Safety Factors in the Use and Formation of Intelligent Economic Systems of Construction Enterprises: Definition and Assessment Features

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Abstract. The relevance and necessity of identifying safety factors for the use and formation of intelligent economic systems of construction companies is proven. The purpose of the study is to form a quantitative basis for the development and use of intelligent economic systems of construction companies, considering the influence of safety factors. As a result of studying the condition and development trends of the construction sector, it was determined that the construction sector is essential branch of the state's economy, which affects its development and ensures the functioning of other spheres of activity. It reflects trends and is an indicator of the evolution of the state's economy. The construction sector reacts more inertly to the changes taking place in the state, both in terms of development and the accumulation of negative phenomena. This especially applies to the development and implementation of intelligent economic systems. Proposed security factors for the use and formation of the intelligent economic system of building companies, the evaluation of which is based on the application of qualitative methods used for construction enterprises and regions. The presented indicators are determined by the level of national security, directions of use and formation of financial, economic and information security, features of stakeholder relations of construction enterprises. Safety indicators make it possible to build a quantitative basis for assessing the level of formation and use of an intelligent economic system for making informed management decisions. It has been established that the formation of information and analytical support for the implementation of security measures is mediocre, which indicates the need to implement directions for increasing their effectiveness.

Keywords: Intelligent Economic System · Construction Enterprises · Construction Sphere · Safety Factors · Integral Factor

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1 Introduction

The formation of a modern system of management of construction enterprises requires a rethinking the approaches to the formation of directions for their development. Of particular importance is the use of innovative tools based on the use and formation of intelligent economic systems. An important element of the presented system is the safety component, which includes relevant factors.

In order to make informed management decisions, it is necessary to form a quantitative basis by evaluating the safety indicators of the use and formation of the intelligent economic system of construction enterprises. Along with this, in the construction sector, significant attention is not paid to ensuring the safety parameters of construction enterprises, an intelligent economic system has not been developed and is not applied. This inhibits their development, reduces the efficiency of functioning. An intelligent economic system has not been built at construction enterprises, which allows formation of a quantitative basis for making effective decisions on managing all types of resources. In the intellectual economic system, an important element is the security element, which consists of informational, resource, financial, economic, and physical elements. Unfortunately, only certain safety elements are used at construction enterprises, but a single safety system for the development of business entities has not been built.

The purpose of the study is to form a quantitative basis for the development and use of intelligent economic systems of construction enterprises, considering the influence of safety factors. Achieving the set goal is achieved by solving the following tasks:

Identification of safety factors affecting the use and formation of intelligent economic systems of construction enterprises.
Assessment of safety factors.
Determination of the integral safety indicator of the formation and use of intelligent economic systems of construction enterprises.
Thus, the research topic is relevant, and its development is important.

2 Materials and Methods

The features of the functioning of the construction sector are defined:

non-stationarity, temporary nature, non-homogeneous building production and the nature of the final product;
technological relationship of all operations included in the construction process;
instability of the ratio of construction and installation works in terms of their complexity and types during the month, which complicates the calculation of the numerical and vocational composition of workers;
participation of various organizations in the production of final building products;
role of climate and local conditions in construction works;
features of construction are due to a large variety of objects under construction [1].

It should be noted that during the studied period, undulating nature of changes in indicators of construction products is observed: in 2011–2014, the index decreased, and in 2015–2017, it increased. In subsequent years, the period of decline was replaced

by periods of growth. As a result of the research, ambiguous trends regarding changes in the index of building products for 2021 by region of Ukraine were determined. In general, there was an increase in the index of construction products compared to last year by 6.8% due to an increase in this indicator in the Ukrainian regions [2]. Similar trends characterized changes in the index of construction products for residential and non-residential buildings and engineering structures.

During the studied period, there was an increase in the volume of manufactured construction products by their types, in addition to the construction of ports, canals, dams, and other water structures. In 2021, the largest volume of manufactured construction products was observed in the Odesa, Vinnytsia, Dnipropetrovsk, and Kharkiv regions. Kirovohrad, Luhansk, Chernivtsi, Sumy, and Kherson regions were characterized by the lowest specific weight of the presented indicator. The total area of residential buildings at the start of construction in 2018–2021 generally decreased. This process took place due to the reduction of the total area of single-apartment houses and houses with two or more apartments. Only the total area of dormitories increased by 31% during the studied period [2]. The total area of residential buildings at the start of construction in 2021 by region was characterized by the largest values: Kyiv, Lviv, Dnipropetrovsk. The regions with the lowest values were: Kirovohrad, Luhansk, and Donetsk. It should be noted that the total area of non-residential buildings by types of construction products increased in 2018–2021. Only the total area of non-residential buildings decreased by 10% during the studied period [2].

During the studied period, there is an increase in the total number apartments in residential buildings at the beginning of construction by 2%, which occurred due to an increase in apartments in buildings with two or more apartments. This process of reducing the number of objects in single-apartment houses was slowed down. The largest number of apartments in residential buildings at the start of construction by type in the regions of Ukraine in 2021 was observed in the regions: Kyiv, Odesa, Dnipropetrovsk, and Kharkiv. Along with this, the low level of this indicator was characterized by: Luhansk, Donetsk, Kirovohrad regions [2].

Indices of capital investments by types of economic activity in 2021 indicate their growth throughout Ukraine. This was due to their increase in: agriculture, forestry and fisheries, industry, real estate transactions, activities in the field of administrative support services, health care and social assistance, arts, sports, entertainment and recreation, and other types of services. The reduction of the volume of capital investments during the investigated period occurred in the following areas: information and telecommunications, financial and insurance activities, public administration and defense; mandatory social insurance, education [2]. By region in the construction sector, there is a slowdown in the number of active economic entities, which corresponds to the general trend in Ukraine as a whole. In addition, it should be noted that the formation and functioning of economic entities is carried out according to the directions of construction: construction of buildings; organization of building construction; construction of residential and non-residential buildings; construction of buildings; construction of roads and railways; construction of roads and highways; construction of railways and metro; construction of bridges and tunnels; construction of communications; construction of pipelines; construction of power supply and telecommunications facilities; construction

of other buildings; construction of water structures; construction of other structures, not classified in other groups; specialized construction works; demolition and preparatory work at the construction site; exploratory drilling; electrical, plumbing and other construction and assembly works; construction completion works; plastering works; installation of carpentry; floor covering and wall cladding; painting and glazing; other construction completion works; other specialized construction works; roofing works; other specialized construction works, not classified in other groups.

As a result of the study, the increase in the turnover of personnel in Ukraine as a whole and in the construction sector, in particular, was determined. Moreover, this process took place for all types of construction activities. This testifies to the growing attention to the provision of working capital and the possibilities of its implementation in the production process. In addition, there are changes in focusing attention on the provision of working capital as an important element of the development of construction enterprises.

The dynamics of added value by production costs by types of construction activity is characterized by its growth both in Ukraine as a whole and in construction during the studied period. This was facilitated by the increase of this indicator by types of construction activity.

The dynamics of capital investments during the studied period in Ukraine as a whole was characterized by growth. A similar trend was observed by types of construction activity. Moreover, capital investments in tangible assets increased, along with the reduction of this indicator in intangible assets. In the largest part of types of construction activities, capital investments grew during the studied period. However, this process was hampered in the following areas: organization of construction of buildings; construction of railways and metro; construction of other buildings; demolition and preparatory work at the construction site.

Average number of employees in the equivalent of full employment, the number of hours worked by employees during the studied period decreased in Ukraine as a whole and in construction in particular. This was facilitated by a decrease in the presented indicators by types of construction activity: building; construction of residential and non-residential buildings; construction of structures; construction of bridges and tunnels; construction of other structures; construction of water facilities; construction of other structures not classified in other groups; specialized construction works; dismantling and preparatory work at the construction site; exploration drilling; electrical installation, plumbing and other construction and installation works; electric installation work; installation of water supply networks, heating and air conditioning systems; plastering works; installation of joinery; flooring and wall cladding; painting and glazing; other specialized construction works; roofing.

During the researched period, there is an increase in incomes performed under contract conditions for most types of construction activities. Only the construction of railways and the metro and exploratory drilling are characterized by a decrease in income. The presented trend shows the growth of income and opportunities of construction enterprises. Along with this, the processes are affected by factors related to the increase in prices, in particular, for construction materials, wage levels, inflationary processes that affect the formation of income from construction works.

The dynamics of profit before taxation shows the growth of its value over the studied period by regions in Ukraine as a whole and in construction in particular. This indicates an increase in the level of effectiveness of activities, including by types of construction activities. It should be noted that according to the presented indicators, there is a decrease in the level of information and analytical support, which negatively affects the ability to make informed management decisions and build an intelligent geospatial economy at construction enterprises.

The dynamics of non-current assets in Ukraine as a whole and in the construction sector in particular shows growth [2]. This indicates the strengthening of the production and economic potential and the increase of opportunities for the performance of production tasks. Along with this, for some types of construction activities and especially for medium and small enterprises, there is a decrease in the volume of non-current assets. This indicates a decrease in attention to the growth of the production and economic potential of the represented business entities and the increase in the level of monopolization of construction activities. It should be pointed out the decrease in information and analytical support regarding the dynamics of non-current assets, which affects the level of effectiveness of making informed management decisions.

It should be noted the growth of current assets in most types of construction activities. This testifies to the growing possibilities of construction enterprises to use the most mobile funds. However, a similar trend has been identified as with previous assets regarding the reduction of information and analytical support.

The dynamics of own capital during the investigated period indicates a reduction in its volume due to construction and outflow. This affects the financial stability of construction enterprises. Special attention is focused on the reduction of information and analytical support in the system of use and formation of own capital.

During the studied period, there is a reduction in the volume of long-term obligations and guarantees in construction, which does not correspond to the general trends in Ukraine [2]. This indicates an effort to reduce debt by types of construction activities, unsatisfactory conditions for long-term lending, a decrease in the ability of customers, instability of socio-economic conditions.

Along with this, there is an increase in current liabilities and collateral, which indicates an increase in opportunities for attracting short-term borrowed funds, as well as a slowdown in the processes of forming the financial stability of building enterprises.

It should be noted a decrease in the amount of liabilities for non-current assets and disposal groups and the net value of assets of a non-state pension fund by types of construction activities. In addition, it is necessary to note the low level of information and analytical support for these obligations, especially for specific types of construction activities.

In general, Ukraine and regions have the largest share of enterprises with positive financial results. The specific weight of a positive result for enterprises varies from 50% to 100%. This testifies to the effectiveness of business entities.

The practice of applying intelligent economic systems at construction enterprises is carried out along the lines of introducing artificial intelligence as an integral part of the fourth industrial revolution “Industry 4.0” [3].

The international experience of the development of artificial intelligence is determined by the creation of new platforms. The World Economic Forum has launched The Global AI Action Alliance, a new multi-stakeholder collaboration platform and project incubator designed to accelerate the adoption of inclusive, trusted and transparent artificial intelligence, bringing together more than 100 leading companies, governments, international organizations, non-profit organizations and scientists [4].

Identified artificial intelligence technologies used in the personnel management system: Resume Matcher (SAP); Skillaz; TalentTech Sever.AI; Hurma System; Veriato 360; Workday; Yva.ai 3.0 – Visier Announces Asset Acquisition; Isaak Status Today by Glickon; Cornerstone + EdCast; Degreed; Filtered Content Intelligence; WalkMe ActionBot; AIOps.

The presented artificial intelligence technologies are used to organize the recruitment of personnel, control their movement, provide training, form appropriate management decisions, and automate the processes of using labor resources.

The introduction and development of artificial intelligence in economic processes is connected with the development of the "Industry 4.0" system, which uses the Internet of Things (IoT), big data (BigData) and cyber-physical systems.

According to experts, the prospects for the development of artificial intelligence in Ukraine are important, but to a greater extent they are related to the areas of: autonomous control; biotechnology; face recognition; internet of things; trade; robotic systems.

As a result of studying, the methods and models of using artificial intelligence were determined: methods of finding solutions in the space of states; bidirectional search method; methods of uninformed or "blind" search (full search); methods of complete search; finding a solution when reducing tasks to subtasks; heuristic search methods; knowledge presentation models in artificial intelligence systems; proof methods; method of resolution in numerous predicates; models of fuzzy logic; production models of knowledge presentation; scenario approach; formation of expert systems; formation of neural networks.

At construction enterprises, separate elements of spatial support are used, but the directions and features of the application of geoinformation systems and technologies are insufficiently defined.

To ensure the safety of the development and use of an intelligent economic system at construction enterprises, information systems of the first generation are formed based on the formation of data and the construction of a mathematical model for a separate economic task. Second generation information systems are aimed at information management. Information systems of the third generation are defined by decision support.

Identified information economic systems and their application in international practices:

SCAN (large projects implemented in developing countries. Developed according to directions proposed by the UN);
BUSINESS (international trade, contracts, technology development and implementation, licensing activities);
HURFAX (market research, formation of results in the form of relevant documents);
PASCAL, SGBD (economic, financial and banking sector of France);

COMEXT (trade area of the European Union);
CISI (formation of databases to ensure the development of the spheres of economic activity of the European Union);
BRIL (scientific research activity);
WATS (assessment and analysis of directions and features of the economic activity of the American company);
PUNS (evaluation and management of activities of international companies);
ICOF, JORDAN, IML (evaluation and analysis of the activities of British companies);
BODAS, ESSOR, DETOFEL (commercial sphere, management system, distribution of property, formation and use of capital, use of personnel of French companies) [3].

A wide range of application of economic information systems has been established, but they solve only certain issues of the functioning of enterprises. There are no comprehensive economic systems for managing all types of resources, automation of the processes of their use and formation, taking into account the modern tools of artificial intelligence, spatial aspects of the activities of business entities, which is especially relevant in the construction sector. Therefore, the development of the intellectual economic system of construction enterprises proposed by the author will solve the actual issues aimed at the development of construction enterprises, using modern informational, analytical, economic, geospatial, security tools and tools of artificial intelligence.

There are no unified approaches to the definition of the intellectual economic system of construction enterprises in the existing scientific developments. It should be noted that the formation and use of the intelligent economic system of construction enterprises is influenced by relations with stakeholders [5–12].

Dovbysh, V. Tron, R. Kvasny, and L. Chernyak, N. Nylson, A. Horelyk, D. Goldberg focus on the functional directions for the formation and use of the intellectual economic system of enterprises [13–17].

The modern toolkit used for the formation and use of the intellectual economic system of building enterprises is presented in the works [18–21].

Thus, a theoretical basis and a platform for defining the intelligent economic system of construction enterprises have been formed, where the main attention is focused on the formation of a set of economic, informational, geospatial, and security components that allow building directions for making management decisions in the context of the development of construction enterprises.

To develop and implement sound management decisions regarding the formation and use of intelligent economic systems of construction enterprises, the selection and evaluation of safety factors is carried out. As a result of the study, the necessity of characterizing financial and economic security was determined. P. Nikiforov, V. Stolbov, T. Davidyuk point to the importance of financial and economic security [22–24].

In addition, in the context of the assessment of security indicators, the level of information security of construction enterprises is determined using the method of expert assessments:

Because of the study, the factors of the level of information security were determined, which are characterized by:

Principles of ensuring information security.
Interests reflected in the information sphere.

Real and potential threats to information security.
Priorities of state policy in the field of information security.
Stakeholders to ensure information security.
Coordination and control over the activities of stakeholders that ensure information security.
Level of personal data protection.
The level of ensuring information protection in information, electronic communication and information and communication systems.
Organizational areas of ensuring information protection.
The level of interaction of stakeholders with the information protection service;
Level of information society formation. An important indicator in the system of safety indicators is the level of safety of interaction between stakeholders of construction enterprises:
Customers of construction products;
Contractors;
Social organizations;
Suppliers of goods and material values;
Project organizations;
Internal and external audit organizations;
Public organizations;
Workers of construction enterprises;
Owners;
Top management;
Managers of different levels.

The presented factor is determined on the basis of expert assessments for each construction enterprise. So, summarizing the above, the safety indicators of construction enterprises are highlighted (Table 1).

Table 1. Safety factors of the formation and use of the intellectual economic system of construction enterprises.

Indicators	Evaluation methods		Object of assessment
	Quantitative assessment methods	Qualitative evaluation methods	
The level of national security			
formation and implementation of the principles of ensuring national security	–	+	Regions
interaction of interested parties in the field of national security	–	+	Regions

(*continued*)

Table 1. (*continued*)

Indicators	Evaluation methods		Object of assessment
	Quantitative assessment methods	Qualitative evaluation methods	
The level of financial and economic security of construction enterprises			
ensuring interaction between interested parties in the field of financial and economic security	–	+	Construction enterprises
The level of implementation of measures for the formation and application of financial and economic security	–	+	Construction enterprises
prevention of threats and risks based on financial and economic security	–	+	Construction enterprises
The level of formation of information security of construction enterprises			
implementation of information security principles	–	+	Construction enterprises
ensuring the interests of construction enterprises in the field of information security	–	+	Construction enterprises
identification of real and potential threats to the information security of construction enterprises	–	+	Construction enterprises
ensuring the priorities of state policy in the field of information security	–	+	Construction enterprises
interaction of interested parties in the field of ensuring information security	–	+	Construction enterprises

(*continued*)

Table 1. (*continued*)

Indicators	Evaluation methods		Object of assessment
	Quantitative assessment methods	Qualitative evaluation methods	
protection of personal data	–	+	Construction enterprises
ensuring the protection of information in information, electronic communication and information and communication systems of construction enterprises	–	+	Construction enterprises
formation and implementation of organizational measures to ensure information security of construction enterprises	–	+	Construction enterprises
functioning of the information protection service of construction enterprises	–	+	Construction enterprises
information society formation	–	+	Regions
ensuring the interaction of stakeholders of construction enterprises			
Customers of construction products	–	+	Construction enterprises
Contractors	–	+	Construction enterprises
Social organizations	–	+	Construction enterprises
Suppliers of commodity values	–	+	Construction enterprises
Project organizations	–	+	Construction enterprises
Internal and external audit organizations	–	+	Construction enterprises

(*continued*)

Table 1. (*continued*)

Indicators	Evaluation methods		Object of assessment
	Quantitative assessment methods	Qualitative evaluation methods	
NGOs	–	+	Construction enterprises
Workers of construction enterprises	–	+	Construction enterprises
Owners of construction enterprises	–	+	Construction enterprises
Top management	–	+	Construction enterprises
Managers of different levels	–	+	Construction enterprises

The determination of the safety factors of the construction enterprise with regard to the formation and use of the intellectual economic system is carried out through the prism of local indicators.

At the intermediate level, directions for the formation and implementation of financial and economic security at the construction enterprise are carried out in relation to:

Ensuring interaction between interested parties in the field of financial and economic security.
Implementation of measures for the formation and application of financial and economic security.
Prevention of threats and risks based on financial and economic security (Tables 2 and 3).

Table 2. Expert survey results of builders' experts on the level of financial and economic security of construction enterprises, resp. Unit

Indicators	K_{311}	K_{312}	K_{313}
Experts			
E_1	6	5	6
E_2	6	6	5
E_3	6	5	5
E_4	6	7	6

(*continued*)

Table 2. (*continued*)

Indicators	K_{311}	K_{312}	K_{313}
E_5	5	6	5
E_6	6	5	5
E_7	5	7	5
E_8	6	5	6
E_9	6	5	5
E_{10}	5	7	5
E_{11}	6	6	5
E_{12}	5	6	6
Wed arithmetic	5,667	5,833	5,333
Wed geom	5,646	5,78	5,313

Table 3. The results of the statistical processing of the results of the expert survey, taking into account the weighting coefficients of expert builders of the level of financial and economic security of construction enterprises, resp. Unit

Indicators	K_{311}	K_{312}	K_{313}
Experts			
E_1	0,855	0,713	0,855
E_2	0,805	0,805	0,671
E_3	0,761	0,634	0,634
E_4	0,694	0,81	0,694
E_5	0,437	0,524	0,437
E_6	0,468	0,39	0,39
E_7	0,355	0,496	0,355
E_8	0,383	0,319	0,383
E_9	0,362	0,301	0,301
E_{10}	0,219	0,307	0,219
E_{11}	0,237	0,237	0,198
E_{12}	0,185	0,222	0,222
$\sum_k^y$	5,761	5,759	5,359

Expert survey results of builders' experts on the level of formation of information security of construction enterprises are presented in the Table 4.

Table 4. Expert survey results of builders' experts regarding the level of formation of information security of construction enterprises, resp. Unit

Indicators	K_{321}	K_{322}	K_{323}	K_{324}	K_{325}	K_{326}	K_{327}	K_{328}	K_{329}	K_{3210}
Experts										
E_1	5	5	6	5	6	5	6	6	4	5
E_2	6	5	6	5	5	6	5	5	6	5
E_3	4	6	5	6	5	6	5	5	5	6
E_4	6	5	5	6	6	5	6	6	5	5
E_5	6	5	5	5	5	4	5	5	5	6
E_6	6	7	6	5	6	5	5	6	4	6
E_7	5	6	6	5	6	5	5	6	6	5
E_8	6	6	5	6	5	5	6	5	4	5
E_9	6	5	6	6	7	6	5	6	5	6
E_{10}	6	5	6	6	6	6	6	6	5	5
E_{11}	5	5	6	7	6	6	6	6	6	5
E_{12}	6	6	6	4	6	6	4	6	5	6
Wed arithme-tic	5,583	5,5	5,667	5,5	5,75	5,417	5,333	5,667	5,0	5,417
Wed geom	5,542	5,464	5,646	5,446	5,719	5,376	5,295	5,646	4,949	5,395

At construction enterprises, the level of information security for the formation and use of an intelligent economic system is decreasing, which negatively affects the possibilities of applying innovative development tools (Table 5).

Table 5. The results of statistical processing of the expert survey taking into account the weighting coefficients of construction experts of the level of formation of information security of construction enterprises, resp. Unit

Indicators	K_{321}	K_{322}	K_{323}	K_{324}	K_{325}	K_{326}	K_{327}	K_{328}	K_{329}	K_{3210}
Experts										
E_1	0,713	0,713	0,855	0,713	0,855	0,713	0,855	0,855	0,57	0,713
E_2	0,805	0,671	0,805	0,671	0,671	0,805	0,671	0,671	0,805	0,671
E_3	0,507	0,761	0,634	0,761	0,634	0,761	0,634	0,634	0,634	0,761
E_4	0,694	0,579	0,579	0,694	0,694	0,579	0,694	0,694	0,579	0,579
E_5	0,524	0,437	0,437	0,437	0,437	0,35	0,437	0,437	0,437	0,524

(*continued*)

Table 5. (*continued*)

Indicators	K_{321}	K_{322}	K_{323}	K_{324}	K_{325}	K_{326}	K_{327}	K_{328}	K_{329}	K_{3210}
E_6	0,468	0,546	0,468	0,39	0,468	0,39	0,39	0,468	0,312	0,468
E_7	0,355	0,425	0,425	0,355	0,425	0,355	0,355	0,425	0,425	0,355
E_8	0,383	0,383	0,319	0,383	0,319	0,319	0,383	0,319	0,255	0,319
E_9	0,362	0,301	0,362	0,362	0,422	0,362	0,301	0,362	0,301	0,362
E_{10}	0,263	0,219	0,263	0,263	0,263	0,263	0,263	0,263	0,219	0,219
E_{11}	0,198	0,198	0,237	0,277	0,237	0,237	0,237	0,237	0,237	0,198
E_{12}	0,222	0,222	0,222	0,148	0,222	0,222	0,148	0,222	0,185	0,222
$\sum_k^y$	5,494	5,455	5,606	5,452	5,648	5,354	5,368	5,588	4,96	5,389

At the intermediate level, information-analytical support is determined by the interaction of stakeholders regarding the formation and use of the intellectual economic system of construction enterprises (Tables 6 and 7).

Table 6. The results of an expert survey of builders' experts regarding the level of ensuring the interaction of stakeholders of construction enterprises, resp. Unit

Indicators	K_{331}	K_{332}	K_{333}	K_{334}	K_{335}	K_{336}	K_{337}	K_{338}	K_{339}	K_{3310}	K_{3311}
Experts											
E_1	6	6	5	6	6	5	6	6	6	5	6
E_2	7	6	5	5	6	6	5	6	6	5	6
E_3	6	7	5	5	6	6	5	5	6	6	5
E_4	6	7	5	6	5	6	5	6	5	5	6
E_5	6	6	5	7	6	5	6	5	6	5	5
E_6	6	6	5	6	5	6	5	5	5	6	5
E_7	6	5	5	6	6	5	5	5	6	5	6
E_8	6	7	6	6	6	5	6	6	6	7	6
E_9	7	5	5	5	5	5	4	6	6	5	5
E_{10}	6	5	5	6	5	5	5	6	5	6	5
E_{11}	6	6	5	5	6	6	4	5	6	6	6
E_{12}	6	6	6	5	7	6	6	5	5	5	5
Wed arithmetic	6,167	6,0	5,167	5,667	5,75	5,5	5,167	5,5	5,667	5,5	5,5
Wed geom	6,156	5,958	5,154	5,633	5,719	5,477	5,119	5,477	5,646	5,464	5,477

Table 7. The results of the statistical processing of the expert survey, taking into account the weighting coefficients of expert builders of the level of ensuring the interaction of stakeholders of construction enterprises, resp. Unit

Indicators	K_{331}	K_{332}	K_{333}	K_{334}	K_{335}	K_{336}	K_{337}	K_{338}	K_{339}	K_{3310}	K_{3311}
Experts											
E_1	0,855	0,855	0,713	0,855	0,855	0,713	0,855	0,855	0,855	0,713	0,855
E_2	0,939	0,805	0,671	0,671	0,805	0,805	0,671	0,805	0,805	0,671	0,805
E_3	0,761	0,887	0,634	0,634	0,761	0,761	0,634	0,634	0,761	0,761	0,634
E_4	0,694	0,81	0,579	0,694	0,579	0,694	0,579	0,694	0,579	0,579	0,694
E_5	0,524	0,524	0,437	0,612	0,524	0,437	0,524	0,437	0,524	0,437	0,437
E_6	0,468	0,468	0,39	0,468	0,39	0,468	0,39	0,39	0,39	0,468	0,39
E_7	0,425	0,355	0,355	0,425	0,425	0,355	0,355	0,355	0,425	0,355	0,425
E_8	0,383	0,447	0,383	0,383	0,383	0,319	0,383	0,383	0,383	0,447	0,383
E_9	0,422	0,301	0,301	0,301	0,301	0,301	0,241	0,362	0,362	0,301	0,301
E_{10}	0,263	0,219	0,219	0,263	0,219	0,219	0,219	0,263	0,219	0,263	0,219
E_{11}	0,237	0,237	0,198	0,198	0,237	0,237	0,158	0,198	0,237	0,237	0,237
E_{12}	0,222	0,222	0,222	0,185	0,259	0,222	0,222	0,185	0,185	0,185	0,185
$\sum y_k$	6,194	6,131	5,101	5,69	5,739	5,531	5,231	5,56	5,725	5,416	5,567

Generalized indicators of safety factors for the use and formation of intelligent economic systems of construction enterprises are determined by the geometric mean of group local indicators of the i-th group:

$$K_i = \sqrt[n]{K_{ij}} \tag{1}$$

n – the number of local factors in the i-th group, resp. Unit.

The generalized economic indicators calculated according to model (1) are presented in the Table 8.

Table 8. Generalized indicators of safety factors for the formation and use of intelligent economic systems of construction enterprises.

Group indicators	Value
financial and economic security of construction enterprises,	5,623
formation of information security of construction enterprises	5,428
ensuring the interaction of stakeholders of construction enterprises	5,617

3 Result

The general indicator of safety factors in the formation and use of intelligent economic systems of building enterprises should be resistant to possible fluctuations in the values of individual group indicators. Based on statistical observations, the integral indicator of safety factors of the formation and use of intelligent economic systems of construction enterprises was calculated according to the Kolmogorov root mean square, which fully meets the requirements of stability:

$$I = \sqrt{\frac{1}{k}\sum_{i=1}^{k} K_i^2}, \tag{2}$$

k – safety factors of the formation and use of intelligent economic systems of construction enterprises.

The value of the complex indicator of the level of safety factors of the formation and use of intelligent economic systems of the construction enterprise calculated by (2) is equal to 5.557.

4 Conclusion

So, because of the study of the state and development trends of the construction sector, it was determined:

1. Construction industry is an important branch of the state economy, which affects its development and ensures the functioning of other spheres of activity. It reflects trends and is an indicator of the development of the state's economy. Construction industry reacts more inertly to the changes taking place in the state, both in terms of development and the accumulation of negative phenomena.
2. For the period until 2020, there is an increase in the main indicators of the construction sector. In particular, the production and economic potential is strengthened due to the growth of fixed assets, current assets, sources of financing. It should be noted that the value of equity is decreasing along with an increase in the level of current liabilities. This affects the level of financial stability of construction enterprises.
3. During the studied period, the majority of enterprises in the construction sector are profitable, which indicates positive financial performance and provides a shift in the development of construction business entities.
4. It should be pointed out the slowdown in the development of labor potential in the construction sector, which reduces the trends and level of development of construction enterprises. This especially applies to the development and implementation of intelligent economic systems.

Thus, safety factors for the use and formation of the intelligent economic system of construction enterprises are proposed, the assessment of which is based on the application of qualitative methods used for construction enterprises and regions. The presented indicators are determined by the level of national security, directions of formation and use of financial, economic and information security, features of interaction of construction

companies with stakeholders. Safety indicators make it possible to build a quantitative basis for assessing the level of formation and use of an intelligent economic system for making informed management decisions.

A quantitative basis for the development and implementation of safety directions for the formation and use of the intellectual economic system of construction enterprises has been formed by evaluating safety factors. It has been established that the formation of information and analytical support for the implementation of security measures is mediocre, which indicates the need to implement directions for increasing their effectiveness.

The formation of intelligent economic systems requires the solution of complex problematic issues related to:

transformation of the information security system and the use of modern information technologies;
Expanding the possibilities of using artificial intelligence tools;
Low level of personnel training regarding the development and application of intelligent economic systems;
Insufficient level of completeness of spatial information on the functioning of construction companies;
The Problem of the formation of economic and social factors for the development of intellectual economic systems;
Transformation of the organizational structure of construction enterprises in accordance with the directions of formation and use of intelligent economic systems;
Insufficient Level of determination of urban planning factors, considering the peculiarities of regulatory and legal support.
Based on the identified problematic issues, directions for further research are proposed:
Studying and determining the possibilities of applying artificial intelligence at construction enterprises;
Formation of educational programs for personnel training, taking into account directions and features of implementation and application of intelligent economic systems;
Determination of directions of organizational and instrumental transformation at building enterprises for the use of intelligent economic systems;
Research of spatial aspects regarding the activity of construction enterprises using geoinformation systems and technologies;
Study of economic factors as a system affecting the formation of intellectual economic systems of construction enterprises;
Determination of urban planning factors and their research in the system of formation of factors of intellectual economic systems;
Determination of growth points of relevant factors;
Development of an organizational and economic mechanism for the use and formation of intelligent economic systems of construction enterprises.

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