SECURITY OF THE XXI CENTURY: ECONOMIC AND TECHNOGENIC DISCOURSE

Monograph

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The interdisciplinarity, multidimensionality and complexity of the security paradigm in the 21<sup>st</sup> century are reflected. Theoretical and applied (practical) aspects of ensuring the security of objects of global, sub-global, macro-, meso- and micro-levels of security in the conditions of an unprecedented transformation of the world, an increase in the level of turbulence and uncertainty recorded in the global and national contexts of development, the latest challenges, opportunities and threats at the beginning of the 21<sup>st</sup> century. The theoretical and scientific-applied provisions outlined in the monograph will be useful to scientists, teachers, graduate students, applicants for higher education, as well as decision-makers in the field of ensuring the security of objects at the global, sub-global, macro-, meso- and micro-levels.

The practical significance of the results obtained in the monograph lies in the fact that the proposed scientific and practical recommendations and conclusions can be used to study, form and implement models and strategies for ensuring and improving the security of objects of different levels.

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## ABSTRACT

The interdisciplinarity, multidimensionality and complexity of the security paradigm in the 21<sup>st</sup> century are reflected. Theoretical and applied (practical) aspects of ensuring the security of objects of global, sub-global, macro-, meso- and micro-levels of security in the conditions of an unprecedented transformation of the world, an increase in the level of turbulence and uncertainty recorded in the global and national contexts of development, the latest challenges, opportunities and threats at the beginning of the 21<sup>st</sup> century.

The development of theoretical aspects of ensuring security has found manifestation in: identification of approaches to understanding the essence of the concept of «security», security paradigms, object-subject, sectoral structure, analytical levels of security; substantiation and presentation of the author's approaches to understanding the essence of the concepts of «national security», «public administration in the field of security», «financial security», «financial security of sustainable development», «economic security», «security and protection in global tourism», «security enterprises», incl. «economic security of the enterprise»; allocation of components and indicators of national security, incl. national financial and economic security, economic security of enterprises, industries, innovative ecosystems; determining the meaning and role of language and linguistic identity, development of innovative ecosystems, financial and economic security, enterprise security to ensure national security; determining the importance and role of national security and its components, financial security of sustainable development, tourism security to ensure personal and global security; improving the classification of international financial resources involved in the field of sustainable development, identifying measures to ensure the financial security of sustainable development at different levels of management; identification of models for ensuring the security of states and their features; substantiation of the architecture of the intellectual control system of food industry enterprises.

The development of practical aspects of ensuring security has found expression in: the identification of global threats to national security in the 21<sup>st</sup> century, the vector of their transformation, the time lag of manifestation and the degree of influence; sound configuration of global financial security of sustainable development, measures to ensure financial security of sustainable development at different levels of government; development of a model for predicting the emergence of threats to the financial condition of Ukraine, a system of corrective measures of economic policy on the part of macroeconomic regulation bodies in order to stop the inertial development of the forecast situation to ensure the financial security of the state; assessment by the taxonomy method of the integral indicator of the economic security of the EU countries; construction of a matrix of transitions of the EU countries between the states of economic security of the pre-covid and covid-periods; building a security profile for Ukraine and the EU; forecasting the losses of the EU countries from military operations on the territory of Ukraine; identification of security parameters

and efficiency markers of innovative ecosystems; identification of the state and features of the development of innovative ecosystems of the leading countries of innovative development; determining the 10 most and least safe and reliable countries in the world for travel; building a map of the distribution of countries in the world according to the Global Peace Index; determination of the current state and features of the development of hotel and restaurant enterprises in Ukraine; calculation and interpretation of the integral indicator of economic security of hotel and restaurant enterprises using the taxonomy method for 2015–2020; substantiation of the strategy for ensuring the economic security of hotel and restaurant enterprises and management decisions for its implementation for the future period; development of mathematical models for the processes of preparation and improvement of water quality indicators, preparation and dosage of flour, preparation of bread starter, dough, dispersion for dough of functional applications, proofing and baking processes using ultrasonic monitoring and intensification systems; designing local adaptive control systems for relevant processes; substantiation of modern features of intelligent control of complex technological processes for the production of bakery products with digital control algorithms for food industry enterprises in the territories of technogenic load.

## KEYWORDS

Security, security paradigm, national security, public administration in the field of security, threats, risks, national identity, language identity, financial security of the state, economic security of the state, economic security of the enterprise, global financial security of sustainable development, security indicators, integral indicator of security, innovative development, innovative ecosystem, global tourism, hotel and restaurant business, security strategy, intelligent system, technogenic security, food security.

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## CIRCLE OF READERS AND SCOPE OF APPLICATION

The theoretical and scientific-applied provisions outlined in the monograph will be useful to scientists, teachers, graduate students, applicants for higher education, as well as decision-makers in the field of ensuring the security of objects at the global, sub-global, macro-, meso- and micro-levels.

The practical significance of the results obtained in the monograph lies in the fact that the proposed scientific and practical recommendations and conclusions can be used to study, form and implement models and strategies for ensuring and improving the security of objects of different levels.

# INTRODUCTION

Oksana Chernega, Yuliia Bocharova

Security is one of the basic human needs, one of the most important conditions for the existence of animate and inanimate nature, so it is natural that the phenomenon of security is an integral part of a multidisciplinary scientific discourse.

Under the influence of modern unprecedented transformations of the world, the national and global contexts of development, ideas about the risks, threats and opportunities for the further genesis of various security objects are changing, which means that the security paradigm requires transformation, updating and further development. We propose a new interdisciplinary approach for solving security issues based on the integral security paradigm, covers the theoretical and practical aspects of ensuring the security of objects at the global, sub-global, macro-, meso- and micro-levels of security, focuses on the complementary relationship of the security state of objects at different levels.

The theoretical and methodological basis for the interdisciplinary study of the security phenomenon became the provisions of economic theory, macro- and microeconomics, international economics and international economic relations, political science, sociology, management, philology, technical sciences, the works of leading domestic and foreign scientists, incl. Ladislav Hofreiter, Ludek Lukas, Matthew Sussex, Michael Clarke, Rory Medcalf, Andrea Monti, Raymond Wacks and others.

The paper raises both general questions of the transformation of the security paradigm in the 21<sup>st</sup> century, and a wide range of issues related to the transformation of approaches to understanding and ensuring the security of individual objects of the global, sub-global, macro-, meso- and micro-levels of security, incl. explored the importance of language, linguistic and national identity for ensuring national security; substantiated the importance of innovative ecosystems for ensuring national security and determined their security parameters and development markers; analyzed the global aspect of ensuring the financial security of sustainable development; the level of financial and economic security of Ukraine was studied and measures aimed at their increase were proposed; an assessment of security and security in global tourism was carried out; the state and features of ensuring the security of products and processes in the food industry were studied.

To solve a wide range of ambitious tasks, the following research methods and techniques were used in the work: analysis and synthesis, induction and deduction, comparative analysis, graphical and tabular methods; cluster analysis; factor analysis; regression method; method of taxonomic analysis, system analysis, etc. Data processing was carried out using MS Excel modules and STATISTICA 10.0 application software.

The monograph is a collective work of the teachers of the Donetsk National University of Economics and Trade named after Mykhailo Tugan-Baranovsky. The authors of the monograph are:

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The theoretical and scientific-applied provisions presented in the monograph will be useful to scientists, teachers, graduate students, applicants for higher education, and all persons interested in security issues.

The monograph has been prepared to fulfill the tasks of a set of research works approved by the Ministry of Education and Science of Ukraine: «Effective models of social partnership to ensure sustainable development: state, education, business» (state registration number 0120U101528, 2020–2022); «Automation of technological processes in the food industry» (state registration number 0121U109320, 2021–2023); «Ukraine in the system of international integration processes» (state registration number 0121U110138, 2021–2023); «Assessment of the impact of COVID-19 on the market of tourist services in Ukraine and the formation of development models in the post-crisis period» (state registration number 0121U110132, 2021–2023); «Development of the hotel and restaurant industry in Ukraine: organizational and economic aspects» (state registration number 0121U110147, 2021–2023).

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## ABSTRACT

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The place and role of the security phenomenon in the scientific discourse are studied. Approaches to understanding the essence of the concept of «security» are identified. The stages of evolution of the security concept in the 17<sup>th</sup>–20<sup>th</sup> centuries are analyzed. Security paradigms (traditional security paradigm, sectoral security paradigm, human security paradigm, integrated security paradigm) are identified. The types of security in the 21<sup>st</sup> century are identified and it is substantiated that the variability of types of security is primarily associated with its subject-object structure. Analytical security levels are proposed. It is substantiated that, despite the complexity, interdisciplinarity and multidimensionality of the modern concept of security, the defining place in it is still occupied by the concept of national security. It is substantiated that at the present stage of development of theory and practice, national security is considered as a prerequisite and indicator of the socio-economic development of the state, its competitiveness. Approaches to understanding the concept of «national security» are considered and the author's approach to understanding the essence of this term is proposed. The components of national security are identified and it is substantiated that the significance and role of different components of security differ significantly from one group of countries to another, which is dictated by the achieved level of socio-economic development, the geo-economic and geopolitical potential of countries' influence, and their national interests. The essence of the concept of «public administration in the field of security» is revealed. The variability of models for ensuring the security of states and their features are identified. Based on the analysis of the Global Risks Reports, the global threats to national security in the 21<sup>st</sup> century are systematized and analyzed, the vector of their transformation, the time lag of manifestation and the degree of influence are determined.

## KEYWORDS

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Security, security paradigm, national security, security governance, threats.

## 1.1 THE PHENOMENON OF SECURITY IN SCIENTIFIC DISCOURSE

Although «the problem of security is relevant in any historical period» [1], «the issue of security has been in the focus of attention of many scientists, historians, lawyers, philosophers, as well as politicians, those in power, the military for hundreds and thousands of years» [2], unprecedented

transformation of the world, an increase in the level of turbulence and uncertainty, which is recorded in the global and national contexts of development, the development of the international division of labor, internationalization, cooperation, and, at the same time, the escalation of competition in the geo-economic and geopolitical plane, logically cause an increase in the attention of both scientists and practitioners to the problem of security in the XXI century. Actual focus on the theory and practice of security in the context of the transformation of the development context, the picture of the world, incl. scientific, quite logical, because the idea of security, which is one of the basic human needs (according to the theory of the hierarchy of needs by A. Maslow), is also undergoing transformation, requires updating and further development.

The etymology of «security» depends on the language in which the term is used. So, according to the Etymological Dictionary of the Ukrainian language, the concept of «security» comes from the Old Slavonic prefix «without» and the noun «pek», associated with the verb «peka». The prefix «pre» is «in the absence, except», and the noun «peck» is «care, worries» [3], so the concept of «security» means without worries, without hassle, which is possible in the absence of threats. At the same time, as noted by Agnieszka Bien-Kacala, Maciej Serowaniec, «the 'security family' refers to the Latin *insane*, which are a combination of two Latin words – blue and space – and it must remain in full. European English languages, including English and French (*securite*). Since from Latin is without. Whereas *cura* means 'concern', 'fear', 'anxiety'. This word security is orientally translated as there is no doubt, heaviness or danger» [4]. Lyashenko, E. states that «...Greek contains the first references to security in the broadest sense. The Greek expression «to be safe» means «to control the situation»... In Hebrew, the word «security»... is often... identified with the Hebrew word «shalom», meaning «peace, prosperity» [5].

The first attempts to define the essence of the concept of «security» were made in 1190 [2], however, at the present stage of development of the theory and practice of security, there is no generally accepted approach to understanding the essence of this term, the variability of approaches to its understanding is fixed, because it has evolved over time, formed under the influence of theoretical interpretations of the variability of relations both within the country and outside it (under the influence of the development of international relations), as well as historical events and trends, various sciences and scientific schools, is a very wide, complex phenomenon, has many dimensions, objects and indicators. Ladislav Hofreiter comes to similar conclusions, arguing that «Security itself is complicated, internally structured, multifactor and hierarchized phenomenon. Structuralization and hierarchization of security are given by its internal structuring in subsystems along with their identification in systems of high level» [6].

Today, there are more than 5 different approaches to understanding the essence of the concept of «security»:

- security as a state of protection of vital interests, values, properties of someone and/or something;
- security as the absence of danger to someone and/or something;

- security as a property (attribute) of someone and/or something;
- security as a specific activity;
- security as a state that contributes to the most complete satisfaction of the needs of someone and/or something;
- security as a set of factors that ensure the development of someone and/or something;
- security as a cultural and historical phenomenon [1, 2, 7–13].

Thus, it is quite logical that, in accordance with the most general and widespread approach to understanding the essence, the concept of «security» is a state when, for some reason, nothing threatens someone [14] or «...» for extremely stringent requirements – threats that could so endanger core values that those values would be damaged beyond repair if we did not do something to deal with the situation» [15]. At the same time, the content analysis of works [1–29] allows to assert that the concept of «security» acquires a meaningful meaning, provided it is associated with a specific object (state, region, individual, sphere of human activity, etc.), and is also subjective (associated with the subjective perception of threats).

The first scientific concept of security appeared in the 17<sup>th</sup> century. Its formation and development were associated with the works of Locke, J., Rousseau, J.-J., Spinoza, B. the works of Machiavelli, N., Montesquieu, C., Kant, I., Hegel, G. and others [2], in these studies, the idea is gradually formed that security is determined by the ability of individuals, states to resist external (exogenous) threats, mainly due to the power component. Thus, as Kim R. Holmes notes, «Modern concepts of national security arose in the 17<sup>th</sup> century during the Thirty Years War in Europe and the Civil War in England. In 1648, the Song of Westphalia established the idea that the nation-state had legal control not only of domestic affiliation, like religion, but also of external security...» [18]. In the 20<sup>th</sup> century, with the development of the international division of labor, internationalization, scientific thought, the very nature of security was rethought, its understanding went beyond the limits of only the power component, exogenous threats, and began to be applied to a wider list of objects, incl. regions, industries and sectors of the economy, ecosystems, enterprises, the world as a whole, took into account the threats of endogenous and exogenous origin. Thus, the genesis of security theory in the 20<sup>th</sup> century can be represented as a staged process consisting of four stages: Stage 1 (40–50s of the 20<sup>th</sup> century), associated with the theory of classical realism, which focused on issues of national security, led to the emergence of the term «national interests», ensuring security was understood as ensuring the protection and implementation of the national interests of the state; Stage 2 (60s of the 20<sup>th</sup> century) – the theory of pluralism, which laid the foundation for the development of the theory of regional and international security; Stage 3 (70s of the 20<sup>th</sup> century) – the use of the ideas of Marxism in the theory of security, which laid the foundation for the formation of the theory of global security; Stage 4 (90s of the 20<sup>th</sup> century) – the theory of social constructivism, which laid the foundation for universal security, the introduction of the term «human security», a departure from understanding national security only through the ability to ensure security by military means [5].

The consequence of the evolution of the concept of security, the development of scientific schools of security during the 17<sup>th</sup>–20<sup>th</sup> centuries was the formation at the beginning of the 21<sup>st</sup> century of three security paradigms:

- the paradigm of traditional security – the object of security is the state; the object of protection is the integration of state and military security; potential threats – military aggression, nuclear war, etc.;

- the paradigm of sectoral security – individuals, groups, groups of states, humanity, civilizations are the object of security; the object of protection is military, political, economic, environmental, social, societal security, etc.; potential threats – two groups of threats: military (power) and non-military;

- the paradigm of human security – the object of security is humanity, individuals; the object of protection is human and social rights, freedom from fear, freedom from scarcity; potential threats – violence, crime, poverty, repression, hunger, disease, unemployment, etc. [1–13, 15–29].

Content analysis and systematization of information in works [1–13, 15–29] allows us to state that:

1. At the beginning of the 21<sup>st</sup> century, the formation of the fourth paradigm is observed – an integral one that unites the ideas and results of the development of the above three paradigms, which is due to the dialectical unity of the functioning and development of man, society and the state.

2. Security theory is closely related to risk theory (basic methodological principle: threat – risk – measurement), crisis theory – solution of security or security event; causality – causes of security or security event [9, 12].

3. The concept of «security» acquires a meaningful meaning if it is connected with a specific object (state, region, individual, sphere of human activity, etc.) and subject (it is subjective, associated with the subjective perception of threats).

4. Security, regardless of the object, is characterized by both internal and external dimensions (threats are formed both inside the security object and outside it). At the same time, as noted by Agnieszka Bien-Kacala, Maciej Serowaniec, «...on account globalization... The boundary between external and internal security threats becomes vague or even disappear» [4].

5. In the 21<sup>st</sup> century, the list of objects and subjects of security is very wide, as a result, there are a large number of varieties of security. At the same time, as noted by Ludek Lukas, Martin Hromada, Lukáš Pavlík. This usually includes sets of measures that serve to minimize harm. All kinds of security spheres or technical security are implemented as periodic activity, as regulated by the authorities, certain measures and tools... protect before this pathologic phenomenon... Society solve the security or security problems by introduction of security or security in the form of institutionalized children of security or security. These types of security or security are included in certain national territory and provided against certain specific threats» [10].

Thus, Ladislav Hofreiter identifies five varieties: global security, regional security, national security, group security, individual security [6].

Ludek Lukas distinguishes three types of security: international security, physic security, fire security [9]. At the same time, he notes that «Currently, security and security research is realized independently, with all sector addressing its own kind of security or security. Its basis of security or security basically creates its own professional conceptual tool» [9]. At the same time, Ludek Lukas, Martin Hromada, Lukáš Pavlík note that «From historic perspective, first kinds of security were physical security and international security» [10].

Lyashenko distinguishes six types of security: individual security, local security, regional security, national security, international security, global security [5].

Umaru Ibrahim Yakubu, Mohammed Shuaibu distinguish the following types of security:

- international security (development of a general medical system; this is related to the amalgamation of measures by states and international organizations);
- human security (this is a particular dimension that focuses on the individual, not in the state. Human protection is about people, centrifugation, multi-disciplinary understanding of security involving a number of search fields including development studies, strategic studies, human rights);
- national security (this traditionally implies the physical protection of the territories of the state from municipal attacks on other states);
- environmental protection (these threats exams consist of trends in nature, communication and peoples. This type of security includes, among other things, water security, energy security, food security);
- transnational security (these practices are taking into account threats such as organized crime, terrorism, trafficking, arms proliferation and other forms of transnational security issues);
- reference information (this refers to processes a methodologies which are designed and implemented to protect print, electronic, or any other form of confidential, private and sensitive information or data from unauthorized access, use, misuse, disclosure, destruction, modification, disruption);
- financial security (a referee at school is one of the worst, if the stench is not stolen, it is inconvenient to provide their expenses;
- economic security (this consists of the principle of security, which is a function of basic needs such as health, education, home, and information, as well as work-related security, which includes job security, income security, et cetera) [12].

Identification, analysis, systematization of author's approaches to the identification of security varieties made it possible to propose analytical levels of security: global level, sub-global, macro-, meso- and micro-levels of security (**Table 1.1**).

There is a complementary relationship between all levels and varieties of security. So, as Ladislav Hofreiter notes, «It is visible that individual security is part of global security level and individual security will not exist if the global security is no guaranteed» [6]. James C. Hsiung comes to similar conclusions, arguing that «The various components of comprehensive security are intertwined. Global warming may have worldwide economic implications, and epidemics may ravage the physical and economic security of the individual (and society at large). While heading

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in opposite directions, both globalization shift and the opposite shift to individual are ultimately interrelated because the individual is the ultimate beneficiary of both environmental and economic security» [11]. A similar point of view is shared by Lyashenko, A. [5].

● **Table 1.1** Analytical levels of security in the context of the formation of an integral security paradigm

<b>Analytical Level Security</b>	<b>A kind of security</b>	<b>Security object</b>	<b>Security sectors</b>
Global level	Global Security	Noosphere, world community	Geopolitics, geoeconomics, environmental, military, informational, technological, etc.
Sub-global level	Sub-global security	Macro-regions, continents, integration blocs, groups of countries, international organizations	Military, political, cultural, demographic, social, economic, energy, environmental, scientific and technological, food, healthcare, etc.
Macro level (national level)	National security	States	Social, food, information, cultural, technological, economic, etc.
Meso level (subnational level)	Regional security, sectoral security, etc.	Regions, industries, social groups	
Microlevel	Personal security	Individuals, enterprises	

*Source: compiled by the author based on these sources [1–13, 15–29]*

Thus, the phenomenon of security is an integral part of scientific discourse, in the 21<sup>st</sup> century the concept and phenomenon of «security» is complex, dynamic, interdisciplinary, multidimensional, security theory is developing dynamically, which is reflected in the variability of approaches to understanding the types and levels of security of complementary communication.

## 1.2 NATIONAL SECURITY: ESSENCE AND COMPONENTS

Despite the complexity, interdisciplinarity and multidimensionality of the modern concept of security, the concept of national security still occupies a decisive place in it.

According to Umaru Ibrahim Yakubu, Mohammed Shuaibu, «From the Treaty of Westphalia in 1648, the concept of security was linked to the state. Hence, the state had exclusive preserve to decide what security meant to it» [12].

As evidenced by a critical analysis of sources [1–13, 15–35], at the present stage of development of the theory and practice of security, it is national security that is considered as an important prerequisite and determinant of the socio-economic development and growth of not only individual states, but also the world community as a whole.

Thus, as PwC experts note, «Security and security lie at the heart of any nation's prosperity» [19]. A similar point of view is shared by OECD experts, arguing that «Security is fundamental to people's

livelihoods, reducing poverty and achieving the Millennium Development Goals» [33], «The security industry is a large and expanding area of economic activity» [28].

The position of international institutions on the importance of national security for ensuring the socio-economic development of countries and the world community is shared by individual researchers. Thus, Ladislav Hofreiter notes that «Security is one of the most sense human needs, is a precondition of development» [6]. Wolfgang-Peter Zingel states that «Development – Developing Security» [22]. While being an economist, Wolfgang-Peter Zingel submits the paper looks into the field of security (pre-)configuration for development, understanding that the problem is part of what economists refer to a «(non-)economic framework» [22]. Ebeh, J. I. objectively proves that «national development and national health are two essences at the same age ... security is anchored on national development. On the other side, development can be supported in the field of security» [24]. Sebastian Vaduva, Andrew R. Thomas are convinced that Growth, Security and Development are interconnected [34]. Andrea Monti and Raymond Wacks are convinced of the exceptional role of national security at the present stage of development, arguing that «National security is at the heart of contemporary public policy debate. Not only the conventional domains of intelligence and terrorism, but the economy, scientific research, education, and even the COVID-19 pandemic are in the cross-hairs of national security» [25]. The team of authors of the work [1] headed by Professor With, A. P. a beak, they come to the conclusion that «The existence of any sovereign state is impossible without the protection of its national interests, which is the main, fundamental condition for guaranteeing self-preservation and progressive self-development of society. For such reasons, the national security of transitional societies is a paramount condition for a successful socially organized existence» [1]. This point of view is shared by the authors of the work [7], arguing that «The issue of security is a matter of survival, successful existence and interaction between government and society» [7].

Both the concept of security in general and the concept of national security, in particular, are characterized by variability in approaches to understanding the essence of its fundamental concepts.

As Kim R. Holmes notes, a correct understanding of the concept of «national security» (national security) is impossible without a correct understanding of such concepts as:

- power is the nation's possession of control of its sovereignty and destiny, which can be either hard (largely military, power is about control) or soft (it is mainly about influence);
- military strength (This term refers to military capacity and the capabilities of the armed forces);
- force is a way to use a political or legal heart attack capacity to achieve some objective;
- national defense – the ability of the placed force to fight against the limited responsibility of the people and the lives of their people [18].

A similar point of view is shared by the experts of the National Council of Educational Research and Training in India, noting that «Traditional security policy has a ... component called balance of power. If countries look nearby, they say that some countries are big and strong. This is who may be in the future» [15].

A wider list of concepts and categories, on the correct understanding of which the approach to understanding the concept of «national security» depends, reports Lipkan, V. Thus, Lipkan, V. notes that «The conceptual and categorical framework objective formed in the general theory of national security compresses basic and specific notions such as national security (insecurity), national threat, safeguard, ensuring, support, probability, risk, catastrophe, crisis, vital functions, system environment, adverse factor, dangerous impact, system response, algorithm of managing, national idea, national interests, national outlook, national sufficiency, national security system, state administration of national security system, etc.» [17].

Kim R. Holmes defines national security as «...the safekeeping of the nation as a whole». This is a high circle of entrepreneurship – this is the protection of the people and their people from attack and other external citizens to manage the forces and protect state secrets» [18]. At the same time, he notes that national security involves both national defense and the protection of a number of geopolitical, economic and other interests that affect not only defense policy, but also foreign and other policies [18].

In the Law of Ukraine «On the Fundamentals of National Security», the concept of «national security» was identified as «the protection of the vital interests of a person and a citizen, society and the state, which ensures the sustainable development of society, timely detection, prevention and neutralization of real and potential threats to national interests...» [35]. At the same time, the concept of «national interests» is understood as «vital material, intellectual and spiritual values ... of the people as the bearer of sovereignty and a single source of power ... that determine the needs of society and the state, the implementation of which guarantees state sovereignty ... and its progressive development», and «threats» – present and possible phenomena and factors that create a danger to vital national interests...» [36]. In the Law of Ukraine «On the National Security of Ukraine», which replaced the Law of Ukraine «On the Fundamentals of National Security», national security is identified as «the protection of state sovereignty, territorial integrity, democratic constitutional order and other national interests ... from real and potential threats» [37]. At the same time, the concept of «national interests» is understood as «the vital interests of a person, society and the state, the implementation of which ensures the state sovereignty of the country, its progressive democratic development, as well as safe living conditions and the well-being of its citizens», and «threats to national security...» – «phenomena, trends and factors that make it impossible or complicate or may make it impossible or complicate the realization of national interests and the preservation of national values ... of the country» [37].

The authors of the work [8] understand the concept of «national security» as «the protection of the vital interests of society and the state from internal and external threats, which ensures the sustainable and progressive development of the country» [8]. At the same time, they argue that at the present stage of development of security theory, two main approaches to understanding the essence of the concept of «national security» have been formed: «According to the first, national security is considered in the context of national interests..., and according to the other, in the context of the basic values of society» [8].

Lipkan, V. understands the concept of «national security» as «the level of a nation's interests being safeguarded from natural and man-caused dangers using various methods, including investigation of the self-organization of so-called disrupters (destabilizing systems)» [17].

Ladislav Hofreiter, argues that the concept of «national security» should be understood as «...the ability of the state to ensure the protection of its independence, sovereignty, integrity, ensuring its sectorial essential needs, interests and core values against internal and external threats» [6].

Andrea Monti and Raymond Wacks believe that national security is «protection and prevention of internal and/or external actions, activities, or events that harm directly and/or endanger national interests in the economic, scientific, technological, and political field without warning about the functions of the municipal in the fight against the state and what corresponds to 'home-land security'» [25].

Umaru Ibrahim Yakubu, Mohammed, Shuaibu identify «...two main tendencies in defining national security: The first is the State-centred concept, which views national security in terms of defense and survival of the State. This conception equates «defense» with «security» and bestows its protection to the military as the custodians of national security, and equates national security with the security of the State. The second tendency in the definition of national security involves the factoring of the State and the individual into the constituents of the definition. According to this definition, security involves freedom from danger or threat to a nation's ability to protect and develop itself, promote its cherished values and well-being of its people. This takes into account the significance of human well being in the security considerations of a country» [8]. In addition, as noted by Umaru Ibrahim Yakubu, Mohammed Shuaibu, «Theories and perspectives such as idealism, realism, neoliberalism and constructivism have viewed the meaning of security differently» [8]. This point of view is shared by Lucia Retter, Erik Frinking, Stijn Hoorens, Alice Lynch, Fook Nederveen and William Phillips, arguing that the understanding of the concept of «national security» from the standpoint of Realism, Liberalism, Constructivism, Critical Theory, Critical Political Economy [23].

Considering all of the above, the approach to understanding the essence of the concept of «national security», identifying related and important concepts for the correct understanding of this term is determined by which paradigm of security prevails in a particular society, to which the author is more inclined; under national security, it is expedient to understand the ability of the state, due to the existing economic potential and the potential of force, to effectively respond to internal and external challenges, to ensure the implementation of national interests in the short, medium and long term. The decisive role in security is assigned to the state, the government. However, as evidenced by a number of studies, in the context of globalization, the importance and role of the state in ensuring national security, although it remains fundamental, is gradually decreasing.

Thus, as noted by Andrea Monti and Raymond Wacks, «National security is no longer controlled by governments. It is shared with the private sector. This often engenders tension between their respective objectives and hence strategies» [25].

Ripsman, Norrin M., Paul, T. V. come to similar conclusions, arguing that «Since its inception as a social institution, the primary purpose of the nation-state has been to provide security within

a geographically defined territory against both external and internal threats. Throughout many political, economic, and social changes, ranging from the emergence of nationalism, the industrial revolution, two world wars, and the development of nuclear weapons, the state has remained at the forefront of organized protection, and the protection of national security has been its hallmark. However, during the contemporary era, when economic, political, and social interaction expanded beyond national boundaries to reach a global scale, many believe that the state is losing its relevance not only as a welfare provider, but also as a guarantor of security. Consequently, many theorists assert that globalization has begun to dismantle the national security state» [34].

Similar views are held by Lucia Retter, Erik Frinking, Stijn Hoorens, Alice Lynch, Fook Nedeveen and William Phillips, arguing that in the 21<sup>st</sup> century national security is ensured given that security has been extended from nations to the security of individuals; it also accounts for the international system; it has been extended to look beyond military aspects of security to previously neglected dimensions of security, including political, economic, social, environmental or 'human' security aspects; political responsibility for dealing with security matters now includes actors beyond national governments, such as international organisations, local government, the public, the media and the private sector» [23].

Changing views on the importance and role of the state and governments in ensuring national security is associated with:

- changes in the understanding of subjects and objects of national security. A critical analysis of the sources [8, 11, 19, 20, 25, 29–36] shows that at the present stage of development of the theory of security, incl. national security, the objects of national security include not only states, but also people and citizens, society; subjects – not only state institutions, but also society and citizens;

- the evolution of approaches to understanding the components of national security: if in the 17<sup>th</sup> – early 20<sup>th</sup> century national security was associated only with military security (actually it was a synonym), then since the middle of the 20<sup>th</sup> century national security has been understood more broadly, including both power and non-military security, power components. Thus, as James C. Hsiung notes, «A burning issue on the agenda of nations in the twenty-first century is the new meaning of security and its place in world politics. A nation security is no longer the traditional national defense (military security) but has economic, environmental, and human dimensions as well (separately known as economic security, environmental security, and human security). All three dimensions be subsumed under the rubric of «comprehensive security» a new umbrella concept that grew out of the post-Cold War debate over the ramifications of security and over security studies as a field of inquiry» [11].

Experts from the United Nations Office for Coordination of Humanitarian Affairs (OCHA) identify seven components of national security: Economic (creation of employment and measures against poverty); Food (measures against hunger and famine); Health (measures against disease, unsafe food, malnutrition and lack of access to basic health care); Environmental (measures against environmental degradation, resource depletion, natural disasters and pollution);

Personal (measures against physical violence, crime, terrorism, domestic violence and child labour); Community (measures against inter-ethnic, religious and other identity tensions); Political security (measures against political repression and human rights abuses) [20].

PwC experts distinguish four components of national security: physical security (this is the ability to protect one's territory, the administrative apparatus); digital security (The protection of data and digital networked assets, regardless of whether they are owned by the state, corporations or private individuals); economic security (The safeguarding of financial stability, nationally and within the wider global financial system. For the individual, this means, at a minimum, having enough to live on and pay the bills); social security (Protection of citizen rights and civil liberties as traditionally defined in each state or territory. This is wider than social security as defined by a typical welfare system, including benefits and pensions; it includes food and water security, environmental sustainability, education and health) [19].

Kim R. Holmes argues that national security includes 2 components: military and non-military, he refers to the latter:

- political security (It refers to protecting the sovereignty of the government and political system and the security of society from unlawful internal threats and external threats or pressures, involves both national and homeland security and law enforcement);

- economic security (It involves not only protecting the capacity of the economy to provide for the people, but also the degree to which the government and the people are free to control their economic and financial decisions. It also entails the ability to protect a nation's wealth and economic freedom from outside threats and coercion. Thus, it comprises economic policy and some law enforcement agencies but also international agreements on commerce, finance, and trade. Recently, it has been defined by some in a human security context to mean eradicating poverty and eliminating income inequality);

- energy and natural resources security (It is most often defined as the degree to which a nation or people have access to such energy resources as oil, gas, water, and minerals. It would be more accurate to describe it as access freely determined by the market without interference from other nations or political or military entities for nonmarket, political purposes);

- homeland security (It is a set of domestic security functions that since 9/11 have been organized in a single agency, the Department of Homeland Security. It includes airport and port security, border security, transportation security, immigration enforcement, and other related matters);

- cybersecurity (It refers to protection of the government's and the peoples' computer and data processing infrastructure and operating systems from harmful interference, whether from outside or inside the country. It thus involves not only national defense and homeland security, but also law enforcement);

- human security (It refers to a concept largely developed at the United Nations after the end of the Cold War. It defines security broadly as encompassing peoples' security from hunger, disease, and repression, including harmful disruptions of daily life. Over time, the concept has expanded to include economic security, environmental security, food security, health security,

personal security, community security, political security, and the protection of women and minorities. Its distinguishing characteristic is to avoid or downplay national security as a military problem between nation-states, focusing instead on social and economic causes and an assumed international «responsibility to protect» peoples from violence);

– environmental security (it is an idea with multiple meanings. One is the more traditional concept of responding to conflicts caused by environmental problems such as water shortages, energy disruptions, or severe climate changes; it is assumed that these problems are «transnational» and thus can cause conflict between nations. The other, more recent concept is that the environment and the «climate» should be protected as ends in and of themselves; the assumption is that the environmental degradation caused by man is a threat that must be addressed by treaties and international governance as if it were the moral equivalent of a national security threat. In the past, natural disasters were not considered threats to national security, but that presumption is changing as the ideology of «climate change» and global warming takes hold in the national security community) [18].

As a result, at the present stage of development, the concept of «national security» includes both power and non-power components, incl. economic, energy, environmental security, health care security, food security, etc.

At the same time, as evidenced by the analysis of sources [6, 23], the determinants of national security are not only characterized by being formed in various areas, but can also be formed both within a certain country and outside it, that is, they can have both exogenous and endogenous origin (in relation to a particular state).

As Ladislav Hofreiter notes, national security is significantly influenced by global security, such factors as global asymmetries, polarization and stratification of the world's population [6]. This conclusion of Ladislav Hofreiter is quite logical, because, as we mentioned above, there is a complementary relationship between security levels.

A similar point of view is shared by RAND Europe experts, arguing that national security is influenced by factors such as:

1. Ownership (through control and influence) by public or private actors of critical infrastructure and sectors, or ownership of assets in physical proximity to critical infrastructure and sectors.
2. Espionage and access to sensitive information enabled, for example, by physical proximity or ownership.
3. Natural resource dependence on third countries and actors for the supply of critical raw materials and energy.
4. Supplier dependence on specific suppliers for the provision and maintenance of critical infrastructure and processes, reinforced by the presence of a skills and technology gap and lack of competition, which may result in reduced efforts to ensure resilience of critical infrastructure, sectors and processes as well as reduced innovation and R&D.
5. Government intervention through expenditure, economic policy and regulation (or lack thereof), which can have a strong influence on the quality, availability and resilience of critical infrastructure, sectors and processes.

6. Corruption and fraud, which may undermine the resilience of critical infrastructure and potentially create opportunities for malicious actors to obtain physical or digital access to sensitive assets and information.

7. Socio-economic inequality resulting from factors such as economic policies and neoliberal market forces, which may reduce the ability of citizens to provide for themselves, as well as risk social unrest and domestic instability that pose a threat to critical infrastructure, sectors and processes [23].

Megatrends, including:

1. Globalisation and interdependence between critical infrastructure, sectors and processes of one country with others, magnifying risks to an individual country's national critical infrastructures, which can be affected through cascading effects from developments elsewhere.

2. International economic trends playing a critical role on countries due to increased interconnectedness via economic, business, political and governance structures, as well as the expanded influence of private actors over political processes.

3. The political and economic paradigm of foreign states which, similar to protectionism, considers the risks related to different national economic models and their impact on the competitiveness in the area of critical sectors and processes.

4. Uncertainty in relation to resource security, particularly in relation to reliance on foreign suppliers of energy and the uptake of alternative energy generation, distribution and storage technologies.

5. Potential concerns with regard to information integrity and trustworthiness, which may act as an avenue for malicious actors including private companies to disrupt critical processes – such as elections and democratic decision-making – and gain influence in critical sectors (such as telecommunications or political institutions) [23].

In this way, national security is determined by a great number of exogenous and endogenous officials in various ethiology and nature. Ladislav Hofreiter comes to a similar conclusion, firmly, that «Security margin of the man, social group, state (hereinafter referred to as objects) will be always the result of interaction of external and internal security risks and threats and protective properties, abilities and capabilities of security object» [6].

Critical analysis of sources [1–3, 5, 6, 15–35] shows that the significance and role of various components in ensuring national security varies significantly from one group of countries to another, determined by its achieved level of socio-economic development and its features. At the same time, as evidenced by the content analysis of sources [1–13, 15–35], at the present stage of development of the theory and practice of security in general, national security in particular, economic and political security remain the most important components of ensuring national security.

Thus, as Lucia Retter, Erik Frinking, Stijn Hoorens, Alice Lynch, Fook Nederveen and William Phillips argue, «In a context of globalisation and further economic integration in recent decades, the relationship between the economy and national security has become increasingly interlinked [23]. In this context, Lucia Retter, Erik Frinking, Stijn Hoorens, Alice Lynch, Fook Nederveen and William Phillips point out the importance for national security Critical sectors (are sectors whose assets,



systems and networks (whether physical or virtual) are considered so vital that their incapacitation or destruction would have a debilitating effect on national security, the functioning of the economy and society), Critical infrastructure (is an asset or system that is essential for the maintenance of vital societal functions or processes), Critical processes (are those processes that could result in severe social disruption in the event of their failure or disruption) [23].

In turn, Krishtanovich, M., Pushak, Ya., Fleychuk, M., Franchuk, V. argue that «security in the political sphere occupies one of the key places in the national security system and acts as one of its main structural elements. This is due to the comprehensive nature and vital importance of the political sphere for the existence of the state and society, as well as the functioning of the main social institutions and organizations» [8]. At the same time, Krishtanovich, M., Pushak, Ya., Fleychuk, M., Franchuk, V. note that «...political security should be understood as a dynamically structured state that ensures the stability, unity and integrity of the political system, its ability to self-regulate, self-develop and respond to adverse internal and external influences. It is a set of measures aimed at preserving the constitutionally legitimized political system of the state, ensuring the creation of the state and constructive politics» [8].

Taking into account all of the above, as well as the fact that political security cannot be ensured without a military component, each state, in order to ensure its security, must understand and correctly evaluate the existing three strategic alternatives for the model of behavior in the face of an existing or potential military threat: «...to surrender; to prevent the other side from attacking by promising to raise the costs of war to an unacceptable level; and to defend itself when war actually breaks out so as to deny the attacking country its objectives and to turn back or defeat the attacking forces altogether... Therefore, security policy is concerned with preventing war, which is called deterrence and with limiting or ending war, which is called defence» [15].

The alternative behavior of the state in the face of an existing or potential military threat, the presence of a large number of areas in relation to which coordinated and balanced decisions must be determined, necessitates their coordination from a single center, the implementation of state administration in the field of national security.

The content analysis of sources [5, 8, 15, 29–37] indicates that public administration in the field of security should be understood as a specific type of public administration that involves the use of the capabilities and resources of the state in order to influence national security objects in order to find and achieve a compromise between human interests, society and the state, and, consequently, the realization of national interests. As noted by Abramov, V., Sytnik, G., Smolyanyuk, V. et al., «The main goal of these managerial influences is forecasting, timely detection, and neutralization of threats... The content and direction of state administration in the field of security depends on the form of government, the political system and the state policy of national security...» [8].

Ludek Lukas, Martin Hromaa, Lukáš Pavlík distinguish six main models of public administration in the field of security:

- regime model (it is based on specification the rules and their following. The regime model is controlled order);

– proactive model (it is based on proactive approach, is oriented on future and prediction of events with goal to avoid negative impact. Model is based on management, active work with information, searching and monitoring undesirable events and their solving. This model has 2 types: predictively-security model, minimize collisions model, stress reduction model);

– barrier model (flexible barrier model, layer barrier model, filter model);

– preparedness model (flexible capabilities model, business continuity model, substitution model, transformational model, redundant model);

– model of participation (it is based on creation collective goal and also on type of its attainment);

– reactive model (it is based on reactive approach, which is also based on reaction of starting event) [10].

Lyashenko, E. identifies five main models of national security, due to the cultural, historical, socio-economic and political features of the development of countries:

– american model (combination of external and internal security);

– the Japanese model (focused on ensuring internal social security, maintaining and developing the economic potential of the state);

– chinese model (based on the principles of social society);

– a model of countries with economies in transition (focusing on current socio-economic efficiency and creating prerequisites for ensuring the implementation of promising innovative projects);

– a model of developing countries (focusing on ensuring the maximum effectiveness of the use of economic potential in the shortest possible time) [5].

Since, as the studies of the National Council of Educational Research and Training of India show, at the present stage of development the thesis continues to dominate that «most threats to a country's security come from outside its borders», Holmes, R. identifies the following three main models through which national security can be ensured:

1) collective defense (collective defense is an official arrangement among nation-states to offer some defense support to other member states if they are attacked);

2) collective security (collective defense involving mutual commitments of member states could be considered a form of collective security, albeit one limited geographically to military defense. Their distinguishing characteristic is their hybrid character between collective action at the international level and the acceptance of nation-states being ultimately responsible for their own security);

3) global security (the world's security is everybody's business, the far greater focus is on attempting to eliminate conflict through international law, aid, confidence-building measures, and global governance) [18].

Thus, national security is a complex and multifaceted phenomenon, characterized by the variability of dimensions that make up the object-subject structure, management models and ensuring the containment or leveling of threats of various etiologies. The choice of models of public administration in the field of security depends on the characteristics of the historical, cultural and

political development of states, national interests, threats, etc., and may change over time under the influence of the transformation of the trajectory and context of development.

### 1.3 THREATS TO NATIONAL SECURITY IN THE XXI CENTURY

At the present stage of development of the preservation paradigm, incl. national security, as Ladislav Hofreiter notes, «Security does not mean only absence of security risks and threats but first of all protection against them» [6]. Given this, the success of public administration in the field of security depends on the timeliness of identifying, assessing risks and developing measures aimed at their leveling and/or reduction. At the same time, not only internal risks are taken into account, but also external ones, because in the context of globalization, the boundary between internal and external threats is blurred.

Among the institutions that systematically identify and differentiate global threats to global and national security, the World Economic Forum (WEF) conducts the most comprehensive and representative study. According to the results of its research, the World Economic Forum – The Global Risks Report, where risks are differentiated by the sphere of occurrence, as they impact and the horizon of their actualization.

Content Analysis of WEF Global Risk Studies 2010–2022 [38–42] allows us to state that in 2010–2022, the risks and threats that affect global and national security have changed significantly – if in 2010 the largest number of the most probable and potentially influential threats were formed in the economic sphere, since 2011 the largest number of security threats with a high level of probability of manifestation (**Table 1.2**) and potential force of influence (**Table 1.3**), arose in the social sphere and ecology.

Among the risks characterized by a high level of probability and potential impact potential, in 2010–2022:

- in the economic area: Fiscal crises; Financial failure; Chronic fiscal imbalances; Unemployment; Asset price collapse; Energy price volatility; Energy price shock;
- in the environmental area: Storms and cyclones; Biodiversity loss; Climate change; Flooding; Rising greenhouse gas emissions; Extreme weather events; Failure of climate-change mitigation and adaptation; Natural disasters; Extreme weather; Human environmental damage; Climate action failure;
- in the social area: Chronic disease; Severe income disparity; Large-scale involuntary migration; Livelihood crises; Infectious diseases; Social cohesion erosion; Water crises; Social Cohesion Erosion;
- in the technological area: Cyber-attacks; Data fraud or theft; Massive incident of data fraud/theft; Infrastructure breakdown;
- in the geopolitical area: Interstate conflict with regional consequences; Corruption; Global governance gaps; State collapse or crisis; Failure of national governance; Large-scale terrorist attacks; Weapons of mass destruction.

● **Table 1.2** Top five risks by probability of occurrence

Year	Probability of manifestation					Risk area						Geopolitics
	1	2	3	4	5	6	7	8	9	10	11	
2010	Asset price collapse	Slowing Chinese economy (< 6 %)	Chronic disease	Fiscal crises	Global governance gaps		3	0	1	0	1	
2011	Storms and cyclones	Flooding	Corruption	Biodiversity loss	Climate change		0	4	0	0	1	
2012	Severe income disparity	Chronic fiscal imbalances	Rising green-house gas emissions	Cyber-attacks	Water supply crises		1	2	1	1	0	
2013	Severe income disparity	Chronic fiscal imbalances	Rising green-house gas emissions	Water supply crises	Mismanagement of population		1	2	2	0	0	
2014	Income disparity	Extreme weather events	Unemployment	Climate change	Cyber-attacks		1	2	1	1	0	
2015	Interstate conflict with regional consequences	Extreme weather events	Failure of national governance	State collapse or crisis	Unemployment		1	1	0	0	3	
2016	Large-scale involuntary migration	Extreme weather events	Failure of climate-change mitigation and adaptation	Interstate conflict with regional consequences	Major natural catastrophes		0	3	1	0	1	
2017	Extreme weather events	Large-scale involuntary migration	Major natural disasters	Large-scale terrorist attacks	Massive incident of data fraud/theft		0	2	1	1	1	
2018	Extreme weather events	Natural disasters	Cyber-attacks	Data fraud or theft	Failure of climate-change mitigation and adaptation		0	3	0	2	0	
2019	Extreme weather events	Failure of climate-change mitigation and adaptation	Natural disasters	Data fraud or theft	Cyber-attacks		0	3	0	2	0	

● Continuation of Table 1.2

1	2	3	4	5	6	7	8	9	10	11
2020	Extreme weather	Climate action failure	Natural disasters	Biodiversity loss	Human-made environmental disasters	0	5	0	0	0
2021	Extreme weather	Climate action Infectious diseases failure	Human environmental damage	Infectious diseases	Biodiversity loss	0	4	1	0	0
2022	Extreme weather	Livelihood crises	Climate action failure	Social cohesion erosion	Infectious diseases	0	2	3	0	0
Total						7	33	11	7	7
Absolute deviation						-3	2	2	0	-1

Source: compiled by the author based on data from [38–42]

● Table 1.3 Top five risks by impact

Year	Probability of manifestation			Risk area						
	1	2	3	4	5	Economy	Ecology	Society	Technosphere	Geopolitics
1	2	3	4	5	6	7	8	9	10	11
2010	Asset price collapse	Retrenchment from globalization (developed)	Oil price spikes	Chronic disease	Fiscal crises	4	0	1	0	0
2011	Fiscal crises	Climate change	Geopolitical conflict	Asset price collapse	Extreme energy price volatility	3	1	0	0	1
2012	Financial failure	Water supply crises	Food crises	Fiscal imbalances	Energy price volatility	3	0	2	0	0
2013	Financial failure	Water supply crises	Fiscal imbalances	Weapons of mass destruction	Failure of climate-change mitigation and adaptation	2	1	1	0	1
2014	Fiscal crises	Climate change	Water crises	Unemployment	Infrastructure breakdown	2	1	1	1	0

● Continuation of Table 1.3

1	2	3	4	5	6	7	8	9	10	11
2015	Water crises	Infectious diseases	Weapons of mass destruction	Interstate conflict	Failure of climate-change mitigation and adaptation	0	1	2	0	2
2016	Failure of climate-change mitigation and adaptation	Weapons of mass destruction	Water crises	Involuntary migration	Energy price shock	1	1	2	0	1
2017	Weapons of mass destruction	Extreme weather	Water crises	Natural disasters	Failure of climate-change mitigation and adaptation	0	3	1	0	1
2018	Weapons of mass destruction	Extreme weather	Natural disasters	Failure of climate-change mitigation and adaptation	Water crises	0	3	1	0	1
2019	Weapons of mass destruction	Failure of climate-change mitigation and adaptation	Extreme weather	Water crises	Natural disasters	0	3	1	0	1
2020	Climate action failure	Weapons of mass destruction	Biodiversity loss	Extreme weather	Water crises	0	3	1	0	1
2021	Infectious diseases	Climate action failure	Weapons of mass destruction	Biodiversity loss	Natural re-source crises	0	3	1	0	1
2022	Climate Action Failure	Extreme Weather	Biodiversity Loss	Livelihood Crises	Social Cohesion Erosion	0	3	2	0	0
Total						15	23	16	1	10
Absolute deviation						-4	3	1	0	0

Source: compiled by the author based on data from [38–42]

According to The Global Risks Report 2022:

– in the next 2 years, the greatest number of threats will arise in the social sphere (4 out of 10 most likely threats). The main threats to national and global security will be: Extreme weather (31.3 % of respondents), Livelihood crises (30.4 % of respondents), Climate action failure (27.5 % of respondents), Social cohesion erosion (27.5 % of respondents), Infectious diseases (26.4 % of respondents), Mental health deterioration (26.1 % of respondents), Cybersecurity failure (19.5 % of respondents), Debt crises (19.3 % of respondents), Digital inequality (18.2 % of respondents), Asset bubble burs (14.2 %);

– in the next 2–5 years, the greatest number of threats will arise in the field of ecology (4 out of 10 possible threats). The main threats to national and global security will be: Climate action failure (35.7 % of respondents), Extreme weather (34.6 % of respondents), Social cohesion erosion (23 % of respondents), Livelihood crisis (20.1 % of respondents), Debt crises (19 % of respondents), Human environmental damage (16.4 % of respondents), Geoeconomic confrontations (14.8 % of respondents), Cybersecurity failure (14.6 % of respondents), Biodiversity loss (13.5 % of respondents), Asset but (12.7 % of respondents);

– in the 5–10-year perspective, the greatest number of threats will arise in the field of ecology (5 out of 10 conditional threats). The main threats to national and global security in the 5–10-year perspective will be: Climate action failure (42.1 % of respondents), Extreme weather (32.4 % of respondents), Biodiversity loss (27 % of respondents), Natural resource crises (23 % of respondents), Human environmental damage (21.7 % of respondents), Social cohesion erosion (19.1 % of respondents), Involuntary migration (15 % of respondents), Adverse tech advances (14.9 % of respondents), Geoeconomic confrontations (14,1 %) of respondents), Geopolitical resource contestation (13.5 % of respondents).

Taking into account the results of a retrospective analysis of the trajectory of the transformation of global risks in 2010–2022, the results of a study of global risks in 2022 in the development of a national security strategy, the formation and improvement of the state security policy will increase their effectiveness and ensure an increase in the level of national security.

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## ABSTRACT

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The object of research is the transformational processes of the national identity of Ukrainians, the role of language in this process in the context of national security. The methodological base is made up of general scientific methods: an analytical review of scientific works of leading Ukrainian and foreign scientists on the structure, stages of formation and factors that determine national identity; analysis of the results of a survey of Ukrainians during 2005/06 to the present; generalizations and synthesis of the obtained observations and comparisons to clarify the role of language in the process of formation of national identity in the context of national security.

It was found that language is a key factor, which is the basis for identification with a particular nation of an individual, affects the security of the nation as a whole. It has been proven that identification with the Ukrainian nation depends entirely on the level of proficiency, use and knowledge of the Ukrainian language. The regions where the indicator was the lowest gave an erroneous identification, that is, a reason for the neighboring state to consider russian-speaking representatives of the russian ethnic group.

It is determined that one of the key moments in the process of forming a national identity was a full-scale invasion, which prompted a more conscious choice of the language of communication in various areas, in particular, in everyday life, at work. The analyzed data also showed a gradual increase in the competitiveness of the Ukrainian language as a factor contributing to the formation of a conscious nation capable of protecting the security and national interests of the state.

## KEYWORDS

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National identity, identification, security, national security, regional identity, language identity, national values.

## 2.1 THE ROLE OF LANGUAGE IN THE CONSOLIDATION OF SOCIETY

Today, the world is on the verge of a new geopolitical distribution, where the issues of national security of the state occupy perhaps the most important place, because it covers all spheres of the life of the individual and the functioning of society as a whole. The main components of national security are the security of the individual; state security; public security; technogenic security; ecological security; energy security; information security; cybersecurity [1, 2]. The state language

is an important component of national identity and is intended to become a unifying factor in all areas of functioning and development of a sovereign state.

The so-called language issue and long-term manipulative politics in Ukraine ensure its constant relevance as a factor in the formation of national identity in the context of Ukraine's national security.

The issue of national identity and the factors influencing its formation is complex and multi-dimensional. In Ukraine, it is even more acute, because it is closely related to the processes of formation and development of an integral nation, multi-ethnicity and geopolitical position of the country. In recent years 5–7 in scientific circles, there has been an opinion that the Ukrainian nation has just begun its path of formation.

Gnatenko in the early 2000s argued that uniting the population of Ukraine into a nation is generally unacceptable, since 12 million (at that time) russians live on its territory. However, in the same work, the author says that through language, national feelings, character, spirit are formed and unite the people into a single whole. The scientist agrees with I. Ilyin's opinion that speech «in a mysterious and concentrated way contains the whole soul, the whole past, the whole spiritual structure and all the creative ideas of the people», draws attention to the fact that the upbringing of children up to 4–5 years old should take place on native language, so that the child learns to form his thoughts, to speak freely, that is, a «cult of language» must be formed [1]. Language is an integral part of ethnic and national identity.

The fact is that the concept of a nation is much broader than a people. The dictionary defines a nation as «A specific historical form of a community of people united by a common language and territory, deep internal economic ties, certain features of culture and character» [3]. For a long time, Ukrainian territories have undergone significant changes and the influence of cultures far from Ukrainian – Lithuanian, Polish and russian. The latter dealt a crushing blow to Ukrainian culture and completely halted the formation of the Ukrainian nation with the introduction of russification. For decades, the image of a Ukrainian has been shaped as stupid, inferior, not independent, and so on. Customs, traditions, folklore, national clothes, sights – the entire cultural heritage as a whole was so «adapted» to the Soviet culture, and where it was impossible – distorted beyond recognition that the Ukrainian was embarrassed to identify himself with this nation. Despite the fact that the roots of the Ukrainian language go back to ancient times, it recently received the status of the official (state) language, and therefore could not contribute to the consolidation of Ukrainian society either. So the Ukrainian community, which could be called a nation in the dictionary sense, was out of the question. Rather, it was a pre-active (weak) stage in the formation of a nation in conditions of statelessness.

In the last two or three decades (1990–2022), not only significant historical events for the nation have taken place in Ukraine – Ukraine has become an independent state with a clearly defined territory, but also a number of transformations of Ukrainian society, indicating significant shifts towards the active formation of a conscious Ukrainian nation. The integrity of the nation is important in this case because without its existence there is no point in talking about anything national at all: after all, it is the nation that creates, develops and protects its own values in all areas.

Let's try to analyze the transformation of the national identity of Ukrainians by analyzing statistical data, to determine the role of language in this process in the context of national security.

## 2.2 ISSUES OF NATIONAL IDENTIFICATION IN SCIENCE

Issues related to identity in scientific circles have begun to be discussed relatively recently, in particular, domestic scientists have become more active over the past two decades. The phenomenon of national identity is multidisciplinary, because it covers a wide range of areas of activity of both an individual and its relationship with society, as well as the development of society itself. The concept of «national identity», «identification» is the subject of study of philosophy, psychology, sociology, ethnopsychology, political science, history, linguistics and other humanities. However, there are quite a few complex interdisciplinary studies (Stepiko, M., Vilchinskaya, I., Yegupov, M., Voropaeva, T., Kozlovets, M.).

Most scientists in the field of psychology focus on certain components that make up the integral structure of the process of national identity: cognitive, affective and behavioral (Spivak, L., Stavitsky, G., Grineva, O., etc.). In the definitions of the concept, there is a tendency towards a generalized, broad understanding of the process of national identification as self-identification with a group – ethnic or national. Considering the fact that national identity has a two-dimensional character (a combination of objective and subjective features, relationships), scientists talk about the interconnectedness of the formation of the «I-image» of a person as a representative of a certain nation, feeling a common culture, territory, language, ideas, etc., which will form the formation of a «national we». Considering only the communicative function of language, psychologists do not define its role as decisive in the formation of national identity, rather social or cultural. The language functionality is much larger, and therefore there is a need to consider it in a broader aspect [4–6].

## 2.3 TRANSFORMATION OF NATIONAL IDENTITY IN THE CONTEXT OF NATIONAL SECURITY OF UKRAINE

In the early 2000s, scientists actively proposed the creation of a «national idea» as a consolidating factor for Ukrainians. The national idea as a core around which all dominant national values, statehood, religion, democracy, etc. are formed. In turn, all these factors also influence the formation of national identity, therefore, by raising the level of national identity of Ukrainians with a national idea, a high level of national security of the state would also be achieved. However, «Unlike the state strategy, the national idea is not decreed from above, it must mature in the depths of society. It cannot be constructed, it can only be caught in the general public mood» [7]. In the 1990s, such an outburst of patriotism and the creation of the Nazis died out rather quickly, so we can assume that the historical events at the beginning of 2000 gave a serious impetus to the «ripening» of such an idea.

In 2004, the Orange Revolution took place, the slogan of which was «East and West together!». Consciously or subconsciously, this phrase contained the main essence of the conflict of the population of Ukraine – language. One of the reasons for this state is that, having separated from the Soviet identity, the state did not create a basis for creating a national Ukrainian identity, giving the titular language and culture priority, as was done in similar Baltic countries. The priority of the russian language in the information [8], educational, professional, socio-political, everyday sphere creates a priori unfavorable conditions not only for the development, but also for the existence of the Ukrainian language. «Fearing to alienate the russian-speakers, the current state leadership does not actively support the Ukrainian language, but such a policy of non-intervention worsens the unfavorable position of this language in different areas and thus provokes discontent among those part of the citizens who consider it a key element of national identity» [8].

Unlike state bodies, linguistic identity has always been in the center of attention of scientists throughout the existence of Ukraine as an independent state. This indicates that the instability of the status of the titular language was recognized as a factor posing a threat at least to the full existence and development of the Ukrainian language. Research, surveys, and population surveys did not stop even after the occupation of 2014; on the contrary, the range of clarifying questions expanded. Despite the fact that the division into regions was carried out constantly, there appeared statistical data of two parts of Ukrainians – Ukrainian-speaking and russian-speaking.

Volovich, O., Voropayeva, T. apply an integrated approach to the study of the transformations of russian-speaking and Ukrainian-speaking Ukrainians. The importance of such studies lies, first of all, in the fact that the difference in the processes of identifying representatives of one nation by the language factor is recognized: «Ukrainian-speaking Ukrainians constitute a more homogeneous community than russian-speaking ones; that the identification priorities of russian-speaking Ukrainians are more unstable» [9]. At the same time, the authors note that language is a distinguishing factor, but does not exclude the commonality of the so-called political nation, the basis of which is common citizenship. Acceptable for russian-speaking citizens of Ukraine is a national identity of a political-civil type, which «covers, but does not abolish ethnic, linguistic, religious, regional, professional, class, age, gender and other identities» [9]. That is, russian-speaking Ukrainians generally gravitate toward the «Soviet» or «post-Soviet» ideology and are more inclined to consume and preserve cultural heritage in russian. Such preferences and values pose a threat to many factors of national security, the functioning of which is provided by the language (informational, educational, scientific, religious, etc. Let's note that this study was published in 2007.

For a long time, a tolerant policy was pursued in Ukraine in relation to the languages of national minorities, primarily russian. And this is quite understandable, because Ukraine is a multi-ethnic country and has entire regions where the russian language occupies a dominant role, in particular in the Eastern and Northern regions. A poll conducted by the Democratic Initiatives Foundation and the Kyiv International Institute of Sociology (DI/KIIS) in April 2005 showed that 76 % of the population voted in favor of granting official status to the russian language – local or nationwide –

in Ukraine as a whole they speak more, incl. e. in the Western region – 43 %, in the Central region – almost 75 %, and in the Southern and Eastern regions – 93 % each.

Previous studies on the peculiarities of the formation of national identity have shown that in scientific circles they quite often appeal to the concept of «regional identity» or «local» (Spivak, L., Kiselev, S., Piontkovska, D., Salnikova, A., Bychko, A.). National identity is not innate, it is the result of the socialization of the individual, and therefore it is not surprising that it can change under the influence of socio-cultural, political, ethnic and other factors. In particular, we are talking about identification, which is associated with a certain territory, language features, social status, etc. According to the sociological monitoring of the Institute of Sociology of the National Academy of Sciences of Ukraine in 2006, in the structure of national identity, regional identity ranks second after national identity – 34 % and 52 %, respectively.

During these years, there is another impressive phenomenon that Ukrainians perceive residents of different regions as representatives of different peoples with different cultural heritage and mother tongue. Moreover, they do not exclude the creation of separate countries. The results of the study concluded that identification with the Ukrainian nation, culture, recognition of the Ukrainian language as a mother tongue are factors that «increase respondents' support for the territorial integrity of Ukraine» [10, 11].

The distribution of a person into «one's own» and «alien» occurs at different levels, depending on personal boundaries and criteria. Within the territorial boundaries, the «alien» will be the one who is further away, social – who occupies the highest / lowest status, cultural – who has differences in traditions, folklore, etc. «Alien» is defined by the presence or absence of common features; in this complex process, both the human senses and his psyche are involved, and what factors have become dominant in the process of forming his identity, what values are priority, etc. For Ukrainians, the language is not a unifying factor in the process of nation formation, on the contrary, it is a dividing factor, because the title language in different regions is a different language – Ukrainian and russian. Identification in this case occurs at the level of the language – the speaker of another language is a stranger. At the same time, Ukrainians do not take into account either common citizenship, or a common territory, or basically a common religion, or many other factors that determine national identity.

Kozlovets, M. considers the phenomenon of bilingualism as ambiguous, having its positive and negative consequences, but one way or another it leads to the oppression of one language and the dominance of another. The dominant russian language becomes a priority in communication, fills the information, educational, cultural space and thus leads to the actual harassment of Ukrainian-speakers in russian-speakers. [12]. In the process of studying public opinion regarding the status of languages – Ukrainian and russian – the respondents were asked the question «How should the Ukrainian and russian languages coexist in Ukraine?». The results are summarized in **Table 2.1** according to different sources. In 2006, the highest percentage is gaining the answer that both languages should be state in Ukraine – 37 %, a slightly lower percentage has an answer regarding the Ukrainian autocracy – 35 %. It is striking that the population of a sovereign state

assumes the answer to the russian language as an autocratic one, where Ukrainian should be the language of everyday communication – 0.8 %, and 3 % of the respondents would give the Ukrainian language only a regional significance! Such figures indicate an extremely low level of formation of national identity, when the distribution of «own»/«foreign» is blurred.

● **Table 2.1** Results of a sociological study of the status of the Ukrainian language in Ukraine (2006–2020), %

Answer options	2016					
	2006	Language of communication russian	Language of communication sometimes Ukrainian, sometimes russian	Language of communication russian	2019	2020
Ukrainian should be the only state and official language, russian can be used at the household level, like the languages of other national minorities	35.0	75.8	46.5	24.9	68.5	66.1
Ukrainian should be the state language, russian may be official in some regions of Ukraine	20.3	16.2	30.7	33.6	15.0	17.9
Both languages must be state languages in Ukraine	37.0	4.1	15.8	32.7	11.5	12.6
Russian should be the state language, Ukrainian may be official in some regions of Ukraine	3.0	0.9	1.3	2.7	–	–
Russian should be the only state and official language in Ukraine, Ukrainian can be used at the household level	0.8	1.1	0.6	1.8	–	–
Difficult to answer	3.9	2.0	5.0	4.3	5.0	3.5

*Source: compiled by the authors based on [13–16]*

During the data collection process, a difference was noticed in the figures for 2006. So, in No. 1 of «National Security and Defense» for this year, we have the following comparative indicators: the status of the sole official Ukrainian language, where russian, like other languages, was used only at the household level, in 2006–2007 was supported by 39.2 % of respondents, the full rights of two languages – 31.4 %, russian as official in certain regions – 24.3 % of respondents.



In 2016, the survey was conducted in a different way, the respondents were divided into three groups according to the language of communication. As a result, we have 75 % of Ukrainian speakers for recognizing Ukrainian as the only state language and 46.5 % among bilinguals. The status of a russian as an autocracy in Ukraine was supported by 1.8 % of russian speakers. Another indicator causes concern – the percentage of those who have not decided on the status of the language – from 2 to 5 %. This is an indicator of the blurred linguistic identity of persons for whom the language does not embody the spiritual values of the nation, the ethnic group with which they identify themselves. Often, individuals with blurred identities are easy prey in manipulative socio-political games. It is noteworthy that over 14 years of conscious Ukrainians has increased from 35 % to 66.1 %, the ostentatious equal status of languages has fallen significantly (from 37 % to 12.6 %). The results of the 2019 and 2020 surveys were taken from another source for greater objectivity, however, in these questionnaires, options for the state status for the russian were not offered.

Taking into account the analyzed data and the multi-ethnicity of the country, the linguistic identity of the people itself requires a more detailed study. Summary **Table 2.2** presents survey data from the Razumkov Center, the Rating Sociological Group, the Gradus Research company, the Ilko Kucheriv Democratic Initiatives Foundation, together with the sociological service of the Razumkov Center, from 2006 to the present.

◆ **Table 2.2** Results of a sociological study of language identity in 2006–2022, %

Question asked by the respondents	Years	Ukrainian	russian	Ukrainian and russian	Other languages	Difficult to answer
What is your native language?	2006	52	30.7	15.6	1.1	0.6
	2007	51.4	25.7	21.5	0.9	0.5
	2011	61	36		2	
	2012	57	42			
	2013	62	37			
	2014	67	32			
	2015	66	33			
	2016	68.8	27.0		1.7	2.5
	2017	67.7	13.8	17.4	0.7	0.4
	2018	71	27			
	2019	73	26			
	2020	73.4	22.0		1.7	2.9
	2021	78.3	18		1.1	2.6
	03.2022	76	20			

Source: compiled by the authors based on [13–15, 17, 18]

The first thing that catches your eye is the gradual growth of the population, which considers the Ukrainian language native. This indicates that in 14 years a new generation has grown up in an independent state, where, despite all the tolerance towards the languages of national minorities,

they consider the state language to be their mother tongue. Research conducted by the Razumkov Center in 2006–2007 showed that 30.7 % of Ukrainians speak russian as their mother tongue. And, although this indicator decreased to 25.7 % over the year, the number of those for whom both russian and Ukrainian are native languages has increased. A simple calculation shows that more than 5 % of those who considered russian as their native language began to doubt the priority of their native language, due to which the percentage of bilinguals increased. In the period 2014–2017, the percentage of respondents for whom Ukrainian is their native language has slight deviations in the range of 1–2.2 %. From 2017 to the present, there is a gradual but stable increase in indicators, the difference is approximately 8–10 % (deviations are due to information obtained from various sources).

The results of a survey conducted by the Ilko Kucheriv Democratic Initiatives Foundation, together with the sociological service of the Razumkov Center, showed in 2021 that a young generation of 18–29 years old has indeed formed in Ukraine, for 83 % of whom Ukrainian is their native language. The older the respondents, the lower the percentage: 30–39 years old – 78.1 %; 40–49 years old – 80.7 % (the generation of the 90s, when there was the first surge in the formation of national identity, Ukraine gained independence); over 60 years old – 73.6 %, which is also a fairly high figure, given the Soviet restrictions and the persecution of Ukrainian-speaking citizens.

We have the greatest fluctuations in the results in relation to respondents who recognize the russian language. Various sources give somewhat drastically different percentages, making it difficult to draw conclusions. Taking into account the figures for 2006 and 2021/22, the downward trend in russian speakers is noticeable – from 30.7 % in 2006 to 18–20 % in 2021/22. This is also observed in the results of the study of the Sociological Group Rating from 2012 to 2022. The percentage of those for whom russian is native in 2012 starts from almost half of the respondents 42 % and is halved in March 2022 to 20 %. The number of those who consider Ukrainian as their native language has also increased by almost 20 %.

The indicators of bilingual Ukrainians, for whom both languages are native during 2006–2017, did not change significantly – 15.6 % and 17.4 %, respectively. Special attention should be paid to the indicator of respondents for whom it is difficult to determine which language is their native language. For a conscious citizen, the concept of language is obvious, because it is the language of the clan, the language with which knowledge of the world is connected from childhood, with which you think, with which you feel a spiritual connection, etc. The native language acts as a kind of chain that connects an individual with a group, community, unites the current generation with the past. That is, through the language the basic principles of world perception are formed, the attitude towards oneself as a member of the community, it forms the collective memory, etc. The percentage of such citizens in 2021 was 2.6 %. Losing this connection with the language, the identity of the individual, group and nation as a whole is gradually destroyed. «If the role of language as the main factor in the formation of identity is leveled, ethnic assimilation occurs: losing speech, the people cease to be psychologically aware of their identity, cultural identity and separateness and quantitatively replenish other, majority ethnic groups» [12]. Osnach, S. believes that such citizens, losing their speech, drift towards a decrease in patriotism [19]. Also, the author, using the example of the Crimean Tatars,

proves that language stamina is indeed the key to the viability of the people. A people who realize the value of language cherishes it much more than those who do not have such a powerful unifying factor.

In the past few years, the vector of language policy in Ukraine has changed with the adoption of the Law of Ukraine «On Ensuring the Functioning of the Ukrainian Language as the State Language» No. 2704-VIII dated April 25, 2019. This law had a significant impact on the distribution of priorities for language communication in various areas. Thus, in 2005 the Ukrainian language was not dominant in many areas: educational, scientific, professional, service sector, information space, etc. Moreover, internal documentation at the enterprises was partly conducted in russian, in particular, in the Autonomous Republic of Crimea and the eastern regions. Knowledge of the Ukrainian language was required but not subject to any control, so the percentage of communication in Ukrainian and russian is almost the same with a slight advantage of russian 30.2 % and 31.7 % respectively. Only 10 % less is the indicator of bilingual speakers, where the speech of communication is determined by the circumstances, or by the language in which the interlocutor speaks. In 2020, the percentage of Ukrainian-speaking communication is growing by 27 %, while russian-speaking and bilingual communication are declining to 24.1 % and 16.2 % [20, 21].

We observe a similar thing in the domestic sphere (**Table 2.3**). Compared to 2011, in 2020 the Ukrainian language, as a priority in communication at home, increased by 8.5 %, respectively, the indicator of communication in russian decreased by 9 %. Surveys in March and May 2022 conducted by various companies paint an interesting and mixed picture. Thus, the sociological company Rating published information on the results of a survey of respondents over the course of 11 years, the indicators were fixed several times a year. Thus, according to their data, the percentage of russian speakers in everyday life has decreased by more than half: from 40 % to 18 %. At the same time, communication in Ukrainian did not grow so significantly, only by 4 %, but the use of two languages increased significantly from 15 % to 32 % [15].

● **Table 2.3** Results of a sociological study on the priority of the language of communication (2005–2022), %

Question	Year	Ukrainian	russian	Ukrainian and russian (according to circumstances)	Other languages	Difficult to answer
What language do you communicate at work?	2005	30.2	31.7	21.8	0.2	7.0
	2017	48.7	9.4	23.6	0.1	0.3
	2020	57.2	24.1	16.2	1.4	1
What language do you mostly speak at home?	2011	52.4	45.0	–	0.9	1.7
	2016	55.4	41.3	–	1.4	1.9
	2017	52	10.3	20.5	0.4	0.5
	2020	60.9	36	–	1.4	1.6
	03.2022	48	18	33	–	–

*Source: compiled by the authors based on [12–16]*

Surveys conducted by the Gradus Research research company using the self-filling questionnaire method in a mobile application in May 2022 show that before the full-scale invasion, 41 % of respondents spoke Ukrainian and 58 % russian, respectively, 1 % another language, 3 %, 46 % respectively. The percentage of users in other languages is stable. At the same time, the percentage of those who continue to speak russian in everyday life is extremely high – 98 %. It should also be noted that this survey concerns, as the researchers note, the 4<sup>th</sup> wave of displaced persons, so it is dangerous to regard this indicator as objective [22].

The highest rate of bilingual communication is in March 2022 – 33 %. Polukhtovich, T. calls political processes one of the key factors in the formation of national identity at the present stage, when a significant part of Ukrainians felt the process of changing ideological, cultural, political identification [23]. This fact can be explained by russia's full-scale invasion of the territory of sovereign Ukraine. Russian-speaking citizens actively began to refuse to communicate in russian, but knowledge of Ukrainian still does not allow to fully replace the language of communication, even at the household level. Ukrainian at home is mainly spoken by young people (18–29 years old) and the middle generation (36–50 years old) 86–87 %.

As already noted, for several decades, scientists have been studying issues of national identity in Ukraine and even considering models that are acceptable for Ukrainian society, mainly based on survey data. So, Korostelina, K. identified 6 models of identity «double identity; pro-Soviet existence; struggle for Ukrainian identity; recognition of Ukrainian identity; multicultural civic model; and Crimean Tatars» [24], where the language plays an important role. 28 % of respondents, supporters of dual identity, believe that the russian language is under threat and should take the status of the second state language, while supporters of the 6<sup>th</sup> model (16 %) believe that the Ukrainian language is under threat, and should not be imposed. The goal of the Ukrainian language policy should not be a ban on russian or other languages of national minorities, but a competitive Ukrainian language in all areas, in particular, in cultural and information [12].

The phenomenon of identity cannot be called permanent; it changes under the influence of various factors, primarily socio-political, spiritual and cultural. The growth of the welfare of citizens leads to an increase in attention to cultural and spiritual heritage and values, on the basis of which the formation and interests take place, the vector of development of the nation as a whole is determined. The process of formation of national identity does not occur at an accelerated pace even under favorable conditions (socio-historical shifts) and «it cannot be easily or quickly instilled in the population using artificial means» [25].

Chupriy, L. believes that at present in Ukrainian society we can talk about three groups of identities that strive to become national: national-patriotic, pro-European identities, pro-russian identities [26], opposing each other and creating extraordinary social and political tension in Ukrainian society. The main threat is posed by those who have assimilated with another people up to identification with it. According to statistics, the role of language in this matter is leading, because «a foreign language has always been an instrument of assimilation, designed to blur, or better, forever erase the national self-identification of the conquered people, to promote its

self-identification with the invader people. The assimilated people no longer had the ambitions of their own state, and therefore, lost the motive for the struggle for independence and contributed to the development of another state» [27].

For a long time in Ukraine, the concept of «nationalism» had a negative connotation with an aggressive attitude towards representatives of another nation [28, 29], and therefore, to the question «What content do you put into the concept of «Ukrainian nationalism»?» in 2006, the Razumkov Center achieved stunning results. The majority of Ukrainians are still convinced that Ukrainian nationalism «is an ideology that splits society into ethnic Ukrainians and non-Ukrainians and provides for the restriction of the rights of non-Ukrainians» and only 27.3 % understand that this is «a worldview, the main idea of which – the transformation of Ukraine into a strong state with high international prestige and a high standard of living for citizens» [13]. It is noteworthy that in 10 years the situation is changing. The respondents were divided into three groups according to the language of communication: in Ukrainian, russian and two languages. So, Ukrainian-speakers are 29.7 % inclined to interpret nationalism as the ideology of a strong state, its development and strengthening, and among russian-speakers, 20.2 % more believe that this phenomenon is of a schismatic nature.

For several decades, Ukrainians have not put issues of cultural, ethnic and national identity as a priority, and therefore their own understanding of the Ukrainian nation, for the most part, is not associated either with the language, or with national traditions, or with ethnicity – 43.1 % (2006); 38.8 % (2007), determining the citizenship of Ukraine. The process of identification («On what grounds should nationality be determined?») Ukrainians understand as innate, that is, what is determined by the ethnicity of the parent (39 % (2006); 47.4 % (2007)). The role of language is not a key one at all – 8.2 % (2006); 6.8 % (2007). The second city in terms of indicators is the free choice of each person – 25.6 % (2006); 23.3 % (2007), which by itself crosses out the essence of national identity as identification with a certain nation according to common characteristics, culture, values, etc.

A clear evidence of how the language of communication affects the identification process is the indicators of 2016, where the highest percentage of identification with Ukrainians was demonstrated by Ukrainian speakers – 97 %, the percentage of bilinguals was 89 % and russian speakers – 66 %. 27 % of russian-speakers and 7 % of bilinguals consider themselves russians [14].

The factor of culture in general is no less important than language preferences and national identity. In 2006–2007 cultural identity gravitates toward Ukrainian 56.3 % (2006) and 57.9 % (2007). The second place is occupied by the Soviet cultural tradition, the pro-European one has only 6.6 % (2006), 6.4 % (2007) [16], which fully confirms the classification of identities by Chupriy, L. However, let us return to the actual processes of identification of the Ukrainian people. Throughout life, a person repeatedly asks himself the question «Who am I?» and at each stage the answer may be different. Why? Depending on what priorities and values are important at the moment, identification (identification) occurs within the age category, gender, social, ethnic, national, territorial, cultural, civil, etc. National identity is a complex process and has its own markers, on the basis of which there is a distinction between «one's own»/«alien» and awareness of another self [30]:

- 1) historical territory or native land;
- 2) general myths and historical memory;
- 3) general mass, public culture;
- 4) uniform legal rights and obligations for all members;
- 5) a common economy with the ability to move within the national territory.

So, already in 2006, 31 % of Ukrainians admitted that they are not like any other nationality, but more than half – 54.2 % saw similarities with russians.

In the study of identity, the answer to the question «Who are we?» is also important, to clarify the criteria of generality. According to the Ilko Kucheriv Democratic Initiatives Foundation, the criteria for commonality are primarily citizenship 35.9 % (2013) and 52.3 % (2015); secondly, family ties 53.5 % (2013) and 52.9 % (2015); and thirdly, the age factor of 32.2 % (2013) and 30.7 % (2015); and territorial (residents of one city, village) 30.6 % (2013) and 27.8 % (2015).

To study changes in society in recent years, let's also take data from the Razumkov Center for August 2021. Figures are eloquent about what, according to Ukrainians, now unites people in Ukrainian society. So, if in 2002 the primary factor was faith in the future of 38.4 %, then in 2015 41.7 % are patriotic feelings of a citizen of Ukraine, and in 2021 optimism again becomes the dominant factor in uniting society – 35.7 %. Unfortunately, the language of communication in the period 2002–2015 reduces its importance as a unifying factor: 22.7 % (2002) and 7.5 % (2015), and in 2021 it doubles – 14.8 %. The indicator of general political views is growing only by 2015 (4.7 % (2002) and 13.9 % (2015)), which indicates the formation of a socio-political nation, and in 2021 it is already halving – 6.7 %. Dissatisfaction with the authorities is also reduced by 14 %. All this together suggests that by 2021 the peak of the formation of a socio-political nation has occurred (**Table 2.4**).

**Table 2.5** reflects the transformation of Ukrainian society from 2006 to 2021. Identification civil during a certain period occupies the first positions. Taking into account the fact that the data sample was made from different sources, the indicators are heterogeneous. So, the period from 2006 to 2016 is taken from one source and there is a gradual increase of 8.5 % over 10 years. In the future, the figures range from 57.2 to 74.9 % depending on the year. Of course, there are many factors influencing identification, and one of the most important are socio-political processes, legislative changes that directly affect the standard of living and self-awareness of the individual. In any case, public identity consistently dominates in Ukraine, which since 2014 has a percentage of more than 50 %. Local or regional identity occupies the second step in the hierarchy of Ukrainian identities. Geographically, Ukrainians identify themselves as residents of a certain village, city 27.7 % (2006), over the years the percentage decreases to 20.8 % in 2021, which indicates changes in the minds of Ukrainians. Interestingly, identification at the larger level of an area or region is well below the 6.6 % percentage (2006) and 1 percent less in 2021. In general, such figures give an understanding of why there is a high level of difference between the regions of Ukraine in all areas. The consolidating factor is citizenship, not ethnicity or nationality, so the fact of the development of a political (civil) nation in Ukraine is also obvious.

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● **Table 2.4** Results of a sociological study of the question «What unites people in Ukrainian society today?», %

Answer options for questions	Years						
	2002	2003	2006	2009	2013	2015	2021
Committed to overcoming life's challenges together	24.1	22.8	22.7	24.0	22.7	35.3	22
Feeling the loss of normalcy	29.1	31.3	24.5	32.3	27.7	34.1	19.1
Faith in a better future	38.4	39.4	43.0	31.2	30.6	35.4	35.7
Joint hardships of life	34.9	40.4	35.6	37.7	33.4	29.3	29.5
Family and social feelings	27.9	25.8	35.9	35.2	23.5	23.9	26.9
Dissatisfaction with the authorities	28.5	39.6	29.5	40.6	34.1	36.3	22.3
Fear of the future	28.9	28.7	19.6	30.4	25.2	21.8	14.9
The language of communication	22.7	22.8	20.7	14.7	10.0	7.5	14.8
Patriotic feelings of a citizen of Ukraine	9.0	9.4	12.1	8.7	8.3	41.7	25.5
Political views	4.7	7.7	12.3	9.3	8.2	13.9	6.7
Religion (religion)	11.8	16.0	19.3	11.9	10.5	10.1	12.0
Nationality	9.9	11.4	13.1	11.6	7.4	12.2	14.0
Other	0.2	0.1	0.3	0.2	0.1	0.5	1.4
Nothing unites	4.2	3.3	3.8	7.5	8.1	3.7	8.3
Difficult to answer	10.0	6.7	6.7	5.7	8.3	1.8	4.9

Source: compiled by the authors based on [29, 31]

● **Table 2.5** Results of a sociological study of the question «Who do you consider yourself?», %

Respondents' answers	Years											
	2006	2008	2010	2012	2013	2014	2015	2016	2017	2018	2019	2021
Resident of the village, district or city where you live	27.7	24.5	27.3	29.8	28.7	16.1	23.0	22.1	24.7	–	–	20.8
Resident of the region (region or several regions) where you live	6.6	9.3	6.6	7.6	7.9	8.0	6.4	6.9	6.2	18.2	15.6	5.6
Citizen of Ukraine	51.6	51.8	51.3	48.4	50.7	<b>64.6</b>	<b>57.5</b>	<b>60.1</b>	<b>57.2</b>	67.2	<b>74.9</b>	<b>62.6</b>
Representative of their ethnic group, nation	1.8	2.6	3.1	1.8	2.0	2.1	3.1	2.9	3.5	3.2	2.6	2.7
Citizen of the former Soviet Union	7.3	9.0	6.9	8.4	6.6	5.5	3.9	3.9	3.2	2.2	2.7	2.8
European citizen	1.3	0.4	0.9	1.2	1.2	1.1	1.3	1.0	1.4	2.0	1.2	0.9
Citizen of the world	2.9	1.7	3.1	2.4	2.4	2.1	4.2	2.6	3.3	1.0	1.5	3.1
Other	0.7	0.6	0.8	0.3	0.6	0.5	0.6	0.5	0.6	–	0.1	1.6

Source: compiled by the authors based on [18, 30, 32, 33]

It is also possible to feel the gap in identification with Soviet culture and ideology. So, in 2006, 7.3 % of citizens experienced their belonging to a country that no longer exists, and already in 2021 – only 2.8 %. This indicates that the generation of the «Soviet Union» has undergone a significant transformation of consciousness towards the formation of a civil one. In terms of age, the figures on Soviet identity seem even more interesting: in particular, in 2017 we observe that the older the respondents, the higher the percentage of supporters (18–29 years old – 2.8 %, and among those over 60 years old – 18.7 %). However, at the time of the collapse of the USSR, only a small number of three-year-old children could have memories of life in the USSR, respectively, the identification of this age category should be much lower, because this is a conscious identification of oneself with representatives of a certain group, their cultural traditions, history, etc.

The percentage of those who consider themselves a citizen of the world has hardly changed – since 2006 it has increased by only 0.2 %. Of course, the influence of European culture in the last two decades has also affected the process of identification, but the growth in the number of people who identify themselves as European citizens has decreased by 0.4 %. All this indicates that Ukrainians are increasingly aware of their strength compared to the first years of independence.

Now let's compare how the language of communication affects national identity (**Table 2.6**). Identifying themselves as representatives of the Ukrainian nationality, Ukrainians do not always choose Ukrainian for the main language of communication. In 2005, out of 78.8 % of respondents who identify themselves as Ukrainians, only 30.2 % communicate in Ukrainian during working hours. Accordingly, the remaining 48.6 % are either in russian or in two, depending on the situation. In 2017, it is possible to correlate two parameters – the language of communication at work and in everyday life of ethnic Ukrainians, especially since over 12 years the number of ethnic Ukrainians has increased by 13.2 %. The general trend remains similar: 48.7 % communicate in Ukrainian with 92 % at work and 52 % at home, in russian, respectively, 9.4 % at work and 10.3 % at home. The growth of ethnic Ukrainians and the number of those who began to speak Ukrainian in the period of 2005–2022 by almost 20 % is a positive indicator of the formation of a conscious nation. The number of ethnic russians also decreased significantly from 18.1 % to 5 %, while representatives of other nationalities decreased by 0.1 %.

● **Table 2.6** Results of a sociological study of the national identity of Ukrainians, %

Nationality	Years				
	2005	2006	2015	2017	2022
Ukrainian	78.8	77.2	86.3	92.0	98
russian	18.1	18.3	8.9	6.0	5
other nationality	3.1	–	2.8	1.5	3
didn't answer	–	1.3	2	0.6	–

Source: compiled by the authors based on [34, 35]



Identifying themselves as Ukrainians in Ukrainian society, unfortunately, they still do not fully understand this concept. Identification occurs at different levels, but partly superficial, external. Over the past few years, there have been more people on the streets who openly demonstrate their identity with Ukrainian culture – they wear vyshyvanka, stylize other elements of national clothing, demonstrate the national emblem, the trident in jewelry and on the body. However, all this is not evidence of a conscious identification of oneself with representatives of a certain nation without a language factor, because speech is an internal core around which national interests and values in the state should develop [36].

In recent years, there has been a clear trend towards a decrease in the level of influence of Russian culture on the formation of the political Ukrainian nation. With the start of Russia's full-scale invasion of Ukraine, the criteria for the division into «friends» and «foes» became clearer: 12 % of respondents in May 2022 recognize the language problem as serious, that is, posing a threat to Ukraine's national security. However, for 67 % of the problem still does not exist [15]. A significant part of the assimilated Ukrainians do not realize that the most important criterion in the distribution of «us»/«alien» should not be a superficial recognition of cultural values in national symbols, but the Ukrainian language.

Language is a key factor that forms the basis for identification with a particular nation of an individual, affects the security of the nation as a whole. It has been proven that identification with the Ukrainian nation depends entirely on the level of proficiency, use and knowledge of the Ukrainian language. The regions where the indicator was the lowest gave an erroneous identification, that is, a reason for the neighboring state to consider Russian-speaking representatives of the Russian ethnic group. Three months of full-scale invasion prompted Russian-speaking Ukrainians to switch to Ukrainian. And even though this percentage is not high yet, it is evidence that a conscious society is being formed in Ukraine, a nation that identifies itself with one ethnic group has a common territory, national interests and values – everything that is «different» that distinguishes us from a neighbor.

The preservation of the language, its development and the return of the proper Ukrainian vocabulary is the key to the safe development of the nation and the state as a whole.

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**ABSTRACT**

The analysis of existing approaches regarding the essence and content of the concept of «economic security» for complex systems was carried out, on the basis of which indicators for assessing the level of economic security were determined: Labour transitions by employment status, Arrears from 2003 onwards, Inability to face unexpected financial expenses (EU countries); The Global Competitiveness Index (EU countries, Ukraine); integral indicator of the level of economic security (Ukraine).

The methodological tools for the study of the economic security of the EU countries and Ukraine have been determined. It is proved that the economic security of a system at any level of the hierarchy is characterized by a significant number of indicators that complicate its analysis and evaluation. In order to fully take into account the impact of all indicators involved in the study, without significant loss of information, it is advisable to use the procedures of multivariate statistical analysis to assess the level of economic security. Using the taxonomy method, an integral indicator of the economic security of the EU countries was calculated, which makes it possible to assert the existence of disproportions between countries regarding the state of economic security. A matrix of transitions of the EU countries between the states of economic security of the pre-Covid and Covid-periods has been constructed. The economic security profiles of the EU countries and Ukraine were built according to the data of 2019, which made it possible to determine the high level (Netherlands and Sweden) and the lowest (Greece). An attempt was made to determine the threat of losses of the EU countries from military operations on the territory of Ukraine.

**KEYWORDS**

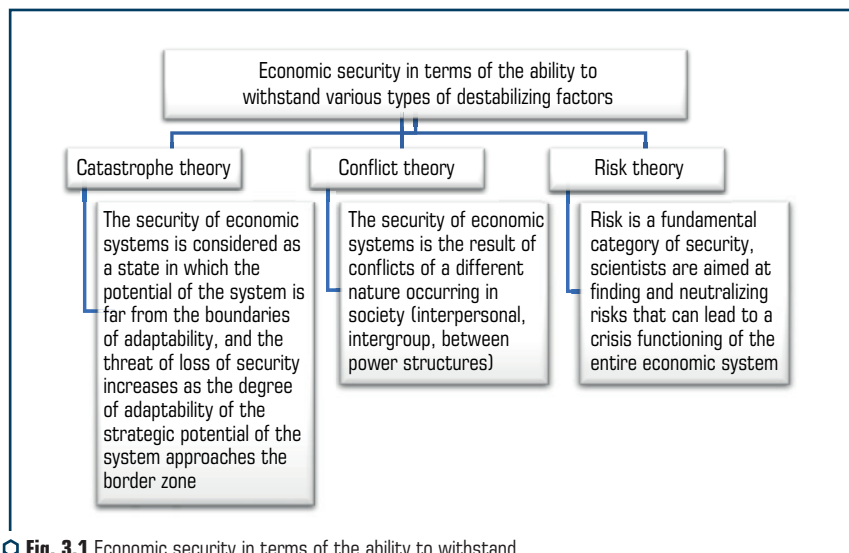
Economic security, indicators of economic security, integral indicator, European Union, taxonomic analysis, Global Competitiveness Index, threats.

**3.1 ECONOMIC COMPONENT OF SECURITY AND INDICATORS OF ITS DETERMINATION**

Features of the modern development of the national economy, volatility, dynamism and multidimensionality of the economic environment determine the growing relevance of the issue of national economic security. Economic security is an important component of national security, its foundation and material basis.

The views on the essence of economic security of foreign and domestic scientists are ambiguous. Yes, if Buzan, B. understands economic security as such a state of the economy, when the economic well-being of the participants in the relevant social relations, the stability of the domestic market of a given country, although it depends on the action of external factors, the negative impact of the latter is neutralized by the reserves of the enterprise, which allows it to be preserved stability [1], then Morgenthau, H. J. – such a state of the economy in which the state, on the one hand, guarantees individuals certain, including economic, security, and on the other hand, is a source of threats to them [2], Maul, H. W. – the absence of threats to the economy emanating from uncontrolled political processes [3]. An important contribution to the definition of the term «economic security» was made by US scientists Olvey, L. D. Golden, J. R., and Kelly, R. C., for the first time in 1984 gave an interpretation of this concept in the book «The Economics of State Security» [4].

The study of the understanding of economic security in terms of the ability to withstand destabilizing factors of various types is carried out in the context of the following areas: «catastrophe theory»; «risk theory»; «conflict theory» [5] (**Fig. 3.1**).



**Fig. 3.1** Economic security in terms of the ability to withstand various types of destabilizing factors

According to the provisions of the system approach, the state of the system is determined by a variety of indicators (indicators). But due to the ambiguity of the definition of the content of the economic security of economic systems of even one level, the definition and unification of a group of indicators is problematic. There are attempts at the level of each country to approve certain recommendations on the composition of indicators and the methodological basis for determining

the integral indicator of economic security, which complicates the process of comparative analysis between different subjects. There are many different scientific approaches to the formation of a list of indicators for determining economic security and methodological tools for its research, which differ from each other depending on the author's presentation of the content of economic security and possession of the relevant research tools.

The depth and content of the study of economic security at the country level also depends on the type of country (**Table 3.1**).

● **Table 3.1** Comparative profile of the economic component of the national security strategies of developed and developing countries [6]

Criteria	Developed countries	Developing countries
<i>Basic normative and program-strategic document regulating national security</i>		
National Security Law	Canada, Norway	China, Mexico, Ukraine
National Security Strategy	USA, UK, Poland, Japan, Australia	Brazil, Ukraine, Singapore, Egypt, UAE
Other documents in the absence of law and strategy (doctrines, white papers, etc.)	Switzerland, Germany, France, Italy, Israel	India
<i>The degree of consideration of the economic component in the program and strategic documents regulating national security</i>		
Taken into account at the level of determining national economic interests and recognizing economic security as an integral component of national security	Canada, UK, Switzerland, Norway, Germany, France, Italy, Poland, Australia, Israel	China, Singapore, Ukraine, Russia, UAE, Brazil, Mexico, India
A separate economic security strategy has been developed or is planned to be developed	USA, Japan	
<i>Strategic goal of managing economic security</i>		
Emphasis on the internal component	Poland	Mexico, Egypt
Balanced provision of internal and external economic security	Canada, Switzerland, Norway, Germany, France, Japan, Australia, Israel	Ukraine, India, Singapore, UAE
Achieving the status of a regional leader or spreading regional influence	Italy	China, Brazil
Achieving global leadership status or spreading global influence	USA, UK	
<i>The main threats to economic security according to the program and strategic documents</i>		
Predominantly endogenous threats	Italy	Egypt
Predominantly exogenous threats	USA, Canada, UK, Switzerland, Norway, Germany, France, Poland, Japan, Australia, Israel	China, Singapore, Ukraine, UAE, Brazil, Mexico, India

A comparative description of approaches to ensuring economic security in European countries [7] indicates that countries have their own idea of economic security and methods for ensuring it, aimed at achieving national, public interests, or at the sustainability of economic development, or at the independence of the national economy from the external market. The author [8] rightly noted that the common characteristic and basis of the presented systems of economic security in different countries is the legal framework for the regulation of domestic and foreign economic operations, including the participation of foreign capital in the national economy, as well as institutional support for the protection of national economic interests. in the context of international integration. Protection of national interests in the aspect of ensuring the economic security of the country is especially relevant in the context of active European integration processes [9].

In 2013, a new version of the Guidelines for calculating the level of economic security of Ukraine was approved in Ukraine, in which the following components of economic security are defined: production, demographic, energy, foreign economic, investment and innovation, macroeconomic, food, social, financial security [10]. The proposed methodological recommendations involve the calculation of an integral indicator of the level of economic security.

We agree with the team of scientists [11], who among the main shortcomings of the proposed approach, scientists distinguish: a significant correlation of indicators, which is unacceptable when using additive convolution; significant discrepancies in the weights of the indicators used; the proposed approach to determining the integral indicator (weighted average additive convolution) cannot reflect the possible non-linear nature of the processes affecting economic security; implicit logic for selecting characteristics and grouping them into categories [11]. The results of the analysis made it possible [11] to testify to the existence of a close relationship between the indicators of economic security and sustainable development and suggest using the concepts and approaches adopted in the theory of sustainable development when assessing economic security.

The same opinion is shared by Gapeeva, O. who takes into account the main indicators of achieving the global goals of sustainable development when calculating the integral index of countries' security [6]. The scientist [6] distinguishes between the economic, social and environmental components of the country's security, while for the economic component 24 indicators are defined in blocks: macroeconomic, foreign trade, investment and innovation, financial.

Among representatives of the scientific community, there is a statement that the main indicator characterizing the level of economic security, subject to its increase, is the index of economic competitiveness (Global Competitiveness Index), which really allows you to avoid the previously mentioned uncertainty in the understanding of the category «economic security» and conduct a comparative analysis of different economic systems.

The Global Competitiveness Index 4.0 assesses the microeconomic and macroeconomic foundations of national competitiveness, which is defined as the set of institutions, policies, and factors that determine the level of productivity of a country [12].

In the scientific work [13], it is proposed to use international indices and ratings that characterize the country's security in the economic, political, social and spiritual fields as unified indicators

of the country's economic security: The Global Competitiveness Index; Index of Economic Freedom; The Global Enabling Trade Index; The Sustainable Society Index; KOF Index of Globalization; Human Development Index; World Happiness; Doing Business; The Worldwide Governance Indicators; The Democracy Index; Corruption Perceptions Index, etc. The disadvantage of this approach is the presence of «similar» indicators (calculated from the same initial data), in order to prevent such multicollinearity, the team of authors [13] carried out a correlation analysis of the selected indicators: only those indicators were selected, the correlation coefficient between which does not exceed 0.7, because correlation coefficient greater than 0.7, the relationship between the indicators on the Chaddock scale can be assessed as high [13].

According to the information published on the website European Statistics (Eurostat) [14], it can be concluded that economic security is assessed precisely from the point of view of ensuring the quality of life of the population of the EU countries. In the section «Economic Security» there are 3 indicators:

- labour transitions by employment status (Wealth);
- arrears (mortgage or rent, utility bills or hire purchase) from 2003 onwards (Debt);
- inability to face unexpected financial expenses (Income Security).

So, the practical part of the presented study of the country's economic security will be based on the approaches discussed above: Labor transitions by employment status, Arrears from 2003 onwards, Inability to face unexpected financial expenses (EU countries); The Global Competitiveness Index (EU countries, Ukraine); integral indicator of the level of economic security (Ukraine).

## 3.2 METHODOLOGICAL TOOLS FOR THE STUDY OF ECONOMIC SECURITY

An analysis of theoretical sources of approaches to assessing the level of economic security of the national economy led to the conclusion that, in general, models for assessing the level of economic security have additive or multiplicative forms, and qualitative and quantitative methods are used to assess the economic security of systems at different levels of the hierarchy [5]. However, despite the fact that qualitative methods are widely used to analyze economic security, their application will bring the greatest effect only in combination with quantitative methods.

To assess the level of economic security of economic systems of different levels of the hierarchy, the following approaches are mainly used:

1. Formation of an integral indicator of the level of economic security and assessment.
2. Estimation of economic growth rates and dynamics of their change.
3. Methods of peer review, which serve to describe the quantitative and qualitative features of the studied actions.
4. Monitoring of the main socio-economic indicators and their comparison with the limit values.
5. Formation of generalizing characteristics.
6. Study of the impact of threats.



As noted above, the economic security of a system at any level of the hierarchy is characterized by a significant number of indicators that complicate its analysis and assessment. In order to fully take into account the impact of all indicators involved in the study, without significant loss of information, it is advisable to use the procedures of multivariate statistical analysis to assess the level of economic security.

At the stage of formation of an integral indicator of economic security, we propose to apply the taxonomy method, which has positively characterized itself in previous studies [15]. The main purpose of using the taxonomy method is to build a generalized assessment of a complex object or process. The taxonomic indicator is calculated according to the classical taxonomic analysis algorithm, which contains the following steps:

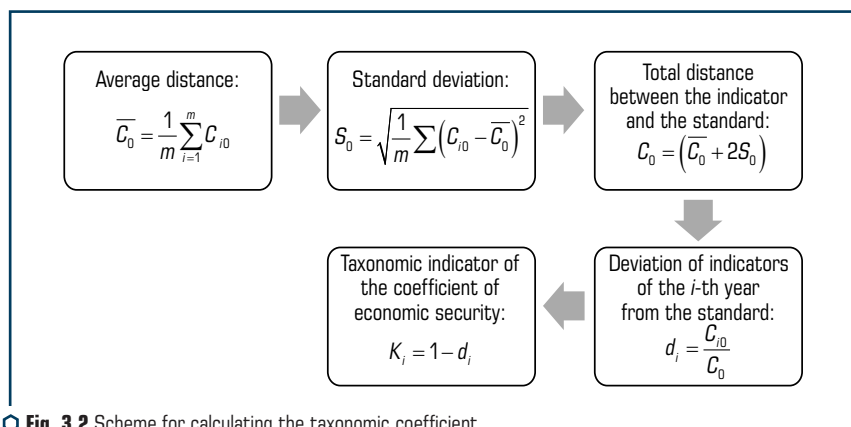
- formation of a matrix of observations;
- standardization of the values of the elements of the matrix of observations;
- identification of the reference vector;
- determination of the distance between individual observations and the reference vector;
- calculation of the taxonomic coefficient of development.

The taxonomy method can be started from the stage of determining the reference vector; for stimulants, the maximum value of the standardized indicator; for destimulants – the minimum value.

The distance between individual observations and the reference vector ( $C_{i0}$ ) is calculated by the formula:

$$C_{i0} = \sqrt{\sum_{j=1}^m (Z_{ij} - Z_{0j})^2}. \quad (5.1)$$

The taxonomic coefficient of economic security ( $K_i$ ) is calculated according to the scheme shown in **Fig. 3.2**.



**Fig. 3.2** Scheme for calculating the taxonomic coefficient of economic security ( $K_i$ )

The integral indicator of economic security for different options ranges from 0 to 1, therefore, such characteristics of the level of economic security are proposed that meet the criteria approved in [10] (**Table 3.2**).

● **Table 3.2** Characteristics of the economic security of the regions according to the integral indicator  $I_{\text{EBX}}$

Scale	State
0–0.2	critical level of economic security
0.2–0.4	dangerous level of economic security
0.4–0.6	unsatisfactory level of security
0.6–0.8	satisfactory level of security
0.8–1	optimal level of economic security

The practical application of multidimensional statistical methods for studying the economic security of regions is carried out using the appropriate modules of the STATISTICA 10.0 software product.

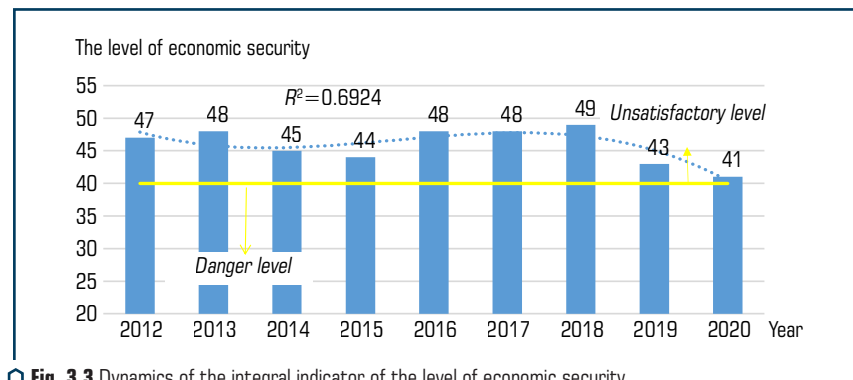
The algorithm for studying the economic security of the EU countries and Ukraine consists of the following stages: analysis of the integral indicator of the level of economic security of Ukraine, calculated according to [10]; assessment of the level of economic security of the EU countries according to the taxonomic indicator; analysis of The Global Competitiveness Index of Ukraine and EU countries; construction of profiles of economic security of research objects.

### 3.3 STUDY OF THE ECONOMIC INDICATORS OF THE SECURITY OF THE EU COUNTRIES AND UKRAINE BEFORE THE WAR

The state of development of the Ukrainian economy over the past decade did not allow ensuring national economic interests. During 2012–2020, the state of economic security was assessed as unsatisfactory, approaching a dangerous level (**Fig. 3.3**).

According to the calculations of the Ministry of Economy of Ukraine, carried out in accordance with the Methodological recommendations for calculating the level of economic security of Ukraine [10], the average value of the level of economic security for this period was 46 percent – an unsatisfactory level of economic security.

The economic security of the 27 EU countries will be assessed according to Labour transitions by employment status (LTES); Arrears (mortgage or rent, utility bills or hire purchase) from 2003 onwards (A); Inability to face unexpected financial expenses (IFUFE) for the period 2012–2020, some of the information is presented in **Table 3.3**.



**Fig. 3.3** Dynamics of the integral indicator of the level of economic security of Ukraine, calculated for [10], 2012–2020

It should be noted that the presented indicators are destimulators, i.e. the lower the indicator value, the better the score; therefore should strive to reduce.

According to the EU as a whole, the value of Labor transitions by employment status (Transition to unemployment) during 2020 increased by 28 % to 3.2 %. The lowest value was recorded during the period 2018–2020 Romania (0.02 – 2020), the highest value – Spain (7.8 – 2020), which is 39 % higher than the value of the previous period) (**Fig. 3.4**).

The value of Arrears (mortgage or rent, utility bills or hire purchases) from 2003 onwards in the EU as a whole by the end of 2020 is 8.8 %, during the entire study period it significantly exceeds the average value of Greece ( $A_{\max}=36.9$  %, which is less than the value of the previous year by 4.5 percentage points); the lowest value is recorded by Czechia (2020 – 3 %). Consequently, there is a significant range between the minimum and maximum values ( $\Delta_{2018}=40$  percentage points,  $\Delta_{2019}=38.6$  percentage points,  $\Delta_{2020}=33.9$  percentage points), which indicates the existence of regional disparities in terms of the state of economic security and the quality of life of the population of the EU countries.

As of the end of 2020, the Inability to face unexpected financial expenses value for the EU as a whole is 32.5 %, which is 2.5 percentage points higher than the value of the previous year. The lowest value of the indicator among the EU countries was recorded in Malta (2020 – 16.3 %, which is 1.2 points more than in 2019); the highest value is observed in the following countries: 2018 – Latvia (55.3 %), 2019 – Croatia (51.7 %), 2020 – Greece (50.7 %). That is, certain improvements in the situation can be witnessed, as evidenced by the decrease in disproportions between the EU countries ( $\Delta_{2018}=41.4$  percentage points,  $\Delta_{2019}=36.6$  percentage points,  $\Delta_{2020}=34.4$  percentage points).

To assess the economic security of the EU countries, taking into account the values of all three indicators using the taxonomy method (**Fig. 3.4**), the taxonomy coefficient was calculated – an integral indicator of the economic security of the EU countries (**Table 3.4**).

● **Table 3.3** Indicators of economic security of EU countries, 2018–2020

	Labour transitions by employment status			Arrears (mortgage or rent, utility bills or hire purchase) from 2003 onwards			Inability to face unexpected financial expenses		
	2018	2019	2020	2018	2019	2020	2018	2019	2020
European Union – 27 countries	2.5	2.5	3.2	8.9	8.2	8.8	32.2	30.9	32.5
Austria	2.8	3.3	4.2	4.9	4.3	5.3	20.1	18.5	17.6
Belgium	1.4	1.5	2.1	6.1	5.5	5.6	24.5	25.3	23.3
Bulgaria	3.3	2.7	4.0	31.9	29.3	23.6	32.1	36.5	43.5
Croatia	3.7	3.2	5.5	18.6	15.7	14.2	52.9	51.7	48.9
Cyprus	3.7	3.8	4.6	21.6	17.6	14.7	49.5	47.5	44.6
Czech Republic	1.2	1.1	1.2	3.0	2.8	3.0	23.7	21.8	19.6
Denmark	2.7	2.6	3.5	8.7	7.3	7.7	25.2	22.9	22.7
Estonia	2.4	2.3	4.0	8.0	8.5	6.0	34.7	31.4	30.5
Finland	2.6	2.5	2.3	10.7	10.5	10.0	27.2	26.4	25.4
France	3.1	3.3	3.6	9.1	8.4	8.9	31.4	30.6	30.4
Germany	1.0	1.4	1.3	4.6	3.7	5.2	28.1	26.0	37.7
Greece	4.7	4.3	5.3	43.0	41.4	36.9	50.4	47.8	50.7
Hungary	2.0	2.4	2.2	12.8	11.2	11.6	33.3	33.0	35.7
Ireland	1.8	2.7	2.6	11.2	11.9	13.9	37.3	38.0	33.7
Italy	3.0	2.4	3.5	6.0	5.9	6.8	35.1	33.8	32.3
Latvia	4.2	4.2	5.8	13.8	9.9	9.7	55.3	49.8	45.6
Lithuania	3.4	3.3	4.0	10.3	8.2	7.1	48.8	46.8	41.8
Luxembourg	2.3	2.3	2.7	–	–	4.9	19.7	16.7	22.5
Malta	0.3	0.5	1.2	8.1	7.8	7.0	13.9	15.1	16.3
Netherlands	1.5	1.5	1.8	3.8	4.0	3.2	21.5	21.9	19.1
Poland	1.9	1.6	2.5	7.7	7.4	5.5	31.7	29.3	25.7
Portugal	3.3	3.2	6.0	6.6	5.8	5.4	34.7	33.0	30.8
Romania	0.1	0.1	0.2	16.5	15.4	14.8	45.9	44.3	47.3
Slovakia	–	1.1	1.7	9.9	10.2	6.7	31.5	30.0	26.1
Slovenia	2.8	2.2	2.7	13.6	12.2	10.3	33.1	33.0	29.6
Spain	6.2	5.6	7.8	9.4	8.1	13.5	35.9	33.9	35.4
Sweden	1.1	1.8	2.7	4.7	4.8	4.9	20.2	20.5	19.8

Source: compiled by the authors based on data [14]

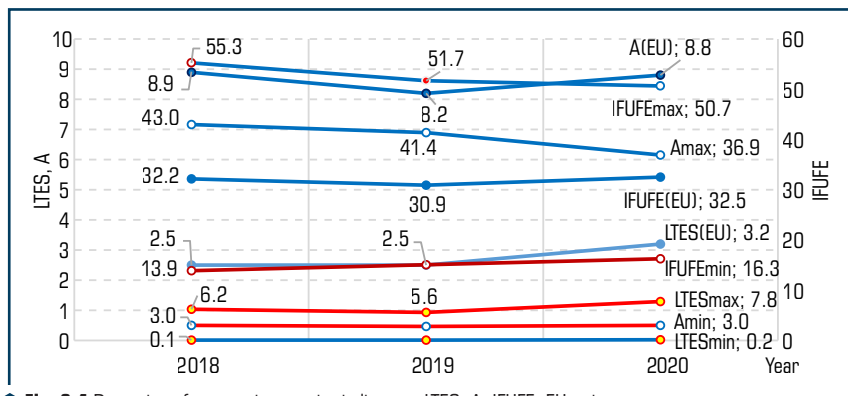


Fig. 3.4 Dynamics of economic security indicators LTES, A, IFUFE: EU, min, max

Table 3.4 Dynamics of the taxonomic indicator of the economic security of the EU countries (calculated according to the indicators LTES, A, IFUFE), 2012–2020

EU countries	2012	2013	2014	2015	2016	2017	2018	2019	2020	2020/2018	2020/2012
1	2	3	4	5	6	7	8	9	10	11	12
Austria	0.94	0.93	0.91	0.92	0.92	0.88	0.85	0.89	0.88	103.7 %	94 %
Belgium	0.90	0.92	0.92	0.88	0.88	0.80	0.77	0.75	0.81	106.1 %	90 %
Bulgaria	0.11	0.12	0.28	0.22	0.12	0.07	0.28	0.21	0.16	58.7 %	151 %
Croatia	0.13	0.15	0.15	0.16	0.15	0.14	0.11	0.10	0.15	134.3 %	116 %
Cyprus	0.34	0.26	0.16	0.13	0.17	0.21	0.15	0.18	0.25	163.9 %	72 %
Czech Republic	0.65	0.66	0.65	0.71	0.78	0.76	0.79	0.84	0.92	115.6 %	141 %
Denmark	0.86	0.88	0.84	0.87	0.91	0.81	0.73	0.78	0.79	108.6 %	91 %
Estonia	0.58	0.63	0.66	0.69	0.76	0.59	0.55	0.60	0.63	116.0 %	108 %
Finland	0.84	0.85	0.84	0.81	0.78	0.70	0.67	0.68	0.72	106.5 %	85 %
France	0.77	0.77	0.76	0.75	0.76	0.70	0.60	0.61	0.62	102.3 %	80 %
Germany	0.79	0.80	0.79	0.81	0.82	0.74	0.70	0.75	0.47	68.0 %	60 %
Greece	0.35	0.20	0.12	0.01	0.00	0.00	0.00	0.00	0.00	–	0 %
Hungary	0.05	0.04	0.00	0.03	0.34	0.61	0.54	0.54	0.48	88.9 %	950 %
Ireland	0.35	0.37	0.35	0.41	0.47	0.46	0.48	0.43	0.50	104.1 %	142 %
Italy	0.62	0.64	0.65	0.60	0.59	0.56	0.54	0.56	0.59	108.5 %	96 %
Latvia	0.08	0.15	0.15	0.24	0.20	0.12	0.09	0.18	0.25	271.3 %	325 %
Lithuania	0.34	0.39	0.41	0.40	0.35	0.32	0.24	0.26	0.36	148.2 %	107 %
Luxembourg	0.92	0.94	0.93	0.93	0.94	0.90	0.77	0.81	0.83	107.7 %	90 %
Malta	0.87	0.87	0.81	0.88	0.88	0.93	0.89	0.88	0.90	100.8 %	104 %

● Continuation of Table 3.4

1	2	3	4	5	6	7	8	9	10	11	12
Netherlands	0.97	0.94	0.93	0.93	0.95	0.90	0.84	0.84	0.92	110.2 %	95 %
Poland	0.43	0.48	0.49	0.59	0.64	0.60	0.61	0.65	0.76	124.0 %	176 %
Portugal	0.71	0.60	0.60	0.61	0.63	0.58	0.55	0.58	0.61	111.8 %	86 %
Romania	0.30	0.32	0.37	0.38	0.28	0.24	0.27	0.27	0.19	71.2 %	64 %
Slovakia	0.74	0.69	0.68	0.70	0.66	0.62	0.60	0.62	0.74	124.1 %	100 %
Slovenia	0.51	0.50	0.47	0.51	0.51	0.52	0.53	0.53	0.62	117.0 %	123 %
Spain	0.60	0.61	0.58	0.61	0.61	0.56	0.50	0.53	0.44	87.3 %	72 %
Sweden	0.94	0.95	0.95	0.96	0.96	0.91	0.86	0.86	0.89	102.8 %	94 %
AVERAGE	0.58	0.58	0.57	0.58	0.59	0.56	0.54	0.55	0.57	106.7 %	99 %
Max	0.97	0.95	0.95	0.96	0.96	0.93	0.89	0.89	0.92	103.2 %	95 %
Min	0.05	0.04	0.00	0.01	0.00	0.00	0.00	0.00	0.00	–	0 %

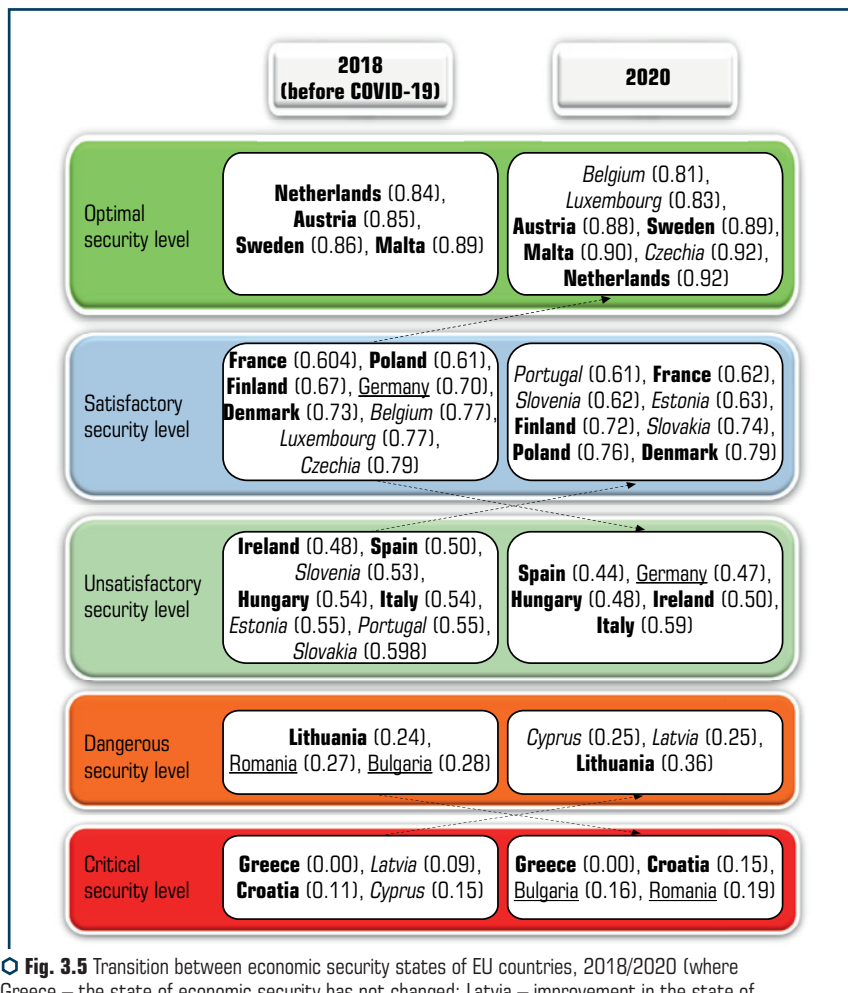
The data in **Table 3.4** indicate the presence of disproportions between countries regarding the state of economic security, which is defined as the difference between the maximum and minimum values. The worst state of economic security among the EU countries at the end of 2020 was recorded in Greece (0 points), deterioration has been observed since 2015 and is characterized as a critical level of economic security (**Fig. 3.5**).

According to 2020 data, in addition to Greece, such countries as Croatia (0.15), Bulgaria (0.16), Romania (0.19) are also characterized by a critical state of economic security. The dangerous level of economic security is defined in the following countries: Cyprus (0.25), Latvia (0.25), Lithuania (0.36), in addition, in 2018 Cyprus and Latvia improved their results. Despite the fact that Lithuania also belonged to this group of economic security in 2018, however, there is a significant improvement in the indicator, which approaches the threshold value of the unsatisfactory state of economic security (0.4).

The group of countries with an unsatisfactory state of economic security includes: Spain (0.44), Hungary (0.48), Ireland (0.50), Italy (0.59); but if Ireland and Italy improved the value of the integral indicator by the end of 2020, then in Spain and Hungary they are deteriorating. According to the results of 2020, Germany joined this group, the integral indicator of which deteriorated significantly (0.47 – 2020, 0.7 – 2018).

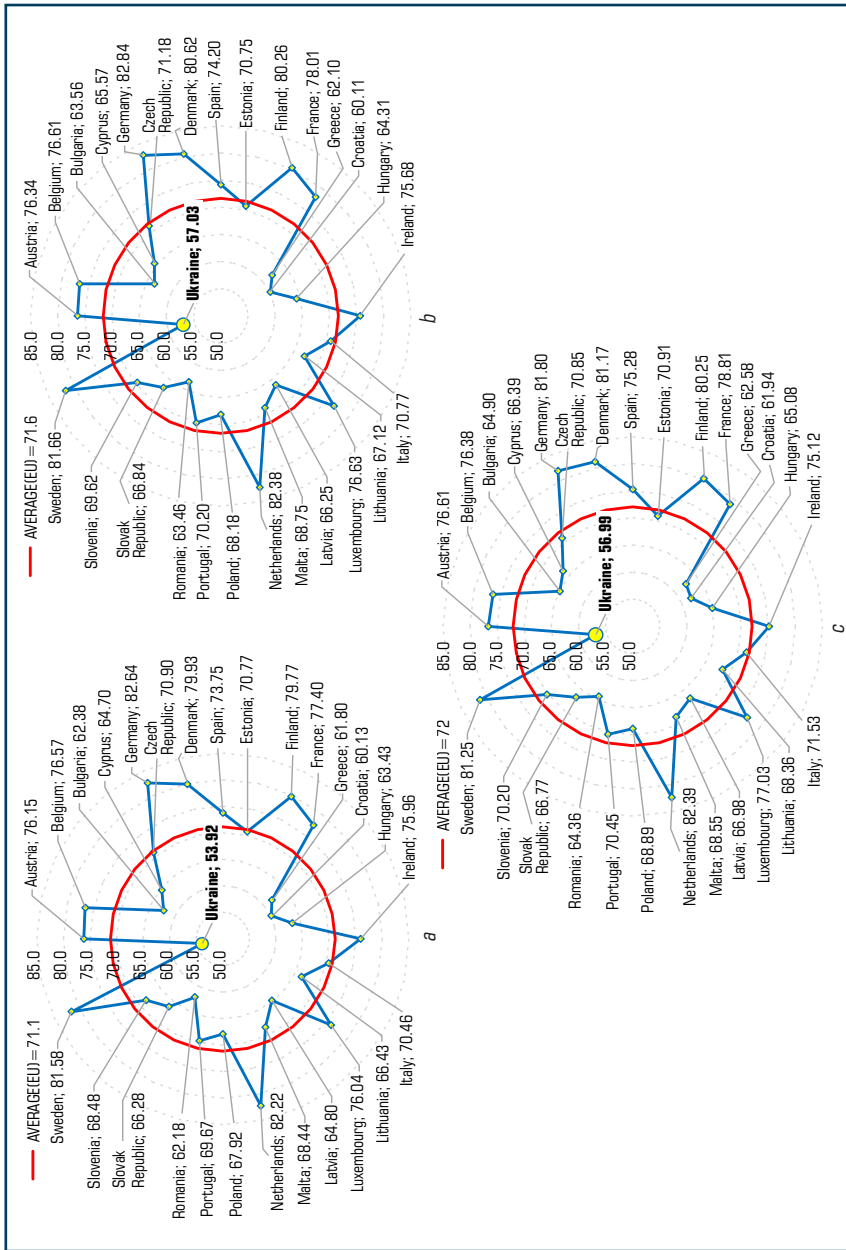
In relation to 2018, in 2020 such countries as Slovenia (0.53 – 2018 0.62 – 2020), Estonia (0.55 – 2018, 0.72 – 2020), Portugal (0.55 – 2018, 0.61 – 2020), Slovakia (0.598 – 2018, 0.74 – 2020). In addition, France (0.62), Finland (0.72), Poland (0.76), Denmark (0.79) during 2018–2020 are also characterized by a satisfactory state of economic security with a positive trend towards an increase in the integral indicator.

Consequently, as of the end of 2020, 15 EU countries (56 %) are characterized by an optimal or satisfactory state of economic security, most countries have an integral indicator value above its average (**Fig. 3.5**).



○ Fig. 3.5 Transition between economic security states of EU countries, 2018/2020 (where Greece – the state of economic security has not changed; Latvia – improvement in the state of economic security, transition to a higher level; Bulgaria – deterioration in the state of economic security, transition to a lower level)

The next stage of the study of economic security, we determined the assessment of the level of economic security of the EU countries and Ukraine in terms of The Global Competitiveness Index (GCI), which will give us the opportunity to compare the EU countries and Ukraine. The dynamics of The Global Competitiveness Index and the rating of the EU countries and Ukraine for 2017–2019 are presented in Fig. 3.6.



**Fig. 3.6** The Global Competitiveness Index of EU countries and Ukraine: *a* – 2017; *b* – 2018; *c* – 2019. Source: built according to [16]



Average GCI values according to EU countries for the period 2017–2019 are respectively: 71.1; 71.6; 72. At the end of 2018 and 2019, the lowest GCI value was recorded in Croatia (60.11; 61.94), the highest in the Netherlands (82.93) in 2019 and Germany (82.84) in 2018. According to the results of 2019, 16 EU countries have a GCI value below its average (72): Italy (71.53), Estonia (70.91), Czech Republic (70.85), Portugal (70.45), Slovenia (70.20), Poland (68.89), Malta (68.55), Lithuania (68.35), Latvia (66.98), Slovakia (66.77), Cyprus (66.39), Hungary (65.08), Bulgaria (64.90), Rumania (64.36), Greece (62.58), Croatia (61.94).

The data in **Fig. 3.6** indicate that the level of GCI value of Ukraine for the period 2017–2019 significantly less than its average values according to the data of the EU countries, this is also evidenced by **Fig. 3.7, 3.8**.

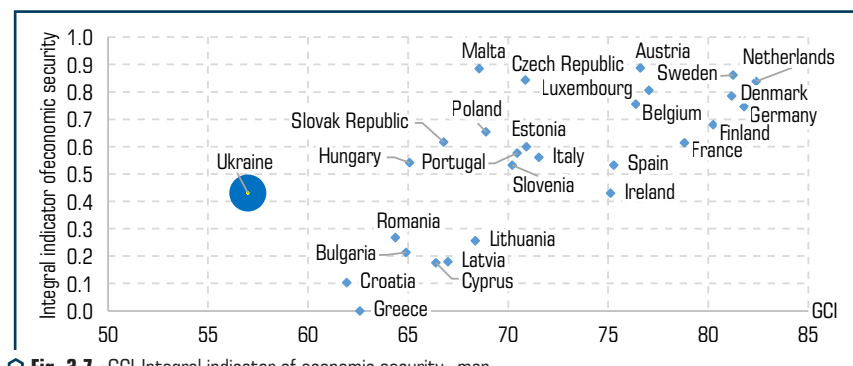


Fig. 3.7 «GCI-Integral indicator of economic security» map

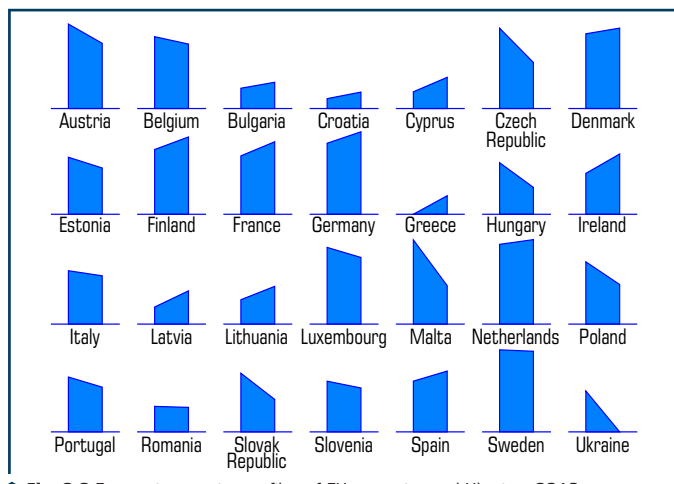


Fig. 3.8 Economic security profiles of EU countries and Ukraine, 2019

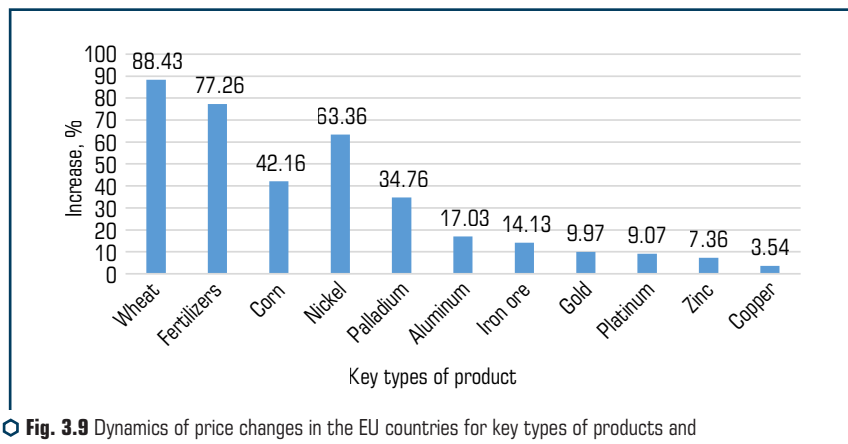
On the pictogram of this type, for each country (observation) its own area is depicted, the relative values of the selected variables (Integral indicator, GCI) for each observation are expressed by the heights of the corresponding contour vertices above the level of the profile base line; profiles reflect the levels of economic security in relation to each other for each period. The constructed economic security profiles of the EU countries and Ukraine according to 2019 data allow us to state that the Netherlands and Sweden have the highest level (almost ideal profile configuration); the lowest level is Greece.

#### 3.4 THREATS OF LOSSES OF THE EU COUNTRIES FROM MILITARY OPERATIONS ON THE TERRITORY OF UKRAINE

The EU economy at the beginning of 2022 experienced the simultaneous impact of two groups of global challenges: the need to move to the recovery phase after the peak of the incidence of COVID-19 and the geopolitical consequences of Russia's military invasion of the territory of sovereign Ukraine [17]. The sources of the crisis in the form of a social threat to the life of the population (from the first source) and a physical threat to the existence of the people of the country of Central Europe (from the second source) are accompanied by an increase in inflation, an energy and fuel crisis, a shortage of raw materials and food supplied by Ukraine, and as well as the collapse of the financial system of countries with weak economies that have not been restored after the pandemic. The OECD [18] predicted the pace of recovery of the economies of the EU countries to pre-pandemic levels did not materialize, and the forecast of global growth of 4.5 % in 2022 and 3.2 % in 2023 as a result of Russia's military aggression in Ukraine already in March 2022 crashed. All these facts are a source of threats to the economic security of the EU countries and the world.

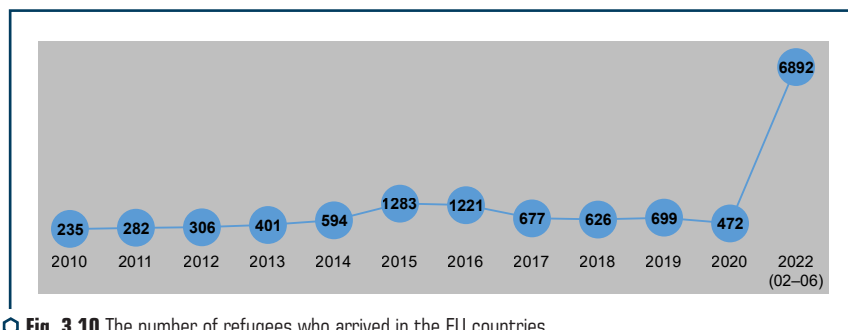
Military operations on the territory of Ukraine will negatively affect, first of all, the economy of the state itself (the OECD experts predict a 30 % drop in GDP in 2022) and the economy of the aggressor country (the OECD experts predict a 30 % drop in GDP in 2022) [19]. Moreover, the consequences of hostilities will not have a local manifestation, but, on the contrary, they will (and already today have) a prolonged negative impact on all economic systems of the countries of Europe and the world, because, despite the fact that Ukraine provides only about 1 % of world GDP (according to the results 2021), it is a key player in the following commodity markets: accounts for about 50 % of global sunflower oil exports; 15 % of world wheat exports; 20 % corn; 15 % barley; mineral fertilizers and 11 % oil [19, 20]. As of April 2022, hostilities covered 10 regions of Ukraine, which accounted for 4 % of sunflower crops, 42 % of corn, 52 % of wheat in 2021 [20]. Disruptions in the supply of plant products such as corn, wheat, and mineral fertilizers from Ukraine could become a catalyst for famine in a number of countries and lead to global food security. Failures in the supply of mineral resources, ferrous and non-ferrous metals threaten a raw material crisis and rising prices for finished products of machine and aircraft building, instrument making, etc.

The EU countries are already feeling the consequences of military aggression on the territory of Ukraine today, and they were primarily reflected in the rise in prices (**Fig. 3.9**). The upward trend in prices for crop products (for wheat (88.43 %) and corn (42.16 %)) is especially threatening, since in the conditions of the disruption of the sowing campaign in the east and in the central part of Ukraine, this may lead in the future to a shortage of traditional EU and the food world. By the end of April 2022, the inflation rate in the EU countries, according to EUROSTAT, was estimated at 7.5 %, and the largest increase in prices was recorded for energy products (an increase of 44.4 %).



**Fig. 3.9** Dynamics of price changes in the EU countries for key types of products and raw materials as a result of military operations on the territory of Ukraine (price increase on February 24 – March 14, 2022) [19]

Since February 24, 2022, the EU has faced one of the biggest emigration crises of World War II (**Fig. 3.10**). Hungary, Moldova, Poland, the Slovak Republic and other countries have become the main centers of forced migration.



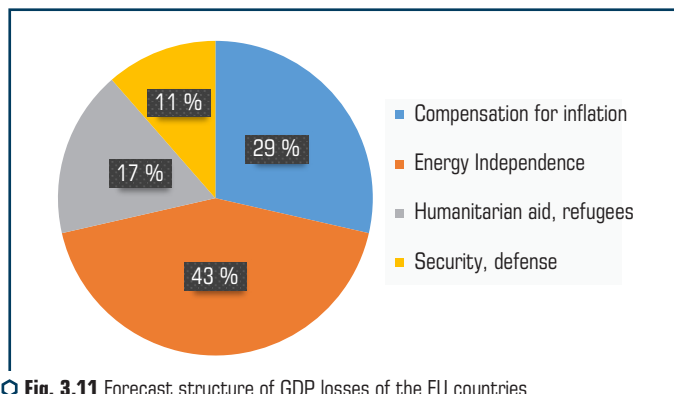
**Fig. 3.10** The number of refugees who arrived in the EU countries for 2010–2022 (2022 for the period 24.02–01.06) [21, 22]

Analysts of the world economic forum [17] determined that the result of hostilities on the territory of Ukraine will be the loss of the economies of the EU countries at the level of about 175 billion EUR – or simply more than 1 % of GDP in 2022. Their structure is shown in **Fig. 3.11**.

As can be seen from **Fig. 3.11**, the main sources of losses are the need to ensure the energy independence of the EU countries (estimated at about 75 billion EUR or 43 % of GDP losses) and inflation compensation (estimated at about 50 billion EUR or 29 % of GDP losses). Provided that the conduct of hostilities does not go beyond the territory of sovereign Ukraine, support for the security and defense of the EU countries will cost approximately 20 billion EUR, or 11 % of GDP losses.

Ukraine, as already noted, does not have a significant impact on the size and structure of the EU GDP, however, it is a unique supplier of local resources that form the starting raw material base to support the production activities of strategically important sectors of the economy of the EU countries. The commodity structure of Ukraine's exports and imports to the EU countries (**Table 3.5**) shows that in 2019–2021, the share of exports of goods to the EU countries in its total volume amounted to approximately 41.46–37.82 % and decreased by 2.1 % over the study period, the share of imports of goods from EU countries is 41.14 % – 39.75 % and has decreased by 1.39 % over three years. That is, approximately 1/3 of Ukraine's trade turnover was made up of transactions with EU countries, a significant part of the export of our state in 2019–2021.

In the structure of Ukraine's exports to the EU countries, as of 2021, 20.26 % were exports of ferrous metals and 14.53 % of exports were mineral products (11.24 % were ores, slags and ash). This trend demonstrates the dependence of the economy of our state on the functioning of the mining and metallurgical complex (MMC) and the dependence of the industry of the EU countries on the supply of raw materials and metal products from Ukraine. Military operations on the territory of Ukraine, which make it impossible to fully fulfill contracts for the supply of metallurgical products and raw materials, generate threats not only for core industries, but also for secondary ones, such as the manufacture of cars, aircraft, the production of microchips, etc.



**Fig. 3.11** Forecast structure of GDP losses of the EU countries from military operations in Ukraine [23]

● **Table 3.5** Commodity structure of foreign trade and trade with EU countries in 2019–2021, % [24]

<b>Export of goods</b>		<b>Import of goods</b>				
<b>Product code according to NACE</b>		<b>years</b>		<b>Δ20/19</b>	<b>Product code according to NACE</b>	
		<b>2019</b>	<b>2020</b>	<b>2021</b>	<b>years</b>	<b>Δ20/19</b>
					<b>2019</b>	<b>2020</b>
					<b>2021</b>	
<i>Commodity structure of Ukraine</i>						
Base metals and products made from them:		20.49	18.36	23.49	3.00	6.00
– black metals		17.45	15.63	20.49	3.04	2.06
– ferrous metal products		2.08	1.78	1.90	–0.18	1.81
Mineral products		9.72	10.84	12.36	2.64	21.36
– ores, slag and ash		7.17	8.99	10.46	3.29	0.87
<i>Commodity structure of EU</i>						
Share of exports to EU countries		41.46	37.82	39.36	–2.10	41.14
Base metals and products made from them:		18.30	16.68	23.72	5.42	5.30
– black metals		15.16	13.51	20.26	5.10	1.36
– ferrous metal products		2.12	2.15	2.23	0.11	1.88
Mineral products		13.00	11.12	14.53	1.53	11.19
– ores, slag and ash		8.54	7.81	11.24	2.70	0.04

The mining and metallurgical complex of Ukraine today is an exporter of 46 % of iron ore to the EU countries. Military operations in Ukraine jeopardize the metallurgical industry of Europe not so much by downtime of their capacities (according to [25] Ukrainian MMC enterprises operate at 50–75 % as of the end of May 2022, preferring the production of current stocks of metal products and raw materials), but by problems with logistical flows (mined seaports, occupation of Ukrainian seaports by Russia, Russian piracy in the Black Sea, undermining of railways and missile attacks on railway infrastructure).

First of all, among the direct threats to the economic security of the EU countries, one should consider a reduction in the production of metal products (**Table 3.6**).

● **Table 3.6** Changes in the operational performance of the metallurgical enterprises of the MMC of Ukraine as a result of hostilities in Ukraine, million tons [26, 27]

	<b>Cast iron</b>	<b>Steel</b>	<b>Rolled steel</b>
3 months of 2021 p.	5313	5291	4734
3 months of 2022 p.	3499	3641	3116
Variation, %	–34.14	–31.19	–34.18
54 thousand jobs, 3.2 % of GDP and about 10 % of exports of goods from Ukraine			

The average reduction in the output of metal products by the main producers from Ukraine is 30 % in the first quarter of 2022 compared to the same period in 2021. This trend exists taking into account the fact that 80 % of the metallurgical enterprises of Ukraine (8 out of 10 plants) are located in three regions: Dnipropetrovsk, Poltava and Zaporizhzhia, that is, in regions that are not a springboard for active hostilities, although it is impossible to call their area of base safe. The threat to economic security also exists taking into account the fact that the cessation of exports of metal raw materials and metal products to the EU countries from Ukraine does not provide for the substitutional possibility of their complete replacement with rolled products from China and metal raw materials from Australia and Brazil. The main reason for the lack of substitution is logistics and the price factor (for example, since the outbreak of hostilities, prices for iron ore (Fe 62 %) in China have increased by almost 15 %, while prices for domestic metal raw materials after rising in early 2022 by 11.7 % stabilized by the end of February, prices for scrap metal from Turkey are growing by 20 % per week since the beginning of the war [26, 27]).

The sources of the main threats to economic security for the EU countries from military operations in Ukraine are summarized in **Table 3.7**.

The largest sources of threats to the economic security of the industrial sector of the EU countries listed in the table are, of course, not exhaustive, but they are a representative sample that proves the magnitude of the consequences of Russia's continued military aggression against Ukraine.

● **Table 3.7** Sources of the main threats to the economic security of the industrial sector of the EU countries from military operations in Ukraine and their consequences [17, 19, 21, 27]

<b>Sphere of occurrence</b>	<b>Source of economic threats</b>	<b>Threat manifestation</b>	<b>Effects</b>
Steel semi-finished products	Supply disruptions 34 % of EU demand for slabs, 50 % for square billets, 84 % for metallurgy	Shutdown of EU steelmaking capacities, rising prices for metal raw materials (for the increase in the price of billet at the end of February 2022 amounted to 14 %)	Global
Gas production	Reduction by 17.3 % of daily gas production, reduction by 8 % of the production of DM «Ukrigasvydobuvannya», a ban on gas exports from Ukraine	Ecological catastrophe as a result of excessive accumulation of liquefied gas and oil in storage	Local, promising (complication of restoring gas production from mothballed wells)
Shipping	Loss of 420 thousand tons of cargo/day, 1666 containers/day	Disruption of sea deliveries: 135.6 thousand/day of grain; 103.7 thousand tons/day of metal ores; 44.3 thousand tons/day of ferrous metals; 14.2 thousand tons/day of oil; 10.6 thousand tons/day of building materials. The threat of starvation	Global
Rail transportation	An increase in the load on the railway infrastructure; change in the structure of transportation; the capacity of railway stations on the territory of Ukraine and border regions has been reduced; discrepancy between the standards of wagons and tracks of the Ukrainian railway to European standards	Disruptions of 50 % of the supply of goods from the pre-war scale	Local
Railway wheels and wheelsets	Ukraine is a supplier of 70 % of the EU market of railway wheels for freight cars (Interpipe plant)	Lack of opportunities to carry out repair work on the rolling stock of railways; violation of logistics processes in the industry; disruption of EU transport sector transition projects to green energy	Global
Production of noble gases, including neon, krypton and xenon	Ukraine is a supplier of 70 % neon and 40 % krypton to the EU market, the availability of technologies for the manufacture of highly purified gases	Shutdown of mechanical engineering (for example, two Volkswagen plants in Germany) in the EU, lack of gas for the manufacture of chips and microcircuits in the EU and the USA	Global

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## 4 THE GLOBAL ASPECT OF ENSURING THE FINANCIAL SECURITY OF SUSTAINABLE DEVELOPMENT

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### ABSTRACT

The object of the study is the process of ensuring the financial security of sustainable development at the global level. Research methods are based on general scientific principles and fundamental provisions of economic theory, theory of finance, international finance, financial security, the works of leading Ukrainian and foreign scientists. The dialectical method of scientific knowledge, the methods of scientific abstraction, analysis and synthesis (to study the theoretical foundations for solving problems of financial security), systemic generalization (to systematize the categorical apparatus of the study of ensuring financial security of sustainable development at the global level, improve the classification of international financial resources involved in the field of sustainable development, determination of measures to ensure the financial security of sustainable development at different levels of management).

The classification of international financial resources involved in the field of sustainable development has been improved by including such features as: forms of existence, ownership, sources of formation, directions of use, period of use, level of use.

The configuration of the global security of sustainable development is justified as a set of elements: subjects, objects, principles and levers of control.

Measures to ensure the financial security of sustainable development at different levels of management have been identified.

### KEYWORDS

Global financial security of sustainable development, global system of financing for sustainable development, structural elements of financial security of sustainable development, factors of financial security of sustainable development.

#### 4.1 ESSENCE AND COMPONENTS OF THE GLOBAL SYSTEM OF FINANCIAL SECURITY OF SUSTAINABLE DEVELOPMENT

In 2015, the UN General Assembly adopted the final document on the development agenda «Transforming Our World: Agenda for Sustainable Development until 2030» [1], the purpose of which was to eliminate poverty and hunger, ensure sustainable development in its three components through promoting inclusive economic growth, protecting the environment and promoting social inclusion.

Achieving sustainable development depends on the state of economic, socio-cultural, environmental, technological security of countries. The state of financial security as one of the components of economic security is the most important factor in ensuring the implementation of sustainable development goals through the need to meet urgent financing needs, the efficient use of financial resources, the prevention of financial threats in the field of socio-economic development and environmental protection.

The global program for financing activities to achieve sustainable development after 2015, aimed at strengthening efforts to mobilize and effectively use financial resources in the field of sustainable development, was determined by the Addis Ababa Action Agenda of the Third International Conference on Financing for Development [2]. Along with this, the achievement of sustainable development goals requires not only significant national and international financial support, but also ensuring the sustainability of the global sustainable development financing system against negative impacts.

Despite taking into account the risks of the global financial and economic crisis of 2008, the strengthening of the global financial security net, the creation of new coordination mechanisms and the initiated regulatory reforms, according to The Inter-Agency, the non-financial corporate sector is growing, and international capital flows continue to be very unstable [3].

The COVID-19 pandemic has dramatically set back progress towards the Sustainable Development Goals and has affected all aspects of financial development. As the UN Secretary-General noted, the world economy is experiencing the worst recession in 90 years, which disproportionately affects the most vulnerable: from 80 to 90 million people are pushed into extreme poverty, 114 million jobs are lost, tax revenues are reduced, foreign direct investment, trade, and remittances, along with rising debt levels, debt vulnerabilities have increased [4].

The global economic outlook remains fragile: in early 2022, the United Nations (UN) predicted that the global economic growth rate, after rising by 5.5 % in 2021, will decrease to 4.0 % in 2022 [5]. Increased global financial instability due to the deregulation of financial markets, labor markets, goods and services, which as a result led to the accumulation of large global imbalances in the world economy (exacerbation of balance of payments problems, an increase in the burden of external debt) that are incompatible with the Sustainable Development Goals [6], the socio-economic crisis caused by COVID-19, Russian aggression against Ukraine has threatened the timely implementation of the 2030 Agenda for Sustainable Development.

Among the priorities identified by the UN in 2022, in addition to fighting the pandemic, overcoming the climate crisis, ensuring peace, there is also the reform of the global financial system, in particular, strengthening financial security [7]. Given the global nature of the above problems affecting the financial system as a whole, as well as the fact that financial security is the state of the financial system, which creates the necessary conditions for stable development, the study of global financial security of sustainable development is one of the pressing issues.

The works of many scientists are devoted to the study of problematic issues of financial security at the macro and micro levels. The issue of ensuring the security of international finance

was considered by Anthony N. Odiadi [8], the origin of the instability inherent in international capital flows, the need to maintain orderliness of the market by government agencies was substantiated by Valpy FitzGerald [9], the relationship between finance and security was studied by Marieke de Goede [10].

Briginets, A. [11], Getmanets, A. [12] paid attention to the issues of legal support of financial security. The works of Dmitriev, E. [13] are devoted to the issues of financial security in the context of globalization.

The most significant from the perspective of considering the problem of ensuring financial security at the global level are the works of Ruyu Han to determine the general relationship between financial internationalization and financial security [14], Nina Boy, J. Peter Burgess, Anna Leander to study issues of global security and financial management [15], Nuryanova Saule, Yessentay Aigerim to identify threats to the financial security of the national economies of countries during the financial crisis [16]. A detailed analysis of the essence of the global financial security net was carried out by Beatrice Scheubel, Livio Stracca, Cédric Tille [17–19], the issues of expanding the global financial security net in response to COVID-19 were studied by Kevin P. Gallagher, Haihong Gao, William N. Kring, José A. Ocampo, Ulrich Volz [20].

Along with this, given the growing global financial instability and other factors that threaten the timely implementation of the sustainable development agenda, it is necessary to pay special attention to issues related to the financial security of sustainable development in the global aspect.

The conceptual apparatus of financial theory and practice, international finance contains a large number of terms, regarding the interpretation of which there is no single point of view among scientists. Therefore, the problem of financial security of sustainable development requires clarification of the content of the concepts used.

Starting with a consideration of the general concept of «security», it should be noted that from the point of view of the system approach, security means a property of a system that ensures its stable functioning and development in the face of various types of external and internal threats, that is, this is such a property of the system that can be reduced to minimum, and at best, completely get rid of the negative impact of destabilizing factors of various nature; the conditions in which a complex system is located, when the action of external factors and internal factors does not lead to processes that are considered negative in relation to this complex system in accordance with the needs, knowledge and ideas available at this stage [21]; the state of the system in which it retains its integrity, stability (stability), the ability to function effectively and sustainable development, and on their basis – the possibility of reliable protection of all its elements (subsystems, spheres, objects) from any destructive internal and external actions [22].

Financial security, as you know, is an integral part of economic security and, in turn, has a complex system containing several subsystems (structural elements). In dictionaries, the term «financial security» is defined as the state of the financial, monetary, currency, banking, tax systems, characterized by balance, resistance to internal and external negative influences, the ability to ensure the effective functioning of the economic system and economic growth [21, 22].

Scientists, considering the structural elements of financial security on a functional basis, distinguish them in different ways, but all of them, of course, relate to the elements of financial security of sustainable development, their generalized characteristics are presented in **Table 4.1**.

● **Table 4.1** Elements of financial security for sustainable development

<b>Element of financial security</b>	<b>Characteristics of the element of financial security</b>
Budget Security	The level of the state's budgetary capacity to fulfill all its functions and tasks is drawn up taking into account the balance of all income and expenses, in compliance with the principles of expediency, legality and efficiency in the use of budgetary funds, the level of external and internal debt burden does not threaten either the financial system of the state or its sovereignty
Monetary security	The state of the monetary system, characterized by the stability of the monetary unit, the availability of credit resources and the level of inflation, which ensures economic growth and an increase in real incomes of the population
Currency Security	The stability of the national currency, the degree to which the state is provided with foreign exchange funds sufficient to maintain the exchange rate of the national currency, which creates optimal conditions for expanded reproduction and economic growth
Banking security	The level of financial stability and the state of the resources of the banking system, which allows avoiding risks and threats, contributes to the sustainable development of both the banking system and the national economy
Security of the non-banking financial sector	The size of capitalization allows to ensure the balanced development of the elements of the economic system and the stable state of all participants (issuers, owners, buyers, traders, intermediaries (brokers), registrars, depositories, custodians, the state, etc.)
Tax security	The state of the effectiveness of the tax policy pursued by the state. An effective tax policy should reasonably combine the interests of the state (primarily in filling the budgets of all levels) and the interests of taxpayers. The appropriate level of tax security of the state is such a level at which the state receives a sufficient amount of tax revenues to implement all the functions assigned to it
Debt security	The state of the state's internal and external debt is sufficient to solve urgent socio-economic needs and only slightly affects the stability of the state's financial system to internal and external threats. An adequate level of debt security of the state allows to ensure a certain level of relative independence of the state, maintaining an appropriate level of solvency and credit rating
Investment security	The state of achieving the investment level, which makes it possible to meet the current and future needs of the state economy for certain capital investments, taking into account their effective use and return on invested funds

*Source: compiled by the authors based on [11, 23]*

Sytnyk, N., Stefankiv, B. distinguish the following aspects of financial security: the current state – the creation of a state of budgetary, tax, customs, monetary, foreign exchange, banking, investment systems, the main characteristics of which are: balance, resistance to internal and external negative influences, the ability to prevent external financial expansion, to ensure effective

functioning of the national economic system and economic growth; functional support – protection of the financial interests of subjects at different levels of relations; regulatory support – the creation of the necessary regulatory and legal prerequisites for the functioning of the financial system, allowing to make the direction of financial flows to the shadow or penumbral sphere, as well as to the misuse of financial resources of the state [24].

Briginets, O. defines balance, resistance to internal and external threats, the ability to ensure the effective functioning of the national economy and the economic growth of the state with the characteristic features of financial security [11].

Considering the concepts of «international financial security» and «global financial security», it should be noted that they are closely related to the concept of «global financial security of sustainable development». Thus, the concept of international financial security is interpreted by scientists as a set of international conditions for the coexistence of agreements and institutional structures, under which each member state of the world community is provided with the opportunity to freely choose and implement its strategy of social, economic and financial development, without being subject to external pressure and counting on non-intervention, understanding and mutually acceptable and mutually beneficial cooperation on the part of other states [21].

According to Dmitriev, E., international financial security should be considered from several points of view:

- 1) through the prism of international economic relations as an interconnected system of the following elements: foreign economic and financial security of a separate national economy; financial security of large economic and legal groups and unions; financial security as a response to the main current trends and threats at the global level;

- 2) through ensuring global financial stability, since only a stable international financial system effectively allocates resources, assesses and manages financial risks, maintains employment at a level close to natural, and also manages the movement of prices for real and financial assets in order to prevent destabilization of financial and real markets [13].

Nurymova Saule, Yessentay Aigerim, considering the financial security of countries and regions, distinguish the following main segments: budget and taxes; monetary; credit and banking; extra-budgetary fund [16].

Regarding the definition of the concept of global financial security, it should be noted that scientists interpret it as a state of international, economic and financial relations of the world economy, in which sustainable economic development of countries is ensured and conditions for mutually beneficial cooperation are created, stability and balanced development of the economies and financial systems of states are ensured, growth the level of well-being of the world's population [23]. Hetmanenko, O. notes that global financial security contributes to maintaining the stability of the world economy and allows creating conditions conducive to the growth of production, science and welfare of the countries of the world, and also limits spontaneous fluctuations in the global market, including the financial one, and prevents them from developing into a global financial crisis [23].

According to Briginets, A., «now the main task of global financial security is to counter the destabilization of international relations and provide opportunities for stable financial growth of all states» [11].

A study on ensuring the monetary security of sustainable development at the global level necessitates determining the configuration of its system as a set of parts: subjects, objects, principles and control levers.

The subjects of monetary security of sustainable development at the global level include countries, international financial universities (International Monetary Fund, international and regional development banks), UN agencies, stabilization funds.

The objects of global financial security of sustainable development are financial interests (determining financial needs, the satisfaction of which will contribute to the achievement of sustainable development, ensuring the financial stability of the world community, strengthening the global financial system, the effective use of international financial resources to ensure the implementation of sustainable development programs), international financial resources, involved in the field of sustainable development; global system of financing sustainable development.

Concretizing the concepts of international financial resources involved in the field of sustainable development, it is necessary to define them as the financial resources of countries, international financial organizations aimed at achieving sustainable development goals at the international and global levels.

The classification of international financial resources involved in the field of sustainable development provides a clearer definition of the specifics of the interpretation of this concept (**Table 4.2**).

It should be noted that international financial resources involved in the field of sustainable development have specific functions to eradicate poverty, achieve sustainable development goals, finance the provision of regional and global public goods, maintain macroeconomic stability in the context of a broader global favorable environment, channel funds for the purpose of long-term investments, the use of funds along with private capital with the distribution of risks and profits [25].

As for the definition of the essence of the global sustainable development financing system, this term should be understood as a set of interrelated elements of the national, international and world levels: subjects (countries, international financial organizations, UN agencies, global funds) and objects by areas of financing (social, economic, production, infrastructure, food security, environmental protection, global public goods), which should interact on the basis of the principles of synergy, differentiation of sources of financial support, subordination to certain goals of sustainable development, efficiency, optimality through the use of economic and administrative levers for managing sustainable development [25].

Consideration of the essence of the financial security of sustainable development also requires the identification of factors that lead to financial risks and create threats to its provision at the national and global levels.

● **Table 4.2** Classification of international financial resources involved in the field of sustainable development

Criterion	Types
According to the forms of existence	Cash Securities Debentures Grants Loans Investments
By affiliation	Own Loan Attracted (international financial assistance)
According to the sources of formation	State Private Financial resources of international financial organizations
By directions of use	For sustainable development Complementary Climate Finance (Climate Change Mitigation and Adaptation Finance) To finance global public goods (communicable disease control and treatment, ecosystem services and biodiversity, technology development)
By period of use	Short-term (up to 1 year) Medium-term (from 1 to 3 years) Long-term (from 3 to 10 years)
By level of use	Micro level (national) Meso level (regional) Macro level (international) Mega level (global)

*Source: compiled by the authors based on [25]*

Speaking about financial security at the national level, it should be noted that its condition as a whole depends on the factors of both the internal and external financial and credit policy of the state, the political situation in the state, the perfection of legislative support for the functioning of the financial system, as well as international obligations of the state [26].

The factors of threats to the financial security of sustainable development at the global level include global factors that impede or pose a threat to the implementation of the Sustainable Development Goals, the implementation of which is associated with the financial support of programs in this area.

The analysis of sources [14, 26, 27] made it possible to clarify the classification of risk factors and threats to the financial security of sustainable development at the national, international and global levels of formation (**Table 4.3**) and identify global factors that have a negative impact on it, namely: the debt of countries liquidity shortage in developing countries, capital



volatility, financial market instability, problems of financial regulation, problems of international financial institutions.

● **Table 4.3** Classification of risk factors and threats to the financial security of sustainable development by the level of formation

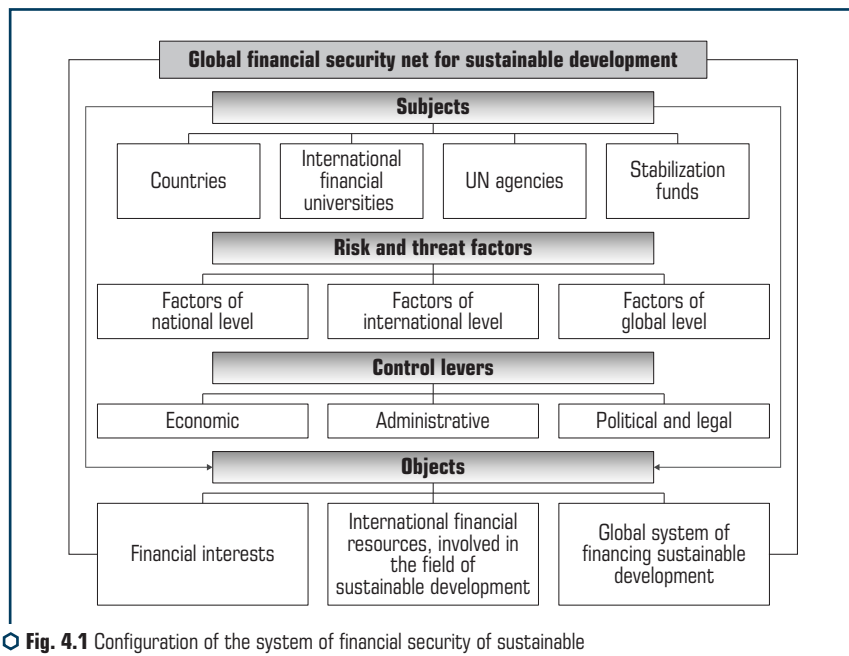
Level	Factors
National	Instability and imperfection of legal regulation in the financial sector Uneven distribution of the tax burden on business entities, which leads to tax evasion and capital outflow abroad Outflow of capital abroad as a result of the deterioration of the investment climate Low level of budgetary discipline and imbalance of the budgetary system Increase in public debt Shadowing the economy Insufficient level of gold and foreign exchange reserves Significant level of dollarization of the economy Insufficient level of capitalization of the financial system
International	Limited access to international financial markets Deterioration of foreign trade Growing balance of payments deficit Significant dependence on external creditors The impact of global financial crises on the financial system of the state
Global	Developing country debt Liquidity shortage in developing countries Capital volatility Financial market instability Problems of financial regulation Problems of activity of international financial institutions

*Source: compiled by the authors based on [14, 26, 27]*

The configuration of the system of monetary security of sustainable development at the global level is shown in **Fig. 4.1**.

Thus, based on the consideration of the characteristics of the elements of general financial security, the essence of the global sustainable development financing system, taking into account the analysis of the interpretation of scientists regarding the essence of financial security at different levels, it is necessary to understand the financial security of sustainable development at the global level as the state of the global sustainable development financing system characterized by balance, resistance to internal and external negative impacts, the ability to ensure socio-economic development, which involves the interaction of economic growth, social development and environmental protection in order to meet existing needs, as well as future generations of the population of all countries of the world.

The threat to the financial security of sustainable development at the global level – factors that pose a threat to the financial interests of sustainable development and form the potential for causing losses or additional losses in the area of achieving the Sustainable Development Goals.



**Fig. 4.1** Configuration of the system of financial security of sustainable development at the global level

Source: compiled by the authors based on [23, 25]

## 4.2 INSTITUTIONAL SUPPORT OF THE SYSTEM OF FINANCIAL SECURITY OF SUSTAINABLE DEVELOPMENT AT THE GLOBAL LEVEL

The UN agencies, international financial institutions and international organizations deal with issues and problems related to ensuring the financial security of sustainable development at the global level. United Nations Inter-Agency Task Force on Development Finance (IATF) A task force established to implement the Addis Ababa Agenda, consisting of more than 60 UN agencies, programs and offices, regional economic commissions and other international institutions the IATF is coordinated by the Department's Sustainable Development Financing Office Economic and Social Affairs of the United Nations, the main participants of the group are the main institutional stakeholders of the development finance process – the World Bank Group, IMF, WTO, UNCTAD and UNDP. The main areas of work of the IATF are: environmental, social investment and profit, trade finance gap, aligning capital markets with sustainable development, financing social protection floors, impact of new technologies on labour markets, illicit financial flows, infrastructure investments and public-private partnerships, measuring international public finance [28].

Financial Stability Board (FSB) The Financial Stability Board is an international organization whose goal is to promote international financial stability by identifying weaknesses in global financial stability, monitoring, developing and providing recommendations in the global financial system. The FSB became the legal successor of the Financial Stability Forum, founded in 1999 by G7 finance ministers and central bank governors. 2009 The FSB Charter was adopted by the G20 Heads of State and Government, the FSB assumed a key role in advancing the reform of international financial regulation and supervision. The mandate of the FSB covers in particular:

- assessing the vulnerabilities affecting the global financial system, as well as timely and on-going, from a macroprudential point of view, identifying and reviewing the regulatory, supervisory and related actions needed to address these vulnerabilities and their consequences;
- facilitating coordination and information exchange between the authorities responsible for financial stability;
- monitoring and advising on market developments and their implications for regulatory policy, best practices for compliance with regulatory standards;
- conducting overall strategic reviews of international standard-setting bodies and coordinating their work to develop appropriate policies that ensure timeliness, coordination, focus on priorities and elimination of shortcomings;
- support for contingency planning for cross-border crisis management;
- cooperation with the International Monetary Fund to conduct Early Warning Exercises [29].

The priority areas of work and new initiatives of the FSB in 2022 are:

- *support for international cooperation and coordination on current financial stability issues* – strengthening monitoring to identify, assess and address new risks to global financial stability against the backdrop of the Russian-Ukrainian war and its economic consequences;
- *enhancing the resilience of the non-banking financial intermediation sector while maintaining its benefits* – advancing the FSB work program to enhance the resilience of the sector;
- *strengthening cross-border payments* – improving existing payment systems and mechanisms, developing new systems, continuing cooperation with international organizations to implement the FSB roadmap to improve cross-border payments;
- *capitalizing on the benefits of digital innovations while containing their risks* – continuing to work on financial stability, regulatory implications of technological innovations with a focus on various forms of crypto assets, including decentralized finance (DeFi), increasing cyber resilience;
- *elimination of financial risks from climate change* – continued coordination of international work to create and strengthen the analytical base for monitoring climate risks for financial stability; identification of regulatory and supervisory approaches to address climate-related financial risks [30].

The Global Financial Security Net (GFSN) plays an important role in anti-crisis and stabilization support for countries whose efforts are aimed at achieving sustainable development goals, the function of which is equivalent to that of an international lender of last resort [17].

As noted by Beatrice Scheubel, Livio Stracca, «the current constellation of the GFSN is not the result of coherent design, and there is no 'benevolent social planner' behind it. It is rather the result of the stratification and interaction of different factors and interests and historical developments, often pursuing domestic rather than global objectives» [17]. In relation to sovereign governments, the GFSN pursues a triple goal: providing preventive crisis insurance, providing liquidity during a crisis, and stimulating prudent macroeconomic policies [31].

The Global Financial Security Net (GFSN) covers 4 elements that can be used by countries at different levels:

- *national foreign exchange reserves (national level)* – accumulation of foreign exchange reserves, their support at the level of generally accepted sufficiency criteria in order to increase the stability of the financial system and economies of countries to adverse events. National foreign exchange reserves differ from other elements of the GFSN in that they do not require agreement with other parties and can be considered as a means of self-insurance;

- *Regional Financing Arrangements (RFAs) (regional level)* – lines of defense in the GFSN that help prevent and mitigate the effects of economic and financial crises. RFAs – mechanisms or agreements through which groups of countries mutually undertake to financially support countries that are experiencing financial difficulties in their regions (for example, European Stability Mechanism (ESM) – a regional financial agreement for the eurozone [32], Arab Monetary Fund (AMF) [33], Latin American Reserve Fund (FLAR) [34], Chiang Mai Initiative Multilateralisation (CMIM) [35], Eurasian Fund for Stabilization and Development (EFSD), etc.);

- *central bank swap lines negotiated bilaterally (international level)* – the use of swaps by central banks to obtain short-term access to foreign currency liquidity in exchange for its national currency in order to increase reserves and provide loans to domestic banks and corporations;

- *funding through the IMF (global level)* – traditionally the central element of the GFSN, which has a long experience in resolving crises using various instruments and effective lending technology. The IMF plays a special role in the overall functioning of the GFSN, since the main purpose of the IMF is to ensure the stability of the international monetary system.

### 4.3 MODERN TRENDS IN THE FIELD OF FINANCIAL SECURITY OF SUSTAINABLE DEVELOPMENT AT THE GLOBAL LEVEL

The economic and financial consequences of the COVID-19 pandemic have become unprecedented on a global scale, the socio-economic crisis that it provoked increased the main risks of the international financial system, created threats to the financial security of sustainable development, as evidenced by the reports of international organizations, the conclusions of experts in the field of financing, sustainable development, global financial security net [4, 5, 20, 36]:

- first, the shock of COVID-19 negatively impacted developing countries' access to foreign exchange through four channels: non-resident capital flight, which excluded low-income and least

developed countries from capital markets; a sharp drop in international trade; a sharp decline in global remittances; a sharp decline in foreign direct investment. And although, according to the UN, countries have activated all levels of the global financial security net, access to it has been uneven. The main instruments of the global financial security net available to most countries were a new allocation of special drawing rights on a record scale and emergency lending from the IMF, while bilateral currency swaps were available only to a small number of countries, and regional financing mechanisms did not live up to their potential. Immediate needs of developing countries amount to 2.5 trillion USD, but the funding available to them is only 700–971 billion USD [20];

– secondly, the COVID-19 crisis has highlighted the impact of environmental risks on the financial sector. There are two main types of *climate change-related* financial risks: physical risks, as climate-related hazards could reduce the value of financial assets and/or increase liabilities; transition risks as changes in climate change mitigation and adaptation policies, as well as market sentiment and technology changes, affect the value of financial assets and liabilities. Climate change can also create liability risks, where actors are held liable for environmental damage they may have caused. Despite the rise in climate-related risks, the number of financial institutions that consider them in their decision-making and risk management remains small. Few financial institutions directly integrate specific climate variables into credit risk models or institution-wide risk management systems;

– thirdly, one of the most important shifts in the financial markets was the growth of digital financial services, which, on the one hand, supported the functioning of the financial system, and on the other hand, raised concerns about fairness and regulation, growing threats to cybersecurity and financial stability. There is currently progress in the development of standards in this area thanks to the active interaction of national regulators with service providers, but the growing role of large global technology platforms in the provision of financial services requires a review of this policy, as their potential to dominate the market creates additional risks.

Another long-term trend is the development of digital currencies, including privately issued so-called stablecoins and central bank digital currencies. Significant fluctuations in the valuation of crypto assets make them unsuitable for performing the main functions of a currency (as a store of value, unit of account and medium of exchange), and anonymity and decentralized nature leads to fears of their use in illegal financing and other fraudulent activities [36].

The above trends and problems necessitate their immediate solution in order to return the world community to the path of progress in achieving the Sustainable Development Goals in accordance with the 2030 Agenda. Consideration of risk factors and threats to the financial security of sustainable development, analysis of international sources regarding ways to overcome such threats and risks [4, 5, 20, 36, 37] allows us to draw conclusions about the need to implement such measures in order to ensure the financial security of sustainable development at different levels of management:

1) *at the national level:*

– conducting a balanced stimulating monetary and fiscal policy. It is important to provide cash subsidies to the population with low incomes, reduce taxes for small and medium-sized enterprises, encourage banks to lend;

- careful management of cross-border capital flows (use of macroprudential policies, capital controls to prevent a sharp increase in capital inflows and outflows);
- support for non-banking financial institutions (strengthening the role of non-banking financial institutions (NFI), adjusting their capabilities through the analysis of systemic risks caused by the activities of NFIs (the main causes of systemic risk are general risks, concentrated markets, dominant investors and the relationship between banks and NFIs), as well as setting up instruments by central banks to directly support NFIs (providing liquidity for sectors and economies in need of dollar financing);
- reducing the risks associated with digital currencies – careful monitoring of the further development of digital currencies by national authorities, ensuring comprehensive regulation and supervision, reviewing the legislative and regulatory framework, if necessary, cooperation with international organizations, using the developed recommendations of the FSB;
- maintaining sufficient foreign exchange reserves for self-insurance purposes;

*2) at the regional level:*

- strengthening regional financial security nets – strengthening liquidity support mechanisms for countries in crisis by regional financial mechanisms (ESM, AMF, FLAR, CMIM), in particular by expanding their membership base and increasing the volume of resources. This may help to increase cooperation with international financial institutions, including the IMF, although such mechanisms should retain sufficient autonomy to better meet the needs of their member countries; strengthening experience sharing and peer learning, including through annual high-level dialogue and joint research workshops; continued collaboration with the IMF to share information and coordinate assistance to member countries on the ground;

*3) at the international level:*

- ensuring the availability and increase of bilateral swaps for countries in need of financial support. It is necessary to expand the coverage of currency swaps of the Federal Reserve System, the creation of a multilateral swap in the IMF;
- expanding international cooperation to create a comprehensive and coordinated regulatory framework for crypto assets and so-called «stable cryptocurrencies», which can eliminate side risks to the global financial system;

*4) at the global level:*

- urgent mobilization of the IMF and the World Bank of financial resources to solve global problems;
- allocation by the IMF of Special Drawing Rights (SDRs) to meet the long-term needs of individual countries to supplement official reserves and to enhance the resilience and stability of the global economy; redistribution by countries with a positive balance of payments balance of payments of SDRs in favor of countries in need of support; countries with strong external positions using their SDRs to help the IMF's Poverty Reduction and Growth Trust (PRGT);

- debt relief for the world's poorest countries, debt suspension, rescheduling of payments for middle-income countries; replenishment by IMF members of accounts under concessional financing instruments and debt relief;

- ensuring the availability for developing countries of long-term financing for sustainable development, including by replenishing the capital needs of multilateral development banks;

- revision of the policy on the functioning of a global large technological platform in the provision of financial services in connection with the creation of additional risks through the potential for market dominance;

- improvement of global financial regulation, in particular, it is necessary to include the consideration of climate risks in global timely financial regulation with the establishment of mandatory reporting standards and the integration of climate risk scenarios into financial stress tests to assess the impact on financial institutions.

Thus, the study on ensuring the financial security of sustainable development at the global level allowed:

- determine that financial security is one of the key prerequisites that determine the effectiveness of the implementation of sustainable development goals;

- establish that the financial security of sustainable development at the global level should be understood as the state of the global system of financing sustainable development, characterized by balance, resistance to internal and external negative impacts, the ability to ensure socio-economic development, which provides for the interaction of economic growth, social development and protection of the environment in order to meet the existing needs, as well as future generations of the population of all countries of the world;

- establish that the threat to the financial security of sustainable development at the global level are factors that pose a threat to the financial interests of sustainable development and form the potential for damage or additional losses in the area of achieving the Sustainable Development Goals;

- clarify the classification of risk factors and threats to the financial security of sustainable development at the national, international and global levels of formation and highlight the global factors that have a negative impact on it, namely: debt of developing countries, liquidity shortage in developing countries, capital volatility, financial market instability, problems of financial regulation, problems of activity of international financial institutions;

- identify measures to ensure the financial security of sustainable development at different levels of government.

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## ABSTRACT

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Dedicated to the study of the possibility of using the signal approach to determine the level and assess financial security. It is noted that early warning systems based on qualitative analysis, econometric modeling and non-parametric models based on the approach are called upon to identify threats, identify accumulated and possible imbalances, in order to further level the effect of factors that can undermine the financial security of the country. To predict the emergence of threats to the financial condition of Ukraine, a regression model of the growth rate of the Consolidated Budget of Ukraine (as an indicator of the public finances of Ukraine) was developed and proposed, which reflects the dependence of the probability of a decrease in this indicator on a number of security indicators, and its approbation was carried out for the conditions of Ukraine. The selected set of indicators for identifying threats to the financial security of Ukraine provided the basis for building and forming a base of scenarios for the possible behavior of the economy under the influence of external factors for 2022–2023. The authors have identified corrective measures of economic policy on the part of macroeconomic regulation bodies in order to stop the inertial development of the forecast situation.

## KEYWORDS

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Financial security, financial impact, financial system, threat to the financial security of the state, causes of threats to the financial security of the state, indicator for assessing the level of financial security, signal approach, regression model.

### 5.1 ESSENTIAL CHARACTERISTICS OF FINANCIAL SECURITY AND THE NEED TO ENSURE IT

The key link in the economic security of any country in the world is its financial security. This is of particular importance in the context of the globalization of economic imbalances, because external control and the use of financial means of penetration can provide violent pressure on the elected state. Financial security is the key to conducting an independent financial and economic policy of the country.

At the macro level, financial security is the ability of the state in peacetime and in emergency situations to adequately respond to internal and external negative financial influences [1]. Financial security reflects the readiness of the country's financial system for timely and reliable financial

support of economic needs in amounts sufficient to maintain the necessary level of economic and military security of the country.

However, the emergence of modern economies inevitably leads to an increase in threats to financial security. Even with the achievement of sustainable development goals in many countries, financial crises have become systematic.

That is why the search for tools for forecasting and assessing the level of threats to the financial security of the country, and if they occur, for further response measures, is becoming of great relevance.

The threat to financial security implies the potential for such a development of events in which, under the influence of various factors (or their combination), there is a danger of destruction of key parts of the financial system, its management system, damage to national wealth and, as a result, the danger of loss of sovereignty. Studies [2, 3] are devoted to attempts to classify threats to the financial security of the country.

In the **Table 5.1**, the authors attempted to generalize the classification of financial security threats.

● **Table 5.1** Classification of threats to the financial security of the country

Classification sign	Elements of a classification feature
Depending on residency	Internal External
Depending on the action in time	Permanent Temporary
Depending on the degree of impact on financial security	Main Minor
Depending on recognition capabilities	Explicit Hidden
Depending on the attitude to threats	Objective Subjective

*Source: compiled by the authors based on these sources [2, 3]*

Let's agree with the opinion [4–7] that among the main causes of threats to the financial security of the state, the following should be singled out (**Table 5.2**).

The issue of determining the components of financial security remains relevant. Modern scientific opinion [3, 7] identifies the following components of the financial security of the state: budgetary, tax, debt, financial security of the banking system, currency, monetary security, investment security and security of the non-banking financial sector.

● **Table 5.2** The main causes of threats to the financial security of the state

The main causes of threats to the financial security of the state	the rapid development of the process of globalization of the world economy
	the rapid development of the process of interpenetration of foreign policy into the domestic policy of states dependent on world finance
	a constant increase in the huge mass of capital both in individual states and in international organizations, the mobility of which creates a tense situation
	the growing influence of transnational banks and companies on the national economies of individual countries
	high mobility of financial markets as a result of the rapid development of information technology
	high dependence of the public sector of countries on foreign short-term speculative capital, which increases their vulnerability
	inability of international financial institutions to effectively control the emergence of threats in the financial sector

*Source: compiled by the authors based on these sources [4–7]*

It is possible to investigate the nature and causes of threats to the financial security of the country and obtain a risk prevention mechanism using model testing.

## 5.2 JUSTIFICATION OF THE EXPEDIENCY OF USING THE SIGNAL APPROACH TO DETERMINE THE LEVEL AND ASSESS FINANCIAL SECURITY

Early warning systems based on qualitative analysis, econometric modeling and non-parametric models based on the signal approach are called upon to identify threats, identify accumulated and possible imbalances, in order to further level the effect of factors that can undermine the financial security of the country. The main advantage of the signaling approach lies in the ability of the predictive power of each predictor indicator to individually assess the level of threat to the country's financial security [8]. In this case, it is important to identify and justify a set of indicators that are hypersensitive to sudden changes – this is what requires a qualitative analysis. The signal approach makes it possible to determine the indicative limits of fluctuations that characterize resistance to threats to financial security. Econometric modeling based on regression models allows comparison between countries and highlights potential risks.

Within the framework of this approach, it is possible to build a model for diagnosing the danger of monetary security (**Fig. 5.1**).

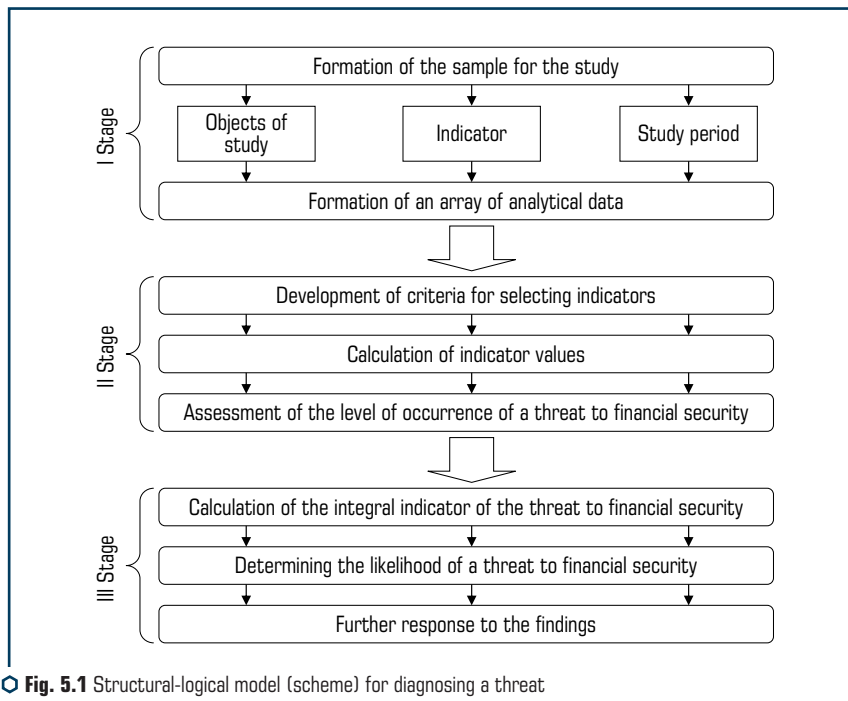
The structural-logical model presented by the authors has three components:

- a mechanism for the formation of space for the study of the level of financial security;
- a table of indicators and their threshold values used to identify external and internal imbalances;

– a thorough review with the calculation of an integral indicator, the purpose of which is to determine the status of a potential imbalance – adjustable at an early stage or problematic – and developing measures for further response to the results.

The metrics/indicators selected for the Scoreboard (table/dashboard) were selected based on the following principles:

- 1) certain indicators are grouped according to the areas of occurrence of threats to financial security;
- 2) certain indicators provide reliable signals about potential imbalances and threats to financial stability;
- 3) certain indicators are intuitive, have a clear economic interpretation, which makes them the most suitable for use by responsible persons in the field of financial security management;
- 4) certain indicators can be calculated on the basis of statistical data for different countries, which ensures the comparability of the results obtained;
- 5) certain indicators are able to reflect both short-term negative changes and the gradual accumulation of such changes in the long term.



**Fig. 5.1** Structural-logical model (scheme) for diagnosing a threat to the financial security of the state

*Source: developed by the authors*

The classification of indicators – harbingers of financial instability can be presented in the following categories (**Table 5.3**).

The indicators indicated in **Table 5.3** and their threshold limits, of course, cannot fully reflect all the threats to the country's financial security.

● **Table 5.3** Scoreboard (table/dashboard) for assessing the level of financial security of the state

<b>Components of the financial security of the state</b>	<b>Indicators</b>	<b>Threshold limits for indicator changes</b>
Fiscal security	Government budget deficit/surplus ratio to GDP, %	no more than 3
	Level of GDP redistribution through the consolidated budget, %	no more than 25
	The ratio of the volume of aggregate payments for servicing and repayment of the public debt to the state budget revenues, %	no more than 6
Debt security	Ratio of total government debt to GDP, %	no more than 60
	Ratio of total external debt to GDP, %	no more than 25
	Ratio of domestic debt to GDP, %	no more than 30
Monetary security	Level of monetization of the economy, %	no more than 50
	Inflation rate (until December of the previous year), %	no more than 107
	Volume of cash, %	no more than 4
	The level of the average interest rate of loans of banking institutions in relation to inflation, %	no more than 5
Currency security	Ratio of volumes of deposits in foreign currency to total volumes of deposits, %	no more than 25
	The rate of change of the index of the official exchange rate of the hryvnia to the dollar USA to the indicators of the previous period, %	no more than 6
	Ratio of loans in foreign currency to total loans, %	no more than 25
	Coverage ratio of international reserves of the state of the monetary base, %	at least 100
Investment security	Ratio of investment growth rates to GDP growth rates, times	2–32
	Volume of foreign direct investment, % of GDP	at least 5
	Expenses for scientific and technical activities, % of GDP	at least 2
Banking security	Share of foreign banking capital in total banking capital, %	no more than 30
	The volume of lending by banks to the real sector of the economy, % of GDP	at least 30
	The level of doubtful debts in the loan portfolio, %	no more than 10
Security of the non-banking financial sector	Share of long-term insurance in the total volume of collected insurance premiums, %	at least 30
	Level of insurance payments, %	at least 30
	Yield of domestic government bonds, %	3-4
	Share of coverage of domestic public debt by government securities, %	no more than 80

*Source: compiled by the authors based on these sources [3, 9, 10]*

This gives us the opportunity to assert that there is no universally recognized list of the main macroeconomic indicators for assessing the level of financial security of the state, and issues related to the algorithm for diagnosing and regulating the level of financial security of the country are insufficiently covered. In this regard, there is a need to search for the existing positive practice of building early warning indicators in order to assess the feasibility of using them for making managerial decisions.

### 5.3 THE RESULTS OF USING THE SIGNAL APPROACH TO DETERMINE THE LEVEL AND ASSESS FINANCIAL SECURITY

**Tables 5.4–5.10** present the indicators of the given indicators in order to determine macroeconomic imbalances in Ukraine and Poland (calculations were made on the basis of official data from the Ministry of Finance of Ukraine, the NBU, the State Statistics Service of Ukraine, the Central Statistical Office of Poland, the People's Bank of Poland, the Ministry of Finance of Poland).

● **Table 5.4** Indicators of fiscal security of Ukraine and Poland, % of GDP

Years	The ratio of the state budget deficit/surplus to GDP, % (threshold value – no more than 3)		The ratio of redistribution through the consolidated budget, % (threshold value – no more than 25)	
	Ukraine	Poland	Ukraine	Poland
2006	–0.7	–3.5	24.8	39.3
2007	–1.1	–1.9	23.0	40.8
2008	–1.3	–3.6	24.5	40.1
2009	–3.9	–7.3	22.9	39.3
2010	–5.9	–7.4	22.2	38.1
2011	–1.8	–5.0	23.9	38.7
2012	–3.8	–3.8	24.6	39.8
2013	–4.5	–4.2	23.3	39.3
2014	–5.0	–3.6	22.8	39.5
2015	–2.3	–2.6	27.0	38.2
2016	–2.9	–2.4	25.7	37.7
2017	–1.6	–1.5	26.6	39.0
2018	–1.7	–0.2	26.1	40.8
2019	–1.9	–0.7	25.1	40.3
2020	–5.2	–6.9	25.7	44.2
2021	–3.6	–1.9	23.8	42.4

Source: compiled by the authors based on these sources [11–13]



Data in **Table 5.4** shows that the ratio of the state budget deficit to Ukraine's GDP in 2009–2014 exceeded the optimal value by up to 3 percentage points, while in 2015–2019 this indicator stabilized. This indicates that in recent years the volume of GDP has grown significantly with an almost unchanged level of the budget deficit. In the Republic of Poland, we observe a similar situation in terms of this indicator of fiscal security: after the aggravation of problems in 2008–2014, when the deficit imbalance increased to a dangerous level, during 2015–2021 the value of the indicator corresponded to the threshold value (**Fig. 5.2**).

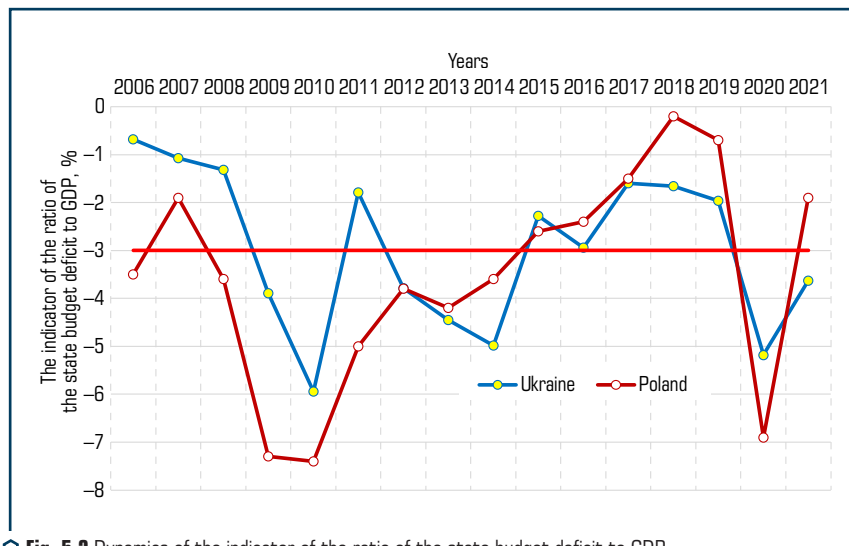
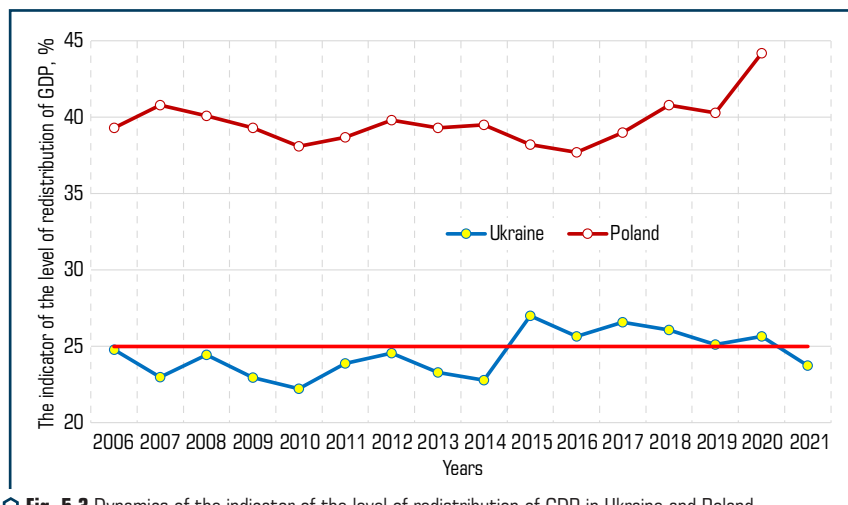


Fig. 5.2 Dynamics of the indicator of the ratio of the state budget deficit to GDP in 2006–2021 in Ukraine and Poland, %

During the entire period under study, there is a balancing on the verge of the limiting value of such an indicator of budgetary security as the level of redistribution of Ukraine's GDP through the consolidated budget. The level of redistribution of Ukraine's GDP through the consolidated budget for 2015–2020 remains at the level as exceeding the limit. During this period, the indicator fluctuated between 25–27 % (**Fig. 5.3**).

However, in Poland, on the contrary, this indicator did not meet the threshold during 2006–2021. This indicates the presence of certain problems in the fiscal sphere both in Ukraine and in Poland, which have accumulated in recent years and are of a systemic nature, lead to a decrease in the stimulating and social function of the tax system, as well as exacerbation of problems in customs and tax administration. The analyzed indicators testify to the insufficient stability of public finances and, as a result, threats to financial security.

Debt security indicators speak about the level of public debt (**Table 5.5**).



**Fig. 5.3** Dynamics of the indicator of the level of redistribution of GDP in Ukraine and Poland through the consolidated budget to GDP in 2006–2021, %

**Table 5.5** Main indicators of debt security of Ukraine and Poland, % of GDP

Years	The ratio of the total amount of public debt to GDP, % (threshold value – no more than 60)		The ratio of the total volume of external debt to GDP, % (threshold value – no more than 25)	
	Ukraine	Poland	Ukraine	Poland
2006	14.8	47.3	50.6	9.4
2007	12.3	44.5	56.0	9.7
2008	19.9	46.7	56.5	11.3
2009	34.7	49.8	88.2	11.5
2010	40.0	53.5	86.0	15.0
2011	36.6	54.7	77.4	16.8
2012	36.7	54.4	76.8	16.2
2013	40.1	56.5	77.5	16.7
2014	70.2	51.1	95.8	17.7
2015	79.4	51.3	131.0	17.5
2016	81.0	54.2	121.7	19.1
2017	71.8	50.6	103.9	17.3
2018	60.9	48.8	87.7	17.2
2019	50.3	45.6	79.2	16.1
2020	60.8	57.1	80.8	17.0
2021	48.9	53.8	64.1	16.9

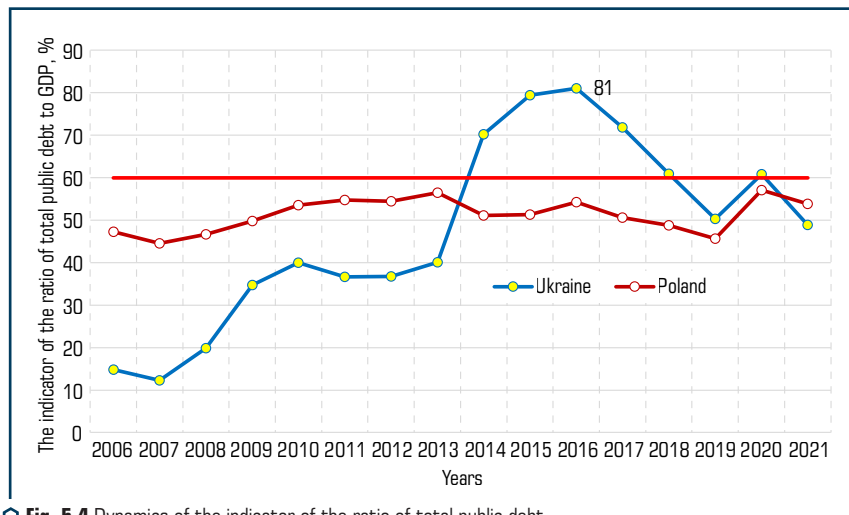
Source: compiled by the authors based on these sources [11, 12]

The state of debt security in Ukraine and the results of determining the main indicators of Ukraine's debt security indicate that the limiting optimal values are exceeded by several times, which leads to the conclusion that Ukraine's debt security is threatened.

During the period under review, there is a negative trend regarding the stability of the indicator of the ratio of Ukraine's total external debt to GDP in 2006–2021. In no year did the value of the indicator meet the threshold value. In 2006–2008 the indicator fluctuated between 50–56 %, since 2009 there has been a significant increase due to the consequences of the global economic crisis (**Fig. 5.4**). A gradual increase has been taking place since 2014, when the figure exceeds the norm by 70 % (95.8 %), which is caused by the armed aggression of the Russian Federation against Ukraine and the need to find additional funds to finance the conduct of hostilities and the maintenance of the armed forces. In 2015–2017 there is a sharp increase in the indicator, which increases to the level of 121.7 % in 2017 and continues to acquire a critical value until 2021 inclusive.

The values of the indicator of the ratio of total public debt to GDP repeat the direction of movement of the values of the ratio of the ratio of total external debt to GDP, starting from 2014 (**Fig. 5.5**). The reasons for the deviations are caused by the above factors – the country is actively confronting the threats of military conflict. The opposite trend in the values of debt security indicators in Poland are given in **Table 5.5**. Analytical data testify to the balanced policy of the government of the Republic of Poland regarding external borrowing, the formation of a debt policy in comparability with the volume of the state's GDP. However, it should be noted that the country does not have military threats (such stability is achieved due to its membership in NATO).

Indicators of monetary security also signal domestic imbalances in financial security (**Table 5.6**).



**Fig. 5.4** Dynamics of the indicator of the ratio of total public debt to GDP in Ukraine and Poland in 2006–2021, %

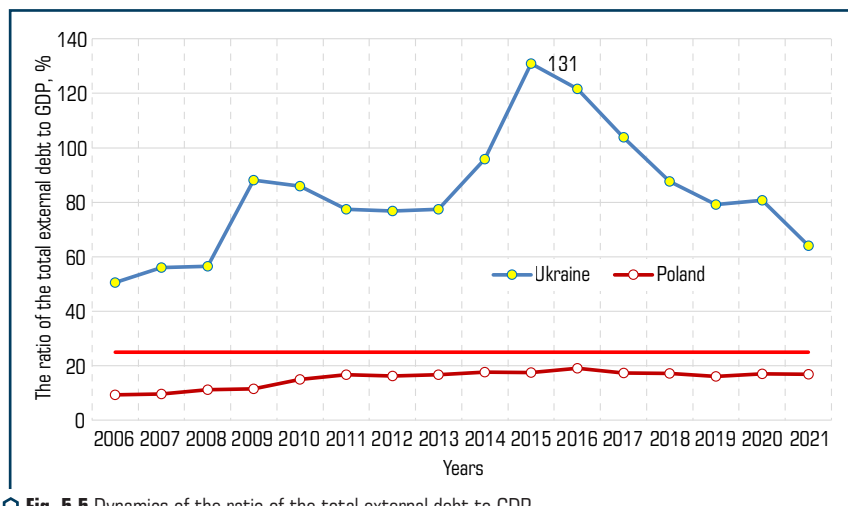


Fig. 5.5 Dynamics of the ratio of the total external debt to GDP of Ukraine and Poland in 2006–2021, %

Table 5.6 Main indicators of monetary security of Ukraine and Poland, %

Years	The monetization rate of the economy, % (threshold value – no more than 50)		The inflation rate (until December of the previous year), % (threshold value – no more than 107)	
	Ukraine	Poland	Ukraine	Poland
2006	48.1	46.3	111.6	101.4
2007	55.0	47.3	116.6	104.0
2008	54.4	51.8	122.3	103.3
2009	53.4	52.5	112.3	103.5
2010	54.6	54.2	109.1	103.1
2011	52.1	56.3	104.6	104.6
2012	54.9	56.8	99.8	102.4
2013	62.5	59.4	100.5	100.7
2014	61.1	61.9	124.9	99.0
2015	69.5	64.1	143.3	99.5
2016	54.2	67.9	112.4	100.8
2017	46.2	66.6	113.7	102.1
2018	39.3	68.2	109.8	101.1
2019	36.2	68.3	104.1	103.4
2020	44.1	77.9	105.0	102.4
2021	38.2	75.7	110.0	108.6

Source: compiled by the authors based on these sources [11, 12, 14, 15]

As **Table 5.6** shows, the monetization rate of the Ukrainian economy, measured by the ratio of the monetary aggregate  $m^3$  to GDP, has been falling since 2017. Saturation of the economy with money is not always a bad factor, since it contributes to the revival of the economy, although there is a risk of inflationary processes (2006–2010).

In 2014–2015 The National Bank of Ukraine announced an inflation targeting policy, which contributed to the return of the indicator of the level monetization rate of the economy to the threshold values. In 2019, it was the lowest – 36 % of GDP, inflation rate – 104.1 % (**Fig. 5.6**).

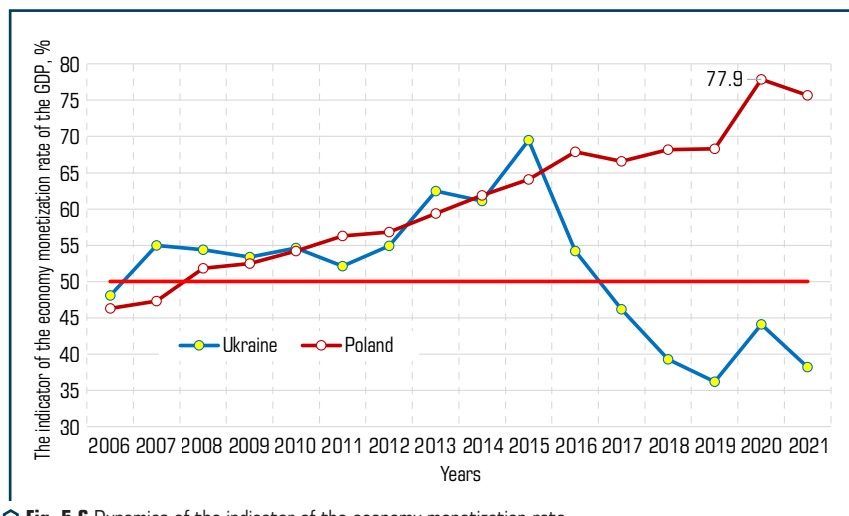


Fig. 5.6 Dynamics of the indicator of the economy monetization rate of the GDP of Ukraine and Poland in 2006–2021, %

Such a low level of monetization of the national economy has become one of the factors of its low dynamism and adaptability, because money is the «blood» of the economic organism. Such a policy led to the emigration of the labor force, the lack of renewal of the country's fixed capital, the degradation and narrowing of the country's industrial base. The level of filling the economy with money from the National Bank is extremely low, if we compare it with the Republic of Poland.

The People's Bank of Poland, since 2008, maintains a high level of monetization of the economy, because it does not pose a threat to inflation if the issue of money has a proper commodity coverage. In confirmation of this thesis, the inflation index in Poland is observed at the level of certain threshold values (**Fig. 5.7**).

Let's consider the existence of a threat to the currency security of Ukraine and Poland (**Table 5.7**).

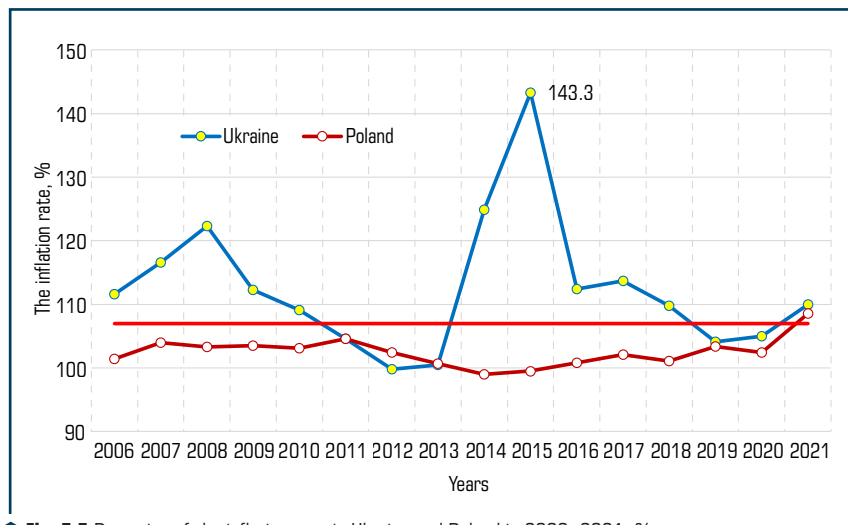


Fig. 5.7 Dynamics of the inflation rate in Ukraine and Poland in 2006–2021, %

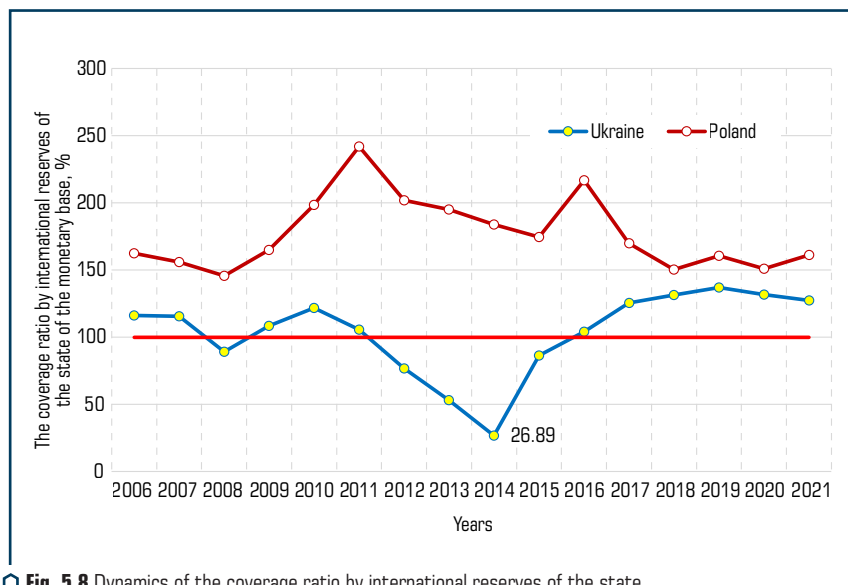
Table 5.7 Main indicators of currency security of Ukraine and Poland, %

Years	Coverage ratio of the international reserves of the state of the monetary base, % (threshold value – not less than 100)		Ratio of volumes of deposits in foreign currency to total volumes of deposits, % (threshold value – no more than 25)	
	Ukraine	Poland	Ukraine	Poland
2006	116.14	162.52	38.08	19.09
2007	115.59	155.93	32.26	17.12
2008	89.05	145.76	43.89	12.50
2009	108.35	164.98	48.32	7.22
2010	121.64	198.38	42.56	17.86
2011	105.64	242.13	42.97	18.16
2012	76.83	201.90	44.04	18.24
2013	53.11	195.07	37.05	13.05
2014	26.89	183.83	45.87	13.23
2015	86.49	174.52	45.32	18.13
2016	104.05	216.82	46.26	8.75
2017	125.38	170.01	45.38	8.63
2018	131.39	150.52	42.05	7.32
2019	136.98	160.47	40.02	6.73
2020	131.79	150.92	37.68	7.30
2021	127.45	161.31	32.37	7.72

Source: compiled by the authors based on these sources [11, 12]

**Table 5.7** gives an idea of the threats to the currency security of Ukraine and Poland.

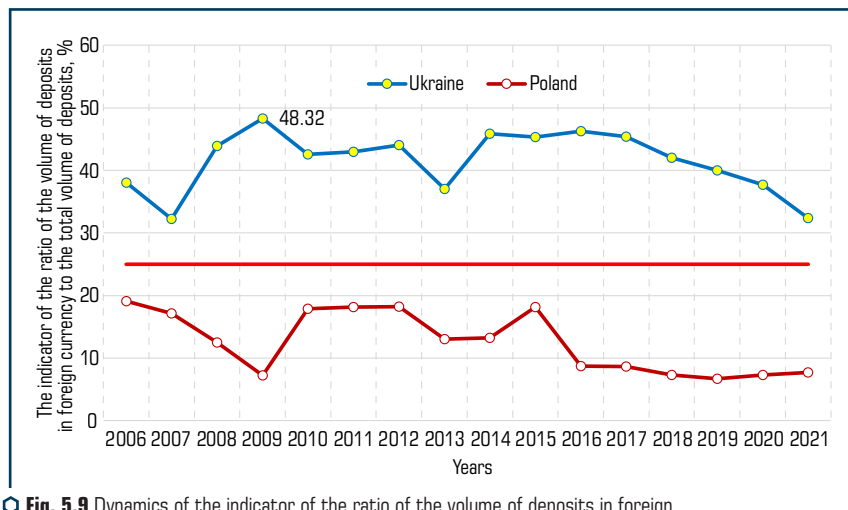
The value of indicators of currency security in Poland indicates the absence of manifestations of imbalances in the periods under review. The country has sufficient gold and foreign exchange reserves, which has a positive impact on the stability of the Polish national currency, the absence of the threat of devaluation (**Fig. 5.8**). As a result, confidence in the Polish zloty and a low level of deposits held in foreign currency. The level of international reserves of Ukraine is confirmed by significant fluctuations during the periods under review, incl. and as a result of two crises (2008–2009 and associated with the russian invasion in 2014).



**Fig. 5.8** Dynamics of the coverage ratio by international reserves of the state of the monetary base of Ukraine and Poland in 2006–2021, %

Destructiveness in the management of international reserves negatively affects the exchange rate of the national currency, which fuels the threat of devaluation and makes it necessary to keep savings in more stable currencies, such as the dollar and the euro. However, given the fact that individuals in Ukraine will not abandon hard currency deposits in the near future, banks will have no choice but to continue to attract them (**Fig. 5.9**).

Let's explore the component of the country's financial security – investment security as a characteristic of the country's ability to reproduce the scientific, technical and intellectual potential of the nation, to carry out expanded reproduction of fixed capital, to maintain the competitiveness of the economy (**Table 5.8**).



**Fig. 5.9** Dynamics of the indicator of the ratio of the volume of deposits in foreign currency to the total volume of deposits in Ukraine and Poland in 2006–2021, %

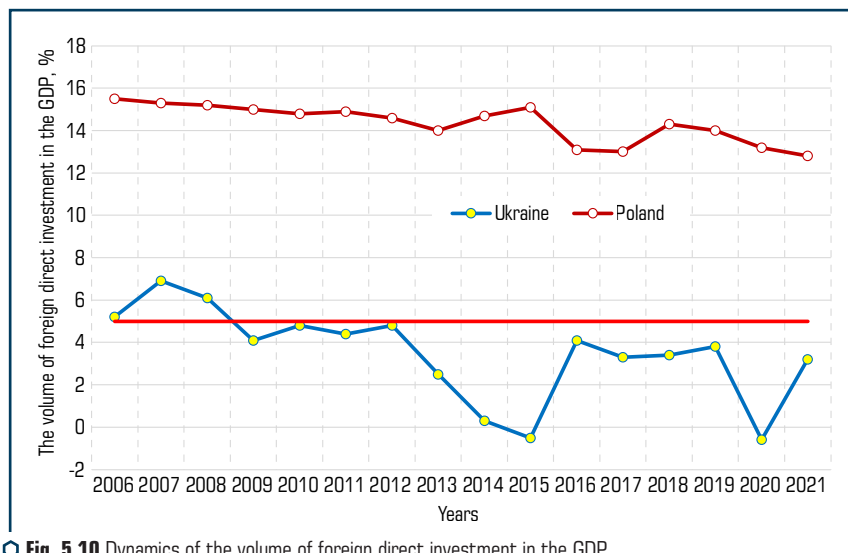
**Table 5.8** Main indicators of investment security of Ukraine and Poland, % of GDP

Years	The volume of foreign direct investment, % of GDP (threshold value – at least 5)		Expenditure on scientific and technical activities, % of GDP (threshold value – at least 2)	
	Ukraine	Poland	Ukraine	Poland
2006	5.2	15.5	0.98	0.56
2007	6.9	15.3	0.93	0.62
2008	6.1	15.2	0.90	0.63
2009	4.1	15.0	0.85	0.64
2010	4.8	14.8	0.75	0.72
2011	4.4	14.9	0.65	0.75
2012	4.8	14.6	0.67	0.88
2013	2.5	14.0	0.70	0.87
2014	0.3	14.7	0.60	0.94
2015	−0.5	15.1	0.55	1.00
2016	4.1	13.1	0.48	0.96
2017	3.3	13.0	0.45	1.03
2018	3.4	14.3	0.47	1.09
2019	3.8	14.0	0.43	1.16
2020	−0.6	13.2	0.41	1.22
2021	3.2	12.8	0.40	1.29

Source: compiled by the authors based on these sources [11, 12]



Investment security indicators characterize the degree of manifestation of the corresponding threats. One of the most important indicators characterizing the degree of development of the country is the volume of foreign direct investment in GDP. During the analyzed period, this indicator of Ukraine had a «safe» value only in 2006–2008 – 5.2–6.9 % and tends to decrease, which indicates insufficient investment in fixed assets and the inability to provide the necessary material and technical base for needs of the economy. In contrast to Ukraine, in Poland this indicator adhered to the threshold value (**Fig. 5.10**).



**Fig. 5.10** Dynamics of the volume of foreign direct investment in the GDP of Ukraine and Poland in 2006–2021, %

Speaking about the costs of scientific and technical activities in Ukraine and Poland (**Fig. 5.11**), we observe deviations from the threshold value of the indicator, and the lack of funds to finance the state order for the most important scientific and technical (experimental) developments and putting the country's scientific and technical products in dependence on imports of advanced technologies from countries such as China, the United States of America, Japan.

Let's assess banking security as a component of the country's financial security (**Table 5.9**).

Analytical data in **Table 5.9** testify to a significant part of foreign banking capital in the total volume of Poland's banking capital, which in this case is a positive moment and indicates the active integration of the banking sector into the European space. However, for Ukraine, which is not a member of the European Union, the presence in the banking market of a significant share of banks with foreign capital may carry various risks and threats. These risks are associated with insufficient competition of domestic banks compared to foreign ones, which have cheap resources of parent banks and much greater opportunities to use them, as well as exchange rate fluctuations

both in the world and in Ukraine, with the possibility of potential influence of non-residents on decision-making, for example, on the choice of lending facilities in Ukraine (Fig. 5.12).

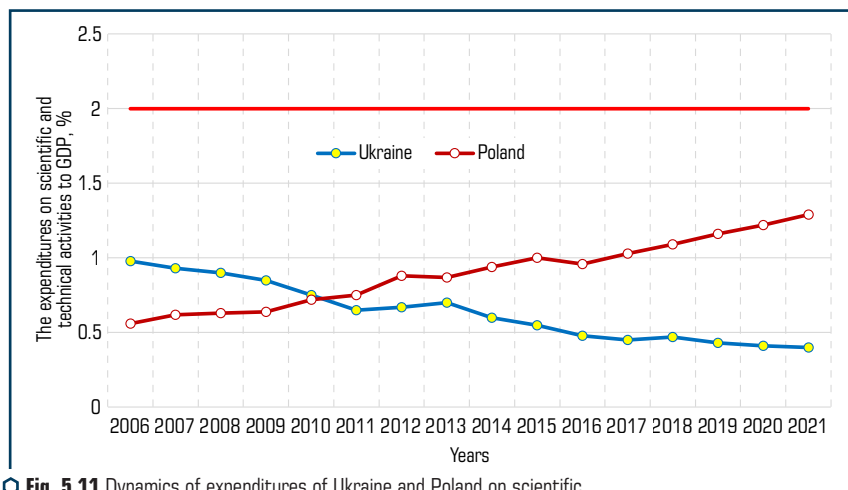


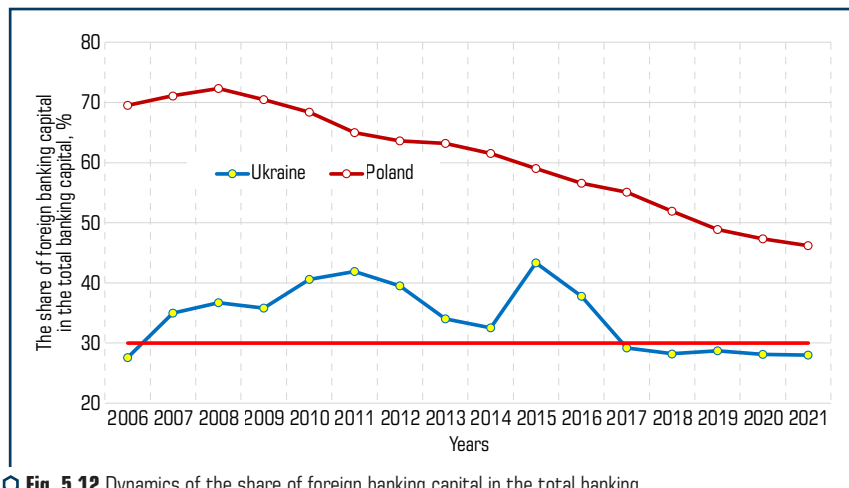
Fig. 5.11 Dynamics of expenditures of Ukraine and Poland on scientific and technical activities to GDP 2006–2021, %

Table 5.9 Main indicators of banking security in Ukraine and Poland, % of GDP

Years	The share of foreign bank capital in the total volume of bank capital, % (threshold value – no more than 30)		The volume of lending by banks to the real sector of the economy, % of GDP (threshold value – at least 30)	
	Ukraine	Poland	Ukraine	Poland
2006	27.6	69.5	30.8	30.5
2007	35.0	71.1	38.3	36.3
2008	36.7	72.3	49.8	22.0
2009	35.8	70.5	52.0	22.1
2010	40.6	68.4	47.1	22.0
2011	41.9	65.0	44.4	21.6
2012	39.5	63.6	43.4	23.5
2013	34.0	63.2	49.2	25.3
2014	32.5	61.5	51.6	26.5
2015	43.3	59.0	40.8	28.2
2016	37.8	56.6	35.1	17.9
2017	29.2	55.1	28.3	17.8
2018	28.2	51.9	24.6	17.9
2019	28.7	48.9	19.2	16.9
2020	28.1	47.3	17.6	16.3
2021	28.0	46.2	14.2	14.7

Source: compiled by the authors based on these sources [11, 12, 15–18]

By the end of 2021 The National Bank of Ukraine has created an optimal share of banks with foreign capital in the structure of the banking system, which reduces the risk of the state's financial security. However, such actions by the regulator limited the volume of resources for lending to the real sector of the national economy, and since 2017, the activity of Ukrainian banks in ensuring economic growth has been declining. A similar situation is taking place in the Republic of Poland: since 2008, the volume of lending by banks to the real sector of the economy has tended to decrease (**Fig. 5.13**). However, this situation is caused by the significant activity of transnational groups, developing the real sector of the Polish economy at their own expense.



**Fig. 5.12** Dynamics of the share of foreign banking capital in the total banking capital of Ukraine and Poland in 2006–2021, %

Let's assess the security of the non-banking financial sector as a component of the country's financial security (**Table 5.10**).

The insurance market, along with the banking market, is the most developed in all countries of the world. This situation is due to the accumulation of significant financial flows through insurance premiums and the socio-economic role played by insurance companies in society and the economy. However, we see that the insurance market in Ukraine is underdeveloped, as evidenced by the low levels of insurance payments during the analyzed periods (**Fig. 5.14**). This means a high probability of the transfer of compensation for insured events, especially in the healthcare sector, at the expense of public funds, which does not create conditions for improving the country's budgetary security. However, as we see from the example of Poland, the development of the insurance market does not pose a threat to the financial security of the country.

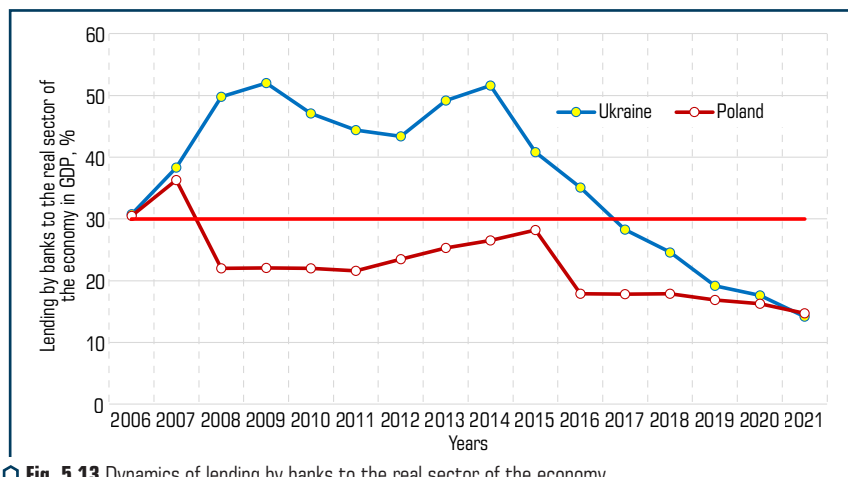


Fig. 5.13 Dynamics of lending by banks to the real sector of the economy of Ukraine and Poland in GDP 2006–2021, %

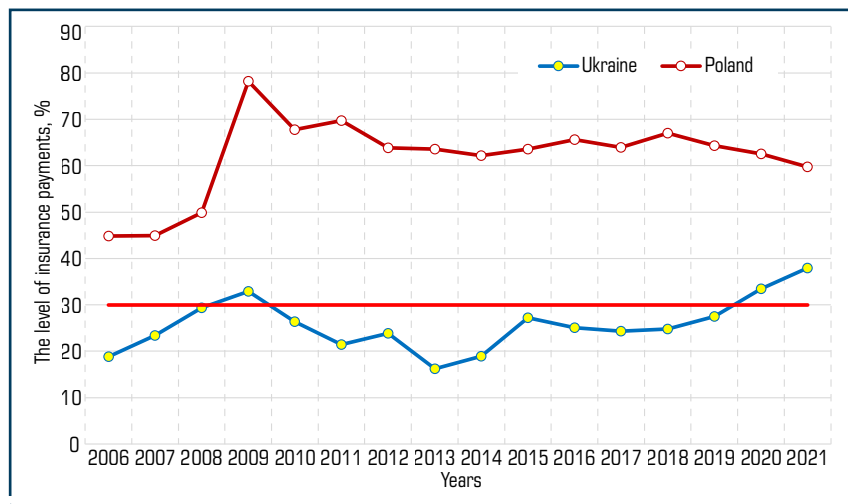
Table 5.10 Main security indicators of the non-banking financial sector of Ukraine and Poland, %

Years	Level of insurance payments, % (threshold value – not less than 30)		Yield of an internal government loan bond, % (threshold value – 3–4)	
	Ukraine	Poland	Ukraine	Poland
2006	18.8	44.8	9.26	4.20
2007	23.4	44.9	6.71	5.30
2008	29.4	49.9	11.86	6.25
2009	32.9	78.2	12.21	4.75
2010	26.4	67.8	10.39	4.00
2011	21.4	69.7	9.17	4.50
2012	23.9	63.8	12.94	3.90
2013	16.2	63.6	13.13	3.00
2014	18.9	62.2	13.98	2.20
2015	27.2	63.6	13.07	2.00
2016	25.1	65.6	9.16	2.00
2017	24.3	63.9	10.47	2.10
2018	24.8	67.0	17.79	2.10
2019	27.5	64.3	16.93	2.10
2020	33.5	62.5	10.20	1.00
2021	37.9	59.7	11.34	1.00

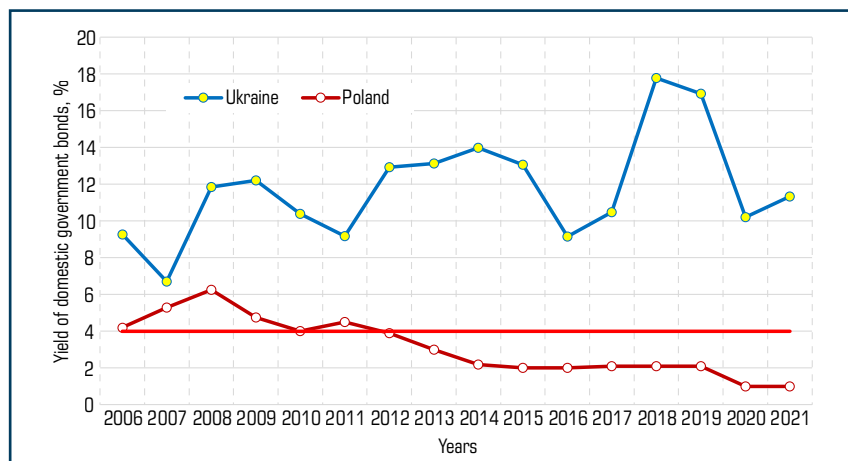
Source: compiled by the authors based on these sources [11, 12, 15, 18, 19]

The high level of social responsibility of the state leads to an increase in the state budget deficit and requires the search for resources to cover it and ensure financing of the necessary state

budget expenditures. As a result, Ukraine is forced to attract the necessary financial resources in the domestic market, stimulating the activity of economic entities with a high level of profitability, which we observe during the analyzed periods (**Fig. 5.15**). This situation creates additional threats to the debt security of the state. At that time, Poland, which has the opportunity to use the resources of the European Union, ensuring a high economic level of growth, during the periods under review, optimized the cost of raising funds in the domestic market.



**Fig. 5.14** Dynamics of the level of insurance payments in Ukraine and Poland in 2006–2021, %



**Fig. 5.15** Yield dynamics of domestic government bonds of Ukraine and Poland in 2006–2021, %

Thus, based on the foregoing, it can be stated that the level of security of the non-banking financial sector of Ukraine is critical. In general, during 2006–2021, in Ukraine, at the same time, four out of fourteen indicators assessing the components of the level of financial security signaled the presence of threats (**Tables 5.5, 5.7, 5.8, 5.10**). The rest with different duration of periods showed deviations from the optimal values. More often, periods of such deviations occurred in the period 2014–2020, which were associated with the crisis of the Russian invasion in the spring of 2014 and the subsequent post-crisis period. The NBU did not achieve the stability of the national currency, which undermined its credibility and provoked an increase in the dollarization of the national economy. There was an increase in external debt. The country's financial system is not capable of protecting national interests and is dependent on external influence.

#### 5.4 JUSTIFICATION OF THE ALGORITHM AND THE RESULTS OF USING A REGRESSION MODEL WITH PERFORMANCE INDICATORS IN ORDER TO PREDICT THREATS TO THE FINANCIAL CONDITION IN THE FUTURE ON THE EXAMPLE OF UKRAINE

In order to foresee threats to the financial condition of Ukraine, a regression model has been developed for the dependence of the growth rate of the Consolidated Budget of Ukraine (as an indicator of Ukraine's public finances) on such factors as the deficit/surplus ratio of the state budget; the ratio of the total public debt; inflation rate; coverage ratio by the international reserves of the state of the monetary base; the amount of lending by banks to this sector of the economy (5.1).

$$Y_{CBGR} = -165.65 + 0.129X_{SBDSR} - 0.22X_{RTPB} + 0.979X_{IR} + 0.529X_{CMB} + 0.998X_{BLRSE} \quad (5.1)$$

The selected set of indicators for identifying threats to the financial security of Ukraine provides the basis for building and forming a base of scenarios for the possible behavior of the economy under the influence of external factors. In fact, the value of these indicators by the end of the period, in the absence of other corrective influences (in particular, the government's macroprudential policy), determines the response and stability of public finances during a crisis. The authors predicted the growth rate of the Consolidated Budget of Ukraine, which makes it possible to assess the process of the spread of crisis phenomena for the public finances of Ukraine over the next two years after the analyzed period.

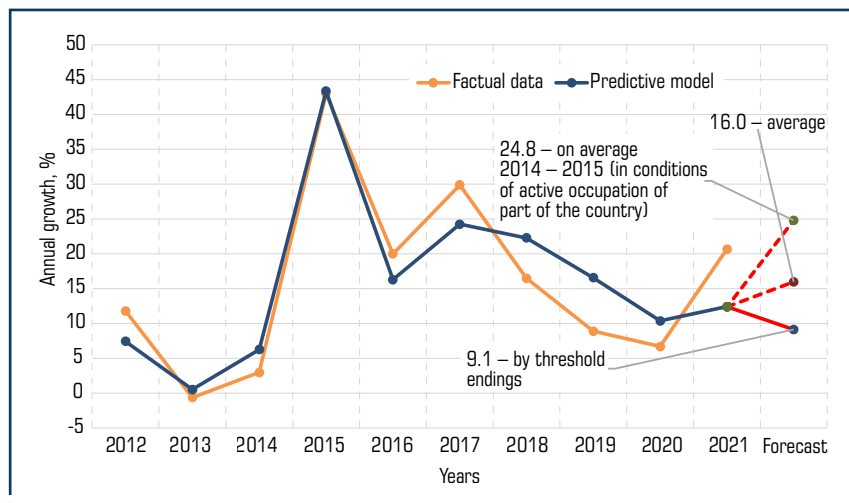
Let's calculate a certain regression model (5.1) for Ukraine using Microsoft Excel tools. The data for calculations are presented in **Table 5.11** (the values of the indicators that exceeded the corresponding threshold values are shaded). The presented model (5.1) has rather high indicators of its evaluation: Multiple  $R=0.92$ ,  $R^2=0.84$ .

The results of the implementation of model (5.1) are shown in **Fig. 5.16**.

● **Table 5.11** Initial data for calculating the regression model with performance indicators reflecting the dependence of Ukraine's public finances on a number of security indicators

Indicator	Government budget deficit/surplus ratio	The ratio of total public debt	Inflation rate	Coverage ratio by the international reserves of the state of the monetary base	The volume of lending by banks to the real sector of the economy	Growth rate of the Consolidated budget
Presentation format	% of GDP	% of GDP	%	%	% of GDP	annual growth, in %
Conventions	SBDSR	RTPB	IR	CMB	BLRSE	CBGR
Thresholds	no more than 3	no more than 60	no more than 107	at least 100	at least 30	
2012	-3.8	36.7	99.8	76.83	43.4	11.8
2013	-4.5	40.1	100.5	53.11	49.2	-0.6
2014	-5.0	70.2	124.9	26.89	51.6	3.0
2015	-2.3	79.4	143.3	86.49	40.8	43.0
2016	-2.9	81.0	112.4	104.05	35.1	20.0
2017	-1.6	71.8	113.7	125.38	28.3	29.9
2018	-1.7	60.9	109.8	131.39	24.6	16.5
2019	-1.9	50.3	104.1	136.98	19.2	8.9
2020	-5.2	60.8	105.0	131.79	17.6	6.7
2021	-3.6	48.9	110.0	127.45	14.2	20.7

Source: developed by the authors



○ **Fig. 5.16** Results of the implementation of the model (5.1), variants of the CBGR forecast

There are three forecast options:

1. All indicators of the model ( $X$ ) will be equal to their threshold values, namely:  $X_{SBSR}=3$ ;  $X_{RTPB}=60$ ;  $X_{IR}=107$ ;  $X_{CMB}=100$ ;  $X_{BLSE}=30$ ; in this case, the forecast value of the growth rate of the Consolidated Budget of Ukraine will be 9.1 (+/-8 %).

2. Model indicators ( $X$ ) will be equal to their average values for the study period 2012–2021, namely:  $X_{SBSR}=-3.25$ ;  $X_{RTPB}=60.01$ ;  $X_{IR}=112.35$ ;  $X_{CMB}=100.036$ ;  $X_{BLSE}=32.4$ ; in this case, the forecast value of the growth rate of the Consolidated Budget of Ukraine will be 16 (+/-8 %).

3. This version of the forecast is based on the assumption of a repetition of the behavior of the financial system during the active occupation of part of the country's territory by the russian aggressor in 2014–2015. Therefore, the indicators of the model (4.1) will be equal to their average values for the period 2014–2015, namely:  $X_{SBSR}=-3.65$ ;  $X_{RTPB}=74.8$ ;  $X_{IR}=134.1$ ;  $X_{CMB}=56.69$ ;  $X_{BLSE}=46.2$ ; in this case, the forecast value of the growth rate of the Consolidated Budget of Ukraine will be 24.8 (+/-8 %).

The forecasting results for 2022 (**Fig. 5.16**) make it possible to determine the scenarios for the movement of the trajectory of the growth rates of the Consolidated State Budget of Ukraine. Taking into account the situation, starting from February 24, 2022, martial law has been in effect on the territory of Ukraine related to the military aggression of the russian Federation, one should take into account the forecast option based on the assumption of a repetition of the behavior of the financial system during the active occupation of part of the country's territory by the russian aggressor in 2014–2015. According to forecasts, in 2022 Ukraine will improve the growth rate of the Consolidated Budget of Ukraine, however, its growth will be caused by the need to cover significant defense spending, devaluation of the national currency. This situation will continue to put pressure on the national currency, causing devaluation processes, reducing the volume of bank lending to the real sector of the economy, the ability of the private sector to act as a source of investment in the economy, including through financial intermediaries, and increasing the need for additional resources from international financial organizations and international assistance.

However, the inertial development of the forecast situation can be stopped by corrective measures of economic policy on the part of macroeconomic regulation bodies, namely:

- resumption of cooperation with the IMF and EBRD;
- development of measures aimed at ensuring the protection of the national interests of Ukraine in the conditions of increased protectionism of other countries, as well as in emergency situations;
- development of a common Ukraine-EU roadmap for the further development of trade and economic ties;
- carrying out further reforms in the field of tax and land policy, active transition to new production standards (in order to increase the competitiveness of domestic products in the context of the need to develop the markets of the European Union);



- use of various forms of public-private partnership in the context of a significant increase in investment activity, which, among other things, will improve the situation on the labor market;
- rapid implementation of the relocation program (transfer to safer territories) of production facilities.

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## 6

## SECURITY PARAMETERS OF THE INNOVATIVE ECOSYSTEM

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Oleksandr Ishchenko, Yuliia Lyzhnyk

## ABSTRACT

It is substantiated that at the present stage of development there is a significant scientific and practical interest in the development of innovative ecosystems, which is due to the importance and role of innovative ecosystems in ensuring the further socio-economic development of countries, their competitiveness and national security. The author's approaches to understanding the essence of the concept of «innovative ecosystem» are analyzed. Two main approaches to understanding the concept of «innovative ecosystem» that have developed in the scientific literature are identified. The links between the concepts of «innovative ecosystem», «innovative infrastructure» and «national innovative system» are analyzed, their common and distinctive features are determined. The author's approach to understanding the essence of the concept of «innovative ecosystem» is proposed. Existing approaches to understanding the life cycle, components and varieties of innovative ecosystems are analyzed and systematized. Approaches to determining the characteristics of security, markers of the effectiveness of innovative ecosystems are analyzed and summarized. A more representative indicator of the development of innovative ecosystems has been identified. A comparative analysis of the characteristics of the functioning and development of innovative ecosystems of the states-leaders of innovative development (top 15 states) was carried out: Switzerland, Sweden, the United Arab Emirates, Great Britain, the Republic of Korea, the Netherlands, Finland, Singapore, Denmark, Germany, France, China, Japan, Hong Kong, Israel. The markers of the effectiveness of innovative ecosystems and their security parameters are determined.

## KEYWORDS

National security, innovative development, innovative ecosystem, innovative infrastructure, national innovative system, security parameters.

## 6.1 THE INNOVATIVE ECOSYSTEM AND ITS ROLE IN ENSURING NATIONAL SECURITY

Modern global risks (Climate action failure, Extreme weather, Biodiversity loss, Social cohesion erosion, Livelihood crises, Infectious diseases, Human environmental damage, Natural resource crises, Debt crises, Geoeconomic confrontation, Digital inequality, etc.) [1] of the world community and individual states to level them, update the issues of ensuring national security for all actors of global interaction both in the short (up to 2 years), and in the medium (2–5 years) and long-term (5–10 years) periods.

Content analysis of works [2–6] allows us to state that:

1) national security – protection and prevention of internal and/or external risks, threats, actions that directly harm and/or threaten national interests (vital values, the implementation of which guarantees the state sovereignty of the country and its progressive development) in economic, scientific, technical, political, as well as in other areas;

2) under the influence of a change in the context of development, both the national interests themselves and the components of national security change.

Study of a number of international institutions [7–13], incl. World Economic Forum (WEF), International Institute for Management Development (MIDM), World Bank (WB), United Nations (UN), Organization for Economic Co-operation and Development (OECD), International Telecommunications Union (ITU), European Commission (EC), McKinsey Global Institute, etc. objectively prove that at the present stage of development of the world community, national interests and national security certainly contain innovative and digital components, which is due to the axiomatic significance of innovations and digital transformations for ensuring socio-economic development.

The innovative and digital components of national security in terms of national interests are described at the present stage of development by the concept of «innovative ecosystem». This is due to the fact that «In the age of non-linear innovation and digital technologies, innovation can be better nurtured within a special, innovation-conducive environment. Such an environment may be seen as an ecosystem meant for co-creation of value through collaboration» [14].

Thus, ITU experts note that «Developing strong innovative ecosystems is a key component of national development, as innovation ... is a driver of economic competitiveness and growth in modern economies» [8], «...any country needs three types of ecosystems, i.e. national innovative ecosystem, entrepreneurship ecosystem, and technology ecosystem, to actualize innovation during their journey to reach digital transformation. These three interconnected ecosystems not only support an innovative environment from brainstorming to marketing but also serve as a complement to the Industry's Innovative ecosystem of any country» [15].

WEF specialists are convinced that in the context of the global crisis that arose under the influence of the global COVID-19 pandemic, in order to increase competitiveness and overcome the crisis, countries should focus on 4 issues:

- 1) reviving and transforming the enabling environment;
- 2) reviving and transforming human capital;
- 3) reviving and transforming markets;
- 4) reviving and transforming the innovative ecosystem [7].

It should be noted that the WEF experts are convinced that in order to overcome the consequences of the crisis, economies should focus their efforts on improving the efficiency of the functioning of innovative ecosystems through «Expand public investments in R&D, and incentivize venture capital and R&D in private sector and the diffusion of existing technologies that support the creation of new firms and employment in «markets of tomorrow» [7]. At the same time, the priorities for the transformation of economies should be Incentivize and expand patient investments

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in research, innovation and invention that can create new «markets of tomorrow». Incentivize firms to embrace diversity, equity and inclusion to enhance creativity [7].

In the EU, the development of innovative ecosystems is seen as a tool and mechanism aimed at facilitating the download of companies, support the scaling of companies, encourage innovation and stimulate cooperation among national, regional and local innovation actors [13]. At the same time, the EU has introduced the EU Innovative ecosystem Development Program. contains actions under three (3) destinations: CONNECT (focus on building interconnected, inclusive innovative ecosystems across Europe by drawing on the existing strengths of national, regional and local ecosystems and encouraging the involvement of all actors and territories to set, undertake, and achieve collective ambitions towards challenges for the benefit of society, including green, digital, and social transitions and the European Research Area); SCALEUP (focus on reinforcing network connectivity within and between innovative ecosystems for sustainable business growth with high societal value); INNOVSMES (will support the European Partnership on Innovative SMEs, which will help innovative SMEs to increase their research and innovation (R&I) capacity and productivity and successfully embed in global value chains and new markets) [16]. Budget for the EU Innovative ecosystem Development Program 2021–2022 is 141.63 million EUR [16]. This program is part of the EU Framework Program for Research, Technology and Innovation 2021–2027, a component of the Innovative Europe subprogramme, which accounts for 14 % of the total budget of the said framework program, which is 13.597 million EUR. In total, the development of the EU innovative ecosystem has an allocation of 527 million EUR, which is 0.5 % of the total budget of the EU framework program on research, technology and innovation of the EU for 2021–2027 [10].

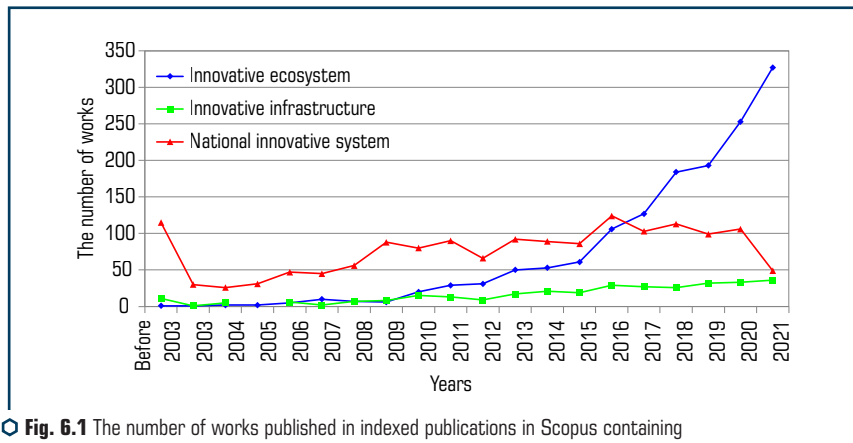
Legislators of Ukraine consider the innovative ecosystem as a condition «...ensuring the rapid and high-quality transformation of creative ideas into innovative products and services, increasing the level of innovation of the national economy, which involves creating favorable conditions for the development of the innovation sphere, increasing the number of implemented developments, increasing the economic return from them, attracting investment in innovation activity» [17].

Despite the significant scientific and practical interest in the development of innovative ecosystems, at the present stage of development of science and practice there are a number of opponents of this concept, there is no generally accepted approach to understanding the essence of the concept of «innovative ecosystem», which, on the one hand, is due to the fact that this the concept is relatively new (**Fig. 6.1**), on the other hand, the presence of a number of concepts similar in content, incl. «national innovative system» (NIS), «innovative infrastructure», etc.

Thus, in the Strategy for the Development of the Sphere of Innovation Activity of Ukraine for the period up to 2030, the innovative ecosystem is understood as «a set of institutions, relationships, as well as various types of resources involved in the process of creating and applying scientific knowledge and technologies that ensure the development of innovative activity» [17].

Komorowski Marlen argues that «Innovative ecosystems are ... as the structures that are formed between actors that pursue technology development and innovation as one of their objectives» [18]. At the same time, he notes that «The definition is intentionally kept broad as

innovative ecosystems are dynamic structures with multiple and changing actors and actions meaning they are highly complex systems» [18].



**Fig. 6.1** The number of works published in indexed publications in Scopus containing the keywords «innovative ecosystem», «innovative infrastructure», «national innovative system»  
Source: compiled by the authors based on data from [19]

Adner, R. is convinced that the innovative ecosystem is «...the collaborative arrangements through which firms combine their individual offerings into a coherent, customer-facing solution» [20].

Santos, G. and Zen, A., Bittencourt, B. at the same time note that «an innovative ecosystem can be defined as a set of interdependent actors with conflicting technical, social, economic and political interests, but also converging goals, priorities, expectations and behaviors that cooperate and compete concomitantly in a specific geographical location. Thus, innovative ecosystems are hybrids of different networks and systems with fractal, multilevel, multimodal, multinodular and multilateral configurations, with tangible and intangible dynamic assets designed to promote innovation in a territory» [21].

Bo Liu, Yun-Fei Sha, Guowei Li, and Debing Ni prove that «an innovative ecosystem is a dynamic co-evolutionary network composed of interconnected relationships and interactions among multiple actors. These simultaneously competitive and cooperative interactions foster ecosystem co-evolution toward innovation capabilities, technologies or skills, resources integration, and motivate actors to co-create value and achieve benefits» [22].

Higgins, A. convinced that «An innovative ecosystem is a network of individuals, entities, resources, and structures that join forces in away that catalyzes new products, ideas, methods, systems, and even ways of life» [23].

Smorodinskaya, N., Russell, M., Katukov, D., Still, K., based on the analysis of the economic literature of 2005–2016 devoted to the functioning of ecosystems, incl. Innovative, state that the innovative ecosystem is «networks of sustainable linkages between individuals and organizations,

which emerge from a shared vision of desired transformations and provide an economic context (milieu) to catalyze innovation and growth» [14]. It is noted that «...innovative ecosystems may be treated both as business networks and as communities meant for innovation. They may assume different scale and design, functioning as regional innovation hubs, nation-wide innovation communities, local inter-firm networks, very small network-based ad-hoc groups of individuals, or global wide networks» [14].

According to the approach of WEF experts, «Innovative ecosystems are a complex process that span the generation of ideas, their translation into products, and the commercialization of these products to a large scale. The success of this progression depends on multiple factors, such as a business culture that rewards entrepreneurship, risk-taking and a will to embrace change, a set of regulations and administrative norms that incentivize this attitude, a strong knowledge-generation sector (universities, research centres and laboratories), and collaboration between these knowledge centres and commercial businesses» [7].

Pidoricheva, I. states that an innovative ecosystem means open dynamic network (non-hierarchical) environments consisting of organizations, people and institutions interacting in the creation, use and dissemination of innovations [24].

As ITU experts note, the concept of «innovative ecosystem» should be understood as «system or network of interconnecting and interacting organizations and stakeholders, from multiple sectors, who come together and address the problems people are facing within their communities» [8].

As noted by Anmar Kamalaldin, David Sjödin, Dusana Hulova, Vinit Parida, an innovative ecosystem is «not only a multiplicity of partners, but also a set of relationships that are not decomposable to an aggregation of bilateral interactions» [25]. Thus, the concept of «innovative ecosystem» is most often understood from the standpoint of two approaches: static (as a network of certain institutions and actors, a system) and dynamic (as a process, an affiliated connection).

As for its connection with such concepts as «innovative ecosystem» and «NIS», the content analysis of works [6,14, 24, 26–32] allows us to state that the concepts of «NIS» and «innovative ecosystem» are very similar in terms of. At its core, however, if the NIS usually includes institutions and institutions located within certain geographical boundaries, relatively static and regulated by the state, then the innovative ecosystem focuses on dynamics, the interaction of actors, does not have a clear link to geographical boundaries, the main trigger for innovation is the industry, self-regulating [4, 14, 32]; the concept of «innovative ecosystem» is broader than the concept of «innovative infrastructure», the innovative infrastructure is a component of the innovative ecosystem. Thus, the concepts of «innovative ecosystem», «innovative infrastructure» and «NIS» are not synonymous, the innovative ecosystem – a new generation NIS, characterized by openness, dynamism, self-regulation, focuses not so much on its elements themselves and their spatial characteristics, but rather on their interaction. As Gouthanan Pushpanathan and Maria Elmquist note, «Innovative systems are often based on geographical boundaries, labelled using constructs such as national or regional innovative systems. In contrast, innovative ecosystems allow for cross-sectoral and cross-regional examination of innovation activities» [31].

As noted by Smorodinskaya, N., Russell, M., Katukov, D., Still, K. «...national or regional innovative systems were seen as static structures regulated by government bodies, with successful performance depending on a critical mass of involved actors and intentional infrastructure. As a departure, innovative ecosystems ...are considered dynamic and agile collaborative structures that enjoy self-governance as a necessary prerequisite for interactive innovation... an innovation-conducive environment, comprised of ecosystems and networks, can increase the likelihood that «softer» innovation takes place [14]. At the same time, Pooya Namaayande, Behrouz Zarei emphasize that «An innovative ecosystem models the economic rather than the energy dynamics of the complex relationships that are formed between actors or entities whose functional goal is to enable technology development and innovation. These innovative ecosystems highlight the dynamic nature of innovation in order to create innovative results and innovation performance» [15].

The analysis of sources [26–43] also shows that in scientific, business and political circles there is no consensus not only regarding the understanding of the essence of the concept of «innovative ecosystem», but also its components and varieties, life cycle.

Most often, the life cycle of an innovative ecosystem is presented as a phasic process containing 4 main stages of development: birth (there is a shared understanding among the actors on what are the common objectives, thus assuring the collaboration among them and the delivery of value), expansion (the relationships between the actors are strengthened and the ecosystem grows. The growing ecosystem starts to be competitive and to compete against other ecosystems), leadership (the ecosystem is a leader in one or more features, being more and richer in networks and generating value, as the competitiveness and complexity grow, the issues related to the coordination of the ecosystem improve simultaneously), and self-renewal or death (the ecosystem must explore new knowledge to invigorate or be terminated due to not being competitive anymore) [20, 31]. In this case Bo Liu, Yun-Fei Sha, Guowei Li, and Debing Ni. They stated that «Ecosystems arise when there is a balance between centripetal and centrifugal forces, that is, when there are benefits of coordination as well as benefits of autonomy» [22].

Anmar Kamalaldin, David Sj ödin, Dusana Hullova, Vinit Parida argue that ecosystems in general, including the innovative ecosystem, include 4 main elements:

1) activities, which specify the discrete actions to be undertaken in order for the value proposition to materialize;

2) actors, which are the entities that undertake the activities (a single actor may undertake multiple activities; conversely, multiple actors may undertake a single activity);

3) positions, which specify where in the flow of activities across the system actors are located and characterize who hands off to whom;

4) links, which specify transfers across actors (The content of these transfers can vary—material, information, influence, funds. Critically, these links need not have any direct connection to the focal actor) [25].

Gouthanan Pushpanathan, Maria Elmquist come to similar conclusions, noting that «... the term «innovative ecosystem» includes all value creating activities performed by an evolving network of actors



integrating their products and services on a technology platform. In such collaborative networks, interaction among firms is both complex and critical, and combines cooperation and competition» [31].

So, the main elements of innovative ecosystems are actors and their roles, connections between actors.

The diversity of innovative ecosystems is explained by the plurality of approaches for scientists to understand the essence of the concept of «innovative ecosystem», the plurality of criteria for their differentiation.

So, Pidoricheva, I. identifies four types of innovative ecosystems: ecosystems organized around a focal (central) firm; ecosystems as «structures» built around a focal value proposition (focus innovation); ecosystems as certain environments (spaces) formed at different levels – from local to global; ecosystems as platforms around which the activities of various stakeholders are organized» [24].

Gouthanan Pushpanathan, Maria Elmquist note that the varieties of innovative ecosystems depend on who is its founder, noting that «an ecosystem comprises of a set of actors with varying degrees of multilateral, non-generic complementarities that are not fully hierarchically controlled». The activities of the actors within an ecosystem are orchestrated by the ecosystem leader(s) or keystone firm(s). A keystone firm is responsible for the ecosystem's overall 'health' and ensures that value is shared amongst the ecosystem participants... Typically, the interactions in an innovative ecosystem are organized around a technology platform with a modular architecture» [31]. Higgins, A. distinguishes 3 types of innovative ecosystems: City innovative ecosystem, Industry innovative ecosystem, Corporate innovative ecosystem [23].

Komorowski Marlen notes that «... innovative ecosystems are highly divers and there are no clear archetypes of innovative ecosystems, but rather a multitude combining very divers criteria» [18]. In this regard, the author proposes to differentiate innovative ecosystems based on 9 criteria (Number of innovative ecosystem actors, Types of actors involved, Expertise and industry sectors, Development stage, Scale of operation, Central entity (organised or unorganised), Leading/initiating actor(s), Actions/goals), but notes that these 9 criteria, although they are basic, are not exhaustive [18]. Komorowski Marlen notes that «...innovative ecosystems are often built around technology parks and integrate research organisations and public agencies. Innovative ecosystems in medium-sized cities have often large enterprises involved, municipalities and are larger small ecosystems of less than 50 actors. Large cities often host innovative ecosystems that are built around formal networks, which involve formal networks and integrate more than 1000 actors. Innovative ecosystems in very large cities integrate actors like universities and more often also venture capital and banks are involved. Cluster organisations are in place. These four archetypes are just highlighting which kind of combinations of the criteria of the model developed above are found often together» [18].

MTS experts identify varieties of innovative ecosystems by specialization, noting that the most important and influential today are innovative ecosystems specializing in ICT development, digital innovative ecosystems [8].

The team of authors of [21] proposes to differentiate innovative ecosystems according to specific models and/or strategies of state regulation [21]. As noted by Santos, G. and

Zen, A., Bittencourt, B. «The simplest mode is shared governance, where a group of organizations collectively works as a network despite not possessing a structure of exclusive and formal management. The second mode is the lead organization-governance, which typically occurs in relationships formed by a bigger, more powerful organization and a set of lesser, weaker firms (Provan & Kenis, 2008). The third mode is the network administrative organization (NAO), where an administrative entity is created, especially to manage the network and its activities» [28].

Consequently, innovative ecosystems can be differentiated by: size and spatial position, level of development, structure-forming institution, specialization, etc. Depending on the approach to understanding the essence of the concept of «innovative ecosystem», its varieties, approaches to understanding the key actors and stakeholders in the scientific literature differ significantly. Thus, MTS identifies the following stakeholders of the innovative ecosystem: Academia, Entrepreneurs, Entrepreneurial support networks, Financiers, Private sector, Public sector [8]. At the same time, Pooya Namaayande, Behrouz Zarei single out such «...the four key actors of an innovative ecosystem are: equipment providers; network operators; content and app providers, and end users. Except for the vertical relationships between the actors that determine the overall shape of the ecosystem, horizontal relationships in each layer of the ecosystem are of special importance» [15]. Rissola, G., Haberleithner, J. note that the actors of innovative ecosystems depend on the ecosystem itself. They divide the actors of the innovative ecosystem into the following groups: the four key actors of an innovative ecosystem are: equipment providers; network operators; content and app providers, and end users. Except for the vertical relationships between the actors that determine the overall shape of the ecosystem, horizontal relationships in each layer of the ecosystem are of special importance» [15]. Thus, most researchers define the actors of the innovative ecosystem based on the Quadruple Helix Model and argue that the relationships between the actors within the innovative ecosystem are symbiotic.

## 6.2 SUCCESS PARAMETERS OF INNOVATIVE ECOSYSTEMS

Despite the fact that innovative ecosystems in one form or another have been formed and are functioning in all countries of the world, they differ significantly in terms of efficiency, which affects their ability to ensure the achievement of national interests and, consequently, ensure national security.

As WEF experts note, «Over the past 20 years, large cross-country innovation divides have not diminished. Just five countries today produce together over 70 % of global patent activity, and the top 10 countries generate over 85 % of global patent shares. These levels of concentration have remained in place for the past 20 years, with the exception of China and Korea» [7]. As the WEF experts note, «This adds to the widening of the productivity divide between top companies and the rest – and leading to economies that are increasingly polarized and unequal» [7].

Merhaba, A., Thuriaux-Alemán, B., Ghanem, E., Aebi, T., Takchi, Y., Alsalloum, N. come to similar conclusions, arguing that «Innovation is key in driving social and economic development and bridging the wealth gap between emerging and developed countries. Over the last 50 years, only a few

countries, such as South Korea and Singapore, have succeeded in unlocking the full benefits of nation-wide innovation. Instrumental to their success is a systematic approach tackling innovation in a holistic manner that captures policy, governance, innovation engines and innovation enablers to shape their innovative ecosystem and bridge systemic and market gaps» [26].

Content analysis of sources [8, 15, 18, 25, 26, 30, 42] suggests that the performance or efficiency parameters of innovative ecosystems are quite different. Proponents of a dynamic approach to understanding the essence of the concept of «innovative ecosystem» propose to evaluate the effectiveness of an innovative ecosystem based on the breadth of the ecosystem itself, the number of participants in it, supporters of a static approach – based on its ability to create value, innovation.

At the same time, MTS experts emphasize that «Out of the estimated 300 million start-ups in the world, very few of them will become high-growth firms because their ecosystems are missing essential elements for success» [8]. They are convinced that in order to ensure competitiveness, any ecosystem, including innovation, must ensure the effectiveness of four main elements: (a) governance; (b) linkages; (c) capacity and (d) focus [8].

Komorowski Marlen notes that «Innovative ecosystems are highly complex structures. A one size fits all strategy for ecosystem development does not exist» [18], but it convincingly proves that ecosystems characterized by a certain set of parameters are relatively more successful than others. According to the results of a comparative study by Komorowski Marlen, the most successful are: innovative ecosystems that operate on a national or international level (around 70 % of experts); innovative ecosystems that have an incubator as central entity (around 80 % of experts); innovative ecosystems that were initiated by a single leading individual (100 % of experts); innovative ecosystems that focus its actions and goals on innovation and technology development, industry growth and firm creation, or provision of education and training (more than 60 % of ecosystems) [18]. At the same time, Komorowski Marlen notes the need to use the 7 P framework (Place, Proximity, Population, Profile, Path-dependency, Policy, Performance) [18] in the analysis of innovative ecosystems [18].

Erkko Autio, Llewellyn D. W. Thomas note that «A healthy ecosystem is productive, in that it consistently transforms technology and other inputs to innovation into lower costs and new markets, and robust, i.e., capable of surviving disruptions such as unforeseen technological change and able to create niches to increase meaningful diversity» [42].

Experts from The International Development Innovation Alliance (IDIA) argue that successful innovative ecosystems are those that have been able to achieve the following nine goals:

1. Building informed human capital.
2. Ensuring accessibility of finance for innovation processes.
3. Establishing supportive research, markets, energy, transport, and communications infrastructure.
4. Creating enabling policies and regulations.
5. Nurturing a culture supportive of innovation and entrepreneurship.
6. Supporting networking assets that enable productive relationships between different actors.
7. Ensuring equal and inclusive ecosystem governance and participation.

8. Creating smoother pathways to scale for specific innovations.

9. Mobilising a collective ecosystem approach to address a particular development challenge» [11].

Analysis and systematization of the parameters of the success of innovative ecosystems allows us to state that they are manifested in the indicators and results of the innovative development of countries, the parameters of the functioning and development of the innovative ecosystems themselves, incl. the number of enterprises engaged in innovative activities included in the innovation process, the volume of innovative export/import, the volume of production and sales of innovative products, etc.

### 6.3 DIAGNOSTICS OF INNOVATIVE ECOSYSTEMS OF THE LEADING COUNTRIES OF INNOVATIVE DEVELOPMENT

An analysis of works [8, 11, 14, 18, 24, 26, 30–42] shows that today the most representative and authoritative indicator that can be used to assess the effectiveness of innovative ecosystems, determine their safe parameters, is the Global Innovation Index (GII).

According to the Global Innovation Index ratings, at the present stage of development, the most effective innovative ecosystems are countries such as: Switzerland, Sweden, the United Arab Emirates, Great Britain, the Republic of Korea, the Netherlands, Finland, Singapore, Denmark, Germany, France, China, Japan, Hong Kong, Israel. Almost all (the exception is China) leading countries in the development and efficiency of the innovative ecosystem are countries with high per capita incomes, most of them are European countries (**Table 6.1**).

● **Table 6.1** Leading countries Global Innovation Index ratings

Rank	2015	2021	Leading countries in 2015–2021
1	Switzerland	Switzerland	Switzerland,
2	United Kingdom	Sweden	United Kingdom,
3	Sweden	United States of America	Sweden,
4	Netherlands	United Kingdom	Netherlands,
5	United States of America	Republic of Korea	United States of America,
6	Finland	Netherlands	Finland,
7	Singapore	Finland	Singapore,
8	Ireland	Singapore	Denmark,
9	Luxembourg	Denmark	Hong Kong,
10	Denmark	Germany	Germany,
11	Hong Kong	France	Republic of Korea
12	Germany	China	
13	Iceland	Japan	
14	Republic of Korea	Hong Kong, China	
15	New Zealand	Israel	

Source: compiled by the author based on data [43]

The leading countries of innovative development, despite the specific features of the formation and development of innovative ecosystems, are characterized by relative similarity. Thus, in all these countries, relatively high indicators of the effectiveness of the institutional conditions for the development of innovative ecosystems are recorded (**Table 6.2**).

The average value for this indicator for the leading countries of innovative development is 84.8 (100-point scale, 0 is the minimum value, 100 is the maximum), the coefficient of variation of the parameter value within the specified group of countries is 9.1 %, which indicates an insignificant level variations in country estimates for the specified parameter.

As evidenced by the analysis of the institutional environment of the leading countries of innovative development, these countries are characterized by a stable political environment and favorable to innovative transformations (business environment).

Thus, the average indicator for the «Political and operational stability» (Government effectiveness) parameter for the leading countries of innovative development is 85 (100-point scale, 0 is the minimum value, 100 is the maximum), the coefficient of variation of the parameter value is within the specified group of countries 9.8 %, which indicates an insignificant level of variation in the estimates of countries for this parameter (**Table 6.3**).

The average indicator for the parameter «Business environment» (Ease of starting a business; Ease of resolving insolvency) for the leading countries of innovative development is 84.6 (100-point scale, 0-minimum value, 100-maximum), coefficient of variation of the value parameter within the specified group of countries is 6.7 %, which indicates an insignificant level of variation in country estimates for this parameter. At the same time, attention should be paid to the fact that the leading countries in innovative development are characterized by relative variability in the regulatory environment. Thus, the average indicator for the «Regulatory environment» parameter (Regulatory quality; Rule of law; Cost of redundancy dismissal) for the leading countries of innovative development is 84.8 (100-point scale, 0-minimum value, 100-maximum), coefficient variation in the value of the parameter within the specified group of countries is 15.6 %, which indicates an average level of variation in the estimates of countries for the specified parameter.

In addition, the leading countries in innovative development are characterized by a relatively high average score for the Market sophistication parameter. Thus, the average value for this indicator for the leading countries of innovative development is 65.1 (100-point scale, 0 is the minimum value, 100 is the maximum), the coefficient of variation of the parameter value within the specified group of countries is 12 %, which indicates an average level variations in country estimates for the specified parameter.

A detailed analysis of the components of the «Market sophistication» parameter of the leading countries of innovative development suggests that these countries are characterized by comparative efficiency and similarity in terms of the «Trade, diversification, and market scale» parameter (Applied tariff rate, weighted avg., %; Domestic industry diversification; Domestic market scale, bn PPP\$). Thus, the average rating of the leading countries in innovative development for the above parameter is 82.4, the coefficient of variation is 8.1 %, which indicates a low level of variation in the assessments of these countries (**Table 6.4**).

● **Table 6.2** Features of the functioning of innovative ecosystems of the leading countries in innovative development in 2021

Countries	Institutions		Human capital and research		Infrastructure		Market sophistication		Business sophistication		Knowledge and technology outputs		Creative outputs	
	grade	place	grade	place	grade	place	grade	place	grade	place	grade	place	grade	place
Switzerland	87.3	13	60.7	6	62.7	2	71.5	6	62.6	4	63.9	1	60.2	2
Sweden	88.8	9	64.1	2	62.6	3	64.6	11	68.1	1	60.3	2	52.9	5
UAE	78.4	30	49.9	22	58.1	14	56.7	26	47.2	22	22.2	59	33.8	40
Great Britain	86.6	15	58.2	10	59.7	10	78.1	4	49.7	21	52.3	10	54.4	4
The Republic of Korea	79.5	28	67.4	1	59.2	12	60	18	60.1	7	54.5	8	52.1	8
Netherlands	88.9	6	55.9	14	57.7	16	55.2	31	61	5	54.8	7	52.2	7
Finland	93.3	2	62.4	2	59.5	11	58.7	19	61	6	56.5	5	42.9	16
Singapore	95.1	1	58.7	9	57.8	15	75.9	5	62.7	3	48.1	13	42.9	17
Denmark	88.8	8	62.3	5	60.8	5	68	7	55.2	11	47.6	14	47.7	13
Germany	84.3	17	62.7	3	55.6	21	57.8	20	54.5	12	53.3	9	50	11
France	83.4	19	55.4	15	57.1	17	61	17	50.4	19	44.3	16	52.6	6
China	64.4	61	50.3	21	54.6	24	61.5	16	54.3	13	58.5	4	46.5	14
Japan	88.8	7	50.8	20	59.8	9	62.1	15	57.3	10	48.3	11	42.1	18
Hong Kong	88.1	11	48.6	25	60.3	6	78.7	3	45.2	24	21.6	62	64.7	1
Israel	76.2	34	51.6	19	50.2	40	66.8	8	58.7	8	55.9	6	36.3	30
Mean	84.8	17.4	57.3	11.6	58.4	13.7	65.1	13.7	56.5	11.1	49.5	15.1	48.8	12.8
Variation coefficient	9.1	89.8	10.5	71.9	5.5	70.5	12.0	61.0	11.4	66.5	24.9	125.0	17.1	83.3

Source: compiled by the author based on data [43]

● **Table 6.3** Features of innovate ecosystems of the leading countries in innovative development in 2021 («Institutions» parameter)

Countries	Institutions		Political environment		Regulatory environment		Business environment	
	grade	place	grade	place	grade	place	grade	place
Switzerland	87.3	13	92.4	3	93.9	7	75.5	47
Sweden	88.8	9	89.4	8	90.5	13	86.3	16
UAE	78.4	30	78.6	24	84.5	21	72	61
Great Britain	86.6	15	80	21	92.4	9	87.4	12
The Republic of Korea	79.5	28	82.1	18	68.2	57	88.1	10
Netherlands	88.9	6	88.4	9	88.9	14	89.4	5
Finland	93.3	2	90.9	5	95.9	5	93.1	1
Singapore	95.1	1	100	1	99.1	1	86.3	17
Denmark	88.8	8	92.8	2	84.6	20	88.9	6
Germany	84.3	17	85.2	14	81.1	29	86.7	14
France	83.4	19	79.9	22	86.3	17	83.9	22
China	64.4	61	65.3	47	49.9	106	78.1	39
Japan	88.8	7	87	11	91.4	11	88.2	9
Hong Kong	88.1	11	86.3	12	96.1	4	81.9	28
Israel	76.2	34	76.6	28	68.6	53	83.4	24
Mean	84.8	17.4	85.0	15.0	84.8	24.5	84.6	20.7
Variation coefficient	9.1	89.8	9.8	81.4	15.6	114.3	6.7	81.3

Source: compiled by the author based on data [43]

At the same time, according to such parameters as «Credit» (Ease of getting credit; Domestic credit to private sector, % GDP; Microfinance gross loans, % GDP) and «Investment» (Ease of protecting minority investors, Market capitalization, % GDP; Venture capital investors, deals/bn PPP\$ GDP; Venture capital recipients, deals/bn PPP\$ GDP), the assessments of the leading countries in innovative development vary significantly and are not characterized by a high level of efficiency – the average assessment of this group of countries is 58.7 and 54.2, respectively, the coefficients of variation are 19.9 % and 35.4 %, respectively. Thus, the assessments of countries vary the most in the Investment parameter. Leading countries in innovative development have comparative success in infrastructure development, which contributes to innovative development. Thus, the average rating of the leading countries in terms of the Infrastructure parameter is 58.4, the coefficient of variation is 5.5 %.

● **Table 6.4** Features of innovative ecosystems of the leading countries innovative development in 2021 (parameter «Market sophistication»)

Countries	Market sophistication		Credit		Investment		Trade diversification and market scale	
	grade	place	grade	place	grade	place	grade	place
Switzerland	71.5	6	69.2	7	70.6	10	74.6	46
Sweden	64.6	11	57.6	17	54.8	16	81.4	24
UAE	56.7	26	50.6	28	41.1	34	78.4	34
Great Britain	78.1	4	65.3	10	80	5	89.1	3
The Republic of Korea	60	18	64.2	12	31.5	65	84.2	16
Netherlands	55.2	31	43	57	39.5	37	83	20
Finland	58.7	19	49.4	34	48.2	22	78.5	32
Singapore	75.9	5	62.5	13	88.4	1	76.6	39
Denmark	68	7	68.5	8	58.6	13	76.9	37
Germany	57.8	20	51.2	27	32.5	60	89.8	2
France	61	17	47.2	43	48.2	21	87.6	8
China	61.5	16	51.7	26	35.9	44	96.9	1
Japan	62.1	15	64.2	11	34.3	51	87.9	5
Hong Kong	78.7	3	87.5	2	75.2	6	73.5	51
Israel	66.8	8	48	39	74.4	7	77.9	36
Mean	65.1	13.7	58.7	22.3	54.2	26.1	82.4	23.6
Variation coefficient	12.0	61.0	19.9	70.7	35.4	80.6	8.1	72.2

Source: compiled by the author based on data [43]

The leading countries of innovative development in terms of infrastructure have achieved the greatest success in the development of information and telecommunications infrastructure, which is quite logical, because in order to ensure effective interaction between the elements of the innovative ecosystem, advanced information and telecommunications technologies are needed. Thus, the average score of the leading countries in innovative development in the parameter «Information and communication technologies technologies «ICTs» (ICT access; ICT use; Government's online service; E-participation) is 87.5, the coefficient of variation is 5.9 % (Table 6.5).

Despite the comparative effectiveness of measures aimed at the development of innovation-friendly infrastructure, the infrastructure in the leading countries of innovative development still requires significant attention, first of all it concerns the «General infrastructure» (Electricity output, GWh/mn pop.; Logistics performance; Gross capital formation, % GDP). Thus, the average



assessment of the leading countries in terms of the General infrastructure parameter is 44.3, while the assessments of countries are characterized by an average level of variability in these parameters – the coefficient of variation is 15.2 %.

As for «Ecological sustainability» (GDP/unit of energy use; Environmental performance; ISO 14001 environmental certificates/bn PPP\$ GDP), the leading countries should also pay attention to it. The average assessment of the leading countries in innovative development in this parameter is 43.3 %, the coefficient of variation is 19.5 %.

The next feature of the innovative ecosystems of the leading countries in innovative development is their comparative efficiency in terms of the «Human capital and research» parameter. The average rating of the leading countries in innovative development for this parameter is 57.3, the coefficient of variation is 10.5 % (**Table 6.6**).

● **Table 6.5** Features of innovative ecosystems of the leading countries innovative development in 2021 (Infrastructure parameter)

Countries	Infrastructure		Information and communication technologies (ICTs)		General infrastructure		Ecological sustainability	
	grade	place	grade	place	grade	place	grade	place
Switzerland	62.7	2	87.8	15	42.1	24	58.1	2
Sweden	62.6	3	84.8	22	53.3	6	49.6	17
UAE	58.1	14	88.8	12	52.9	7	32.7	51
Great Britain	59.7	10	93.4	2	34.7	40	50.9	14
The Republic of Korea	59.2	12	94.8	1	49.4	11	33.4	50
Netherlands	57.7	16	90.8	4	41.1	29	41.3	34
Finland	59.5	11	86.8	17	48.8	12	42.9	30
Singapore	57.8	15	90.5	7	46.7	15	36.3	42
Denmark	60.8	5	91	3	39.6	31	51.7	11
Germany	55.6	21	80.2	32	44.2	20	42.3	32
France	57.1	17	87.7	16	42.2	23	41.4	33
China	54.6	24	79.4	34	54.4	5	29.9	59
Japan	59.8	9	90.1	8	46	16	43.2	28
Hong Kong	60.3	6	89.6	10	35.4	39	55.7	4
Israel	50.2	40	76.6	45	33.7	45	40.3	35
Mean	58.4	13.7	87.5	15.2	44.3	21.5	43.3	29.5
Variation coefficient	5.5	70.5	5.9	85.8	15.2	60.2	19.5	58.3

Source: compiled by the author based on data [43]

● **Table 6.6** Features of innovative ecosystems of the leading countries innovative development in 2021 (parameter «Human capital and research»)

Countries	Human capital and research		Education		Higher education		Research and Development	
	grade	place	grade	place	grade	place	grade	place
Switzerland	60.7	6	61.3	24	45.1	21	75.8	3
Sweden	64.1	2	74.3	4	43.9	25	74.1	5
UAE	49.9	22	52	61	59.2	3	38.6	28
Great Britain	58.2	10	59.7	28	47.4	18	67.7	9
The Republic of Korea	67.4	1	61.5	22	51	13	89.8	1
Netherlands	55.9	14	62.4	20	40.1	39	65	11
Finland	62.4	2	69.6	9	51.1	12	66.6	10
Singapore	58.7	9	54	54	63.1	2	59.1	15
Denmark	62.3	5	74.2	5	43.3	30	69.5	7
Germany	62.7	3	60.1	27	54.7	5	73.2	6
France	55.4	15	60.5	26	42.0	38	63.7	12
China	50.3	21	66.7	12	25.2	83	59.8	14
Japan	50.8	20	54.1	53	24.1	87	74.3	4
Hong Kong	48.6	25	58.1	37	51.1	11	36.4	30
Israel	51.6	19	58.1	38	28.6	77	68	8
Mean	57.3	11.6	61.8	28.0	44.7	30.9	65.4	10.9
Variation coefficient	10.5	71.9	11.0	63.4	25.9	93.7	20.8	77.0

Source: compiled by the author based on data [43]

Compared with the greatest success, the leading countries of innovative development have achieved the parameter (Researchers, FTE/mn pop.; Gross expenditure on R&D, % GDP; Global corporate R&D investors, top 3, mn US\$; QS university rating, top 3). Thus, the average assessment of the leading countries in innovative development for this parameter is 65.4 %, the coefficient of variation is 20.8 %.

The next level of achievement among the leading innovative development countries is education (Expenditure on education, % GDP; Government funding/pupil, secondary, % GDP/cap; School life expectancy, years; PISA scales in reading, maths and science; Pupil-teacher ratio, secondary). Thus, the average rating of the countries-leaders of innovative development in the «Education» parameter is 61.8, the coefficient of variation is 11 %.

As far as higher education is concerned, the leading countries in innovative development have much smaller and more scattered successes. Thus, the average assessment of the leading

countries in innovative development in terms of the «Higher education» parameter (Tertiary education; Tertiary enrolment, % gross; Graduates in science and engineering, %; Tertiary in-bound mobility, %) is 44.7, the coefficient of variation is 25.9 %.

In addition, the leading countries in the innovation rating are characterized by relatively high indicators that determine business sophistication. Thus, the average score of the leading countries in innovative development in terms of the Business sophistication parameter is 56.5, and the coefficient of variation is 11.4 % (Table 6.7).

● **Table 6.7** Features of innovative ecosystems of the leading countries innovative development in 2021 (parameter «Business sophistication»)

Countries	Business sophistication		Knowledge workers		Innovation linkages		Knowledge absorption	
	grade	place	grade	place	grade	place	grade	place
Switzerland	62.6	4	71.4	5	63.9	4	52.4	11
Sweden	68.1	1	77.3	3	70.3	2	56.6	6
UAE	47.2	22	51.4	26	42.5	21	47.7	16
Great Britain	49.7	21	61.2	14	47	17	40.7	27
The Republic of Korea	60.1	7	78.1	1	48.3	15	54	8
Netherlands	61	5	61.4	13	54.8	10	66.9	2
Finland	61	6	66	7	70.1	3	46.7	17
Singapore	62.7	3	65.3	10	52	13	70.7	1
Denmark	55.2	11	65.8	8	58.6	7	41.1	26
Germany	54.5	12	65	12	54.2	12	44.3	21
France	50.4	19	61	16	40.9	23	49.3	13
China	54.3	13	77.7	2	31.3	32	53.9	9
Japan	57.3	10	65.2	11	46.4	18	60.3	3
Hong Kong	45.2	24	44.6	35	40.8	24	50.1	12
Israel	58.7	8	61.2	15	82.1	1	33	48
Mean	56.5	11.1	64.8	11.9	53.5	13.5	51.2	14.7
Variation coefficient	11.4	66.5	14.2	76.4	25.3	68.2	19.4	83.5

Source: compiled by the author based on data [43]

The leading countries of innovative development achieved the greatest success in the direction of providing business sophistication in terms of the «Knowledge workers» (Knowledge-intensive employment, %; Firms offering formal training, %; GERD performed by business, % GDP; GERD financed by business, %; Females employed w/advanced degrees, %), which indicates the

success of structural transformations of economies countries of this group – their innovative reorientation. Thus, the average assessment of the leading countries in innovative development for this parameter is 64.8 %, the coefficient of variation is 14.2 %.

In addition, the leading countries in innovative development demonstrated comparative performance in the direction of the development of Innovation links. Thus, the average rating of the leading countries in innovative development in terms of the Knowledge workers» (Knowledge-intensive employment, %; Firms offering formal training, %; GERD performed by business, % GDP; GERD financed by business, %; Females employed w/advanced degrees, %) is 53.5, the coefficient variations – 25.3 %.

Comparative success of the leading innovative development countries in terms of «Knowledge absorption» (Intellectual property payments, % total trade; High-tech imports, % total trade; ICT services imports, % total trade; FDI net inflows, % GDP; Research talent, % in businesses) is not very high. Thus, the average score of the countries of this group in terms of the Knowledge absorption parameter is 51.2, the coefficient of variation is 19.4 %.

Comparison of the performance of the leading countries in innovative development in terms of «Knowledge and technology outputs» and «Creative outputs» suggests that the leading countries in innovative development are more successful in the first parameter. Thus, the average rating of the leading countries in the innovation rating for the Knowledge and technology outputs parameter is 49.5, and for the Creative outputs parameter – 48.8. However, the scores of countries in the Knowledge and technology outputs parameter differ more in the averages of this group than the scores in the Creative outputs parameter, 24.9 % and 17.1 %, respectively (**Table 6.8**).

The innovation leader countries achieved the greatest success in terms of «Knowledge creation» (Patents by origin/bn PPP\$ GDP; PCT patents by origin/bn PPP\$ GDP; Utility models by origin/bn PPP\$ GDP; Scientific and technical articles/bn PPP\$ GDP; documents H-index). Thus, the average assessment of this group of countries for this parameter is 56.7, the coefficient of variation is 37.4, which indicates that the assessments of countries are quite differentiated in this parameter. In addition, innovative leader countries are relatively successful in knowledge diffusion. Thus, the average assessment of the leading countries of innovative development in terms of the Knowledge diffusion parameter is 49.1, the coefficient of variation is 34 %.

Compared with a lower level of efficiency, the efforts of the leading countries in innovative development are characterized by the «Knowledge impact» (Labor productivity growth, %; New businesses/th pop.; Software spending, % GDP; ISO 9001 quality certificates/bn PPP\$ GDP; High-tech manufacturing, %) – the average score is 42.6, coefficient of variation – 14.7 %. Such results give grounds to assert that, despite significant asymmetries in the levels of success of the leading countries in innovative development in terms of the Knowledge creation and Knowledge diffusion parameters, they are characterized by fairly similar results in the Knowledge impact parameter.

Innovative leader countries are quite successful in terms of «Intangible assets» (Trade-marks by origin/bn PPP\$ GDP; Global brand value, top 5,000, % GDP; Industrial designs by

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origin/bn PPP\$ GDP; ICTs and organizational model creation). The average rating of the group of countries-innovation leaders for this parameter is 54.3 points, the coefficient of variation is 25.2 %. In addition, some of the leading countries are characterized by certain successes in the «Online creativity» parameter (Generic top-level domains (TLDs)/th pop. 15–69; Country-code TLDs/th pop. 15–69; Wikipedia edits/mn 15–69, Mobile app creation/bn PPP\$ GDP (**Table 6.9**).

The average rating of the leading countries in the innovation rating for this parameter is 49.2 %, the coefficient of variation is 41.5 %. The leading countries in the innovation rating are mainly characterized by average scores for the «Creative goods and services» (Cultural and creative services exports, % total trade; National feature films/mn pop. 15–69; Entertainment and media market/th pop. 15–69; Printing and other media, % manufacturing; Creative goods exports, % total trade) – 37.5, coefficient of variation 30 %.

● **Table 6.8** Features of innovative ecosystems of the leading countries in innovative development in 2021 (Knowledge and technology outputs parameter)

Countries	Knowledge and technology outputs		Knowledge creation		Knowledge impact		Knowledge diffusion	
	grade	place	grade	place	grade	place	grade	place
Switzerland	63.9	1	86.6	1	55.4	2	49.7	12
Sweden	60.3	2	78.4	2	44.1	14	58.4	6
UAE	22.2	59	5.9	105	29.5	65	31.3	32
Great Britain	52.3	10	65	8	43.1	19	48.9	15
The Republic of Korea	54.5	8	66.1	7	40.0	23	57.2	7
Netherlands	54.8	7	67.7	6	43.1	18	53.5	8
Finland	56.5	5	62.5	9	39.2	26	67.9	3
Singapore	48.1	13	35.5	28	46.7	11	62.1	4
Denmark	47.6	14	61.5	10	45.1	13	36.2	24
Germany	53.3	9	69.5	5	43.8	15	46.5	19
France	44.3	16	44.8	19	41.5	22	46.7	18
China	58.5	4	70.5	4	52.2	5	52.9	9
Japan	48.3	11	58.3	11	35.1	43	51.5	11
Hong Kong	21.6	62	24.2	40	38.4	31	2.3	128
Israel	55.9	6	53.8	12	42.2	21	71.8	2
Mean	49.5	15.1	56.7	17.8	42.6	21.9	49.1	19.9
Variation coefficient	24.9	125.0	37.4	147.6	14.7	71.5	34.0	156.3

Source: compiled by the author based on data [43]

● **Table 6.9** Features of innovative ecosystems of the leading countries in innovative development in 2021 («Creative outputs» parameter)

Countries	Creative outputs		Intangible assets		Creative goods and services		Online creativity	
	grade	place	grade	place	grade	place	grade	place
Switzerland	60.2	2	63.4	5	47.5	3	66.3	4
Sweden	52.9	5	57.3	8	33	19	63.7	7
UAE	33.8	40	33.1	55	55.5	2	18.4	64
Great Britain	54.4	4	56	10	44.8	6	59	10
The Republic of Korea	52.1	8	74.1	1	32.4	20	28.1	37
Netherlands	52.2	7	51.4	16	36	18	70.1	3
Finland	42.9	16	44.4	32	24.1	41	58.8	11
Singapore	42.9	17	40.2	40	39	13	52.1	19
Denmark	47.7	13	47.2	23	32.1	21	64.3	6
Germany	50	11	58.4	6	25.6	36	57.9	13
France	52.6	6	68.9	3	27.5	30	45.3	25
China	46.5	14	70.9	2	40	11	4.3	125
Japan	42.1	18	56.9	9	29.6	25	24.9	46
Hong Kong	64.7	1	64.7	4	63.7	1	65.7	5
Israel	36.3	30	27.5	75	31.2	23	59	9
Mean	48.8	12.8	54.3	19.3	37.5	17.9	49.2	25.6
Variation coefficient	17.1	83.3	25.2	114.6	30.0	67.9	41.5	127.7

Source: compiled by the author based on data [43]

Thus, the innovative ecosystems of the leading countries in innovation ratings are characterized by the comparative effectiveness of the institutional component, primarily the stability of the political and business environment; relatively high efficiency of the functioning of the infrastructure, which contributes to the innovative development, first of all, of the information and telecommunications infrastructure; relatively high efficiency of market development, primarily Trade, diversification, and market scale; relatively high efficiency of the policy aimed at the development of human capital and research, in the first place, funding for research and development from both the state and enterprises.

Taking into account all of the above, the effectiveness of the institutional and business environment, the efficiency of infrastructure functioning, incl. innovative; the effectiveness of economic restructuring and market development and the effectiveness of the state policy for the

development and use of human capital. Therefore, the security parameters of innovative ecosystems are determined by the peculiarities of the innovative development of countries, the ability of the innovative component to serve as a source of ensuring the implementation of national interests and national security. Under such conditions, the gap between the parameters of functioning and development of innovative ecosystems of the countries of the world and the corresponding parameters of the leading countries in innovative development is an important indicator of the country's ability to ensure the implementation of national interests in the face of escalating competition in the geo-economic and geopolitical arena. The smaller the gap, the more the country has a chance to realize its national interests and ensure national security, and vice versa, the larger the gap, the greater the risk of inability to ensure the implementation of national interests, national security.

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## 7

## ASSESSING SECURITY AND PROTECTION IN GLOBAL TOURISM

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## ABSTRACT

The methodologies and approaches to measuring security and security in global tourism, proposed by the international organizations International SOS and the World Economic Forum, as well as The Institute for Economics & Peace, are considered.

4 rating scales of the countries of the world by the international organization International SOS were highlighted using the interactive Travel Risk Map on risks to the health and security of tourists and travelers, namely: «COVID-19 domestic operations impact scale», «COVID-19 inbound travel impact scale», «Medical risk ratings scale», «Security risk rating scale».

The calculation methodology, full descriptions and sources of indicators of pillars «Security and Security» and «Health and Hygiene» of Travel & Tourism Development Index are given. Identified and analyzed the 10 most and least safe and reliable countries in the world to travel on pillars «Security and Security» and «Health and Hygiene» in the Travel & Tourism Development Index. The distribution of the sub-regions of the world according to the indicated components has been carried out.

The Global Peace Index framework and the methodology for its calculation are given. A map of the distribution of the countries of the world according to the Global Peace Index has been constructed. To assess the security of a tourist trip and conduct a tourism business in a particular state of the world, the criteria for evaluating and determining indicators are described that allow calculating the «Ongoing Domestic and International Conflict» and «Societal Security and Security» domains by Global Peace Index. 10 most and least peaceful countries were identified and analyzed by «Ongoing Domestic and International Conflict» and «Societal Security and Security» domains.

## KEYWORDS

Security, protection, global tourism, international tourism, rating of countries of the world, rating of countries of the world, COVID-19, risks.

## 7.1 INTERNATIONAL SOS TRAVEL RISK MAP

«Security and protection are vital to the quality of tourism. More than any other economic activity, the success or failure of a tourist destination depends on the ability to provide a safe and secure environment for visitors» [1].

Hence, security and security are critical factors in determining the success of the tourism and travel sector in a country. Existing approaches to measuring security and security in global tourism make it possible to determine the extent to which local residents, tourists and businesses are affected by diverse risks and security threats. In addition to creating barriers to investment in the tourism and travel sector, countries with a high level of crime, violence, and epidemiological threat scare away visitors, making these places less attractive for the development of the tourism industry [2].

A comprehensive tool for assessing and measuring a wide range of security risks and threats in tourism are international interactive platforms such as the International SOS Travel Risk Map and international ratings compiled by international organizations [3] based on generally recognized indices that serve as a reliable source of global comparable data. In addition, a number of reports from international organizations reveal certain problematic issues of security and protection in international tourism. Key among them are: «Tourist security and security: practical measures for destinations» [1], «Global guidelines for safe & seamless traveler journey» [4], «Tourism as a Driver of Peace» [5], «Safe and seamless travel and improved traveler experience» [6], International Code for the Protection of Tourists [7], and a number of World Travel & Tourism Council protocols to support the sector in achieving an effective recovery from COVID-19 by developing meaningful action plans that optimize efforts for sector-wide recovery [8–18].

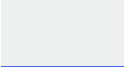



The international organization International SOS provides access to an interactive Travel Risk Map [19] to help organizations and individual travelers better understand the risks in the tourism markets of the countries where they work and travel. International SOS Travel Risk Map is providing 4 underlying health and security risk ratings for each location:

1) COVID-19 home operations impact stroke represents the potential overall impact of disease on operating within a certain location<sup>1</sup>. This is in recognition that the advent of the pandemic has introduced a new variable to all operations – including both office and site-based work. An algorithm that defines a stroke analyzes the underlying health and security threat environment, the recent COVID-19 case active as well as trends of new cases, local travel restrictions, mitigation measures in place [19]. According to the COVID-19 domestic operations impact scale, countries are ranked according to the following scale, each interval of which corresponds to a color-coded interactive map:

	Very low – health and security constraints to business operations are broadly similar to pre-COVID-19.
	Low – COVID-related precautions and restrictions causing some inconvenience to business operations. Most businesses are operating.
	Medium – COVID-related impacts posing routine challenges to business operations.
	High – essential businesses operational but with significant disruption.
	Very high – business operations are severely restricted with only essential services operating.

2) The COVID-19 inbound travel impact scale represents the logistical impact of the disease in travelling to a certain location (i.e. inbound travel). The algorithm which defines the scale analyses the inbound travel restrictions such that locations with a higher score will have progressively more restrictive entry requirements [19]. According to the COVID-19 inbound travel impact scale, countries are ranked according to the following scale, each interval of which corresponds to a color-coded interactive map:

Very low – no restrictions on inbound travel.


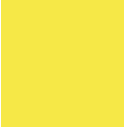
	Low – inbound travel is broadly possible with some inconvenience. Restrictions affect a limited range of travelers.
	Medium – inbound travel is possible, but with no inconvenience; restrictions affect a wide range of travelers.
	High – inbound travel significantly restricted for most travelers.
	Very high – inbound travel is generally not possible. Government authorities may grant exceptions to specific travelers.

3) International SOS assigns medical risk ratings based on the evolution of the pandemic. The rating must be interpreted in conjunction with the COVID-19 domestic operations scale and the COVID-19 cases status. For locations in outbreak status, even the best healthcare systems may be overwhelmed, limiting access to medical care, and the risk of infection in the general community is increased [19].

The medical risk ratings are based on a range of health risks and mitigating factors, including but not limited to: COVID-19 complexity of accessing and provisioning healthcare, infectious disease, environmental factors linked to climate change, security risk rating, medical evacuation data, standard of emergency medical services, outpatient and inpatient medical care, access to quality pharmaceutical supplies, and cultural, language or administrative barriers.

An overall single rating is given for a location; however, the medical landscape can vary widely. For example, major cities may have better access to quality medical care; whereas remote or rural locations may have limited availability of health facilities and specialist care [19].

According to medical risk ratings, countries are ranked according to the following scale, each interval of which corresponds to an interactive map of a certain color:

	Low medical risk – quality medical care is available throughout the country. Specialist care, emergency and dental services, and quality prescription drugs are widely available. Low risk of infectious diseases.
	Medium medical risk – quality medical care is available from selected providers. Reliable emergency services, limited specialist and dental care are usually available. Some risk of food or water-borne diseases. Potentially life-threatening infectious diseases such as malaria and typhoid may be present.

Variable medical risk – significant variation of travel medical risk: Quality medical care, emergency services, and dental care is available from selected providers in major cities, including prescription drugs. Elsewhere: availability of these services may be limited. Similarly, exposure to food, water-borne or potentially life-threatening infectious diseases may vary.

High medical risk – basic emergency services, medical and dental care may be available. Specialist care is limited even in major cities. A wide range of quality prescription drugs may not be available. Food and water-borne infections are common. Potentially life-threatening infectious diseases such as malaria, typhoid and cholera may persistently pose a threat.

Very high medical risk – healthcare is almost non-existent or severely overtaxed. There may be very limited or no primary care, emergency care or dental services. Quality prescription drugs are frequently unavailable. Food and water-borne infections are common. Potentially life-threatening infectious diseases such as malaria and cholera may be persistently present and large outbreaks may occur.


4) The security risk rating evaluates the threat posed to employees by political violence (including terrorism, insurgency, politically motivated unrest and war), social unrest (including sectarian, communal and ethnic violence) as well as violent and petty crime. Other factors, such as the robustness of the transport infrastructure, the state of industrial relations, the effectiveness of the security and emergency services and the country's susceptibility to natural disasters are also considered where they are of sufficient magnitude to impact the overall risk environment for employees [19].

According to the security risk rating, countries are ranked according to the following scale, each interval of which responds to interactive and maps of a certain color:


Insignificant security risk – rates of violent crime are very low. There is no significant political violence or civil unrest and little sectarian, communal, racial or targeted violence against foreigners. Security and emergency services are effective and infrastructure is sound. Transport services are of a high standard with good security records and only occasional travel disruption. Industrial action affecting essential services is rare.

Low security risk – violent crime rates are low and racial, sectarian or political violence or civil unrest is uncommon. If terrorism is a threat, groups have limited operational capabilities, and acts of terrorism are rare. Security and emergency services are effective and infrastructure is sound. Industrial action and transport disruption are infrequent.

Medium security risk – periodic political unrest, violent protests, insurgency and/or sporadic acts of terrorism occur. Travelers and international assignees may face risk from communal, sectarian or racial violence and violent crime. Capacity of security and emergency services and infrastructure varies. Industrial action can disrupt travel.



High security risk – protests are frequently violent and may target or disrupt foreigners; they may be exacerbated by governance issues, including security or law and order capacity. Violent crime and terrorism pose significant direct or incidental risks to travelers and international assignees. Communal, sectarian or racial violence is common and foreigners may be directly targeted. Certain parts of the country are inaccessible or off-limits to the traveler.



Extreme security risk – government control and law and order may be minimal or non-existent across large areas. Serious threat of violent attacks by armed groups targeting travelers and international assignees. Government and transport services are barely functional. Large parts of the country are inaccessible to foreigners.

The combination of these rating results in a comprehensive overview of health, security and COVID-19 risks in a destination, determination of the amount of travel risk mitigation or mitigation efforts required, assessment of tourism business opportunities in a country, etc.

## 7.2 PILLARS «SECURITY AND SECURITY» AND «HEALTH AND HYGIENE» OF THE TRAVEL & TOURISM DEVELOPMENT INDEX

The Travel & Tourism Development Index (TTDI) is an evolution of the 15-year-old Travel & Tourism Competitiveness Index (TTCI) series, a flagship index of the World Economic Forum's Platform for Shaping the Future of Mobility.

The index provides a strategic benchmarking tool for business, governments, international organizations and others to develop the T&T sector. By allowing cross-country comparison and by benchmarking countries' progress on the drivers of T&T development, it informs policies and investment decisions related to the development of T&T businesses and the sector as a whole. The index provides unique insights into the strengths and areas for development of each country to support their efforts to enhance the long-term growth of their T&T sector in a sustainable and resilient manner. Furthermore, it provides a valuable platform for multistakeholder dialogue to formulate appropriate policies and actions at local, national, regional and global levels [20].

The index is comprised of five subindexes, 17 pillars and 112 individual indicators, distributed among the different pillars (**Fig. 7.1**). However, the five subindexes are not factored into the calculation of the index and are used only for presentation and categorization purposes [21].

These 17 pillars are comprised of 112 indicators that are calculated on the basis of data derived from the Executive Opinion Survey (the Survey) as well as quantitative data from other sources. The survey data is derived from responses to the World Economic Forum's Executive Opinion Survey and ranges in value from 1 (worst) to 7 (best).

The TTDI is calculated as an average (arithmetic mean) of the 17 component pillar averages (arithmetic means). While figures for the five subindexes are provided, they are used for

categorization and presentation purposes only. Each of the pillars is calculated as an unweighted average of the individual component variables.

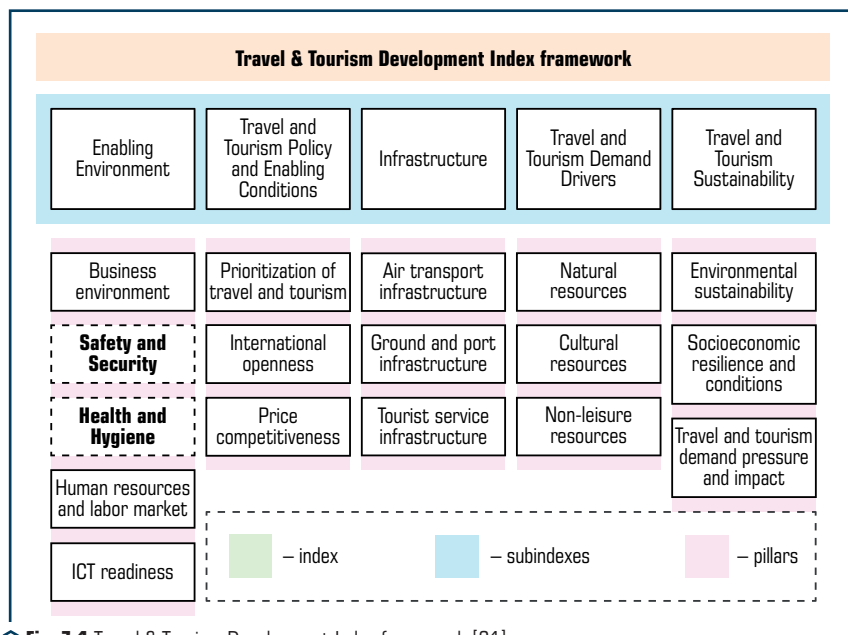


Fig. 7.1 Travel & Tourism Development Index framework [21]

The components by which it is possible to assess the safety of a tourist trip to a particular country are Pillars «Security and Security» and «Health and Hygiene» of the «Enabling Environment» sub-index.

Pillar «Security and Security» (6 indicators). Security and security are critical factors in determining the success of a country's T&T sector. This pillar measures the extent to which a country exposes locals, tourists and businesses to security risks. In addition to creating barriers to T&T investment, countries with a high incidence of crime or violence are likely to deter visitors, making it less attractive to develop the T&T sector in those places. Here, the costliness and occurrence of common crime and violence, police reliability, and terrorism and armed conflict are considered [21].

Pillar «Security and Security» is calculated as an unweighted average of 6 indicators (Fig. 7.2). The data used in the calculation of the pillars includes data derived from the Executive Opinion Survey as well as statistical data from other organizations. In the case of indicators derived from the Executive Opinion Survey (the Survey), the full question and associated answers are provided.

Research has shown that a sustainable and open tourism sector can be resilient to violence and conflict and that it can contribute to positive peace, namely the relationships, institutions and



structures that create and sustain peaceful societies. More precisely, the mechanisms by which tourism can achieve this include cultural and information exchange, the promotion of tolerance, better functioning of government, the development of human capital, and local and cross-border economic benefits, which can reduce risks to the world [5].

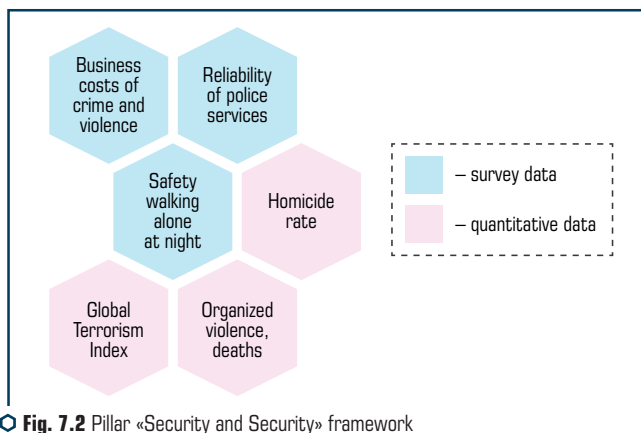


Fig. 7.2 Pillar «Security and Security» framework  
Source: compiled by the authors according to the data [21]

The Travel & Tourism Development Index data, namely Pillars «Security and Security», shows that the Top 10 countries for this component include countries with high-income economies with a diversified regional location. The Asia-Pacific region is represented by Singapore (1<sup>st</sup> place in the rating; 6.7 points). Middle East and North Africa is represented by United Arab Emirates (2<sup>nd</sup> place in the rating; 6.5 points) and Qatar (5<sup>th</sup> place in the rating; 6.4 points). Europe and Eurasia is represented by Iceland (3<sup>rd</sup> place in the rating; 6.5 points), Switzerland (4<sup>th</sup> place in the rating; 6.4 points), Finland (6<sup>th</sup> place in the rating; 6.4 points), Luxembourg (7<sup>th</sup> place in the rating; 6.3 points), Austria (8<sup>th</sup> place in the rating; 6.3 points), Slovenia (9<sup>th</sup> place in the rating; 6.3 points) and Estonia (10<sup>th</sup> place in the rating; 6.3 points) (**Table 7.1**).

TTDI data for 2021 shows that the Americas, Sub-Saharan Africa and South Asia tend to have the lowest security and security scores, creating an additional hurdle for the future development of the tourism and travel sector in these destinations. The less developed economies of the regions require significant investment in mobility and infrastructure services, especially for land transport, as well as a marked need for increased international openness. Moving up 3 places in the ratings compared to 2020 and being at the bottom of the ratings, Mexico was rated 2.39 points out of 7 possible. 116 place Nigeria with 2.85 points (position change in the rating (+1)). By a margin of 0.29 points ahead of Mali (3.14 points; -3 in the ratings). 114<sup>th</sup> place – Venezuela (3.15 points; +1 in the rating), 113<sup>th</sup> place – Yemen (3.18 points; +3 in the rating), 112<sup>th</sup> place – South Africa (3.51 points; +1 in the rating), 111<sup>th</sup> place – Colombia (3.77 points; no change in rating),

110<sup>th</sup> place – Honduras (3.82 points; –4 in the rating), 109<sup>th</sup> place – Brazil (3.86 points; +1 in the rating), 108<sup>th</sup> place – Cameroon (3.87 points; +1 in rating).

● **Table 7.1** Rating of countries in the world according to Pillars «Security and Security» of The Travel & Tourism Development Index, 2021

Rank	Economy	Score	Rank change	Rank	Economy	Score	Rank change
1	Singapore	6.7	=	...	...		
2	United Arab Emirates	6.5	↑1	<b>108</b>	Cameroon	3.87	↑1
3	Iceland	6.5	↑1	<b>109</b>	Brazil	3.86	↑1
4	Switzerland	6.4	↓2	<b>110</b>	Honduras	3.82	↓4
5	Qatar	6.4	=	<b>111</b>	Colombia	3.77	=
6	Finland	6.4	↑1	<b>112</b>	South Africa	3.51	↑1
7	Luxembourg	6.3	↑2	<b>113</b>	Yemen	3.18	↑3
8	Austria	6.3	↑4	<b>114</b>	Venezuela	3.15	↑1
9	Slovenia	6.3	↓1	<b>115</b>	Mali	3.14	↓3
10	Estonia	6.3	↑1	<b>116</b>	Nigeria	2.85	↑1
...	...			<b>117</b>	Mexico	2.39	↓3

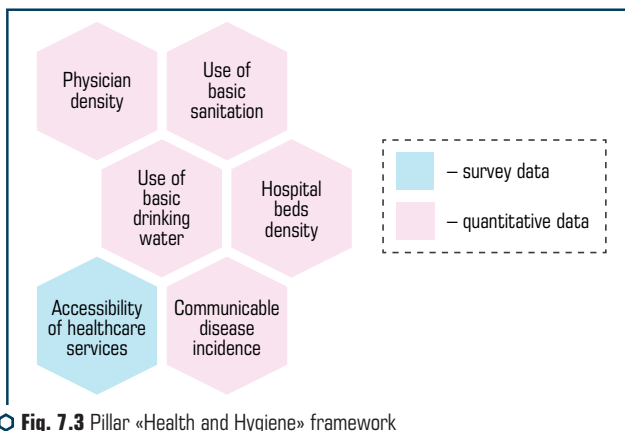
Source: compiled by the authors according to the data [20, 21]

Pillar «Health and Hygiene» (6 indicators). This pillar measures healthcare infrastructure, accessibility and health security. COVID-19 has highlighted the potential impact of communicable diseases on the T&T sector. In particular, the pandemic has demonstrated how important a country's healthcare system is when it comes to mitigating the impact of pandemics and ensuring safe travel conditions, and workforce availability and resilience. In general, if tourists or sector employees do become ill, the country's health sector must be able to ensure that they are properly cared for, as measured by the availability of and access to physicians, hospital beds and general healthcare services. Moreover, access to safe drinking water and sanitation is important for the comfort and health of travelers and locals alike. Please note that due to evolving COVID-19 conditions, this pillar does not track the pandemic itself [21].

Pillar «Health and Hygiene» is calculated as an unweighted average of 6 indicators (**Fig. 7.3**).

The COVID-19 pandemic highlights how important health and security conditions are to protect the openness that the tourism and travel sector relies on and to restore consumer confidence in travel. Countries with advanced health systems are better equipped to mitigate the impact of pandemics on the tourism and travel sector and the economy as a whole by protecting the public, including sector workers and visitors, thus reducing the need for travel restrictions and blockages. The highest three positions in the rating of countries in the pillars «Health and Hygiene» in 2021 are occupied by Austria, Germany, Czech Republic without changes in relation to the previous year with marks of 6.83; 6.54; 6.41 points in accordance with the 7 maximum possible. Moving up 5 steps compared to 2020, Belgium is in 4<sup>th</sup> place with 6.39 points. 5<sup>th</sup> place belongs to Switzer-

land with 6.30 points (change of position in the rating (–1)), 6<sup>th</sup> place – France (6.22 points; –1 in the rating), 7<sup>th</sup> place – Lithuania (6.21 points; +4 in the rating), 8<sup>th</sup> place – Finland (6.15 points; –1 in the rating), 9<sup>th</sup> place – Japan (6.08 points; –3 in the rating), 10<sup>th</sup> place – Republic of Korea (6.08 points; no change in rating) (**Table 7.2**).



● **Fig. 7.3** Pillar «Health and Hygiene» framework  
Source: compiled by the authors according to the data [21]

● **Table 7.2** Rating of countries in the world according to Pillars «Health and Hygiene» of The Travel & Tourism Development Index, 2021

Rank	Economy	Score	Rank change	Rank	Economy	Score	Rank change
1	Austria	6.83	0	...	...		
2	Germany	6.54	0	<b>108</b>	Ghana	2.47	↓3
3	Czech Republic	6.41	0	<b>109</b>	Tanzania	2.36	↑1
4	Belgium	6.39	↑5	<b>110</b>	Cameroon	2.31	↑1
5	Switzerland	6.30	↓1	<b>111</b>	Malawi	2.26	↓2
6	France	6.22	↓1	<b>112</b>	Angola	2.24	0
7	Lithuania	6.21	↑4	<b>113</b>	Nigeria	2.17	0
8	Finland	6.15	↓1	<b>114</b>	Benin	2.13	↑1
9	Japan	6.08	↓3	<b>115</b>	Côte d'Ivoire	2.04	↓1
10	Korea Rep.	6.08	=	<b>116</b>	Sierra Leone	1.65	=
...	...			<b>117</b>	Chad	1.58	=

Source: compiled by the authors according to the data [20, 21]

By regional affiliation, 8 countries from the Top 10 according to pillars «Health and Hygiene» belong to the Europe and Eurasia macro-region, 2 countries to the Asia-Pacific region. The econ-

omies of these countries correspond to the «High-income economies» group. Insufficient infrastructure and limited access to health and hygiene are a major challenge for many countries, with low-income and lower-middle-income countries performing 50.0 % and 25.6 % below average in the Health and Hygiene component. The lowest position in the rating of countries in the pillars «Health and Hygiene», namely 117<sup>th</sup> place, is occupied by Chad for the second year in a row with a score of 1.58 out of 7 possible. At 116<sup>th</sup> place is constantly Sierra Leone with a mark of 1.65. 115<sup>th</sup> place belongs to Côte d'Ivoire with 2.04 points (position change in the rating (-1), 114<sup>th</sup> place belongs to Benin (2.13 points; +1 in the rating), 113<sup>th</sup> place belongs to Nigeria (2.17 points; without changes in the rating), 112<sup>th</sup> place – Angola (2.24 points; no change in the rating), 111<sup>th</sup> place – Malawi (2.26 points; -2 in the rating), 110<sup>th</sup> place – Cameroon (2.31 points; +1 in rating), 109<sup>th</sup> place – Tanzania (2.36 points; +1 in the rating), 108<sup>th</sup> place – Ghana (2.47 points; -3 in the rating). All of these countries belong to the Sub-Saharan Africa region and are predominantly lower-middle-income economies. These countries lack doctors and hospital beds (in relation to population), as well as access to basic sanitation and drinking water, and these problems, combined with low vaccination rates, mean that it will be difficult for these countries to build adequate resistance to future. health risks for both the local population and tourists and travelers. The COVID-19 pandemic has underlined that it is critical to the success of the global travel and tourism sector that vaccine distribution and uptake issues be addressed in an equitable and inclusive manner, inclusive of developing countries.

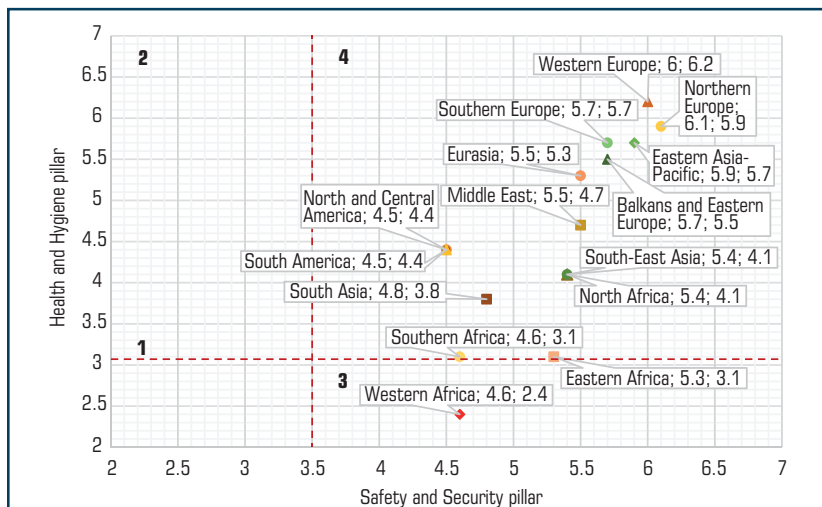
Since the issue of determining, assessing and interpreting security risks and threats in global tourism is relevant both in the country and in the regional context [22], let's build a polyfactor diagram of the location of the world's subregions in terms of the components «Security and Security» (horizontal axis) and «Health and Hygiene» (vertical axis) (**Fig. 7.4**).

Diagram visually allows to compare the subregions with each other and compare the progress achieved by the indicated components. 15 sub-regions according to the classification of the World Economic Forum were chosen as the objects of study, namely: South America, North and Central America, Eastern Asia-Pacific, South Asia, South-East Asia, Balkans and Eastern Europe, Eurasia, Northern Europe, Southern Europe, Northern Europe, Central North, North Africa, North Africa, South Africa, Western Africa. Conditionally dividing the chart field into 4 equivalent intervals:

- 1)  $H\&H \leq 3.5$ ;  $S\&S \leq 3.5$ ;
- 2)  $3.5 < H\&H \leq 7$ ;  $S\&S \leq 3.5$ ;
- 3)  $H\&H \leq 3.5$ ;  $3.5 < S\&S \leq 7$ ;
- 4)  $3.5 < H\&H \leq 7$ ;  $3.5 < S\&S \leq 7$ .

We get data for grouping and comparison. These diagrams allow us to state that the first and second interval groups remained completely empty, while group 4 is oversaturated with subregions that have rather heterogeneous indicators for the «Security and Security» and «Health and Hygiene» components. Analyzing the sub-regions that fell into 4 interval groups, it is advisable to single out the leading regions, which include high-income countries and whose estimates for the «Security and Security» and «Health and Hygiene» components are closer to the maximum possible.

These include Western Europe (6; 6.2), Northern Europe (6.1; 5.9), Southern Europe (5.7; 5.7), Eastern Asia-Pacific (5.9; 5.7). The regions of the lower right quadrant, namely Eastern Africa, Southern Africa, Western Africa, demonstrate the poor level of health, hygiene, security and security in the region. Overall, the Europe, Eurasia, and Asia-Pacific regions dominated the Security and Security and Health and Hygiene dimensions, while Sub-Saharan Africa showed the greatest improvement.



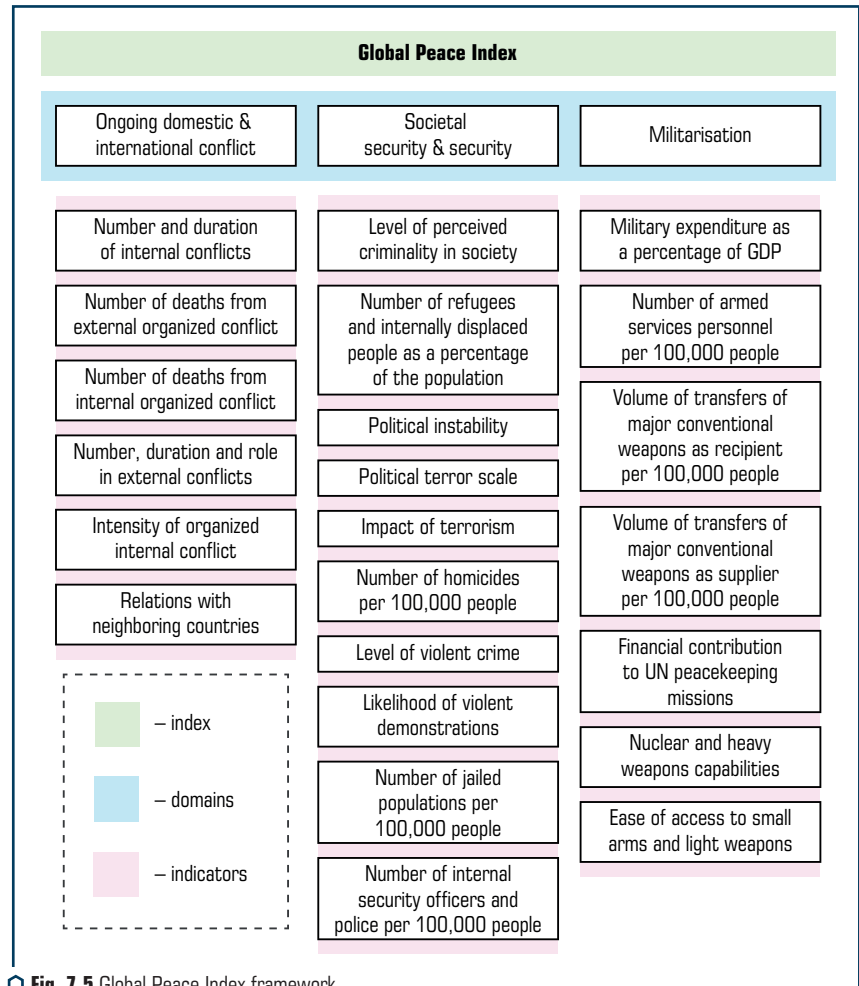
**Fig. 7.4** Distribution of world sub-regions by constituents according to «Security and Security» and «Health and Hygiene» of The Travel & Tourism Development Index in 2021  
*Source: compiled by the authors according to the data [21]*

### 7.3 GLOBAL PEACE INDEX: MEASURING PEACE IN A COMPLEX WORLD

The Global Peace Index (GPI) was founded by Steve Killelea, an Australian technology entrepreneur and philanthropist. It is produced by the Institute for Economics and Peace, a global think tank dedicated to developing metrics to analyze peace and to quantify its economic benefits [23].

The GPI measures a country's level of Negative Peace<sup>1</sup> using three domains of peacefulness: «Ongoing Domestic and International Conflict», «Societal Security and Security», «Militarisation» (Fig. 7.5). The GPI comprises 23 indicators of the absence of violence or fear of violence. All scores for each indicator are normalised on a scale of 1–5, whereby qualitative indicators are banded into five groupings and quantitative ones are scored from 1 to 5, to the third decimal point.

<sup>1</sup> Negative Peace is the absence of violence or fear of violence. Positive Peace is the attitudes, institutions & structures that create and sustain peaceful societies [23].



**Fig. 7.5** Global Peace Index framework

Source: compiled by the authors according to the data [24]

The first domain, «Ongoing Domestic and International Conflict», investigates the extent to which countries are involved in internal and external conflicts, as well as their role and duration of involvement in conflicts [23].

The second domain evaluates the level of harmony or discord within a nation; ten indicators broadly assess what might be described as Societal Security and Security. The assertion is that low crime rates, minimal terrorist activity and violent demonstrations, harmonious relations with

neighbouring countries, a stable political scene and a small proportion of the population being internally displaced or made refugees can be equated with peacefulness [24].

Seven further indicators are related to a country's Militarisation – reflecting the link between a country's level of military build-up and access to weapons and its level of peacefulness, both domestically and internationally. Comparable data on military expenditure as a percentage of GDP and the number of armed service officers per head are gauged, as are financial contributions to UN peacekeeping missions [24].

The average level of global peacefulness worsened by 0.07 % in the 2021 Global Peace Index. Despite a relatively small deterioration, this is the ninth time in the past 13 years that global peacefulness has worsened. 87 countries recorded an improvement in peacefulness, and 73 – a deterioration. Three countries recorded no change in their total scores. The Middle East and North Africa region remained the least peaceful region in the world. Three of the five least peaceful countries in the world are located here. However, it recorded the largest regional improvement in 2021. Europe remains the most peaceful region in the world. The region contains eight of the ten most peaceful countries, and no country in Europe is outside the top half of the index.

The most peaceful countries in the world in 2021 were: Iceland, New Zealand, Denmark, Portugal, Slovenia, Austria, Switzerland, Ireland, Czech Republic, Canada. The least peaceful countries in the world in 2021 were: Afghanistan, Yemen, Syria, South Sudan, Iraq, Somalia, Democratic Republic of the Congo, Libya, Central African Republic, Russia (**Fig. 7.6**).

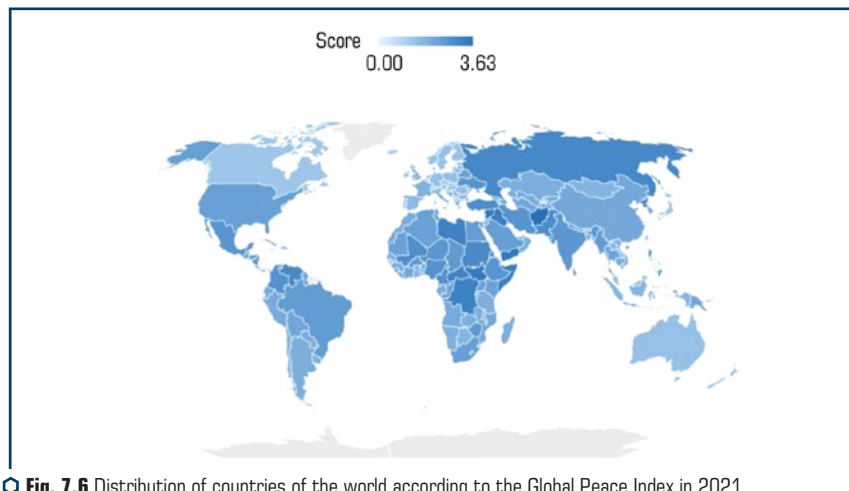


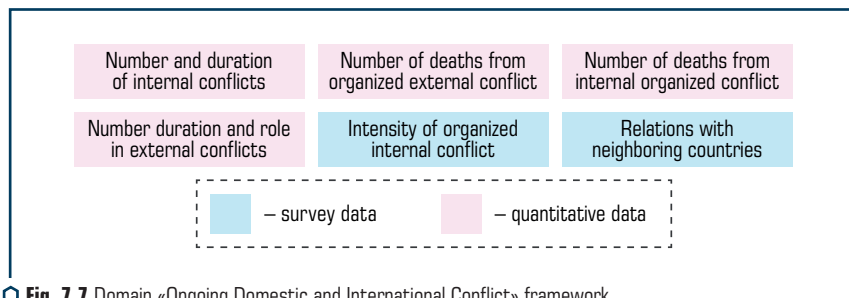
Fig. 7.6 Distribution of countries of the world according to the Global Peace Index in 2021

Source: compiled by the authors according to the data [24]

At the same time, to assess the security of a tourist trip and conduct a tourism business in a particular state of the world, it is more informative to use the indicators not of the Global

Peace Index as a whole, but of its two domains: «Ongoing Domestic and International Conflict» and «Societal Security and Security».

Domain «Ongoing Domestic and International Conflict» consists of 6 indicators (**Fig. 7.7**). All scores for each indicator are ranked or normalized on a scale from 1 to 5, with qualitative indicators grouped into five groups, and quantitative indicators continuously scored from 1 to 5 in the third decimal place.



**Fig. 7.7** Domain «Ongoing Domestic and International Conflict» framework

Source: compiled by the authors according to the data [24]

Domain Ongoing Domestic and International Conflict experienced the largest deterioration of any domain on the GPI, declining by 6.2 % between 2008 and 2021. A total of 83 countries recorded deterioration, with 65 countries reporting improvement and 13 countries not no changes registered. There are now more countries involved in at least one conflict compared to 2008. In 2008, 12 countries were not involved in any conflicts and had no disputes with neighboring countries. In 2021, this number has been reduced to 9 countries.

Top 10 most peaceful countries by domain «Ongoing Domestic and International Conflict» in 2021 opens Botswana unchanged from the previous year. In second place, having risen by 4 lines in the rating compared to 2020, is Bulgaria. Third place belonged to Iceland, which climbed up from 7<sup>th</sup> place in 2020. A record jump of 25 places in the ratings brought Ireland to 4<sup>th</sup> place. Fifth place without changes in relation to the previous year is occupied by Mauritius. The sixth and seventh positions belong to Singapore and Uruguay, respectively, however, due to a decrease in positions in the rating by 3 lines. Eighth place with a mark of 1.002 points is occupied by New Zealand. Close the Top-10 rating by domain «Ongoing Domestic and International Conflict» Canada and Switzerland with 1.004 and 1.005 points respectively (**Table 7.3**).

Since the consideration of ongoing internal and international conflicts is a prerequisite for planning and organizing both independent travel and package tours by tourism industry professionals, special attention must be paid to the least safe countries in this area. The last three lowest rating countries in the world for the domain «Ongoing Domestic and International Conflict» constantly hug Syria, Afghanistan and Yemen with scores of 3.828, 3.641 and 3.559 points respectively. 160<sup>th</sup> place belongs to Somalia with 3.474 points (change of position in the rating (–4)),



159<sup>th</sup> place – Libya with 3.3 points (change of position in the rating (–4)), 158<sup>th</sup> place – South Sudan with 3.267 points (change of position in rating (–4)). rating (–1)), 157<sup>th</sup> place – Pakistan with 3.256 points (change of position in the rating (+2)), 156<sup>th</sup> place – Democratic Republic of the Congo with 3.243 points (change of position in the rating (+4)), 155<sup>th</sup> place – Iraq with 3.162 points (change of position in the rating (+3)), 154<sup>th</sup> place without change of position in the rating belongs to Turkey with 3.159 points.

● **Table 7.3** 10 most and least peaceful countries by domain «Ongoing Domestic and International Conflict»

Rank	Country	Score	Rank change	Rank	Economy	Score	Rank change
1	Botswana	1	=	...	...		
2	Bulgaria	1	↑4	<b>154</b>	Turkey	3.159	=
3	Iceland	1	↑4	<b>155</b>	Iraq	3.162	↑3
4	Ireland	1	↑25	<b>156</b>	Democratic Rep. of the Congo	3.243	↑4
5	Mauritius	1	=	<b>157</b>	Pakistan	3.256	↑2
6	Singapore	1	↓3	<b>158</b>	South Sudan	3.267	↓1
7	Uruguay	1	↓3	<b>159</b>	Libya	3.3	↓4
8	New Zealand	1.002	↓1	<b>160</b>	Somalia	3.474	↓4
9	Canada	1.004	=	<b>161</b>	Yemen	3.559	=
10	Switzerland	1.005	↓2	<b>162</b>	Afghanistan	3.641	=
...				<b>163</b>	Syria	3.828	=

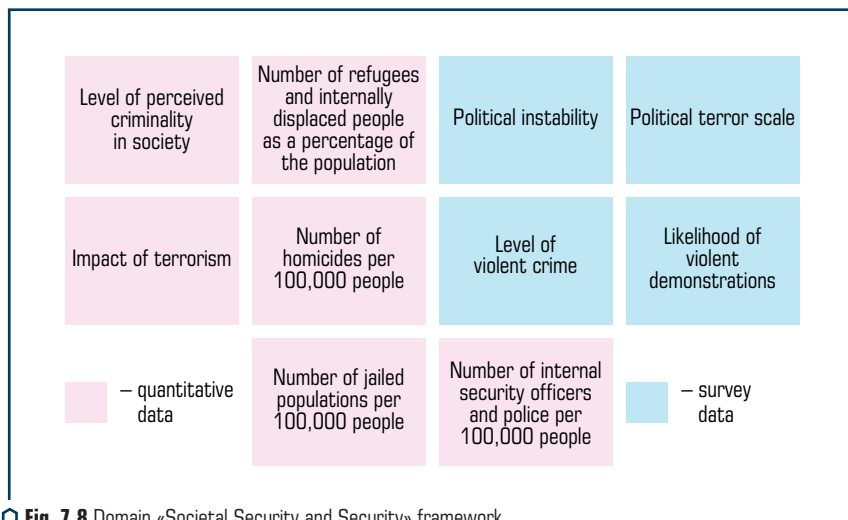
Source: compiled by the authors according to the data [24, 25]

For the vast majority of countries, societal security and «quality of life is a key indicator of sustainable development being as a desired outcome of service delivery in health care, social services and, increasingly, for cross-cutting public sector partnership policy at all levels» [26]. In this regard, the study of the domain «Societal Security and Security», which assesses the level of harmony or discord within the nation and consists of 10 indicators, 6 of which are quantitative («Level of perceived criminality in society», «Number of refugees and internally displaced people as a percentage of the population», «Impact of terrorism», «Number of homicides per 100,000 people», «Number of jailed populations per 100,000 people», «Number of internal security officers and police per 100,000 people»), 4 – qualitative («Political instability», «Political terror scale», «Level of violent crime», «Likelihood of violent demonstrations») (Fig. 7.8).

All scores for each indicator are ranked or normalized on a scale from 1 to 5, with qualitative indicators grouped into five groups, and quantitative indicators continuously scored from 1 to 5 in the third decimal place.

In 2021, Norway was ranked as the most peaceful crane by domain «Societal Security and Security» and with a score of 1,182 points and moving up in the rating by 3 notches, took first place.

Iceland, on the contrary, worsened its loans and lost the first place with 1,218 points. 3<sup>rd</sup> place and a score of 1.242 points in 2021 went to Switzerland. The 4<sup>th</sup> place belongs to Denmark with 1.258 and a positive change in the position in the rating by 2 lines (**Table 7.4**).



● **Fig. 7.8** Domain «Societal Security and Security» framework

Source: compiled by the authors according to the data [24]

● **Table 7.4** 10 most and least peaceful countries by domain «Societal Security and Security»

Rank	Country	Score	Rank change	Rank	Economy	Score	Rank change
1	Norway	1.182	↑3	...	...		
2	Iceland	1.218	↓1	<b>154</b>	Mali	3.528	↓3
3	Switzerland	1.242	↑2	<b>155</b>	Somalia	3.615	↑1
4	Denmark	1.258	↑2	<b>156</b>	Syria	3.657	↓1
5	Japan	1.292	↓2	<b>157</b>	Central African Republic	3.722	↑1
6	Singapore	1.308	↓4	<b>158</b>	Democratic Rep. of the Congo	3.881	↑1
7	Slovenia	1.350	↑5	<b>159</b>	Iraq	3.888	↑3
8	Finland	1.410	=	<b>160</b>	South Sudan	3.891	↑1
9	Portugal	1.443	=	<b>161</b>	Yemen	3.944	↓4
10	Sweden	1.455	↑4	<b>162</b>	Venezuela	4.089	↓2
...				<b>163</b>	Afghanistan	4.258	=

Source: compiled by the authors according to the data [24, 25]

The 5<sup>th</sup> place in the Top 10 countries by domain «Societal Security and Security» is occupied by Japan with 1.292, which has worsened its result compared to the previous year and by two rating positions. 6<sup>th</sup> place belongs to Singapore with 1.308 points (change of position in the rating (–4)). 7<sup>th</sup> place belongs to Slovenia with 1.350 points (change of position in the rating (–4)). The 8<sup>th</sup> and 9<sup>th</sup> places are occupied by Finland and Portugal without changing their positions compared to the previous year. 10<sup>th</sup> place belongs to Sweden, moving up from 14<sup>th</sup> position in 2020. For several years in a row, Afghanistan has been the least safe country in the world by domain «Societal Security and Security», followed by Venezuela (4.089 points; –2 rating positions), at a distance, Yemen (3.944 points; –4 rating positions) and South Sudan (3.891 points; +2 rating positions).

A comprehensive analysis of the indicators of these ratings and data from international interactive platforms provides access primarily to professionals, investors and other players in the global tourism business to objective information and allows you to analyze a combination of factors characterizing the level of social, economic, political security, as well as the level of military, terrorist, epidemiological threats to both an individual country and the whole region. In addition, the possession and ability to use diverse information on protection and security in international tourism by the subjects of tourism activities allows you to take preventive measures and timely inform about the threat to the security of tourists in the country (place, destination) of temporary stay, to provide the necessary assistance to the tourists in an emergency, provide tourists (sightseers) with the opportunity to freely receive medical, legal and other types of emergency assistance, access to communications, etc.

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**ABSTRACT**

The object of the study is the economic security of the enterprises of the hotel and restaurant business in Ukraine. To achieve certain goals, methods of theoretical generalization, analysis and synthesis, logical generalization, analogies, comparison, grouping, the method of taxonomic analysis, and system analysis were used.

Analyzed the current state of development of hotel and restaurant enterprises in Ukraine. The application of the taxonomy method for diagnosing the economic security of hotel and restaurant enterprises is substantiated. The indicators of economic security of enterprises in the hotel and restaurant industry are identified, grouped in key areas: production, market, intellectual and personnel, investment, material and technical and financial. The interpretation of the values of the integral taxonomic indicator of the economic security of hotel and restaurant enterprises in Ukraine is substantiated. In accordance with the value of the integral indicator, a division into five levels of economic security of enterprises is proposed, which correspond to certain strategies and management decisions for their implementation. An integral indicator of the economic security of hotel and restaurant enterprises was calculated using the taxonomy method for 2015–2020. Based on the results of the calculations, a conclusion was made about the uneven development of the hotel and restaurant industry in Ukraine and the existing problems in ensuring the economic security of domestic hotel and restaurant enterprises. The strategy for ensuring the economic security of hotel and restaurant enterprises is substantiated and managerial decisions for its implementation for the future period are proposed.

The applied nature of the proposed methodology is justified by its practical application according to the actual data of the enterprises of the hotel and restaurant business in Ukraine for 2015–2020.

**KEYWORDS**

Economic security, taxonomic analysis, hotel and restaurant business, economic security strategy.

## **8.1 BRIEF DESCRIPTION OF THE CURRENT STATE OF DEVELOPMENT OF HOTEL AND RESTAURANT ENTERPRISES IN UKRAINE**

The current stage of development of hotel and restaurant enterprises is characterized by the growth of internal and external threats, which are complemented by both local and global challenges. The COVID-19 pandemic, the difficult socio-economic conditions of operation, the deployment of

a military conflict, the reduction in tourist flow and other negative factors lead to the problem of ensuring the survival of hotel and restaurant enterprises. However, the reasons for the economic danger of hotel and restaurant enterprises are due not only to modern socio-economic and geopolitical challenges, but also to strategic mistakes in enterprise management. The above actualizes the problem of finding optimal models for assessing the level of economic security of hotel and restaurant enterprises and finding adequate management practices to ensure it.

The object of the study is the economic security of the enterprises of the hotel and restaurant business in Ukraine.

The aim of the study is to analyze the level of economic security of enterprises in the hotel and restaurant business and substantiate, on this basis, a strategy for ensuring the economic security of the enterprises under study for the future period.

To achieve the goals of the study, the following scientific tasks are defined: analysis of the dynamics of the main indicators of the activities of enterprises in the hotel and restaurant business; development of a conceptual descriptive model for taxonomic analysis of the economic security of enterprises in the hotel and restaurant business; formation of a data sample on the economic security of the enterprises of the hotel and restaurant business in Ukraine for 2015–2020; calculation of an integral indicator of the level of economic security of enterprises in the hotel and restaurant business using the taxonomy method; interpretation of the results of the analysis of the integral indicator of the level of economic security of enterprises in the hotel and restaurant business for 2015–2020; substantiation of the strategy for ensuring the economic security of the hotel and restaurant business for the future period.

The security of enterprises in the hotel and restaurant business is a multifaceted phenomenon and covers a wide range of areas: economic, fire, epidemiological, physical, etc. All areas of security are interconnected and actively interact, and the integrating core of this system is economic security. Under it, we mean the ability of an enterprise to develop and operate in a constantly changing internal and external environment that characterizes its sustainability.

The hotel and restaurant business, according to the current classification of types of economic activity of Ukraine, is identified as «temporary accommodation and catering». Therefore, the general indicators of the development of hotel and restaurant enterprises were analyzed.

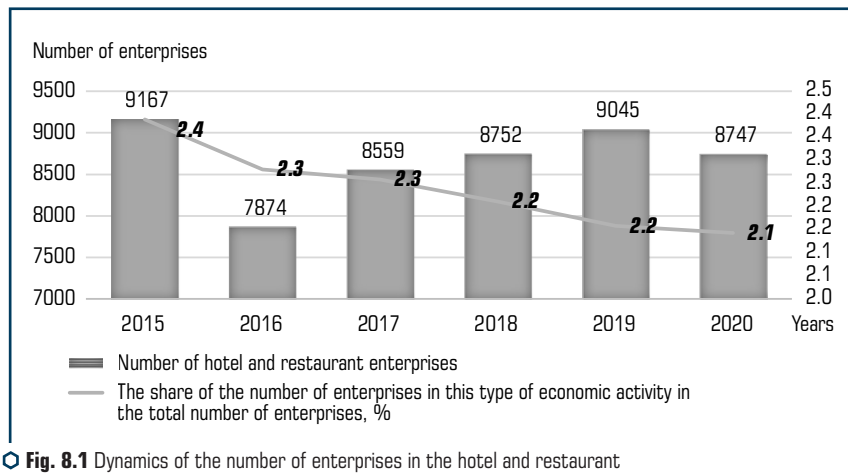
An analysis of the dynamics of the number of enterprises (**Fig. 8.1**) showed that during the study period it changed depending on external factors: military operations in the East of Ukraine, holding the Euro-2017 song contest; beginning of the COVID-19 pandemic. The share of companies in this industry slightly exceeds 2 % of the total number of companies.

According to the data in **Fig. 8.2** shows that the volumes of manufactured and sold products had a positive growth trend by 2019, after which we note a decline in work productivity due to the closure of hospitality enterprises and a decrease in demand under lockdown conditions.

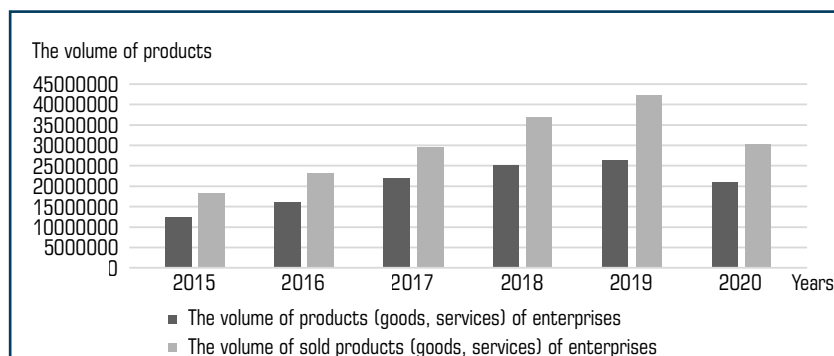
Measures to stabilize the situation on the market were not only the closure of hospitality enterprises, but also a decrease in the number of employees, reorientation to new forms of work, etc. Hotels and restaurants actively implemented new COVID security standards, vaccinated employees, and switched to contactless and takeaway services. The activities of institutions in

the face of a stalemate reduction in foreign visitors have increasingly reoriented themselves to the needs of the domestic consumer, the level of his solvency and needs.

Analysis of the dynamics of the number of employed workers at enterprises in the field of temporary accommodation and catering (**Table 8.1**) shows their growth in 2015-2020. The impact of the coronavirus pandemic led to a reduction in the number of employees in 2020 compared to the previous year by 18.1 %, which is lower even than in 2015. At the same time, there is a similar trend in labor productivity, and the reduction in 2020 was 2.3 %.



**Fig. 8.1** Dynamics of the number of enterprises in the hotel and restaurant business and their share in the total number of enterprises in Ukraine  
 Source: compiled by the authors according to the data [1]



**Fig. 8.2** The volume of manufactured and sold products by hotel and restaurant enterprises in Ukraine  
 Source: compiled by the authors according to the data [1]

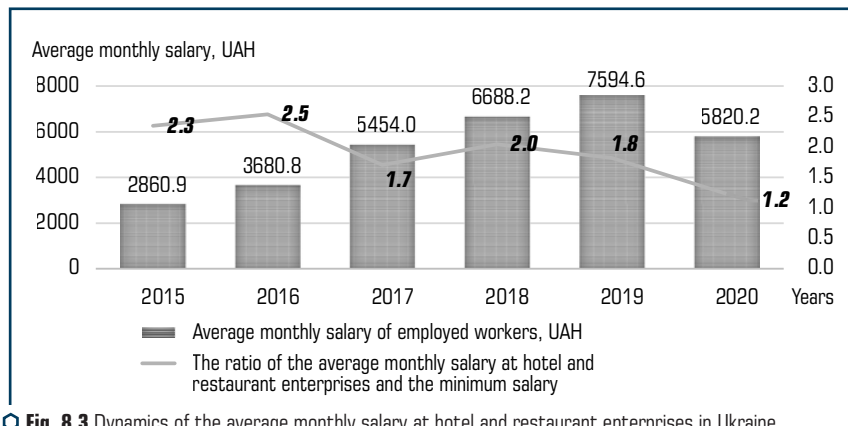


● **Table 8.1** Dynamics of the number of employed workers and their productivity at hotel and restaurant enterprises in Ukraine

Years	Number of employed workers at enterprises, persons	Labor productivity of employed workers, thousand UAH/person
2015	87854	140.63
2016	90264	178.47
2017	92881	236.89
2018	98721	254.04
2019	104852	250.96
2020	85861	245.27

Source: compiled by the authors according to the data [1]

The analysis of the average monthly salary at the hotel and restaurant enterprises of Ukraine is presented in **Fig. 8.3**.



● **Fig. 8.3** Dynamics of the average monthly salary at hotel and restaurant enterprises in Ukraine

Source: compiled by the authors according to the data [1]

During 2015–2019 there was an increase in the average monthly salary, while the level of wages in the industry was 1.7–2.5 times higher than the level of the minimum wage in the country. However, as a result of the coronavirus pandemic, hotel and restaurant enterprises have had to resort to cost savings, which led to a decrease in the average monthly salary by 24 % compared to the level of 2019. Given that the payroll is one of the largest expenses of enterprises, the effect.

The dynamics of the net profit of domestic enterprises in the field of temporary accommodation and catering (**Table 8.2**) indicates a negative dynamics of the indicator during 2015–2016 and in 2020. Since 2017, there has been a trend towards profit and its growth by 2.4 times in 2019.

Moreover, the decrease in the share of profitable enterprises in the industry from 71.6 % in 2015 to 70.5 % in 2019 is negative. According to the results of operations in 2020, the enterprises of the industry received a loss, and the share of unprofitable enterprises increased to 41.3 %, which is a consequence of the impact of the coronavirus pandemic.

As for the profitability of operating and all activities (Table 8.3), only in 2017–2019 it acquires positive values and grows, but in 2020 it decreased to the level of –7.9 %.

● **Table 8.2** Net profit of Ukrainian enterprises in the field of temporary accommodation and catering

Years	Total				
	net profit (loss), thousand UAH	enterprises that make a profit		enterprises that suffered losses	
		in % of the total number of enterprises	financial result, thousand UAH	in % of the total number of enterprises	financial result, thousand UAH
2015	–6874869.7	71.6	670590.8	28.4	7545460.5
2016	–1983088.8	71.4	1505475.1	28.6	3488563.9
2017	1773481.4	69.3	4034334.2	30.7	2260852.8
2018	2350861.6	71.1	3858602.2	28.9	1507740.6
2019	4245604.3	70.5	5745343.1	29.5	1499738.8
2020	–4410448.2	58.7	1841886.8	41.3	6252335.0

Source: compiled by the authors according to the data [1]

● **Table 8.3** Profitability of operating and activities of Ukrainian enterprises in the field of temporary accommodation and catering

Years	The level of profitability (loss) of the operating activities of enterprises					The level of profitability (loss) of all activities of enterprises				
	total	incl.				total	incl.			
		large enter-prises	medium enter-prises	small enter-prises	of which microen-terprises		large enter-prises	medium enter-prises	small enter-prises	of which microen-terprises
2015	–17.3	c	c	–13.1	–20.6	–22.6	c	c	–26.4	–44.2
2016	–0.8	c	c	–2.6	–6.4	–6.5	c	c	–11.3	–15.4
2017	7.8	c	c	–1.3	–4.3	5.0	c	c	–4.8	–8.3
2018	8.6	c	c	–0.2	–0.5	5.8	c	c	–2.3	–3.5
2019	10.1	c	c	2.4	1.5	9.3	c	c	1.1	0.3
2020	–7.9	c	c	–9.0	–8.7	–11.1	c	c	–15.2	–16.2

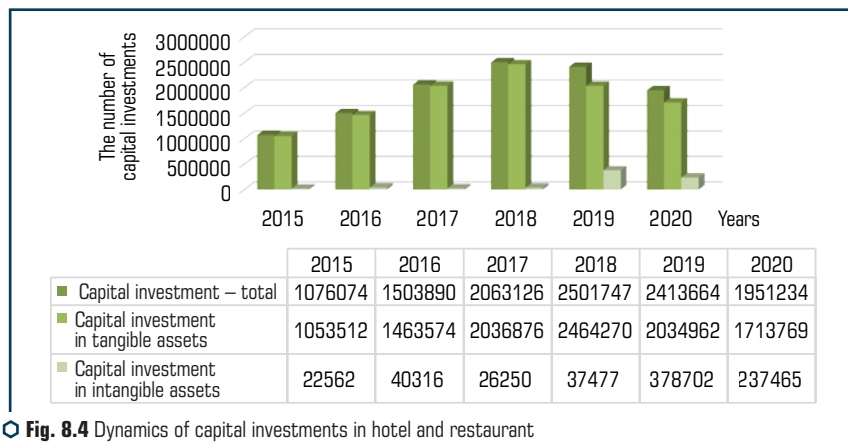
Notes: c – Data are not published in order to ensure compliance with the requirements of the Law of Ukraine On the State Statistics regarding confidentiality of statistical information

Source: compiled by the authors according to the data [1]

However, during 2015–2018 profitability indicators at small enterprises, which make up the vast majority of economic entities, remained negative. In 2019, the profitability, although positive, but in quantitative terms within 1–2 %, which is not enough for the successful functioning and development of enterprises in the industry. According to the results of 2020, the profitability of small enterprises is –9 %.

The results of the analysis of the profit and profitability of domestic enterprises in the hotel and restaurant business allow us to state the problematic nature and low effectiveness of the activities of the majority of small business entities in the industry, which constitute the majority of enterprises.

One of the means of increasing the efficiency of hotel and restaurant enterprises was the attraction of capital investments. As can be seen from **Fig. 8.4** the dynamics of capital investments in the industry until 2019 is characterized positively. The number of capital investments increased, and the main volumes were directed to tangible assets.



**Fig. 8.4** Dynamics of capital investments in hotel and restaurant

enterprises in Ukraine in 2015–2020, thousand UAH

Source: compiled by the authors according to the data [1]

For 2015–2018 the investment growth rate reached 232 %, which contributed to the increase in the number of hotels and restaurants. However, the COVID-19 pandemic had a negative impact on the overall dynamics of investments, and in 2020 they decreased to 1 billion 951 million UAH, or by 19.2 % compared to the level of 2019.

The COVID-19 pandemic contributed to a qualitative transformation of the industry manifested itself in the peculiarities of investing in tangible and intangible assets after 2019. If by 2019 almost 100 % of all investments were in construction, restructuring, equipment, that is, in tangible assets, then in the future the share of investments in intangible assets increases to 15 % in 2019 and 12 % in 2020. At the same time, the lion's share of investments was directed to the purchase of software. The structure of investments in tangible assets has also undergone transformations.

Until 2019, it was dominated by spending related to construction and restructuring. In 2019, the first place in the structure of investments in tangible assets was already occupied by the purchase of equipment and machinery, which reached 43 %.

An analysis of the regional distribution of capital investments allows to state a large share of investments in the largest cities of Ukraine (**Table 8.4**).

So, in 2020, Kyiv accounted for 53 % of all-Ukrainian investments, Dnipro – 18 %, Odesa – 7 %, Lviv – 8 %, Kharkiv – 2 %, respectively, which in total accounts for 88 % of the total capital investments of a hotel and restaurant enterprise.

● **Table 8.4** Dynamics of the efficiency of investments in hotel and restaurant enterprises by regions of Ukraine in 2020

Region name	Profit from the industry in 2020, million UAH	Capital investments at the end of 2019	Investment efficiency, %
Vinnysia	345.2761	17267	2.00 %
Volyn	158.8665	11989	1.33 %
Dnipropetrovsk	2212.601	494265	0.45 %
Donetsk	347.2244	17806	1.95 %
Zhytomyr	291.8279	1871	15.60 %
Zakarpattia	277.1741	47498	0.58 %
Zaporizhzhia	968.6408	74237	1.30 %
Ivano-Frankivsk	436.1165	14767	2.95 %
Kyiv	2240.173	45401	4.93 %
Kirovohrad	47.6963	2080	2.29 %
Luhansk	54.4729	9614	0.57 %
Lviv	2932.573	220605	1.33 %
Mykolaiv	434.5635	27403	1.59 %
Odesa	2169.943	184561	1.18 %
Poltava	475.2808	24459	1.94 %
Rivne	147.5185	2642	5.58 %
Sumy	216.7335	1723	12.58 %
Ternopil	92.9305	31653	0.29 %
Kharkiv	1868.776	44954	4.16 %
Kherson	427.6567	16566	2.58 %
Khmelnitsky	145.9297	5963	2.45 %
Cherkasy	212.8042	4342	4.90 %
Chernivtsi	150.6578	4637	3.25 %
Chernihiv	338.3692	5215	6.49 %
Kyiv City	11754.579	1520660	0.77 %

Source: compiled by the authors according to the data [1]

An analysis of the effectiveness of investments by regions showed that the efficiency of investments in the largest cities of Ukraine was rather low and on average from 1 to 4 %. At the same time, in the Zhytomyr region, the return on investment is 15.6 %, in the Sumy region – 12 %, in the Chernihiv region – 6 %. Therefore, it can be stated that, in terms of the structure of investments, a large share falls on large cities, however, the highest return on investment was observed in other regions.

Consequently, the hotel and restaurant enterprises of Ukraine during 2015–2020 were characterized by ambiguous development trends. The global COVID-19 pandemic negatively affected the development of the hotel and restaurant industry, which was manifested in a reduction in the number of enterprises, a deterioration in their financial results, a reduction in staff and their wages, a decrease in the volume of investments and a restructuring of their structure.

## 8.2 SUBSTANTIATION OF THE METHODOLOGY FOR ASSESSING THE ECONOMIC SECURITY OF ENTERPRISES IN THE HOTEL AND RESTAURANT BUSINESS

Some issues of economic security of hotel and restaurant enterprises were considered in their scientific works by foreign and domestic researchers.

Golovko, O. argues that «the economic security of the hotel and restaurant business is the state of protection of the vital interests of buildings from internal and external threats (sources of danger), formed by the administration and the hotel staff or the relevant restaurant services through the implementation of a system of legal, economic, organizational, engineering, technical and socio-psychological character» [2].

Ribun, M. analyzed the security of hospitality enterprises as an object of scientific research [3]. Gadetska, Z. concretizes modern approaches to the creation of a security system in hotels in Ukraine and the Cherkasy region [4]. Gavlovskaya, N. in her research lays the theoretical basis for the system of economic security of enterprises in the hotel and restaurant sector [5]. Rogovoy's, A. research is devoted to solving the problem of forming the content of the project of organizing a security system in the hotel business [6].

Bievets, A. studied the factors of the emergence of threats to economic security in the hotel and restaurant business and proposed a comprehensive provision of economic security at the macro, meso and micro levels [7].

Yashchuk, V., Gladyshev, T. in the study [8] they emphasize that «a feature of the system of economic security of hotel and restaurant enterprises is that it must ensure the protection of the enterprise in all areas and areas of activity.» Thus, the system of economic security of hotel and restaurant enterprises includes the following security subsystems: financial, intellectual and personnel, market, product, information, power, legal, technical and technological.

In [9], a strategic direction for improving economic security of hotel and restaurant business and measures for the implementation of conceptual foundations of economic security was proposed.

Wolff, K., Larsen, S. and Øgaard, T. (2019) [10] in their scientific work explore the perception of tourists of risks that threaten their security during the planning and implementation of a tourist trip, and prove the inappropriateness of considering the risk perceived by tourists as the estimated probability of its implementation.

An analysis of the scientific literature [2–12] showed that there are various approaches to assessing the economic security of enterprises: using evaluation indicators, resource-functional, program-targeted management and development, using a matrix of dynamic financial equilibrium, the approach of a comprehensive assessment of the economic security of an enterprise and normative plural values of financial and economic indicators. A thorough analysis of existing approaches to assessing the economic security of enterprises of various industries has made it possible to establish that today there is still no single approach that would allow researchers to perform a comprehensive assessment of the security of a selected enterprise. The existing methods offer a different composition of indicators; they do not contain guidelines for an integral indicator of the level of economic security, which complicates analytical and management procedures. Uncertainty in determining the composition of the evaluation criteria for economic security, their gradation and interpretation is problematic.

Therefore, there is an objective need to develop and further improve the methodological base for assessing the economic security of enterprises in the hotel and restaurant business.

For the purpose of a comprehensive assessment of the level of economic security of hotel and restaurant enterprises, it is advisable to use the methods of mathematical analysis, in particular taxonomic analysis. The advantage of the taxonomic method is the standardization of indicators, as a result of which the properties of the object, described by different qualitative and quantitative indicators, are converted into a single standardized measurement system.

The taxonomy method is used in the works of foreign and domestic scientists to study various aspects of strategic management, including in the hospitality industry. Yes, in the work of Bowen, D. T. [13] used taxonomic analysis to formulate the marketing strategy of hotel and restaurant establishments. The authors created regression models for each of three different grouping methods (taxonomic, policy, and industry) that used ROI as the dependent variable.

The work [14] presents a taxonomic analysis that includes seven practical indicators and a decision tree to measure the application of Revenue Management for various enterprises.

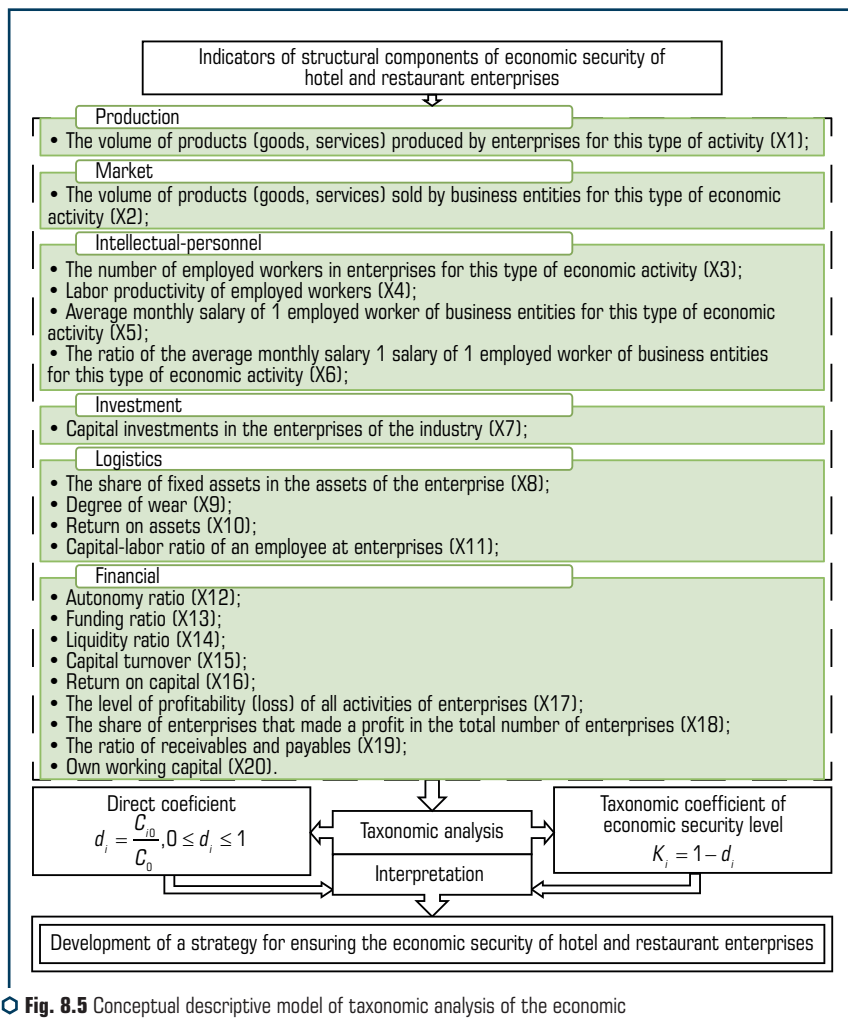
In the article by Shikina, O. [15] considered the application of taxonomic analysis as a method for assessing the competitiveness of small hotels in Odesa.

In the work of Nikolaichuk, O., Pryimak, N., Nykyforov, R., Romanykha, O. [16] application of taxonomy method for diagnosing the development strategy of hotel and restaurant industry has been substantiated.

The taxonomic indicator is calculated according to the classical method of taxonomic analysis [17]: formation of the observation matrix, standardization of the values of the observation matrix parts, identification of the reference vector, determination of the distance between individual observations and the reference vector, calculation of the taxonomic coefficient.

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When substantiating the components and indicators of the structural components of the economic security of hotel and restaurant enterprises, the existing scientific approaches to the composition of the components and indicators of economic security, the information base for analysis that is available in the public domain and the ability to measure indicators (**Fig. 8.5**) are taken into account.



**Fig. 8.5** Conceptual descriptive model of taxonomic analysis of the economic security of enterprises in the hotel and restaurant business  
Source: built by the authors

Taking into account the indicators of dominant areas that affect the economic security of hotel and restaurant enterprises, we have proposed a conceptual descriptive model for a taxonomic analysis of the economic security of enterprises in the hotel and restaurant industry, shown in **Fig. 8.5**.

The reduction of a number of indicators with different characteristics to a single generalizing indicator makes it possible to determine the difference between the achieved state and the comparison base for the group of indicators as a whole.

### 8.3 ASSESSMENT OF THE ECONOMIC SECURITY OF ENTERPRISES IN THE HOTEL AND RESTAURANT BUSINESS

On the basis of the conceptual descriptive model of taxonomic analysis proposed by us, the taxonomic coefficients of the level of economic security of the hotel and restaurant business enterprises were identified by structural components.

Data sample for 2015–2020 are presented in **Table 8.5**.

Obtained from the **Table 8.5** data allowed us to determine the reference vector: for stimulating factors – the maximum value of the standardized indicator; for dissimulators – the minimum value. According to the selected indicators-determinants of the economic security of the hotel and restaurant business, all factors are stimulants, with the exception of the financing ratio and the depreciation ratio of fixed assets.

According to **Table 8.6**, it is possible to conclude that the indicators for 2015, 2018 and 2019 serve as the most standard. The largest number of indicators corresponds to 2019, the reference indicators here are the following: the volume of products (goods, services) produced by business entities for this type of economic activity (X1); the volume of products (goods, services) sold by business entities for this type of economic activity (X2); the number of employed workers in enterprises for this type of economic activity (X3); return on assets (X10); autonomy coefficient (X12); capital turnover (X15); return on equity, (X16); the level of profitability (loss) of all activities of enterprises (X17).

Based on the obtained reference values of key indicators of economic security of hotel and restaurant enterprises for 2015–2020, the distance between individual observations and the reference vector ( $C_n$ ) and the deviation of the first year indicators from the reference were determined.

At the next stage, taxonomic coefficients of the level of economic security of hotel and restaurant enterprises for 2015–2020 ( $K_j$ ) were calculated according to the one shown in **Fig. 8.5** scheme (**Fig. 8.6**).

The values of the taxonomic indicator take values from 0 to 1. The values of the taxonomic indicator close to 0 indicate an unsatisfactory state relative to the optimal indicators. Conversely, if the value of the taxonomic indicator is close to 1, this indicates a positive situation in a certain period compared to others. The calculation results are given in **Table 8.7**.



● **Table 8.5** Initial data for calculating the taxonomic indicator of the level of economic security of the enterprises of the hotel and restaurant business in Ukraine

Characteristics	Year	Year							Mean value	Standard deviation
		2015	2016	2017	2018	2019	2020			
1		2	3	4	5	6	7	8	9	
The volume of manufactured products (goods, services) of enterprises, thousand UAH	X1	12355016.9	16109079.0	22002535.2	25079282.2	26313931.7	21059143.8	20486498.13	5970096.66	
The volume of sold products (goods, services) of enterprises, thousand UAH	X2	18250036.6	23083768.0	29548159.7	36699962.5	42201850.0	30214988.9	29999794.28	9745067.41	
Number of employed workers in enterprises	X3	87854	90264	92881	98721	104852	85861	93405.5	6871.25	
Labor productivity of employed workers, thousand UAH/person	X4	140.63	178.47	236.89	254.04	250.96	245.27	217.71	50.31	
The average monthly salary of employed workers, UAH	X5	2860.9	3680.8	5454.0	6688.2	7594.6	5820.2	5349.8	1986.0	
The ratio of the average monthly and minimum salaries	X6	2.35	2.54	1.70	2.04	1.82	1.23	1.95	0.35	
Capital investments of enterprises, thousand UAH	X7	1076074	1503890	2063126	2501747	2413664	1960740	1919873.5	609842.8	
Share of fixed assets in property, %	X8	52.66	46.81	40.20	39.55	41.56	41.09	43.6	5.5	

● Continuation of Table 8.5

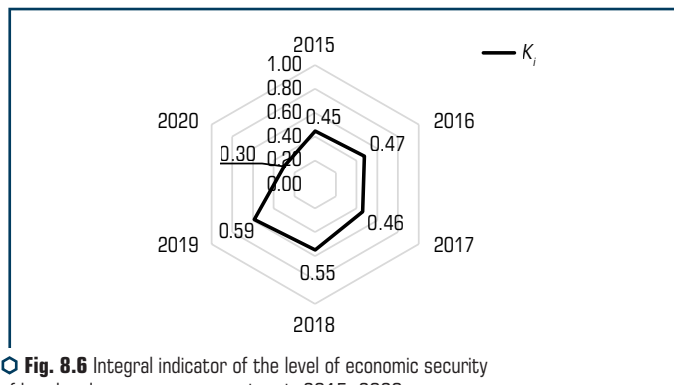
1	2	3	4	5	6	7	8	9
FA wear coefficient, %	X9 32.49	34.94	36.49	34.86	36.15	37.02	35.3	1.6
Capital productivity, thousand UAH/UAH	X10 1.17	1.44	1.87	2.01	2.09	1.34	1.7	0.4
The capital-labor ratio, thousand UAH/person	X11 177.95	177.54	170.34	184.61	192.96	262.59	194.3	8.5
Autonomy ratio	X12 -0.10	-0.18	-0.07	0.06	0.13	0.10	0.0	0.1
Debt to equity ratio (financing)	X13 -10.52	-6.52	-15.51	15.38	6.89	9.17	-0.2	12.8
Liquidity ratio	X14 1.78	1.59	1.64	1.57	1.55	1.66	1.6	0.1
Capital turnover	X15 0.61	0.67	0.75	0.80	0.87	0.55	0.7	0.1
Return on equity, enterprises %	X16 -23.16	-5.79	4.51	5.10	8.72	-8.04	-3.1	12.9
The level of profitability (unprofitability) of all activities of enterprises, %	X17 -22.6	-6.5	5.0	5.8	9.3	-11.1	-3.4	13.1
Share of profit-making enterprises in the total number of enterprises, %	X18 71.6	71.4	69.3	71.1	70.5	58.7	68.8	0.9
Share of profit-making enterprises in the total number of enterprises, %	X19 0.29	0.33	0.33	0.33	0.31	0.32	0.3	0.0
Own working capital, thousand UAH	X20 -23075788.9	-28201335.8	-27314116.1	-26708705.1	-24275239.3	-29654664.7	-26538308.3	2154342.1

Source: compiled by the authors according to the data [1]

● **Table 8.6** Matrix of standardized characteristics

	Year						Reference ( $Z_{0j}$ ) (stimulator – max; stimulator – min)
	2015	2016	2017	2018	2019	2020	
X1	-1.36	-0.73	0.25	0.77	0.98	0.10	0.98
X2	-1.21	-0.71	-0.05	0.69	1.25	0.02	1.25
X3	-0.81	-0.46	-0.08	0.77	1.67	-1.10	1.67
X4	-1.53	-0.78	0.38	0.72	0.66	0.55	0.72
X5	-1.25	-0.84	0.05	0.67	1.13	0.24	1.13
X6	1.14	1.68	-0.69	0.27	-0.36	-2.04	1.68
X7	-1.38	-0.68	0.23	0.95	0.81	0.07	0.95
X8	1.63	0.57	-0.62	-0.74	-0.38	-0.46	1.63
X9	<b>-1.81</b>	-0.24	0.74	-0.30	0.53	1.08	-1.81
X10	-1.23	-0.54	0.54	0.91	1.10	-0.79	1.10
X11	-1.92	-1.97	-2.82	-1.14	-0.16	<b>8.01</b>	8.01
X12	-0.75	-1.35	-0.46	0.58	1.10	0.88	1.10
X13	-0.81	-0.49	<b>-1.20</b>	1.21	0.55	0.73	-1.20
X14	<b>1.60</b>	-0.50	0.12	-0.69	-0.86	0.33	1.60
X15	-0.95	-0.35	0.42	0.88	1.59	-1.59	1.59
X16	-1.55	-0.21	0.59	0.63	0.91	-0.38	0.91
X17	-1.47	-0.24	0.64	0.70	0.97	-0.59	0.97
X18	<b>3.04</b>	2.86	0.58	2.52	1.85	-10.85	3.04
X19	-1.57	0.73	0.56	0.76	-0.30	-0.18	0.76
X20	<b>1.61</b>	-0.77	-0.36	-0.08	1.05	-1.45	1.61

Source: compiled by the authors according to the data [1]



⬢ **Fig. 8.6** Integral indicator of the level of economic security of hotel and restaurant enterprises in 2015–2020

Source: built by the authors

● **Table 8.7** Determination of the distance between the indicator and the standard

Year	$\sum_{i=1}^m (Z_{ij} - Z_{0j})^2$	$C_{i0}$	$C_0$	$d_i$	$K_i$
2015	165.80	12.88	12.34	0.55	0.45
2016	149.09	12.21	12.34	0.53	0.47
2017	158.00	12.57	12.34	0.54	0.46
2018	110.13	10.49	12.34	0.45	0.55
2019	92.43	9.61	12.34	0.41	0.59
2020	264.55	16.26	12.34	0.70	0.30

Source: calculated by the author from the data [1]

The obtained values of the integral indicator of the level of economic security of hotel and restaurant enterprises indicate its unstable state. During 2015–2017 the value of the indicator fluctuated within 0.45–0.47. These trends are explained by the complication of the functioning of hotel and restaurant enterprises due to the fall in the tourist flow as a result of the annexation of Crimea, military events in the East of the country and the difficult socio-economic situation.

Since 2018, there has been a gradual increase in the integral indicator of the economic security of hotel and restaurant enterprises in Ukraine. The highest value of the taxonomic indicator was recorded in 2019 – 0.59, however, it indicates an unsatisfactory level of economic security of the enterprises under study. In 2020, as a result of the coronavirus pandemic, the taxonomic indicator of the level of economic security decreased to 0.3, which is the minimum level of the indicator during the entire study period.

#### 8.4 RATIONALE FOR CHOOSING A STRATEGY TO ENSURE THE ECONOMIC SECURITY OF ENTERPRISES IN THE HOTEL AND RESTAURANT BUSINESS

The use of economic and mathematical methods made it possible to determine a comprehensive indicator of the level of economic security of hotel and restaurant enterprises in 2015–2020.

The interpretation of the values of the integral indicator of the economic security of hotel and restaurant enterprises is given in **Table 8.8**.

Thus, five main strategies for ensuring the economic security of enterprises in the hotel and restaurant industry have been identified, namely:

- a support strategy that meets an absolutely safe level of economic security. Therefore, the main management decisions are measures aimed at maintaining the achieved level of economic security, monitoring the results of activities and preventing the emergence of possible threats to the economic interests of the enterprise;
- strengthening strategy that meets a safe level of economic security and is aimed at taking measures to strengthen one of the indicators of the economic security component of the enterprise;

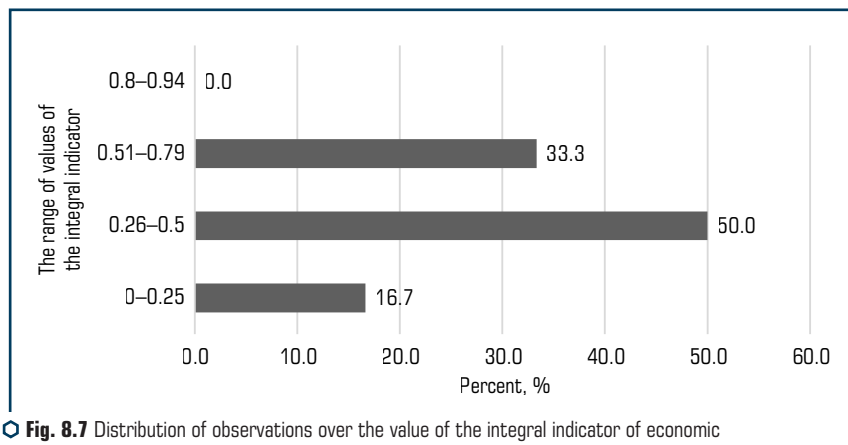
- adaptation strategy – aimed at carrying out measures to adapt the components of the economic security of enterprises to changes in the external environment;
- a transformation strategy that corresponds to a dangerous level of economic security and provides for changes in the type of activity, market transformation, involving the use of innovations, new technologies, the development of new activities, as well as making the necessary changes to the economic security components of enterprises. Taking into account the specifics of the economic security factors of each enterprise, it is advisable to form the directions of transformation processes based on the monitoring of individual components and the general level of its economic security;
- a recovery strategy associated with the implementation of measures aimed at increasing the level of economic security to the desired level for the enterprise and strengthening all components of the economic security of the enterprise.

● **Table 8.8** Interpretation of the values of the integral indicator of economic security of hotel and restaurant enterprises in Ukraine and the corresponding strategy for its provision

The value of the integral indicator	Degree of compliance of economic security determinants with reference values	The level of economic security of hotel and restaurant enterprises in Ukraine	Appropriate economic security strategy	Management decisions to ensure the economic security of enterprises
0.95–1	Parameters approaching maximum values	Absolutely safe	Support strategy	<ul style="list-style-type: none"> <li>– maintaining the achieved level of economic security;</li> <li>– control over the results of activities;</li> <li>– measures to prevent the emergence of possible threats to the economic interests of the hotel and restaurant enterprise</li> </ul>
0.8–0.94	Most of the parameters are at the level of sufficiently high values	Safe	Amplification strategy	<ul style="list-style-type: none"> <li>– holding events for strengthening one of the indicators of individual components of the economic security of the hotel and restaurant enterprises</li> </ul>
0.51–0.79	Most of the parameters are at a satisfactory level, some indicators may correspond to a sufficient level	Safe enough	Adaptation strategy	<ul style="list-style-type: none"> <li>– measures to adapt the components of the economic security of a hotel and restaurant enterprise to changes in the external environment</li> </ul>
0.26–0.5	Most indicators are low level	Dangerous	Transformation strategy	<ul style="list-style-type: none"> <li>– carrying out market transformation changes;</li> <li>– holding necessary changes to strengthen the unsatisfactory components of the economic security of enterprises</li> </ul>
less than 0.25	All indicators are low level	Crisis	Recovery strategy	<ul style="list-style-type: none"> <li>– measures aimed at increasing the level of economic security and strengthening all components of the enterprise's economic security</li> </ul>

Source: built by the authors

According to the proposed in **Table 8.8** approaches to identifying the level of economic security and the corresponding strategy for its provision, the distribution of observations over the value of the integral indicator of economic security of hotel and restaurant enterprises in Ukraine was carried out (**Fig. 8.7**).



**Fig. 8.7** Distribution of observations over the value of the integral indicator of economic security of hotel and restaurant enterprises in Ukraine for 2015–2020

*Source: built by the authors*

The largest share is occupied by observations that correspond to the dangerous state of economic security of hotel and restaurant enterprises – 50 %. In second place with a specific weight of 33.3 % are observations corresponding to a fairly safe state of economic security of enterprises. The smallest number of observations falls on periods with a crisis state of economic security (only 16.7 %). At the same time, during the entire study period, there is by no means a safe state of economic security of hotel and restaurant enterprises.

The worst state of economic security was observed in 2020, which actualizes the need to develop management decisions to ensure the economic security of hotel and restaurant enterprises in Ukraine.

It should be emphasized that the strategy for ensuring the economic security of hotel and restaurant enterprises should be adequate to the economic situation in the country and consistent with the country's security strategy.

In view of this, it is necessary to take into account the impact of the russian war against Ukraine on the development of tourism and hospitality both at the global level and at the level of Ukraine.

According to the WTTC, in 2019 tourism accounted for 6.3 % of the Ukrainian economy and 6.9 % of total employment with international visitor spending, which accounted for 3.7 % of total exports (WTTC, 2022) [18].

Russia's military offensive in Ukraine represents a downside risk for international tourism. This should extend to general low prices and vehicles, accelerated uncertainty and led to the destruction of trade in European Europe [19].

Analysis of previous wars, such as the Gulf War and the Balkan conflict of the 1990s, suggests that the war in Ukraine will only have a short-term impact on global tourism. However, in the event of a prolonged war or its spread beyond Ukraine, global tourism can expect a sharper and longer recovery from the fall, more like the post-9/11 period. In the short term, the war will contribute to the sector's uneven recovery from the pandemic and Omicron. The key channels through which the war could affect global tourism are air space restrictions and security concerns and higher fuel prices.

As for the situation in the tourism and hospitality industry in Ukraine, according to World Bank forecasts, as a result of the war with Russia, inbound tourism to Ukraine will be seriously affected and will probably continue to suffer until the conflict is completely over. As in other post-conflict states, Ukraine's tourism and hospitality sector is likely to take years to recover from the military conflict [18, 19].

Taking into account external dangers, the operating conditions of hotel and restaurant enterprises are likely to worsen; therefore, strategic decisions to restore the economic security of these enterprises are especially relevant.

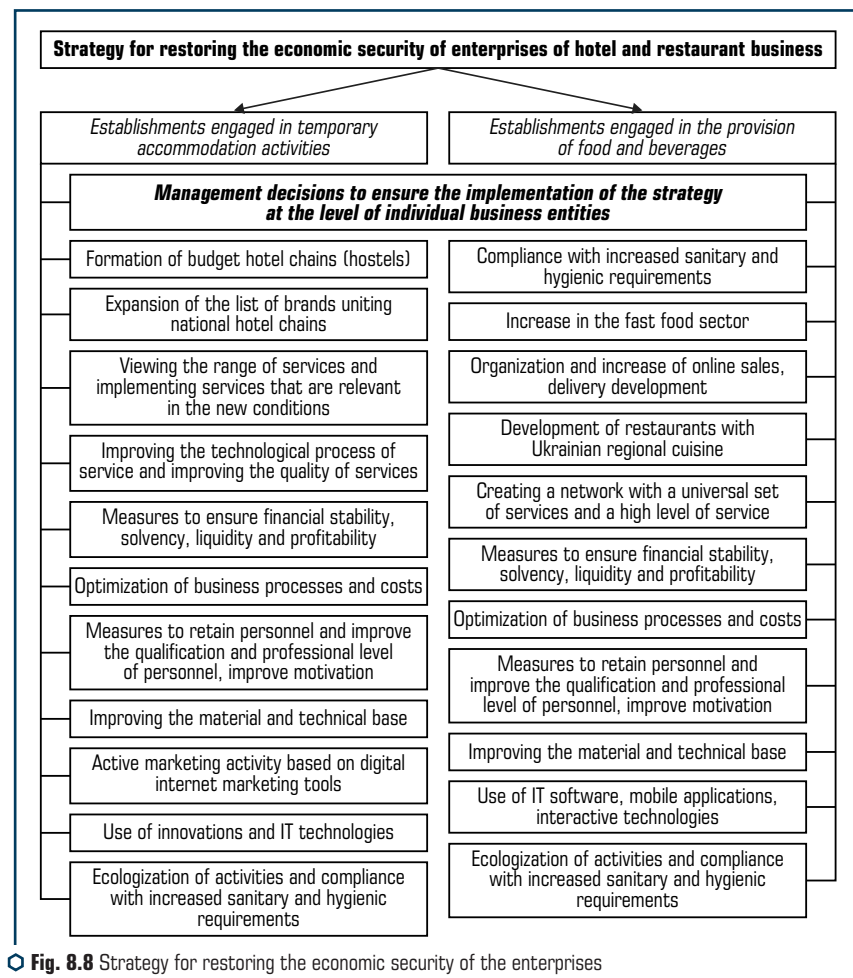
The proposed management decisions as part of the implementation of the strategy for restoring the economic security of hotel and restaurant enterprises are shown in **Fig. 8.8**.

The main strategic priorities for restoring the economic security of hotel and restaurant enterprises are: the development of new establishments, the expansion of the range of products/services, the improvement of the quality of services based on compliance with international service standards, the use of innovations, active marketing activities based on digital Internet marketing tools, the improvement of qualification and professional level of personnel, improvement of the motivational mechanism, optimization of business processes, improvement of the material and technical base, cost reduction, restoration of solvency, liquidity and ensuring profitable activities.

The implementation of the proposed strategy will increase the level of economic security of hotel and restaurant enterprises, will contribute to their transformation into modern ones based on innovations and IT technologies, optimal use of resources and greening of activities.

The scientific novelty of the results obtained lies in the improvement of the approach to the development of a strategy for ensuring the economic security of hotel and restaurant enterprises, which, unlike the existing ones, takes into account the level of economic security of enterprises, which will make it possible to form a set of recommendations for choosing a strategy for ensuring economic security, taking into account the economic state of the enterprise.

Directions for the implementation of these recommendations may be the subject of further scientific research. The results of the study can be used by domestic hotel and restaurant enterprises in the development and selection of a strategy for ensuring economic security.



**Fig. 8.8** Strategy for restoring the economic security of the enterprises of the hotel and restaurant business in Ukraine

Source: built by the authors

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# INNOVATIVE SECURITY TECHNOLOGICAL SOLUTIONS IN THE SYSTEM OF MANUFACTURING PRODUCTS FOR THE POPULATION OF TERRITORIES WITH TECHNOGENIC LOAD

Valentyn Khorolskyi, Radion Nykyforov,  
Yurii Korenets, Olga Simakova, Iuliia Goriainova

## ABSTRACT

The section is devoted to the development and substantiation of scientific provisions for the construction of intelligent control systems for the industrial production of bread with built-in intensifiers of technological processes of ultrasonic nature in the context of ensuring food security. The main scientific results of the work are mathematical models of the processes of preparation and improvement of water quality indicators, preparation and dosage of flour, preparation of bread starter, dough, dispersion for dough of functional applications, proofing and baking processes using ultrasonic monitoring and intensification systems; designing local adaptive control systems for relevant processes; theoretical substantiation of an intelligent control system for the production of bakery products with the development of a conceptual project «Intellectual enterprise for the production of bread for areas with technogenic pressure». It is proved that the development of a reference problem under the conditions of uncertainty of external and internal disturbances not controlled by sensors can be evaluated by an expert system for the formation of algorithms for controlling the technological process of bread production. Thus, the paper systematizes for the first time the theoretical and practical results of intelligent control of complex technological processes for the production of bakery products with digital control algorithms for food industry enterprises in the areas of technogenic load.

## KEYWORDS

Food security, technogenic load, smart food product, intelligent enterprise, fuzzy control, expert system, robotic complex.

## 9.1 GENERAL PRINCIPLES FOR ENSURING FOOD SECURITY IN AREAS WITH TECHNOGENIC LOAD

The world concept of food security was first defined in the mid-1970s during the discussion at the international level of food problems during the global food crisis. The initial attention of world leaders was focused primarily on the problems of food security, namely the availability and, to a certain extent, price stability of basic foodstuffs at the international and national levels.

Subsequently, at the 1996 World Food Summit, a more complex definition was formulated, according to which food security at all levels, from individual to global, is achieved when all people, at all times, have physical and economic access to sufficient, safe and nutritious food to meet nutritional preferences and dietary needs throughout the active life of a healthy lifestyle.

Sociological studies of the present show that in our time there is not a single state that would not be concerned about food security issues. This applies to the production of food products, their distribution, import and export of food, food consumption, etc. Food security is now considered an important component of national policy, it characterizes the political independence of the country, its economic strength and stability, social security of the population and the ability to meet the food needs of its citizens without prejudice to national interests. At the same time, each country determines its own tasks for improving the food supply of its own population, depending on the level achieved in solving this problem.

An important component of the national security strategy of Ukraine, scientists have identified its economic component, including food security as an independent object of domestic and foreign policy of the state [1]. Also, strategic actions to ensure the economic and physical accessibility of food products of high nutritional and biological value to prevent a sharp decline in the health index of the population of Ukraine have now become the priorities of the social policy of Ukraine.

At the same time, food security necessarily includes not only the consumer aspect – taking into account physiological needs – but also the production aspect, which consists in the priority development of domestic production, and only then – the necessary import of agricultural products and food products.

Thus, it can be stated that food security is determined by the level of efficiency of the entire economy. However, food resources are formed in the process of agro-industrial production. Therefore, such subsystems of the agro-industrial complex as the sale and distribution of food, food reserves and consumption are functional subsystems.

In market conditions, state policy should be aimed at achieving food security, creating the necessary reserves of food and agricultural raw materials, increasing the level of food security, the purchasing power of the population, improving the quality of food and agricultural raw materials, ensuring their competitiveness in the domestic and foreign markets. Solving the problem of food security as an essential component of the sustainable development of the country includes not only the production of a sufficient amount of food, but also the preservation of agricultural resources, their ability to reproduce and productivity, which is necessary to ensure the food security of future generations.

As it is possible to see, an important component of food security is food security. In accordance with the Law of Ukraine «On the Basic Principles and Requirements for the Security and Quality of Food Products», a safe food product is a food product that does not adversely affect human health and is suitable for consumption.

In order to protect the life, health and interests of consumers, the state regulates the security and individual indicators of the quality of food products by: establishing sanitary measures; establishing requirements for individual indicators of food quality; state registration of objects of sanitary measures; issuance, termination, cancellation and renewal of operating permits; informing and raising awareness of market operators and consumers about security and certain indicators of food quality; establishment of requirements for the health status of the personnel of the facilities;

participation in the work of relevant international organizations; implementation of state control; bringing market operators and their officials to justice in case of violation of legislation on security and certain indicators of food quality.

Modern scientific and practical experience shows that the issue of food security must be considered from two positions:

- firstly, from the standpoint of the adequacy of the content of essential nutrients in food products and diets in accordance with the physiological needs of a person in these substances;
- secondly, from the standpoint of protecting the internal environment of the human body from the intake of various toxicants of a chemical and biological nature with food.

This sequence and relationship is due to the fact that it is the deficiency of essential nutritional and biologically valuable substances in food products and their imbalance in the diet that leads to irreversible changes in the internal environment of the body, disruption of cellular metabolism, as well as a significant decrease in the protective potential of the body in relation to harmful environmental factors, which dramatically increases the risk of developing both communicable and non-communicable diseases.

Thus, dangerous food products can be considered not only containing toxic substances of chemical and/or biological origin, but also products with low biological value due to the low content of essential quotas of biologically active substances. This proves that today, in the context of the socio-economic crisis in Ukraine, when assessing food security, it is necessary to take into account not only the content of foreign substances in them, but also their qualitative composition.

This range of questions can be expanded for areas with increased technogenic load, for example, the Donetsk and Prydniprovsky economic regions of Ukraine. The peculiarities of such regions are the increased overall need for food products, both for general and medical purposes, to ensure the health and working capacity of the population, strengthen the protective functions of the human body and prevent pathological conditions that can develop under the influence of environmental factors.

At the same time, it should be taken into account that the artificial enrichment of food products with biological additives is a serious interference in the traditional human nutrition system. Therefore, the modeling of fortified foods should be performed only taking into account scientifically sound, clearly articulated and proven principles [2].

Principle one: in the process of fortifying food products and giving them functional properties, only those nutrients, the deficiency of which actually takes place, should be used. However, they should be fairly common and safe for health. For miners (miners) working underground at a depth of 1000–1400 m, metallurgists and representatives of other heavy professions, chemists whose work is associated with harmful influences, soldiers of the Armed Forces of Ukraine, including in field and extreme conditions, such food components have a complete protein, ascorbic acid, B vitamins, folic acid, keratin, iodine, iron and calcium [3]. At the same time, it is possible to use a more complete set of enrichment additives, including by combining vitamins and minerals with the simultaneous addition of other valuable food components: dietary fiber, phospholipids, supplements

of natural origin, which will have a protective, stimulating and, if necessary, therapeutic effect on certain biological systems and functions of the human body.

The second principle: it is necessary to take into account the possibility of chemical interaction of enrichment additives with each other and with the components of the product and choose only those forms, combination methods and stages of application that will ensure their greatest preservation during production and subsequent storage. So, for example, bread and pasta, fish products, side dishes are recommend to be enriched with B and K vitamins, as well as calcium and iron for consumption by groups of people living in areas with a high level of radiation pollution, tuberculosis, etc.

Principle three: fortification of food with vitamins and minerals should be carried out according to WHO standards.

Fourth principle: enrichment of food products with vitamins, minerals and other dietary supplements should not impair the consumer properties of these products: reduce the composition, content and digestibility of other food components, significantly change the taste and aroma properties of products, as well as their shelf life.

Food products that will comply with the listed principles of usefulness for consumers, in terms of nutritional value and therapeutic and prophylactic properties, and the principles of environmental friendliness – the absence of harmful effects on the ecosystem at all stages of the life cycle – are commonly called reasonable food.

An important direction in the implementation of the sustainable development strategy of Ukraine is the development of a system for the production of reasonable food in sufficient quantities to ensure a regular balanced diet of the population, especially in areas with a pronounced technogenic load.

This task was included in the National Economic Strategy of Ukraine for the period up to 2030, approved by the government. And, in our opinion, it can be successfully implemented only taking into account the ideas and technologies of the neo-industrialization of Industry 4.0, which involves the widespread use of smart technologies, the Industrial Internet of Things (IIoT), robotic complexes, including for the development of industrial engineering and the food industry. The use of this approach will significantly increase labor productivity and the level of product quality at food industry enterprises through the use of unmanned technologies based on the automation of production processes, the use of robotics and IIoT.

Within the framework of this strategy, the key issues in the development of the food industry at the present stage are the development and implementation of new standards of food and environmental security, the search for optimal ways of processing products with the preservation and development of their beneficial properties, and the economical use of resources of all kinds.

The object of the study was the intelligent control systems for the industrial production of bread, bakery, flour products under conditions of uncertainty and technogenic pressure. The prerequisite for such a choice was the social nature of this product group, due to accessibility for all segments of the local population. Bread and bakery products are regular consumption products

in Ukraine, which makes them the most convenient components of the diet, through which you can adjust its nutritional and preventive value in the right direction.

The need for bread is 300–500 g/day, depending on the age of the person, the nature of work, national characteristics and economic factors. In Ukraine, about 7 million tons of bread and bakery products are produced annually, or 130 kg per capita [4].

The value of bread lies in the fact that it contains almost all the nutrients a person needs. With the right production technology, the entire mass of bread (100 %) is edible. Almost half of its solids are carbohydrates (45–55 %), of which starch is the main one. Depending on the type of flour, bread contains 5–8 % proteins.

Due to rye and wheat bread, a person satisfies his need for proteins by 25–30 %, in carbohydrates – by 30–40 %.

The biological value of bread depends on the usefulness of proteins, the content of vitamins, ash elements, etc. in it. 100 g of bread contains 5–8 g of protein. The physiological value of bread proteins from flour of the highest grades is 20–25 % of the norm. According to the FAO, rye bread proteins are better balanced than wheat bread.

An important indicator of the biological value of bread is the content of vitamins in it. Bread is the main source of B, PP, E vitamins. Of the minerals, it contains phosphorus, calcium, iron, magnesium, etc. According to the content of vitamins and ash elements, bread made from low-grade flour and especially upholstery flour is dominated by bread baked from high-grade flour.

Bread differs from many other foods in that it is well absorbed by the body. This is due to the fact that it has a porous, soft, elastic and non-sticky crumb, which contains denatured proteins, partially gelatinized and dissolved starch, and highly softened grain segments. Therefore, all components of the bread are available for the action of the enzymes of the alimentary canal.

The energy value of bread is quite high. So, 100 g of it, depending on the yield and type of flour and dough recipe, give the body 798–1390 kJ, which is about 35 % of its energy needs.

Currently, scientists and technologists of the food industry are looking for ways to improve the quality, nutritional and biological value of bakery products, giving them functional properties, which is embodied in the creation of innovative products, the production of which requires special approaches.

The practical experience of bakery manufacturers shows that the characteristics of the main input raw materials (flour and water) can differ significantly depending on the batch of products, storage conditions and terms, season, region of origin and the degree of its environmental pollution [5].

These factors are the reason that manufacturers have to periodically work in conditions of uncertainty, when the adjustment of the technological process must be carried out depending on the set and parameters of the input raw materials. Often this happens without sufficient justification, on the basis of practical experience or even at the level of the technologist's intuition, which leads to destabilization of product quality and, as a result, a decrease in consumer demand for it.

Today, data on the relationship between the properties of the main components (flour, water or other liquid, yeast, fortifying and improving additives) and recommendations for optimizing

technological processes for the production of bakery products under conditions of uncertainty are insufficiently substantiated.

Therefore, the priority areas for stabilizing the quality of bakery products are objective control of the parameters of the input raw materials; water treatment; purification and improvement of the input characteristics of other main ingredients; accounting for input parameters of raw materials in the construction of the technological process for the production of bakery products; application of technologies for economical use of material and energy resources.

The main goal of this study is to develop an intelligent system for the production of innovative varieties of bakery and flour products for areas with a high level of anthropogenic impact.

The subjects of the research are the ingredients for the production of bread, bakery and flour products (flour, water, yeast, etc.), dough, methods of supplying the energy of ultrasonic vibrations, ultrasonic analyzers and intensifiers of technological processes for the production of bakery products, control and measuring equipment. production of bread and flour products.

## 9.2 DIRECTIONS FOR THE USE OF ULTRASONIC TECHNOLOGIES IN THE IMPLEMENTATION OF INNOVATIVE TECHNOLOGICAL SOLUTIONS FOR FOOD PRODUCTION

For food industries operating in areas with technogenic pressure, it is necessary to regularly monitor the environmental component, namely the input characteristics of water, flour, and other ingredients, and predict their impact on the initial indicators of finished products. Such long-term excitations should be taken into account when designing the phase of automated control systems, which should adapt in pace with the process of input ingredients in the process of making bread starters and various types of dough.

Since it is planned to use ultrasonic analyzers and process intensifiers in the project of an intelligent enterprise for the production of bakery and flour products, first of all, mathematical modeling of the process of diffusion of a passive impurity in a liquid medium under the influence of ultrasound was carried out using a sequential construction method [6].

A preliminary analysis of this process showed its exceptional complexity, due, in particular, to the presence of acoustic cavitation and the associated difficulties in its mathematical modeling. The Boussinesq hypothesis on the theory of turbulence made it possible to describe the local mixing that occurs during acoustic cavitation using the cavitation diffusion coefficient, which indicated the possibility of using the methods of mathematical physics to model the process of diffusion of a passive impurity in a liquid medium. At the first stage of modeling, the expediency of constructing a mathematical model in the form of a second-order partial differential equation of a parabolic type was determined:

$$\frac{\partial c}{\partial t} = \frac{\partial}{\partial x} \left( D \frac{\partial c}{\partial x} \right) = D_0 \frac{\partial}{\partial x} \left( \exp(-kx) \frac{\partial c}{\partial x} \right), \quad (9.1)$$



where  $c$  – impurity concentration in the medium,  $\text{kg/m}^3$ ;  $t$  – time, s;  $x$  – the coordinate directed towards the propagation of the ultrasonic wave, m (the origin of coordinates is located at the entrance to the medium);  $D$  – diffusion cavitation coefficient,  $\text{m}^2/\text{s}$ ;  $D_0$  – diffusion cavitation coefficient at the medium inlet,  $\text{m}^2/\text{s}$ ;  $k$  – absorption coefficient of ultrasound in a liquid medium,  $1/\text{m}$ .

For the convenience of solving equation (9.1), it was reduced to a dimensionless form based on the theories of similarity and dimensions. For this purpose, dimensionless variables were introduced:

$$\xi = k \cdot x, \quad (9.2)$$

$$\tau = t \cdot D_0 \cdot k^2. \quad (9.3)$$

The variable  $\xi$  determines the dimensionless distance associated with the value of the ultrasonic absorption coefficient of the liquid medium  $k$ .

The variable  $\tau$  determines the dimensionless time for the absorption of ultrasound by a liquid medium, which is related both to the initial value of the cavitation diffusion coefficient  $D_0$  and to the coefficient of ultrasound absorption by the liquid medium  $k$ .

Through further transformations, the value of the stationary impurity concentration in a liquid medium was invented:

$$\bar{c}_s = \frac{1}{\xi_0} \int_0^{\xi_0} \varphi_1(\xi) d\xi, \quad (9.4)$$

where  $\xi_0 = k \cdot l$  (when setting the boundary value problem, it was assumed that the ultrasonic wave passes through a layer of a liquid medium of thickness  $l$ ).

To obtain specific results, let's use the initial concentration distribution and obtained the value of the stationary impurity concentration in the liquid medium, which was sought:

$$\bar{c}_s = \frac{\xi_0^4}{30}. \quad (9.5)$$

**Fig. 9.1** shows graphs of the initial and stationary impurity concentrations in a liquid medium.

The analytical solution of the problem formulated above presents difficulties associated with the dependence of the cavitation diffusion coefficient on the spatial coordinate. Therefore, to estimate the time interval for the establishment of a stationary regime, it is proposed to consider a simpler problem in which the diffusion cavitation coefficient does not depend on the spatial coordinate. By setting the limiting values of the cavitation diffusion coefficient, it is possible to estimate the minimum and maximum values of the time for establishing a stationary regime.

When solving the problem of modeling the process of diffusion of a passive impurity in a liquid medium under the influence of ultrasound, it is necessary to implement a dual approach. Given that the mathematical model is described by a differential equation with varying coefficients, the solution of which analytically causes significant difficulties, it was decided to simplify the equation to obtain an analytical solution. At the same time, the use of the numerical method as the second

approach made it possible to choose a parameter in the analytical solution in such a way as to minimize the differences between the solutions obtained by the two methods.

In this case, the impurity concentration in a liquid medium can be calculated by the formula:

$$c(x, t) = \hat{c}(kx, tD_0k^2) \cdot m \cdot \int_0^l \varphi(x) dx. \quad (9.6)$$

Thus, to pass to real values, it is necessary to know the values  $D_0$ ,  $k$ ,  $l$ ,  $m$ ,  $\varphi(x)$ . Analyzing the features of the parameters, we can conclude that to determine the parameters  $D_0$  and  $k$ , it is necessary to implement experiments that will allow us to study the attenuation of ultrasound in a liquid medium, which is being considered. The parameter  $m$  is determined by weighing the mass of the impurity loaded into the liquid medium. The function  $\varphi(x)$  determines the initial impurity distribution in the medium during the experiment.

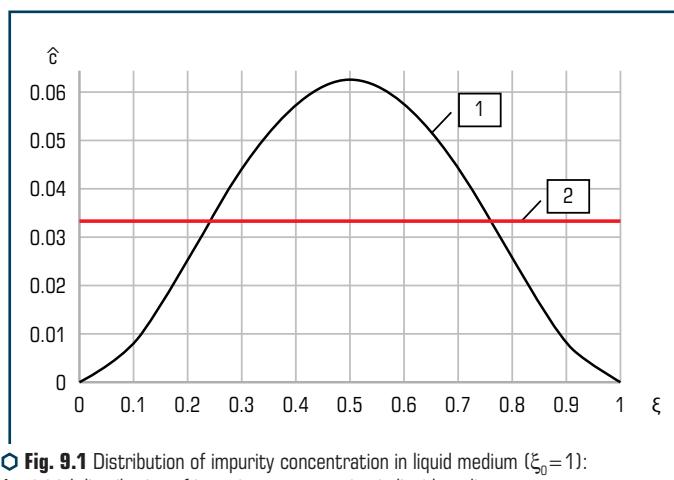


Fig. 9.1 Distribution of impurity concentration in liquid medium ( $\xi_0 = 1$ ):

1 – initial distribution of impurity concentration in liquid medium;

2 – stationary distribution of impurity concentration in a liquid medium

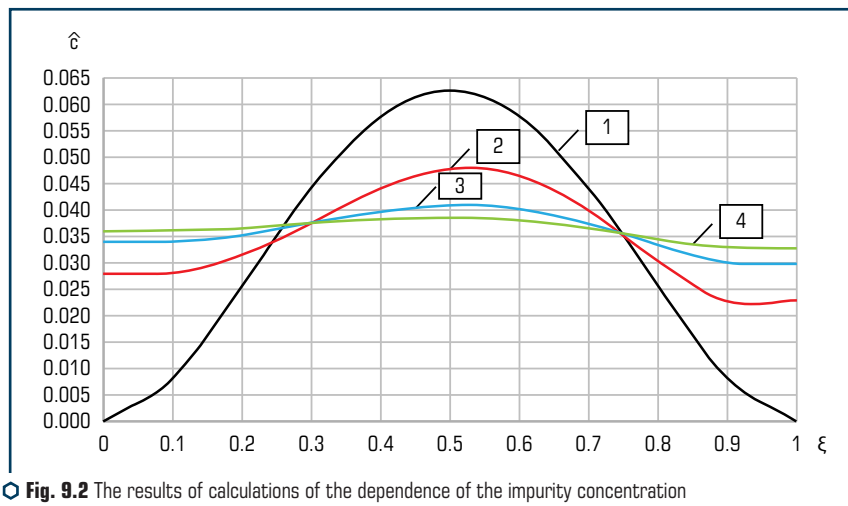
Fig. 9.2 shows a graphical representation of the results of the numerical solution of the problem according to the data in Table 9.1.

An analysis of the numerical solution of the problem shows that the maximum impurity concentration in the medium shifts to the right along the horizontal axis with time.

The application of the theory of similarity and dimensions made it possible to significantly simplify both the solution of the problem posed and the further study of the obtained solution, which is explained by a decrease in the number of variables combined into dimensionless complexes.

Next, let's consider a mathematical model of the interaction of ultrasonic vibrations with food raw materials, which is a heterogeneous medium. Assuming that the state of a heterogeneous

medium is described by a mathematical model using a second-order differential equation with constant coefficients, a spectral analysis of this medium was carried out using ultrasound.



**Fig. 9.2** The results of calculations of the dependence of the impurity concentration in a liquid medium on distance for different moments of time in the numerical solution of the problem: 1 –  $\tau=0$ ; 2 –  $\tau=0.03$ ; 3 –  $\tau=0.06$ ; 4 –  $\tau=0.09$

**Table 9.1** Results of solving the problem by the quantitative method

$\xi$	$\tau$	0	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
0	0	0	0.018	0.024	0.028	0.031	0.033	0.034	0.035	0.036	0.036
0.1	0.008	0.018	0.018	0.024	0.028	0.031	0.033	0.034	0.035	0.036	0.036
0.2	0.026	0.026	0.026	0.029	0.031	0.033	0.034	0.035	0.036	0.036	0.036
0.3	0.044	0.040	0.038	0.038	0.037	0.037	0.037	0.037	0.037	0.037	0.037
0.4	0.058	0.052	0.047	0.044	0.042	0.041	0.040	0.039	0.038	0.038	0.038
0.5	0.063	0.057	0.052	0.048	0.045	0.043	0.041	0.040	0.039	0.038	0.038
0.6	0.058	0.053	0.050	0.046	0.044	0.042	0.040	0.039	0.038	0.038	0.038
0.7	0.044	0.042	0.041	0.040	0.039	0.038	0.037	0.037	0.037	0.037	0.036
0.8	0.026	0.027	0.029	0.030	0.031	0.032	0.033	0.034	0.034	0.034	0.034
0.9	0.008	0.014	0.019	0.023	0.026	0.028	0.030	0.031	0.032	0.032	0.033
1.0	0	0.014	0.019	0.023	0.026	0.028	0.030	0.031	0.032	0.032	0.033

The aim of the research was to search for a «transferring function» of food raw materials, with the help of which it would be possible to identify the structural elements of food raw materials –

to determine its physical and mechanical properties. Formulas have been obtained that make it possible to determine the parameters of the state of food raw materials using such characteristics of the spectral density as the resonant frequency, the magnitude of the resonance and the quality factor of the oscillatory system:

$$k = \omega_0, \quad (9.7)$$

$$h = \omega_0 \frac{4Q + 1}{2\sqrt{4Q^2 - 4Q - 1}}, \quad (9.8)$$

where  $k$ ,  $h$  – numerical parameters associated with the properties of food raw materials, 1/s;  $Q$  – the quality factor of the oscillatory system;  $\omega_0$  – the resonant frequency, rad/s.

The quality factor of the oscillatory system is determined by the formula:

$$Q = \frac{\omega_0}{\Delta\omega}, \quad (9.9)$$

where  $\omega_0$  – the resonant frequency, rad/s;  $\Delta\omega$  – bandwidth of the oscillatory system, rad/s.

The values of these parameters, obtained using ultrasonic vibrations, allow continuous monitoring of the state of food raw materials to assess its quality. Maintaining the quality of the state of food raw materials at a given level will allow, thanks to its operational control, to improve the final product. For the practical implementation of the results of mathematical modeling in practice, it is necessary to conduct a series of preliminary practical experiments to assess the spectral characteristics of the state of the food product, corresponding to the standard of the required quality, for each specific case and adjust the monitoring system.

### 9.3 PRACTICAL ASPECTS OF THE USE OF ULTRASOUND FOR MONITORING AND INTENSIFICATION OF TECHNOLOGICAL PROCESSES IN BAKERY PRODUCTION

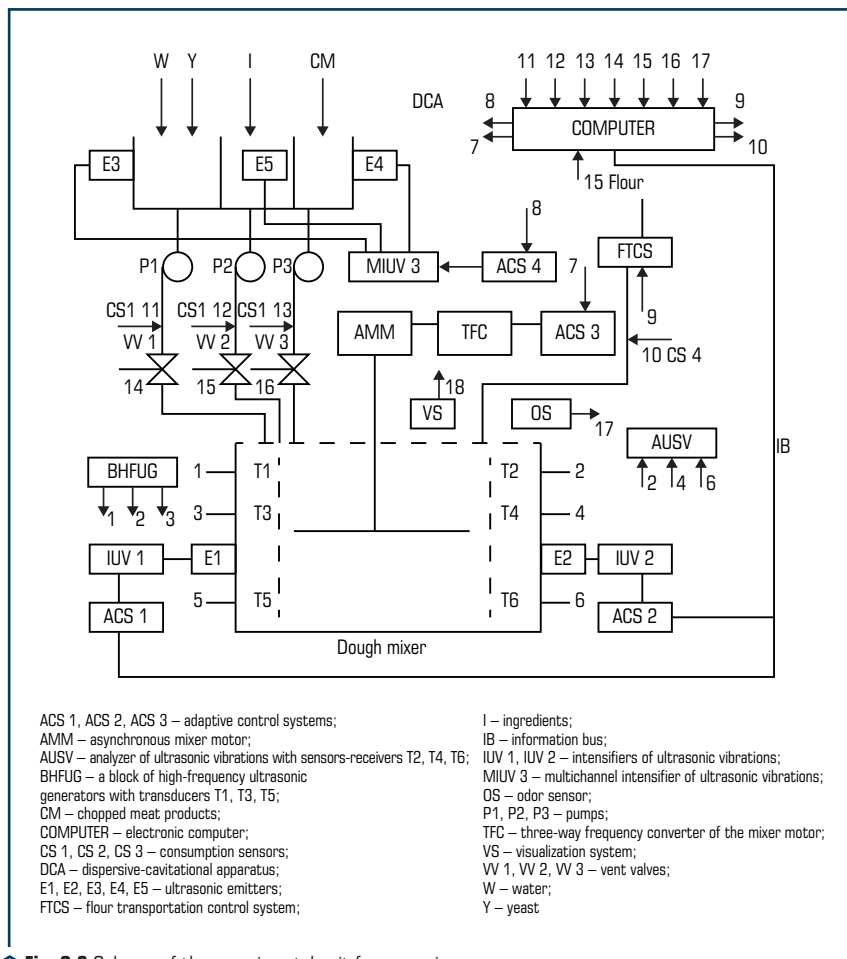
When setting up robotic intensifiers of the technological process for the production of bakery products, it was found that water treatment with ultrasonic vibrations at a frequency of 30 kHz with a power of 200 W (interaction time 186–192 s) makes it possible to achieve the most rational effect on its quality indicators: water hardness decreases by 1 % from the previous values, pH decreases by an average of 0.28–0.35 units, the iron content decreases by an average of 25–28 % [7].

The efficiency of using ultrasonic cavitation for water disinfection was also determined: the impact of ultrasonic vibrations at a frequency of 22 kHz with a power of 200 W (interaction time 210 s) leads to a decrease in the total microbial number (TMN) by 5 times.

A method has been developed for dispersing particles of functional additives [8–10] into dough due to controlled cavitation processes created by low-frequency ultrasonic vibrations. To do this, rational modes of sonication of the dough with functional applications at the stage of its

preparation are determined: sound pressure of 135–140 dB at a frequency of  $22 \pm 1.50$  kHz increases the productivity of the dough mixer by 12–15 % and ensures the production of innovative food products (bakery products of functional additives animal and/or plant nature in an amount of 5 to 10 % of the total mass).

**Fig. 9.3** shows a diagram of an experimental setup for studying the effect of low-frequency ultrasonic vibrations from 20 to 40 kHz and high-frequency ultrasonic vibrations with frequencies from 100 kHz to 1800 kHz.



**Fig. 9.3** Scheme of the experimental unit for preparing dough with ultrasonic intensifiers

The unit consists of two parts: dispersion-cavitation and dough mixing apparatus.

In experimental studies, let's use emitters E1, E2 with AUSV1, AUSV2 with a frequency of ultrasonic vibrations  $F=20-22$  kHz. The choice of such a frequency range is explained, firstly, by the property of ultrasonic vibrations to uniformly penetrate into small pores and capillaries of the dough throughout its volume, and secondly, by the ability to study the dispersion process due to cavitation flows of liquid with particles of crushed functional ingredients and their ability to uniformly test volume, thirdly, to perform controlled squeezing of flour particles and functional applications using ultrasonic vibrations.

The constructed system is distinguished by a large number of connections for controlling the robotic complex and consists of local systems: ACS1, ACS2 – adaptive control systems for intensifiers; AUSV 1, AUSV 2, AUSV 3 – adaptive control systems for the productivity of the dough mixer; ACS4 – adaptive control systems for a multichannel ultrasonic intensifier with emitters E3, E4, E5.

In the robotic complex, purified and prepared water [6, 10] with dispersed yeast particles is supplied to the dough mixing apparatus by a pump P1. The system for monitoring the performance of the pump P1 provides for the determination of the parameters of the flow rate of the CS1 and the position of the actuator A1, the signals 11 and 14 of control and management of which are sent to the computer. The supply of ingredients (I) to the dough mixer is performed by a pump (P2) with a flow sensor CSA2 and an adjustable valve CS2, the signals of which 12, 15 are sent to the computer. The supply of dispersed particles of functional applications is performed by a pump (P2), cost control is performed by the control system CS3 with an actuator A3, the signals of which 13, 16 are sent to the computer. The flour transportation control system provides for cost control using the CS4 system, the signal 10 from which enters the computer.

The following functions are performed in the dispersion-cavitation apparatus (DCA): controlled water purification; preparation of functional applications and other ingredients.

With the help of AUSV developed software products and developed methods of control, the computer controls the process of ultrasonic cavitation. At the same time, robotic intensifiers MIUV1 and MIUV 2 with systems ACS1, ACS2 and sensors for monitoring the parameters of the technological environment T2, T4, T6, interacting with the dough, form the rarefaction phase of the ultrasonic wave. As a result of this controlled phenomenon, breaks in weak points (cavitation nuclei) occur in the core of the technological medium of the dough mixer. In this case, these are particles of flour, yeast, air bubbles, particles of functional ingredients dispersed in the dough.

By means of AUSV and transducers T5, T6, the computer determines the limiting value of the intensity of ultrasound. Therefore, MIUV 1 and MIUV, due to the cavitation-dispersion process, disperse the particles of functional applications into the dough.

As the ultrasonic intensity increases from 100 dB to 140 dB at a frequency of 22 kHz, the rate of ultrasonic dispersion increases. Moreover, it depends on the characteristics of the flour and the magnitude of the forces of interaction between the individual particles of flour and particles of functional ingredients.

The productivity of the dough mixing apparatus is regulated using the ACS3, TFC3 and AP3 systems. Data from the OS visualization system, which involves the use of infrared optical sensors and remote sensing odor sensors, enters the computer and, after calculation using neural networks, informs the operator about the readiness of the product. In the dough readiness system with applications, sensors for controlling dough density T2 and its homogeneity T4 play an important role.

Thus, in the section, methods have been developed to control the parameters of the density of bread dough, arising under the influence of ultrasound of cavitation bubbles of the «dough-functional additives» medium, and to intelligently control the processes of dispersion of functional applications in dough and the productivity of the dough mixer by adaptive control of the power of the ultra-number of bonds.

It has been proven that ultrasonic vibrations, forming a cavitation-dispersing effect, provide a uniform distribution of moisture between flour particles, faster wetting of the particles of the dispersed phase, which causes an adhesive and cohesive effect of flour with particles of additives. As a result, mixing of dispersed flour particles with particles of crushed functional additives under the action of ultrasonic vibrations leads to the formation of a homogeneous heterogeneous medium.

In the process of cavitation dispersion of flour particles and particles of functional ingredients in a powerful field of ultrasonic waves with a frequency of 22 kHz, moisture with dissolved proteins, sugar, and other ingredients will form a thin film on the surface, which will improve not only the appearance of products, but also positively bakery products.

#### 9.4 INTELLECTUALIZATION OF INDUSTRIAL PRODUCTION OF BAKERY PRODUCTS USING ULTRASONIC TECHNOLOGIES

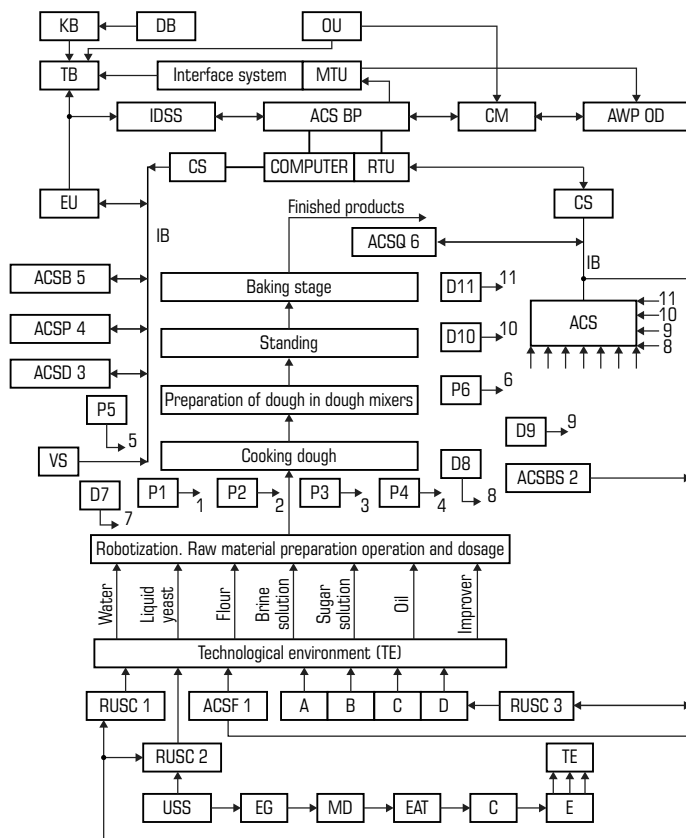
The next step was to develop an intelligent control system for the production of bakery products, in which the analysis of disturbances in raw materials, water and equipment was performed using a system for monitoring the performance of technological equipment.

**Fig. 9.4** shows a block diagram of a robotic complex for the production of bread. The technological line has built-in ultrasonic devices for water purification, disintegration, mixing and intensification of microbiological, biochemical, colloidal, chemical, hydrodynamic processes of bread production.

In the process control system for the preparation of raw materials, the following blocks with robotic ultrasonic complexes are used:

- RUSC1, RUSC 2 for water purification and yeast disintegration, respectively;
- RUSC 3 – in chambers A, B, C, dispersion methods were used to prepare saline solution, sugar solution and the dosage of fatty products with reinforcing components.

The robotic complex consists of an ultrasonic system (USS) interacting with the technological environment. The ultrasonic vibrating system includes an electronic generator (EG), a matching device (MD), an electroacoustic transducer (EAT), a concentrator (C) and an emitter (E).



ACS – automated control system;  
ACS BP – automated control system for the technological process of bread production;  
ACSB 5 – adaptive control system for the stage of baking bread;  
ACSBS 2 – system of adaptive control of the process of bread starter preparation;  
ACSD 3 – adaptive control system for dough preparation;  
ACSF 1 – system of adaptive control of the stage of flour preparation;  
ACSP 4 – system of adaptive control of the proofing stage;  
ACSG 6 – adaptive product quality control system;  
AWP OD – automated workplaces of operators and a dispatcher of a bakery;  
C – concentrator;  
CM – corporate monitor;  
COMPUTER – electronic computer;  
CS – Communication System;  
D7, D8, D9, D10, D11 – sensors;

DB – database;  
E – emitter;  
EAT – electroacoustic transducer;  
EG – electronic generator;  
EU – expert system;  
IB – information bus;  
IDSS – intelligent decision support system;  
KB – knowledge base;  
MD – matching device;  
MTU – Mater Terminal Unit;  
OU – output block;  
P1, P2, P3, P4, P5, P6 – piezo sensors;  
RTU – Remote Terminal;  
RUSC 1, RUSC 2, RUSC 3 – robotic ultrasonic intensifiers;  
TB – training base;  
USS – ultrasonic system;  
VS – visualization system

Fig. 9.4 Block diagram of a robotic complex for the production of bread



With the help of an automated control system (ACS), the control of the parameters characterizing the technological operation of preparing the bread starter-dough was carried out. For this, a system of piezoelectric sensors P1–P2, P3–P4, P5–P6, built into the technological environment of the devices, was used. The analyzer consists of three similar channels:

- 1<sup>st</sup> channel (piezo sensors P1–P2) – indirectly controls the density and other parameters of the dough (the stage of dough kneading);
- 2<sup>nd</sup> channel (piezo sensors P3–P4) – indirectly controls the fermentation stage of dough, evaluating their uniformity, hydrodynamic parameters and other properties;
- 3<sup>rd</sup> channel (piezo sensors P5–P6) – determines the concentration of gas bubbles in the dough-dough medium.

When ultrasonic vibrations pass through a dough or dough, due to absorption due to the viscosity and thermal conductivity of the medium, the signal amplitude is attenuated in accordance with the expression:

$$A_y = A_0 \cdot e^{-\alpha y}, \quad (9.10)$$

where  $A_0$  – the amplitude of oscillations emitted by devices of the source of ultrasonic vibrations T1, T3, T5;  $A_y$  – the amplitude of oscillations received by the piezoelectric sensors (T2, T4, T6);  $\alpha$  – the attenuation coefficient;  $y$  – the distance between the piezoelectric elements.

The third channel of the control system is tuned to the resonant frequency of cavitation bubbles liquid-dough-dough. The channel evaluates the optimal parameters of the cavitation effects of the ultrasonic field on the bread starter dough. The main parameter characterizing the effectiveness of the cavitation effect is the cavitation index (CI):

$$IK = \frac{V}{\Delta V}, \quad (9.11)$$

where  $V$  – the volume of liquid (dough);  $\Delta V$  – the volume of cavitation bubbles.

Let's use the cavitation index for an indirect assessment of the efficiency of the robotic ultrasonic complex, preparation of dough and dough.

In the process of developing an intelligent control system for a robotic complex, the following were built: databases (DB), knowledge bases (KB), an expert system, an intelligent decision support system. Identification of the technological process for the production of bread starter dough was carried out using a system of sensors T2, T4, T6, D7–D9, and the knowledge of technologists for expert evaluation of technological processes for bread production was also used. At the same time, the experts turned to a priori acquired knowledge, rules, models, characteristics of the dough and dough, and models of the interaction of ultrasound with biological objects.

In the process of expert research, the following was established:

- the initial temperature of the dough fermentation (28 °C) is lower than the fermentation temperature of the dough (30 °C). The fermentation of the dough lasts 3.5–4.5 hours, depending

on the content of flour in it, its variety, quality and quantity of yeast. Humidity and temperature of the dough, the gas-forming ability of flour and their acidity, the density of the dough and the lifting force, the active acidity of the dough determine the rheological properties of the dough and dough;

– the process of preparation of dough and dough can be indirectly controlled by aromatic properties, perceiving the diffusion of water vapor from the surface with the TGS2620 odor sensor (Tagushi Gas Sensor, USA) and visually, using the CB system.

In the future, the expert system (ES) becomes a trained artificial neural network (ANN) and, in combination with an electronic computer (ECM), processes and evaluates information coming from sensors:

- piezoelectric elements P2, P4, P6;
- from the D7–D11 sensor system;
- sensors that control the parameters of the MIUV system  $Z_H, R_K, K_S, IK$ .

As a result of EU identification:

– determines the optimal operating time of robotic complexes RUSC 1, RUSC 2, RUSC 3 and power;

– performs the prediction of parameters:  $K_2$  – hydrodynamic conditions of fermentation of the dough and kneading dough;  $P_0$  – the lifting force of the bread starter;  $\rho_o, \rho_d$  – the density of bread starter and dough, respectively;  $\lambda_m$  – the mass conductivity coefficient;  $a_m$  – the coefficient of internal mass transfer, which depends on temperature and moisture and indicates the intensive property of flour to external disturbances of water, solutions and other improvers.

The main task of the expert system is to choose the optimal inserts in proportion to the integral differential controllers (ADD-regulators) ACSF 1, ACSBS 2, ACSD3, ACSP4, ACSB5.

In the process of experimental studies, it was found that:

- at the ultrasonic frequency  $f_1=600$  kHz, the signals from the sensor P2 ( $A_y, 2$ ) indirectly identify the factors  $K_2, P_0, \rho_o$ ;
- at ultrasonic frequencies  $f_2=400$  kHz, the signals from the sensor P4 ( $A_y, 1$ ) indirectly identify the factors  $\rho_d, \lambda_m, a_m$ .

The architecture of an intelligent enterprise management system for the production of bakery products according to IDSS includes:

- expert system (ES), training unit (TU), knowledge base (KB), database (DB), output unit (OU), corporate monitor (CM), automated workstations (AWS) of operators and a bakery dispatcher and interface systems (interactions with an expert, an object and a user);
- APCS for the production of bread production (APCS BP) with a computer at the upper level and local systems of the lower (operational) level.

Bread production process control system built on the basis of SCADA systems includes three structural components:

- 1) RTU, MTU and CS. RTU (Remote Terminal Unit) – a terminal that processes information from sensors P1–P6, D1–D11;
- 2) visualization system (machine vision);

3) robotic ultrasonic intensifiers RUSC 1, RUSC 2, RUSC 3. RTU systems operate in hard real time. In turn, MTU (Mater Terminal Unit) is a dispatch control center with automated workstations for operators and a dispatcher. The main task of the MTU is to provide an interface between the operator and the bakery control system.

The CS (Communication System) system is a communication system (communication channels, information bus (IB).

The main task of the CS system is the transmission of control signals to the RTU. The work-technological complex includes:

- systems for adaptive control of individual technological processes and stages ACSF 1, ACSBS 2, ACS3, ACSP4, ACSB5, ACSQ 6;
- an automated control system (ACS), to the input of which, through ports 1–11, signals are found from sensors T2, T4, T6 – indirectly evaluating piezoelectric elements: rheological properties of dough and dough, dough lifting force, active acidity of dough, acidity of dough and smell (D7, D8), the forming ability of the dough piece (D9), the duration of the proofing of the dough pieces, the proofing temperature, the humidity in the proofer.

The mass of the dough piece is controlled by the D10 sensor system. The porosity of bread, its acidity, form stability, humidity, temperature in the center of the pulp, the duration of baking dough pieces are controlled by the D11 sensor system and the visualization system (VS).

The system uses the apparatus of artificial neural networks to find solutions for optimal modes of operation of the stages of bread production. This is achieved by recognizing production situations and identifying  $S_n$  – problem situations in tempo with the process of bread production. Recognition of situations  $S_b$  and  $S_n$  from a set of  $n$  situations will be called the classification process. With this interpretation, as the initial result at the output of the output unit (OU) of the IDSS system, let's obtain the situation number  $S_b$  or  $S_n$ . To train a multilayer INN, the method of error back propagation was used. In the process of training the network, the learning expert sets: the learning rate, the number of situations  $S_b$ ,  $S_n$  for each of the technological stages. This approach can significantly improve the accuracy of situation recognition and assessment of the state of the performance of technological processes: dough fermentation, dough homogeneity and control of bread baking processes.

The process control system for bread production uses algorithms for intelligent control of the processes of preparing raw materials, preparing dough, dough, aging and baking with expert assessment of the quality of raw materials, semi-finished products and finished products with decision support subsystems, developed in detail by the authors. An intelligent decision support system based on information from the sensors of the DB, KB, TB, output blocks, the EU expert system and ACSF 1, ACSBS 2, ACS3, ACSP4, ACSB5, ACSQ 6, changes the operating modes of ultrasonic systems RUSC1, RUSC2, RUSC3. This is carried out through performing mechanisms by working out optimal management actions on a heterogeneous technological environment. Flour parameters are assessed by the expert product quality management system ACSQ6. The recommendations of the latter through RTU, CS enter the automated control system for the stage of preparation and

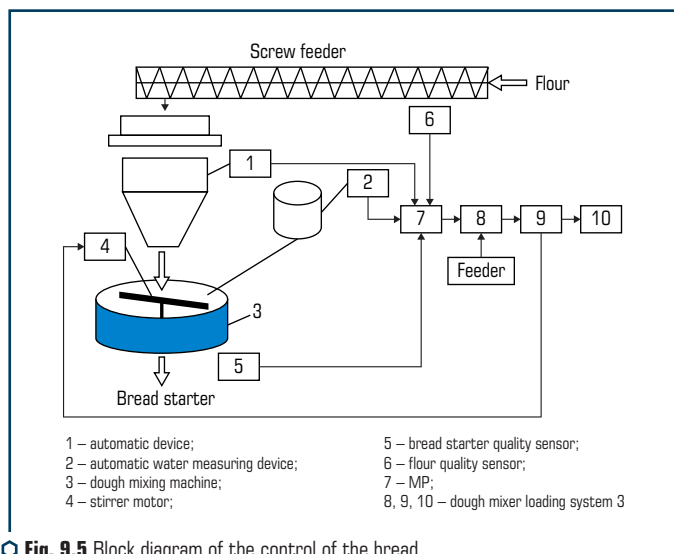
dosage of flour (ACSF 1). IDSS recommends in an interactive mode using KM a way to improve the properties of flour, dough and dough by fortifying the properties of bread.

Later, intelligent control systems for the technological process of production of bakery products were developed at its individual stages. So, **Fig. 9.5** shows a block diagram of the control of the production of bread starter, and **Fig. 9.6** – an adaptive digital control system for the entire dough mixing department with additional capabilities for reproducing the technology of low-temperature slow fermentation of dough, as well as an integrated system for freezing dough semi-finished products.

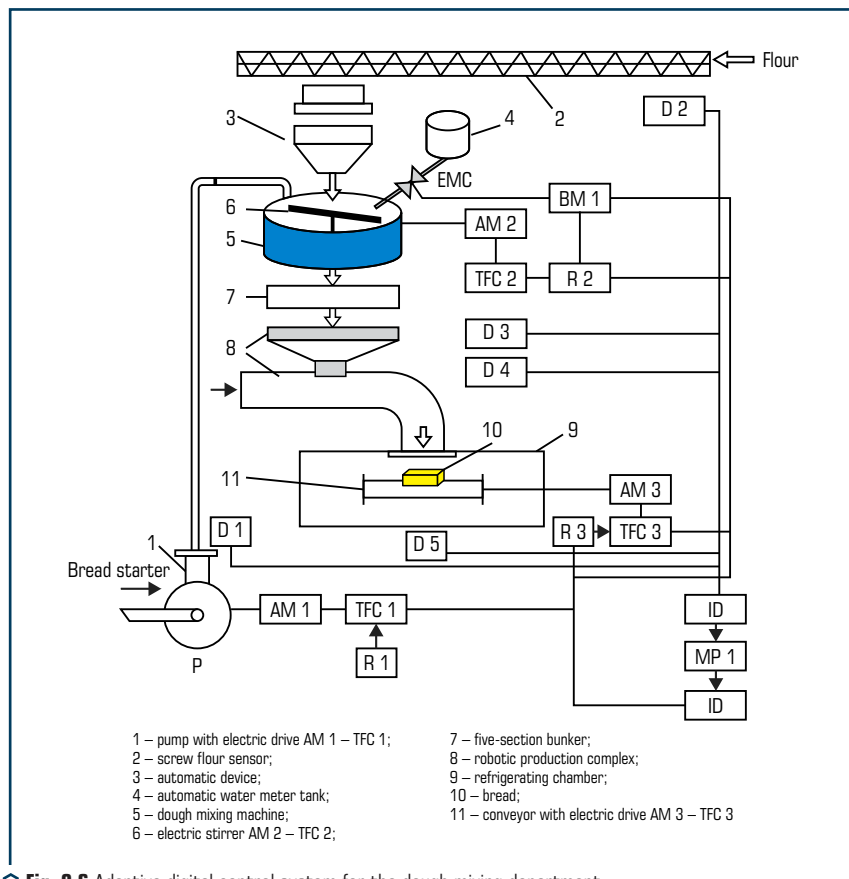
Algorithms have been developed that are embodied in adaptive systems for optimal control of bakery production processes, implemented using modern microprocessor systems that work with identifiers and provide automatic quasi-optimal adjustment of control systems for technological stages of food production. It has been established that the optimal quality parameters of the technological process of bread production can be determined and adjusted using adaptive digital controllers.

Thus, the complex influence of the frequency, intensity and speed of ultrasonic vibrations, the creation of cavitation effects, dispersion, disintegration, coagulation allows to optimize the operations of preparing bread starter and dough. That is, with the help of robotic complexes built into the technological process of bread production, it is possible to achieve a higher quality of bakery products.

Systems for monitoring the performance of equipment and the quality of water, raw materials, bread starter, dough are based on agency technologies, which makes it possible to build adaptive control systems for the dough preparation and bread baking complex based on fuzzy controllers.



**Fig. 9.5** Block diagram of the control of the bread starter production process



An analysis of the results of the functioning of the algorithm and structure of the adaptive automated control system (ACS) with monitoring of equipment performance (monitoring of product quality) allows us to conclude that the method of constructing adaptive ACS allows to synthesize fuzzy controllers for elementary operations of technological processes of bread production, taking into account the nonlinearity of objects of control project.

It is proved that the development of a reference problem under the conditions of uncertainty of external and internal disturbances not controlled by sensors can be evaluated by an expert system for the formation of algorithms for controlling the technological process of bread production. Taking into account the knowledge and skills of operating personnel in an expert control system with agency technologies for monitoring the performance of equipment and the quality of raw ma-

terials, including water [11], makes it possible to build intelligent control systems for the industrial production of bread with optimization of its performance parameters and minimization of specific energy consumption.

A multi-level intelligent system for automated control of the technological process of bread production has been developed. The architecture of this system uses a robotic complex with an intelligent decision support system and training units, databases and knowledge, a unit for displaying information on a corporate performance monitor, an automated workplace with an interface system, and an artificial neural network for recognizing emergency, abnormal and normal situations.

It should be noted that the use of robotic complexes with built-in monitoring systems and ultrasonic intensifiers in the industrial production of bakery products allows reaching a new level of quality and security of reproduction of technological processes and the final product, due to unmanned technologies with adaptive production control systems.

Thus, the development of systems for multi-purpose control of technological processes of bakery production based on product quality control and intelligent technologies will help increase labor productivity and reduce the specific losses of food, energy and other types of resources.

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Thus, the development of systems for multi-purpose control of technological processes of bakery production based on product quality control and intelligent technologies will help increase labor productivity and reduce the specific losses of food, energy and other types of resources.

The scientific novelty of the research carried out lies in the development of an intelligent system for monitoring and controlling the performance of equipment and the quality of water, flour, bread starter, dough based on agency technologies, which allows building adaptive control systems for a complex for automated dough preparation, molding products, baking bread, based on fuzzy controllers. its packaging and freezing.

It is proved that the development of a reference problem under the conditions of uncertainty of external and internal disturbances not controlled by sensors can be evaluated by an expert system for the formation of algorithms for controlling the technological process of bread production.

Thus, for the first time, the theoretical and practical results of intelligent control of complex technological processes for the production of bakery products with digital control algorithms for food industry enterprises are systematized in the work. The principle of their operation is based on the functionality of microprocessor control systems for complex technological processes of production, IIoT, digital platforms, distributed control and software products. The intelligent enterprise provides not only automatic provision of the normal flow of production of bread and flour products, but also automatic control of the start and stop of devices for repair work and critical situations.

It is predicted that the developed intelligent energy saving management systems at food industry enterprises will improve the efficiency of high-quality production and reduce energy costs by 10–15 % of the normal system capacity.

The paper proposes several new systems for quality control of bakery products and technological processes, as well as control algorithms using intelligent mechanisms. A number of adaptive process control systems have been developed.

A conceptual approach to the implementation of research on the development of the project «Intellectual enterprise for the production of bread and flour products» is proposed.

The development of systems for multi-purpose control of technological processes of bakery production based on product quality control and intelligent technologies will help increase productivity, reduce specific losses of input raw materials, human resources, electricity, gas, etc.

The paper analyzes the features of the technological processes of bakery production and the production of flour products as complex objects of quality management, the analysis of existing systems for the production of bakery and flour products at the enterprises of the industry and the determination of the main parameters of the operation of automated technological processes for the production of reasonable food products.

Perspective ways of improving product quality management systems and increasing the efficiency of managing the technological complex of a bakery based on modern achievements in science and practice of managing bakery equipment have been identified, which will improve the ecological state of the environment.

The carried out systematic analysis of the technological subsystems of the bakery made it possible to single out their performance characteristics in terms of assessing the complex indicators of the quality of raw materials, semi-finished products and finished products, and also proved the socio-economic essence of the concept of reasonable food products and their synergistic effect for regions with a technogenic load.

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## CONCLUSIONS

The results of the study allow us to state that the challenges and the paradigm of national and international security, primarily economic and technogenic in the 21<sup>st</sup> century, are being transformed, acquiring new qualitative and quantitative dimensions, approaches to assessment, forecasting and management. The main results of the study, outlined in the monograph, are as follows:

- the place and role of the security phenomenon in the scientific discourse were studied; identified approaches to understanding the essence of the concept of «security»; analyzed the stages of evolution of the security concept in the 17<sup>th</sup>–20<sup>th</sup> centuries; security paradigms are identified (traditional security paradigm, sectoral security paradigm, human security paradigm, integrated security paradigm); the types of security in the 21<sup>st</sup> century are identified and it is substantiated that the variability of types of security is primarily associated with its subject-object structure; proposed analytical levels of security; it is substantiated that in the modern paradigm of security, the place is occupied by the concept of national security; approaches to understanding the concept of «national security» are considered and the author's approach to understanding the essence of this term is proposed; the components of national security are identified and it is substantiated that the significance and role of various components of security differ significantly from one group of countries to another, which is dictated by the achieved level of socio-economic development, geo-economic and geopolitical potential of influence of countries, their national interests; the essence of the concept of «public administration in the field of security» is revealed; the variability of models for ensuring the security of states and their features are identified; based on the analysis of the Global Risks Reports, the global threats to national security in the 21<sup>st</sup> century are systematized and analyzed, the vector of their transformation, the time lag of manifestation and the degree of influence are determined;

- the transformational processes of the national identity of Ukrainians, the role of language in this process, the connection of national identity and language with national security are analyzed; it is substantiated that language is a key factor, which is the basis for identification with a particular nation of an individual, affects the security of the nation as a whole; it is determined that identification with the Ukrainian nation depends entirely on the level of proficiency, use and knowledge of the Ukrainian language; it was found that the regions where the indicator was the lowest gave an erroneous identification, that is, a reason for the neighboring state to consider russian-speaking representatives of the russian ethnic group; it is substantiated that one of the key moments in the process of forming a national identity was a full-scale invasion, which prompted a more conscious choice of the language of communication in various areas, in particular in everyday life, at work; a gradual increase in the competitiveness of the Ukrainian language is identified as a factor contributing to the formation of a conscious nation capable of protecting the security and national interests of the state;

– the existing approaches to understanding the essence of the concept of «economic security» are analyzed, taking into account its application to complex systems; indicators for assessing the level of economic security (Labor transitions by employment status, Arrears from 2003 onwards) were identified; methodological tools for studying the economic security of the EU countries and Ukraine were identified; it was found that the economic security of a system at any level of the hierarchy is characterized by a significant number of indicators that complicate its analysis and assessment; justified the expediency of using multidimensional statistical analysis procedures to assess the level of economic security; using the taxonomy method, an integral indicator of the economic security of the EU countries was calculated, which makes it possible to assert the existence of disproportions between countries regarding the states of economic security; security of the EU countries and Ukraine according to 2019 data, which made it possible to determine a high level (Netherlands and Sweden) and my low level (Greece); threats of losses of the EU countries from military operations on the territory of Ukraine are identified;

– the process of ensuring financial security of sustainable development at the global level was studied; the classification of international financial resources involved in the field of sustainable development has been improved by including such features as: forms of existence, ownership, sources of formation, directions of use, period of use, level of use; the configuration of the global security of sustainable development as a set of elements is substantiated: subjects, objects, principles and levers of control; defined measures to ensure the financial security of sustainable development at different levels of government;

– the possibility of using the signal approach to diagnose the level of financial security is substantiated; a regression model is proposed for predicting the emergence of threats to the financial condition of Ukraine, based on the concept of the dependence of the probability of reducing the country's consolidated budget on a number of security indicators; scenarios for the possible behavior of the economy under the influence of external factors in 2022–2023 were determined; proposed corrective measures of economic policy by the bodies of macroeconomic regulation in order to stop the inertial development of the forecast situation;

– the importance and role of innovative ecosystems in ensuring the further socio-economic development of countries, their competitiveness and national security are justified; the author's approaches to understanding the essence of the concept of «innovative ecosystem» are identified; two main approaches to understanding the concept of «innovative ecosystem» that have developed in the scientific literature are identified; the links between the concepts of «innovative ecosystem», «innovative infrastructure» and «national innovative system», identified their common and distinctive features are identified; the author's approach to understanding the essence of the concept of «innovative ecosystem» is proposed; existing approaches to understanding the life cycle, components and varieties of innovative ecosystems are analyzed and systematized; approaches to the definition of security parameters, markers of the effectiveness of innovative ecosystems are researched and summarized; the most representative indicator of the development of innovative ecosystems is identified; a comparative analysis of the parameters of functioning and development

of innovative ecosystems of the leading countries of innovative development (top 15 countries) is carried out: Switzerland, Sweden, the UAE, Great Britain, the Republic of Korea, the Netherlands, Finland, Singapore, Denmark, Germany, France, China, Japan, Hong Kong, Israel; markers of efficiency of innovative ecosystems and their security parameters are determined;

– the approaches of international organizations (International SOS and World Economic Forum, as well as The Institute for Economics & Peace) to the measurement of security and security in global tourism are considered; 4 rating scales of the countries of the world by the international organization International SOS are presented using the interactive Travel Risk Map on the risks to the health and security of tourists and travelers, namely: «COVID-19 domestic operations impact scale», «COVID-19 inbound travel impact scale», «Medical risk ratings scale», «Security risk rating scale»; calculation methodology, full descriptions and sources of indicators of pillars «Security and Security» and «Health and Hygiene» of Travel & Tourism Development Index; identified and analyzed the 10 most and least safe and reliable countries in the world to travel on pillars «Security and Security» and «Health and Hygiene» in the Travel & Tourism Development Index; the distribution of the subregions of the world according to the indicated components was carried out; presented the Global Peace Index framework and the methodology for its calculation; a map of the distribution of countries of the world according to the Global Peace Index was built; to assess the security of a tourist trip and conduct a tourism business in a particular state of the world, the criteria for evaluating and determining indicators are described that allow calculating the «Ongoing Domestic and International Conflict» and «Societal Security and Security» domains by Global Peace Index. Identified and analyzed 10 most and least peaceful countries by «Ongoing Domestic and International Conflict» and «Societal Security and Security» domains;

– the current state of development of hotel and restaurant enterprises in Ukraine is analyzed; the application of the taxonomy method for diagnosing the economic security of hotel and restaurant enterprises is justified; indicators of economic security of enterprises in the hotel and restaurant industry are identified, grouped in key areas: production, market, intellectual and personnel, investment, material and technical and financial; justified the interpretation of the values of the integral taxonomic indicator of the economic security of hotel and restaurant enterprises in Ukraine; identified five levels of economic security of enterprises, which correspond to certain strategies and management decisions for their implementation; the integral indicator of economic security of hotel and restaurant enterprises was calculated using the taxonomy method for 2015–2020; the uneven development of the hotel and restaurant industry of Ukraine and the existing problems in ensuring the economic security of domestic hotel and restaurant enterprises are determined; the strategy for ensuring the economic security of hotel and restaurant enterprises is substantiated and managerial decisions for its implementation for the future period are proposed;

– the relationship of food security and technogenic security with national security is substantiated; scientific provisions for the construction of intelligent control systems for the industrial production of bread with built-in intensifiers of technological processes of ultrasonic nature are substantiated; mathematical models of the processes of preparation and improvement of water

quality indicators, preparation and dosage of flour, preparation of bread starter, dough, dispersion for dough of functional applications, proofing and baking processes using ultrasonic monitoring and intensification systems are proposed; designing local adaptive control systems for relevant processes; theoretical substantiation of an intelligent control system for the production of bakery products with the development of a conceptual project «Intellectual enterprise for the production of bread for areas with technogenic pressure»; it has been proved that the development of a reference problem under the conditions of uncertainty of external and internal disturbances not controlled by sensors can be evaluated by an expert system for the formation of algorithms for controlling the technological process of bread production.

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CHALLENGES AND PARADIGM OF NATIONAL AND INTERNATIONAL SECURITY  
OF THE XXI CENTURY: ECONOMIC AND TECHNOGENIC DISCOURSE

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