I.J. Information Engineering and Electronic Business, **2022, 5, 1-14**
Published Online on October 8, 2022 by MECS Press (http://www.mecs-press.org/)
DOI: 10.5815/ijieeb.2022.05.01

Technologies Ensuring the Sustainability of Information Security of the Formation of the Digital Economy and their Perspective Development Directions

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Received: 19 February 2022; Revised: 18 March 2022; Accepted: 13 May 2022; Published: 08 October 2022

Abstract: The article is devoted to the technologies to ensure the sustainability of information security in the formation of the digital economy and their prospects. It has been shown that the digital transformation of the economy and society is a priority for the advanced countries of the world. It was argued that the safe and sustainable formation of an intellectual society and economy based on new information, knowledge and technology is one of the main goals. The features of the transition from an industrial economy to a new ICT-based information economy were analyzed. The issues of digital transformation of real economic sectors were considered. It was noted that ensuring the development of the modern economy on the basis of digital technologies, the development of high-tech sectors is one of the main goals. Potential areas for digitization of the economy have been identified. The economic features of the main technologies that shape the digital economy have been studied. The stages of analysis of the secure development of the digital economy sectors have been developed. Many concepts of the digital economy are systematized and approaches to its features are explained. Forecast options for the impact of the digital economy on GDP in the countries of the world are given. Mechanisms to ensure economic security, investment forecasts made by different countries to ensure economic cybersecurity are given. Research on the level of economic security and the main threats to the economy was analyzed. The main directions of security of the national economy and the main factors affecting the economic security of the country have been identified. Current approaches to economic security are summarized. The main types of economic security are given and a system of indicators is defined. The structural elements of the system of indicators for the analysis of economic security are proposed. System indicators have been developed to analyze the sustainability of economic security. Criteria for assessing the sustainability of regional economic security have been proposed. The assessment of the cybercrime market in the world is one of the most important issues and the most common types of cyber attacks are shown. An analysis of the state of growth in the field of cyberattacks in different years and the main stages of the evolution of cybersecurity are described. Proposals and recommendations have been developed in accordance with the experience of advanced countries on intelligent cybersecurity technologies.

Purpose of the research. The purpose of the research conducted in the article was a comparative analysis of technologies to ensure the sustainability of information security in the digital economy and to identify their future development directions. Attention was paid to identifying potential areas for digitalization of the economy, the stages of safe development of digital economy sectors.

An attempt was made to develop a conceptual model to ensure the security and sustainability of the national digital economy. The objectives of the research include: 1) Summarizing the modern existing approaches to economic security, 2) Developing a system of indicators of structural elements of economic security, 3) Developing system indicators to analyze the sustainability of economic security, 4) Suggesting criteria to assess the sustainability of regional economic security, etc.

At present, the assessment of cybercrime cases in the world, the study of the types of cyberattacks, the analysis of the state of growth in the field of cyberattacks in different years and the study of its main stages have created conditions for the study. Therefore, one of the goals was to offer tools and mechanisms to ensure the sustainability of information security in the digital economy.

***Research methods used*.** Research methods such as systematic analysis, correlation and regression analysis, mathematical and econometric modeling methods, expert assessment method, measurement theory, algorithmization, ICT tools and soft computing technologies, information theory were used to study the technologies of ensuring the information security sustainability of the digital economy and their perspective development directions.

Achievements of the author. Technologies to ensure the cyber resilience of the formation of digital economy are one of the key issues in the sustainability of information security in the economy. The development of a system of indicators characterizing economic security and system indicators on the sustainability of economic security has helped to achieve some of the goals set by the researcher by supporting the sustainability of the digital economy. The

scientific-methodological approaches proposed by the author can support the development of the digital economy as a special tool to ensure the sustainability of its information security. The recommendations presented can lead to more effective results in achieving a secure and sustainable economy in the face of regional conflict and unforeseen interference. The researcher tried to contribute to the study of solutions to the problems that will help each country to ensure the sustainability of the information infrastructure of its national economy through the application of modern ICT technologies. For this reason, the generalizations, models, mechanisms and criteria proposed by the author can help to ensure the sustainability and development of regional economic security and cyber security of the digital economy.

Index Terms: Information and digital economy, digital economy sectors, digital transformation, economic information security, cybersecurity technologies, economic security indicators.

1. Introduction

The experience of economic growth in countries with strong economies shows that their economic development is based on innovative technologies, knowledge and information. At present, one of the urgent issues is to achieve sustainable development of the regional economy, the formation of new socially oriented, diversified national economies. There is a need to further improve the model of balanced economic development based on macroeconomic stability, rapid regional development, favorable business and investment environment [1]. The main purpose of these measures is to strengthen economic sustainability and resilience, ensure economic dynamism by increasing the efficiency of enterprises, develop human capital and further improve institutional mechanisms in the business environment. The main tool here is to increase the level of digitalization of the economy by increasing the development potential of ICT and improving the ICT infrastructure. Improving the efficiency of governance through the application of ICT in the public sector is to build an innovation-oriented, information and knowledge-based economy. It is the introduction of competitive ICT products to the markets and the attraction of new investment projects based on high technologies [2].

Development of the economy on the basis of ICT is one of the main modern trends [3]. In order for the Azerbaijani economy to integrate into Europe, the informatization of the economy must be carried out more effectively. There is a great potential for the transition to a new economy in the field of informatization of economic sectors, mainly in energy, agriculture and transport. In particular, there are favorable conditions for the use of ICT in the energy sector, the development of the agricultural sector in accordance with modern ICT requirements, the preference for new technologies in the field of transport. At the root of the effective development of such real economic spheres and processes is the mass informatization of society [4]. Therefore, it is considered that informatization in general has a very important role in ensuring the stability and sustainability of the economy in the process of building the Information Society. The study of information security factors of these problems, as well as the study of aspects of information security sustainability is one of the urgent issues.

2. Problem statement and Research Situation

The security of regional and national economies is a complex issue. It is influenced by many internal and external factors. Our focus is mainly on ensuring the information security of the economy and increasing its sustainability. In general, the problem of economic information security has been studied to some extent [5-7]. However, there are many obstacles and potentials in solving problems in a similar area. It is of particular importance to identify these factors and potential opportunities to address them and to include them in the functional cycle.

Building a society based on information and knowledge, creating high-tech parks, developing electronic information resources, banking, finance, trade, education, medicine, etc. wider application of electronic services in socio-economic spheres, organization and development of production of software and technological equipment in the regions are the main directions of development of the emerging information and digital economy [8]. Therefore, there is a serious need for economic security of modern information and knowledge economy sectors based on a socially oriented liberal market economy. The urgency of this problem is reflected in the Strategic Roadmaps [1] for the development of national economic sectors, especially telecommunications and information technology, for 2025 and beyond. The safe and sustainable formation of an intellectual society and economy based on information and knowledge is one of the main goals of the state and society. This problem, first of all, requires ensuring the information security of the country's economy in many areas. Therefore, the study of information security issues and their sustainability in the new economy, its assessment as an important factor is quite relevant and pending.

3. Research of Relevant Related Works

The problems of technologies to ensure the sustainability of information security in the formation of the digital economy and the definition of their perspective development directions have been studied in many scientific

publications. In connection with the degree of development of the studied scientific publications, it should be noted that the features of their development-research stages, the formation of scientific and technological bases, features have been the subject of research of many foreign, including Russian and domestic scientists. Many fundamental scientific-theoretical and applied research works have been carried out to develop scientific, technical and technological aspects of information security sustainability in the formation of the digital economy. At the same time, research work was carried out to improve the activities of traditional information security processes. Different researchers have tried to study the development problems of approaches, models, new processes analyzed in the scientific literature in this direction in different ways. Therefore, in accordance with the challenges of modern ICT, serious attention has been paid to the technologies to ensure the sustainability of information security in the formation of the digital economy and the definition of their future development directions. We also paid a little attention to this problem at the time. Aliyev [26] considered the directions of ensuring cyber security of the information economy and the application of technologies. The article analyzes the features of the formation of a new type of economy based on ICT and shows the main risks and threats to economic development. The system of indicators characterizing the level of economic security is explained. The tasks of information infrastructure and technologies in the new economy have been identified. Sources of information security and basic technologies in the digital economy sectors have been studied. Cyber security areas of the information economy and relevant technologies have been proposed.

Adel [33] considers the issue of assessing the development of information security of enterprises under uncertainty using the method of Fuzzy Analytical Hierarchy Process (AHP). Assessing the development of information security is the first step in establishing an information security management system in any organization. One of the possible ways to solve the problem of information security development is to use a multi-criteria decision-making methodology. The process of analytical hierarchy involves human subjectivity, which presents a type of uncertainty and requires the use of decision-making methods under these uncertainties. This information security maturity is based on a hierarchical multi-level information security vulnerability analysis model for the ISO 27001: 2013 security standard. The concept of fuzzy set applies the Analytical Hierarchical Process to measure the development of information security of organizations in an uncertain environment. Using this approach helps to determine the importance of factors and indicators more effectively.

Isma [34] analyzes data security problems in cloud computing and their solution directions. It was noted that cloud computing technology consists of a modern web technology-based computing network that offers users resources that allow them to access to various cloud applications and work with them comfortably. The possibility of accessing data stored on a remote server using cloud service provider software on cloud computing computers was explored and the advantages of cloud computing were analyzed. The importance of addressing information security issues in organizations before applying the technology was also highlighted.

Zhengbing [35] has developed a method for optimizing the behavior of information security systems under impact conditions. The article analyzes modern methods of modeling the impact on information systems. This allows to identify effective approaches and use them to optimize security system settings. The article also provides information on special software that allows you to test the proposed method.

Serhii [36] discusses the issues of risk-based decision-making systems for information processing systems.

The basics of the methodology for establishing a decision support system under threats and risks were explained. This method was developed by changing the methods of purposeful evaluation of options and is used to build a scheme of the decision support system. When making decisions taking into account the risks, the following tasks should be addressed: determination of the quantitative characteristics of the risk; determination of quantitative indicators of the effectiveness of decisions in the presence of risks; distribution of resources between means of combating threats and means aimed at improving information security. The basic idea of the approach to threat and risk impact analysis in decision-making is that events that pose a threat or risk are considered as part of a decision support system. Therefore, such threat or risk models are included in the hierarchy of goals, linking them to other parts and goals of the system. The main functional modules that ensure the sustainable and efficient operation of the decision support system are the following subsystems: a subsystem for the analysis of problems, risks and threats; subsystem for the formation of goals and criteria; decision-making subsystem; formation of the decisive rule subsystem and analysis of alternatives. Structural operating schemes are established for each subsystem.

Zhengbing [37] discusses the development of an anomaly detection system in a secure cloud computing environment.

In the modern world, the steady increase in the use of information technology leads to a gradual increase in the amount of information circulating in the information and telecommunications system. This creates an urgent need to create areas for large-scale data storage and collection, and creates many new threats that are not easy to detect. However, the problem of provider data protection is so great that the risk of losing all data in the "cloud" is almost constant. This necessitates the processing of large amounts of data in real time and the notification of potential threats. Therefore, it is advisable to use an intelligent system that can process large data sets in the network of data centers and detect possible violations. It is more expedient to use intellectual methods that can track any unusual activity in a particular system - methods of detecting anomalies. Big Data methods can speed up such a system and process data dynamically.

Ahmet [38] examines the analysis of cyber attack risks in the 4.0 industrial ecosystem and the challenges of assessing its defense strategies. The significant impact of the development and application of high technologies on the

development of interconnected digital ecosystems has been studied and its relevance has been substantiated. It has been shown that this system is based more on usage than data. The study examines the problems associated with the threats posed by cyber attacks in all areas where digital information is used. For this reason, the great need to address the problems posed by cybersecurity has been confirmed. The fact that the main base of ICT systems in modern times is data shows that the risk of cyber attacks in Industry 4.0 continues to grow. The fact that cyber-attacks will continue in the future makes it even more necessary to study the probabilities of its risk. This article examines the sources of cybersecurity threats in the Industrial 4.0 ecosystem and examines its interpretation by corporate and end users. The most common problems of application of cyber security in management systems in industrial 4.0 systems have been identified. The study identifies cybersecurity strategies and requirements for solving its problems, as well as analyzes the possibilities of how to implement security for corporate users. The approaches proposed in the article show that preventing the problems identified by the research can help minimize the damage in cyber attacks.

Petrenko [32] explores ways to ensure cyber resilience and security in the digital economy. It was noted that in some cases there is a widespread threat to the sustainability of the digital economy, in which case the attacks take place over a long period of time. In addition to phishing messages and malware, various social engineering methods have been used by criminals. It is stated that the assessment of the cybercrime market in the world is one of the most important issues for today. Detection of cases of anomalies in intelligent cyber security technologies has been identified. In the aspect of intelligent cyber security technologies, issues such as the falsity or legitimacy of transactions, connection analysis, detection of fraudulent transactions, identification of accounts used for cash transactions were investigated.

4. Research Methodology

The article examines the identification of the directions of information security sustainability in the formation of the digital economy as an object of research. The subject of research is to ensure the sustainability of information security in the digital economy and their promising development technologies.

Attempts were made to develop the scientific and methodological basis of technologies to ensure the sustainability of information security in the formation of the digital economy, to identify potential areas for digitization of the economy, to study the economic characteristics of key technologies forming the digital economy. Efforts were made to identify the system of indicators of economic security and its structural elements, to develop system indicators for the analysis of the sustainability of economic security. Some criteria for assessing the sustainability level of regional economic security and proposals and recommendations for assessing the global cybercrime market have been developed.

International economic development trends, requirements of high and modern ICT technologies, main trends of the 4.0 Industrial platform have been taken into account in ensuring the sustainability of information security in the formation of the digital economy.

5. Digital Economy and Digital Transformation of Economic Sectors

Digital economy consists of the electronic part of the economy directly with the application of modern ICT. Digital economy consists of the implementation of e-business, e-commerce, e-products and services, economic and social activities in the virtual space, other business processes in the electronic mode with the direct application of ICT. The digital economy has features such as digitalization, tracking, distribution, privatization and etc. It also has many traditional stages of the economic process such as production, distribution, exchange, consumption and so on. [9, 10]. Digital economy consists of the main driving forces and constituent elements such as digitalization, Internet network, telecommunication industry, digital service providers, e-business and e-commerce industry, information and knowledge management systems, intellectual property rights, human capital, high technology, fast and reliable communication technologies, application of 5G technology, different production of new products, etc. The digital economy has a number of differences and advantages over the traditional economy.

The development of agreed plans for the activities of enterprises in the field of informatization, especially in the production and application of software products of information systems, should be carried out both in terms of time and the level of information security of these products. Issues of ensuring the necessary level of information security of these products can be considered from a legal, technical and organizational point of view. In this process, information threats such as unauthorized interference by malware, falsification of data, seizure of information in storage and transmission, violation of software products, illegal administrative rights and privileges, information errors of access operators, etc. could be occur. Therefore, appropriate information protection methods should be developed [11].

6. From an Industrial Economy to a new ICT-based Information Economy

In line with the development trends of the world, the industrial economy has developed mainly on the basis of ICT and other automation technologies. In our opinion, the greatest path of development of the industrial economy has passed through ICT without such information. There is considerable development potential in the field of automation of production, informatization of management processes. Therefore, the thesis of economic development should first be

considered in the context of informatization of the economy. In other words, it is necessary to achieve the application of technologies for the development of a new economy - the information economy in innovative ways. This, in turn, is the formation and development of an innovative information economy. At the same time, the level of formation of the digital economy can be further strengthened by informatizing the traditional economic sectors at a higher level. This can be achieved mainly through the digital transformation of economic sectors and processes.

At present, in order to achieve faster development of the economy, one of the main goals is to ensure its development on the basis of digital technologies, modernization on the basis of technological innovations. The development of artificial intelligence and robotics, bio, nano, information and communication, space high-tech sectors is also of particular importance. The sustainability and effectiveness of economic reforms in Azerbaijan in this direction are reflected in the Strategic Roadmaps for the development of the country's economy [12], the National Priorities for Socio-Economic Development of Azerbaijan adopted in 2021 [13].

Sustainable development of entrepreneurship in the real economic sectors, in the spheres of economic activity is one of the main priorities of the state's economic policy. In recent years, in line with global economic challenges, large-scale economic reforms aimed at specific goals have taken comprehensive measures to improve the business and investment climate and further improve the country's position in international rankings [14].

Improving the ICT infrastructure and increasing the country's ICT industry potential are also important tasks for the digitalization of the economy [1]. In modern times, information and telecommunication technologies have seriously penetrated into all spheres of society and created ample opportunities for development. Quality, secure and efficient digital transformation, as well as the efficient use of resources in this area, is a driving force in the development of innovation. Leading countries have achieved increased efficiency and transparency through the expansion of digital services and the development of e-government.

Digital transformation of the economy and society has become one of the priority issues facing the world in recent years. Important work has been done in the field of digitalization, construction of new infrastructure in the field of ICT, application and modernization of modern technologies. The formation and application of scientific and technological innovation policy is one of the key issues in the development of the economies of developed countries. It is planned to implement promising digital projects in Azerbaijan such as development of the Internet network, which is the basis of ICT infrastructure in Azerbaijan, "Government Cloud" (G-Cloud), "Big Data", "Smart City", "Smart Village" and others. Consistent reforms are underway to turn the country into a digital hub in the region [15]. There is a need to expand the use of digitalization in various sectors of the economy, to improve quality. Improving regulatory mechanisms and creating a healthy competitive environment in the development of communications and information technologies is of great importance for the country. Their implementation is one of the main goals [2]. Therefore, economic sectors with high potential for digitalization are studied and evaluated separately. As a result, first of all, the digital transformation of these areas must be carried out, taking into account international, national and regional characteristics.

7. Potential Directions for digitization of the Economy

At present, along with the informatization of traditional economic spheres, there are also areas where there is a great potential for development and informatization. The following can be attributed to such areas: 1) Technologies for efficient distribution of energy resources. 2) Technologies for efficient use of resources through the creation and application of new innovative technologies in all sectors of the economy. 3) Extensive use of ICT in the formation of a new way of life, the organization of cultural-educational work. 4) Technologies for efficient organization of work and efficient use of resources in the field of agriculture through ICT. 5) Application of ICT in the construction sector, transport, industry, management, efficient allocation of resources. 6) Benefit from the ICT factor in the management of urban economy, organization of municipal activities, use of housing. 7) Use of ICT opportunities in the field of ecology, nature protection, geological prospecting, tourism, etc. As a result of informatization, on the one hand, an innovative information economy is formed, on the other hand, the volume of the digital economy is growing. This process also creates many dangerous problems. Such problems can be solved only through the development and application of appropriate security technologies.

The main directions of the technological basis of the formation and development of the digital economy include 3D printing, digital twins, blockchain technology, nanotechnology, Big Data, cloud computing, smart systems, quantum, new generation supercomputers, industrial systems with artificial intelligence and global digital infrastructure elements, cyberphysical systems , the creation of bio-intelligent systems, the emergence of "smart factories", "smart cities and villages", the formation of digital currency, cryptocurrencies, "Internet of Things", etc. such as can be attributed to the achievements of the 4.0 Industrial Revolution [16, 17].

8. Stages of analysis of the Development of the Digital Economy

The digitization of the national economy and the formation of new digital economic sectors require the development of innovative ICT infrastructure in line with modern requirements and the formation of a digital ecosystem

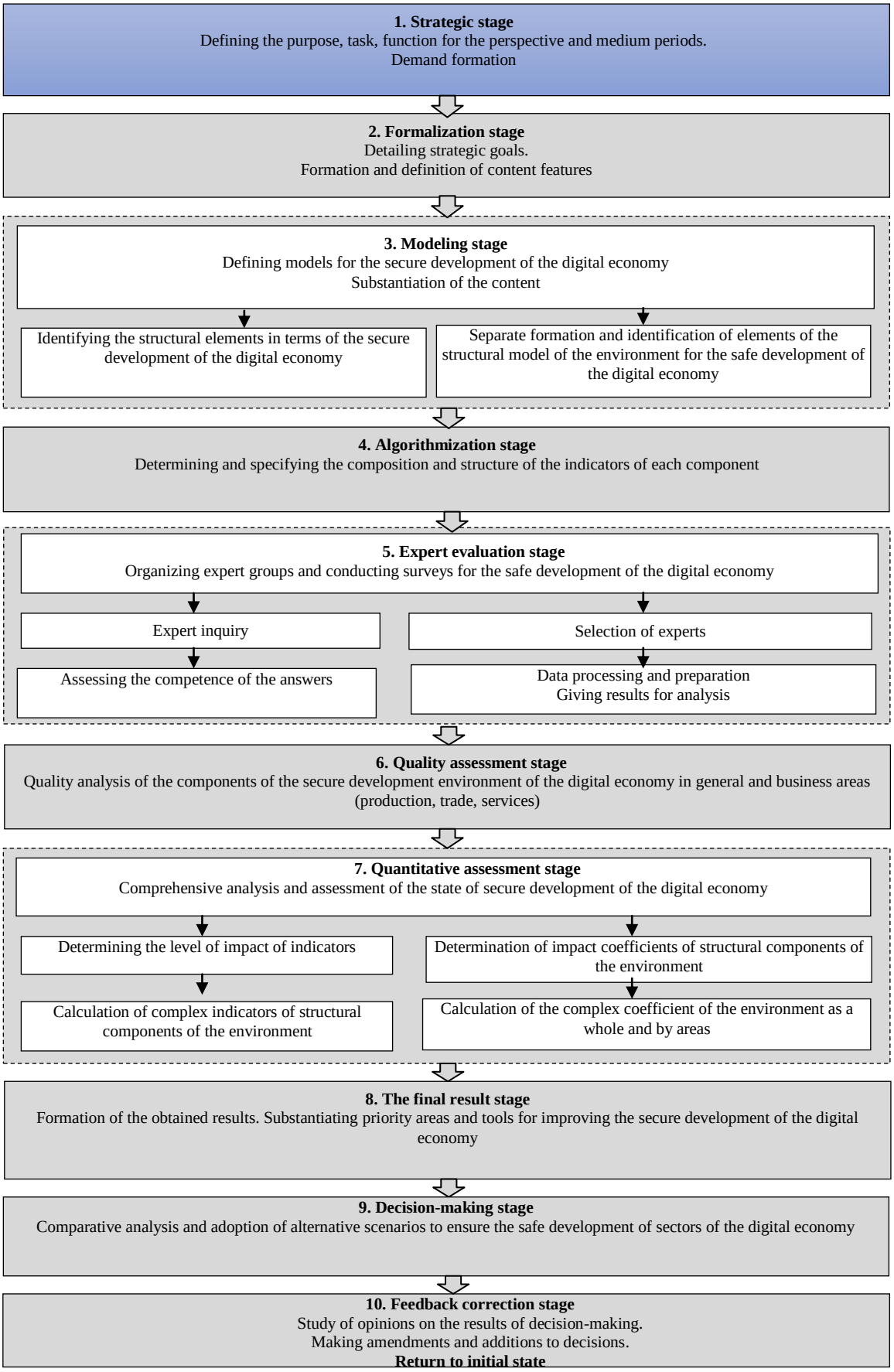

Fig. 1. Algorithmic stages of secure development analysis of digital economy sectors (compiled on the basis of analysis of scientific literature)

in the country. At the same time, the application of innovative technologies based on the international experience of developed countries in this area should be widely encouraged. In this regard, it is considered expedient to take appropriate measures to accelerate the implementation of new state programs and concepts. All this necessitates an in-depth analytical analysis of the stages of secure formation and development of the digital economy. Therefore, the identification of the characteristics of the methodological and algorithmic components of the analysis process in stages and the development of the basis for their consistent formation is aimed at facilitating the implementation of this process [18].

With this in mind, the stages of the analysis of the secure development of the digital economy sectors can be given as shown in Figure 1.

Information support for decision-making on the secure development of the digital economy is aimed at large-scale real-time data processing, remote access and simplification of functionality. It is important that people and businesses increasingly switch to online interactions and online services, digitize businesses and digitize most products. The implementation of live labor in a robotized, electronic way, the development of new types of items, even computerized production of human organs on 3D printers is becoming a reality [19]. The reduction of information asymmetry is also very important due to the ease of access to information and the use of advanced technologies for its processing. The emergence of the Internet of Things and unmanned transport, the formation of new types of electronic money are among the factors that give a serious impetus to economic development. Many important perspective projects, trends such as the concepts of "digital city/village", "digital twins/analogues, digital enterprise, digital person" are becoming more and more real, the introduction of e-government / state programs in general, etc. also show that the digital economy has great potential.

The approach to the characteristics of the digital economy can also be explained by systematizing many concepts [20, 21]:

- Relies on technologies for *efficient use of resources*, information sources, data processing (E. Brynjolfsson, B. Kahin), as well as human resources, ie human knowledge and creativity arising from information and communication technologies (D.Tapscott);
- modern technology is used to carry out *procedural* operations (T.Mesenborg);
- new information and information flows are created through ICT (N. Lane);
- effective changes occur in technological processes (M.Bahl);
- *structural* transformation process (E.Brynjolfsson, B.Kahin) and structures based on network technologies as components of the digital economy are covered;
- become business-oriented, business models are considered components of networking and e-commerce in the digital economy (T.Mesenborg);
- becomes business-oriented, new business models, network business, e-commerce emerge (T.Mesenborg) [20].

The goal of the digital economy is to organize and accelerate the application and development of digital technologies in all areas of society. The emergence of the digital economy opens up new opportunities for computerization and competitiveness of all sectors of the economy, creating a sustainable platform for economic development.

9. Aspects of the impact of the digital economy on GDP

According to international organizations, as a result of digital transformations, by 2030, 14% of the world's workforce will be forced to change their profession. Due to the digitalization of jobs, the world's gross domestic product (GDP) could increase to $ 9 trillion by that time [10, 22]. All these forecasts pose serious and important challenges to the higher education system. The projected volume of the global digital economy by 2035 is 16 trillion dollars. In 2025, up to 22% of China's GDP growth will be provided by Internet technology. In 2025, the expected increase in the value created by digital technologies in the United States will be around 1.6-2.2 trillion dollars. The digital economy in the United States accounts for 10.9% of GDP. In 2018, the volume of exports of services using digital technologies has reached 2.9 trillion dollars. This is 50% of world service exports. By 2025, the Internet will bring income contributing 4-11 trillion a year to the world economy. In 2025, digitalization will provide 19-34% of GDP growth. By 2036, up to 50% of work processes will be automated [23, 24]. Over the past decade, the development of ICT in the country has led to a doubling of GDP for the development of the non-oil sector as a whole, the formation of new forms of socio-economic activity. With the development of ICT, the country has achieved the establishment of a knowledge-based innovation-oriented economy, strengthening the intellectual potential, business advancement, development of e-services. There is an opportunity to fully meet the demand for information products and services, to strengthen the potential of export-oriented ICT. Expansion of digitalization in the financial and banking system of Azerbaijan, improvement of the institutional environment of digital payments, the revival of the financial and banking sector have been implemented. Development directions have been identified to increase awareness of digital payments, as well as to achieve the important goals of expanding digital, online payments.

10. Mechanisms for Ensuring the Sustainability of Economic Security

Economic security functions as a specific field of modern economics. It mainly studies the systemic and dynamic state of the economy. It provides high sustainability and sustainability of its development for medium, strategic and long-term periods [25]. Ensuring economic cybersecurity is quite investment intensive. In the United States alone, 140 billion dollars have been spent in this area this year. More than $ 1 billion is expected to be spent on hardware, software, and services. More banks are investing here: about $ 20 billion. close to a dollar. Then the sphere of production (10 billion), central and tax authorities (8 billion). The main cost is expected in the telecommunications sector. In this area, the United Kingdom and China are the next only to the United States.

An analysis of research on the level of economic security and major threats to the economy shows that in the context of accelerating modern globalization and integration processes, as well as intensifying international competition, each country's national and problem of economic security is becoming more urgent and strategic. Against the background of the crises of the world economy, each state has its own national interests, which can be protected only if the country's economic security is stable [26]. The level of economic security of the state is characterized by certain quality criteria and indicators. In this direction C.Y.Glazyev [27] proposed 22 key indicators (production dynamics, national budget, public debt, etc.), and V.K.Senchagov [28] proposed 16 indicators (low-income population ratio, high-income population ratio, etc.). In general, economic security is characterized by more than 150 indicators. In addition, 18 key indicators characterizing economic security are given in. 8 of them are macroeconomic indicators, and 10 are economic indicators that can be attributed to the middle and lower levels of management. Research shows that [29, 30] the main threats to most national economies include the following serious problems: low level of industrial production, dependence of the economy on imports and exports of raw materials, low living standards, development of the shadow economy, increasing corruption, science, education and innovation. poor development, strong brain flow, etc.

Economic security consists of many sub-systems and main goals related to the protection of the country's economy at the international and global level in the context of meeting the needs of society and the efficient use of government resources [31]. Based on such goals, the main directions of security of the national economy can be given as shown in Figure 2.

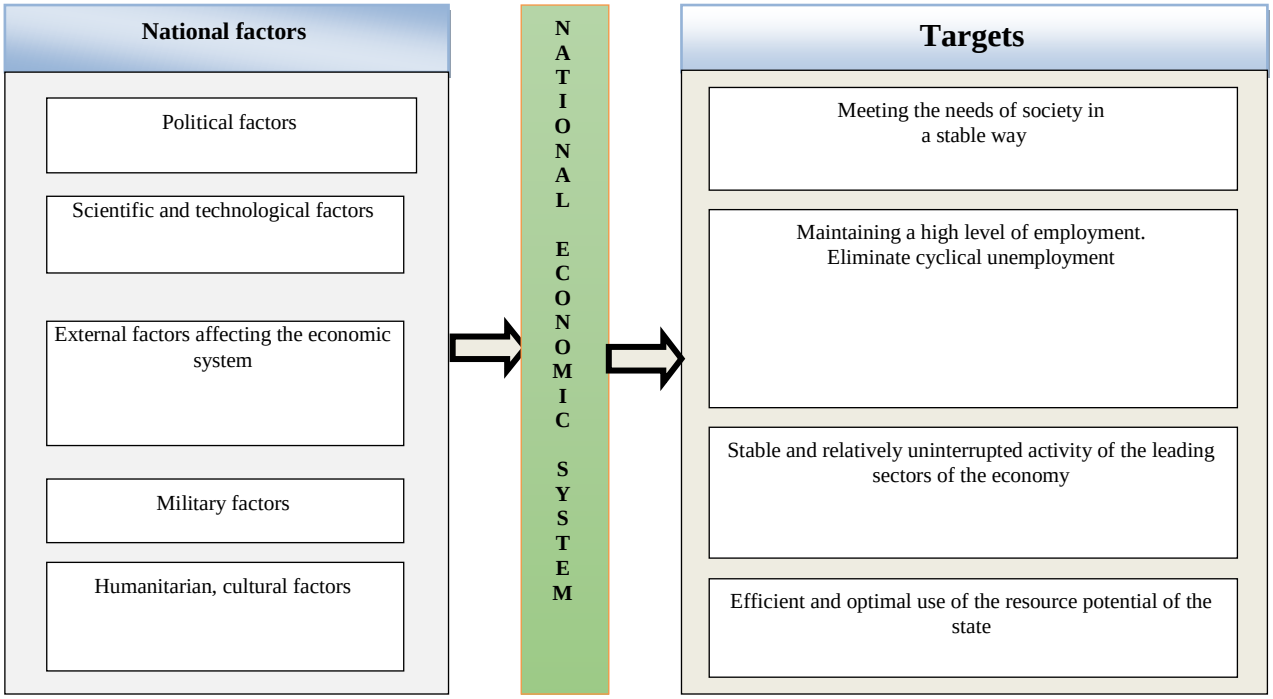

Fig. 2. The main directions of security of the national economy (compiled on the basis of analysis of scientific literature)

Many professors, studying the content and essence of economic security, note that the economic system depends on many external and internal economic factors [25, 28, 30, 31]. In the context of globalization of the economy and the development of international cooperation between countries, the impact of states on economic systems depends on factors such as the innovativeness and competitiveness of economic development. These factors include: the sustainable meeting of society's needs without a critical reduction in the quality of life of the population; protection of high level of employment and absence of periodic unemployment; ensuring stable and relatively uninterrupted operation of key sectors of the economy; efficient and optimal use of the state's resource potential, etc.

Given that one of the main factors affecting the economic security [31] of the country is internal factors, its structural scheme can be given as shown in Figure 3.

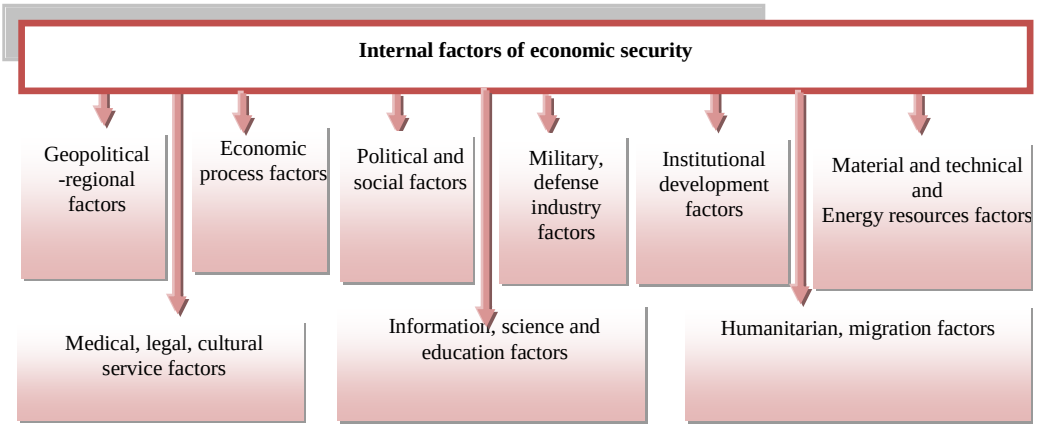

Fig. 3. Internal factors affecting the economic security (compiled on the basis of analysis of scientific literature)

By summarizing the current approaches to economic security, it can be classified as shown in Figure 4.

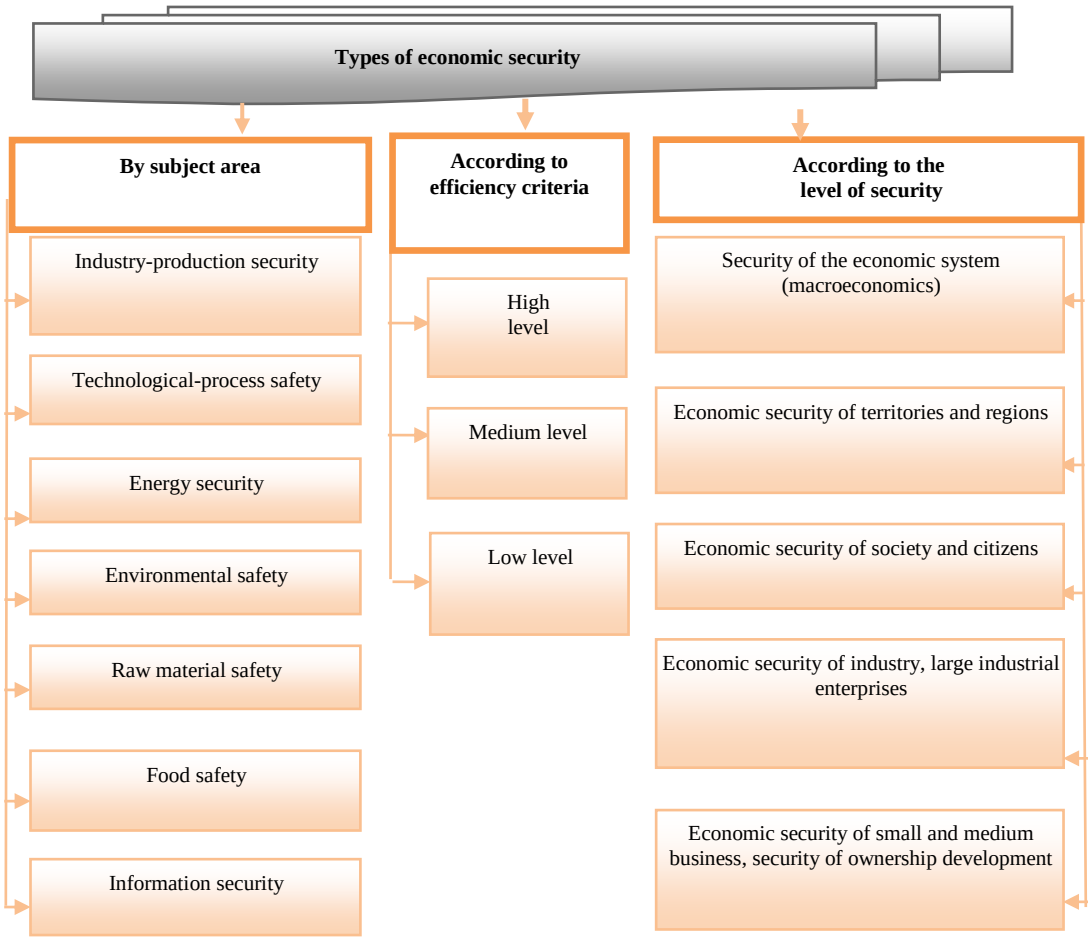

Fig. 4. The main directions of economic security (compiled on the basis of analysis of scientific literature)

When making decisions on the development of mechanisms to ensure economic security, the current economic situation should be seriously analyzed on the basis of a number of indicators.

The system of these indicators is analyzed by systematizing the country's economy as a whole in the sectoral and regional context [31].

The structural elements of the system of indicators for the analysis of economic security are shown in Figure 5.

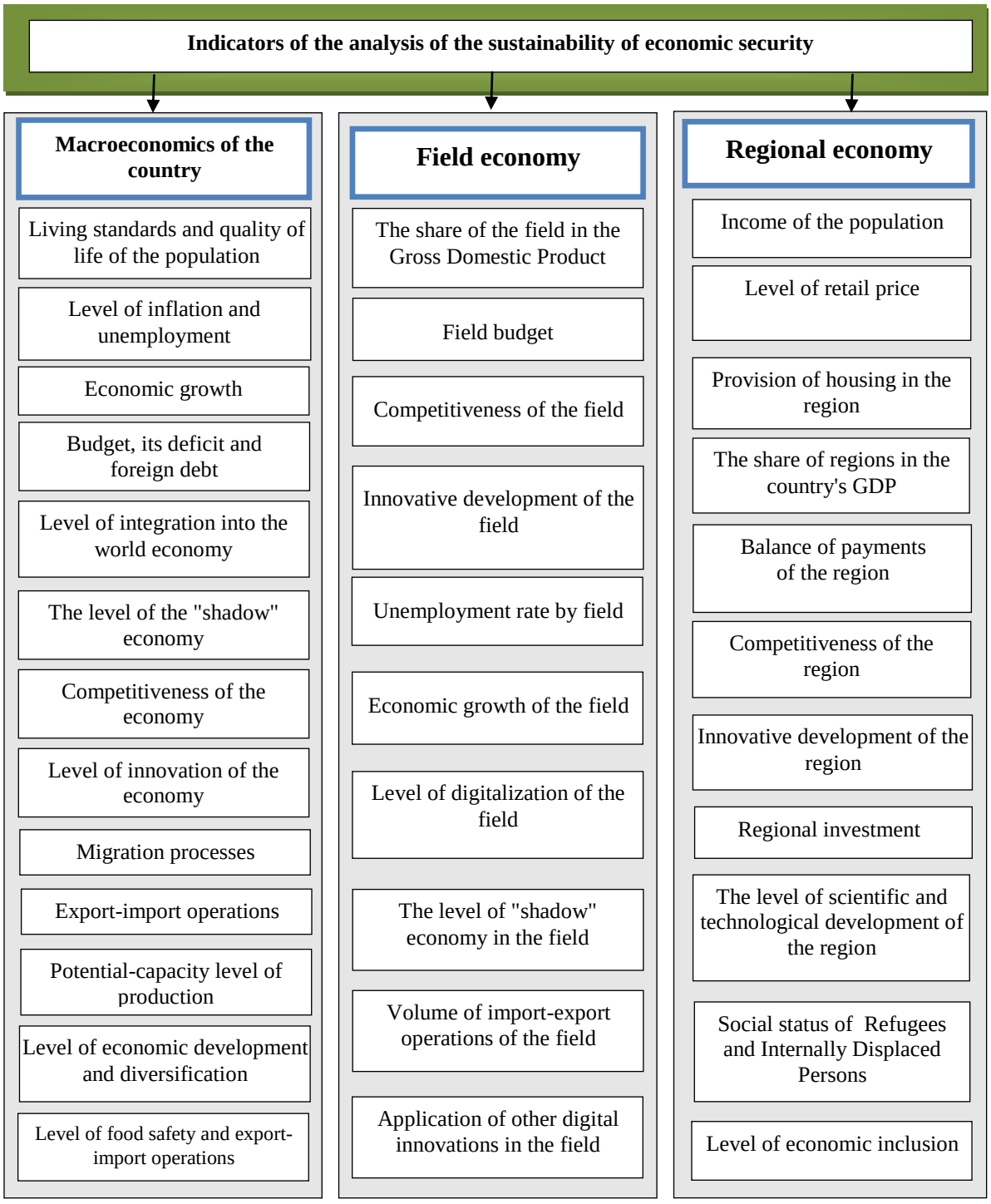

Fig. 5. System of indicators of the sustainability of economic security (compiled on the basis of analysis of scientific literature)

The criteria for assessing the level of sustainability of economic security include the following [25]:

1)macro criteria,
2) regulatory criteria,
3) specific institutional criteria,
4) social criteria,
5) environmental criteria,
6) military/military-industrial criteria,
7) science-education criteria,
8) innovation criteria,
9) food level of security, etc. Taking these into account, the criteria for the sustainability of regional economic security can be expressed as in Figure 6.

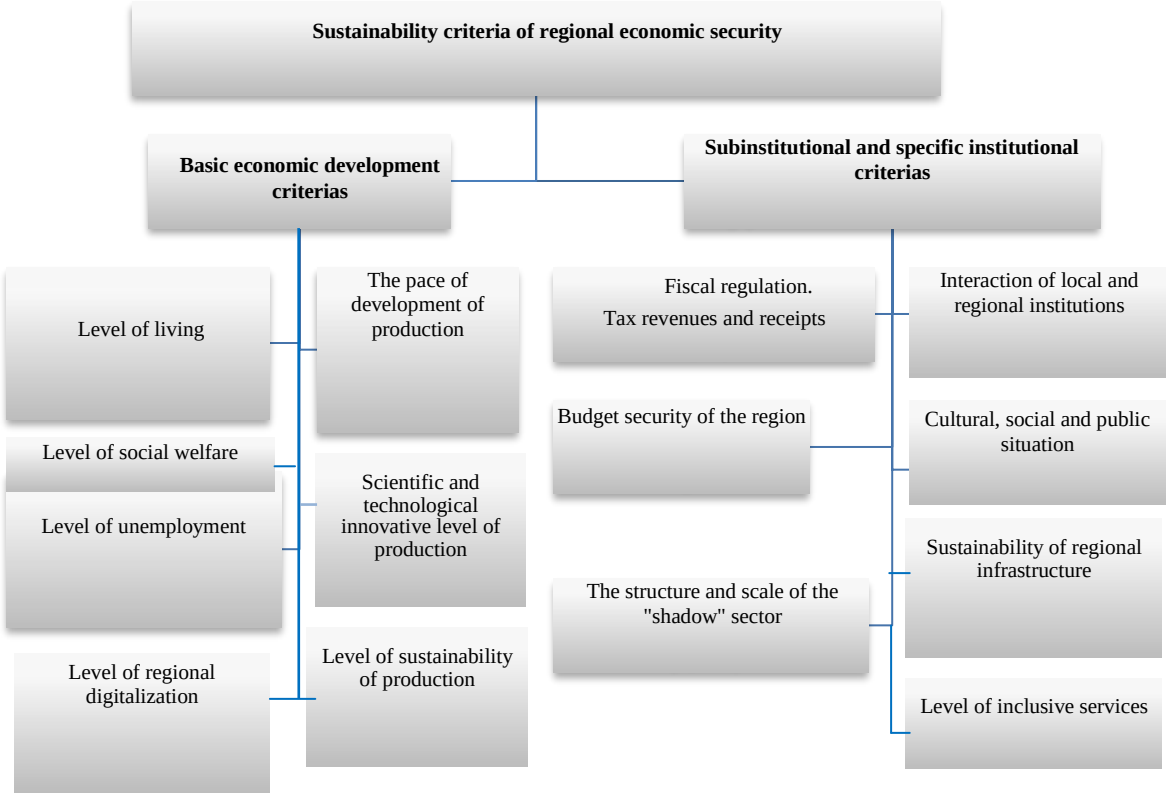

Fig. 6. Sustainability criteria for regional economic security (*compiled on the basis of analysis of scientific literature)*

In some cases, there is a widespread threat to the sustainability of the digital economy, with attacks taking place over a long period of time. In addition to phishing messages and malware, various social engineering methods are used by criminals [32]. In general, the most common types of cyberattacks are cyber intelligence, element database attacks, botnets, insider attacks, data and password theft, software attacks, phishing, data leakage, malware, attacks on services, denial of service, spam.

The assessment of the global cybercrime market is one of the most important issues for today. The analysis of the growth situation in the field of cyber attacks in different years can be expressed as follows. There are 800+ million cyberattacks in 2016, 71+ billion cyberattacks in 2017, and an unprecedented number of combined cyberattacks in 2018-2019.

The main stages in the evolution of cybersecurity can be described as follows. Until 2000, all information was available within companies. All the information of the company was under his full control. In the mid-2000s, cybersecurity went beyond the company's control. However, with the development of new technologies in the early 2010s - clouds, social networks, this trend takes on a different character. So, from the disclosure of information security to the warning, it is completely beyond the boundaries of the company. Therefore, there is a transition to a new "digital sustainability" paradigm for the current period. There is already a risk-based approach. Flexible approaches to ensuring information security are being implemented. More and more intelligent cybersecurity technologies are being used.

Intelligent cybersecurity technologies include anomalies detection, counterfeiting or legitimacy of transactions, connection analysis, detection of fraudulent transactions, identification of accounts used for cash transactions, detection of fraudulent activities with employees, early detection of attacks on infected network components, etc. can be attributed [32]. Taking into account the initial stages and requirements of the life cycle of cyber security of intelligent devices is becoming a very important issue. It should be noted that relevant guidelines, proposals, and recommendations on cyber security technologies of intelligent devices have already been developed in the leading countries of the world. Thus, the British government has developed and approved a guideline for IoT security. (https://www.gov.uk/government/publications/secure-by-design/code-of-practice-for-consumer-iot-security). The German government has developed a set of standards for the basics of cyber security for such devices (https://www.theregister.co.uk/2018/11/20/germany_versus_openwrt_ccc/).

11. Conclusion

Ensuring the development of the economy on the basis of digital technologies at the international and national levels, as well as the formation of high-tech sectors is one of the main goals of states. Digital transformation of the economy and society is one of the priorities for the world. The application of modern technologies to ensure the sustainability of information security in the digital economy and the development of their promising areas of

development has become a topical issue of our time. Safe and sustainable formation of an intellectual society and economy based on information, knowledge and digital technologies is one of the main goals. It should be noted that in the context of digital transformation of key sectors of the country's economy, the sustainability of their information security can be achieved only on the basis of a systematic approach. There should be a comprehensive use of administrative mechanisms in terms of legislation, as well as effective organizational measures, as well as relevant modern hardware and basic technologies.

In this regard, indices, indicators, methods and methodology for assessing the level of development of the information economy on the basis of national and regional cyber security technologies should be developed to ensure sustainable and sustainable development. At the same time, the direction of economic modernization should be focused on such advanced innovative, digital cybersecurity technologies that ensure the development of economic business to improve the fertility and accessibility of the environment. The formation of a secure economy that interacts with the international community and ensures sustainable development is a key way to both maintain a healthy economic environment and ensure the sustainability of long-term sustainable development based on available natural resources and technological knowledge. One of the important issues is to determine the mechanisms of economic security, the investment made by different countries to ensure the sustainability of economic cybersecurity. The system of indicators for the analysis of economic security and ensuring the sustainability of information security in the digital economy, its assessment indices should be developed in a comprehensive manner. At a time when the assessment of the global cybercrime market is one of the most important issues, the state of growth in the field of cyber attacks should be analyzed and appropriate proposals and recommendations should be made. Proposals and recommendations should be developed in accordance with the experience of advanced countries on intelligent cybersecurity technologies.

Improving the functioning of the digital economy, ensuring the sustainability of its information security with modern technologies, will create additional opportunities to increase the efficiency of its economy and future development in the context of economic governance.

Usefulness of the obtained result and application in practice. Technologies to ensure the sustainability of information security in the formation of the digital economy and the study of their prospects for development can be applied in other regional economies in the information systems of relevant ICT structures.

The complex results of the proposed criteria can serve as a platform for ensuring the sustainability of information security in the formation of the digital economy in general.

In this direction, in the context of sustainable development of the digital economy, it also reveals additional opportunities to study aspects of the digital transformation of the economy and society. Ensuring the sustainability of information security in the digital economy and increasing the level of security provide a basis for making appropriate management decisions in the activities of ICT, information systems and resource security structures.

As a result of the research, the economic features of the main technologies that form the digital economy were identified, and the stages of analysis of the secure development of the digital economy sectors were developed. The proposed methodological approach to ensure the sustainability of information security in the formation of the digital economy can be applied in other regional-sectoral economies. In this case, more effective results can be achieved by applying the proposed generalized criteria to ensure the sustainability of information security in the formation of the digital economy.

Identifying the main directions of security of the national economy and the main factors affecting the economic security of the country can be characterized as scientific support for management decisions in ensuring regional technological sovereignty. More effective results can be achieved by summarizing existing approaches to economic security and defining a system of indicators of economic security. The structural elements of the proposed system of indicators for the analysis of economic security, the proposed criteria for assessing the level of sustainability of regional economic security can be applied to ensure the sustainability of information security in the formation of other regional digital economy sectors.

In accordance with the experience of advanced countries, a number of proposals and recommendations on the assessment of the situation in the global cybercrime market, the analysis of the dynamic situation in the field of cyberattacks and the evolution of cybersecurity, as well as intellectual cybersecurity technologies have been developed.

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How to cite this paper: Alovsat Garaja Aliyev, " Technologies Ensuring the Sustainability of Information Security of the Formation of the Digital Economy and their Perspective Development Directions", International Journal of Information Engineering and Electronic Business(IJIEEB), Vol.14, No.5, pp. 1-14, 2022. DOI:10.5815/ijieeb.2022.05.01