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Modeling of the Assessment System of the Main Risks of Investing in Engineering Enterprises in the Conditions of the Development of the Knowledge Economy

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ABSTRACT

The main purpose of the study is to form a theoretical and methodological model for assessing the risks of investing in engineering enterprises in the context of the development of the knowledge economy. To achieve this purpose, it was necessary to apply the modeling methodology through the use of elements of functional processes that are aimed at achieving the goals and objectives. The relevance of the research topic is given by the fact that today engineering enterprises are extremely sensitive to changes in the operating environment and require a high level of investment. According to the results of the study, we have formed a theoretical and methodological decomposition of a two-variant type of modeling of both external (those that do not directly relate to the enterprise but come from outside) and internal risks (those that arise within the enterprise). The study has limitations and, first of all, they relate to the narrow level of the practical application of the model. Its current state implies a theoretical presentation of the possibilities of informing investors about the state of external and internal risks in the activities of engineering enterprises. Further research will include expanding the modeling process and tasks.

1. INTRODUCTION

Risks during investment exist for any socio-economic system, but it is for very specific sectors of the economy that these risks have the most threatening effect. Engineering enterprise is very sensitive to changes in the operating environment and is highly dependent on security engineering. That is why, in their case, the risk management system and investment attractiveness play an extremely important role in their economic development.

The absence of structural changes in production, the use of outdated equipment and technologies, excessive conservatism of management, and resistance to changes on the part of employees, as well as the humiliation of innovation in the production process are the reasons for poor quality, technological backwardness, inconsistency with modern consumer requirements, and, consequently, low prices for own products. Therefore, the innovative development of engineering enterprises requires specialized organizational, structural, and functional units that are part of them, which, in the process of interaction, form the innovative system of the enterprise. This will change their investment attractiveness.

The functioning of engineering enterprises takes place in conditions of volatility and uncertainty, complicated by the geo-economic transformation of the country, changes in the technological structure of production, and structural shifts in the industry, which actualizes the problem of forming the economic sustainability of enterprises in economic science and practice. The complex nature of systemic economic phenomena, which include economic sustainability, leads to the search for new theoretical and methodological approaches to their knowledge, based on the principles of hierarchy, interdisciplinarity, and convergence inherent in the systemic economy, which has become a natural result of increased interaction and interdependence of economic ones. However, in economics, there is no formed holistic theoretical and methodological paradigm, which, under the needs of the practice, provided systematic research and an appropriate risk assessment. This is one of the determining reasons for the low efficiency of many years of attempts to improve the risk management systems of engineering enterprises, their instability and destructive nature of development, and acts as the basis for rethinking the theoretical, methodological, and applied foundations for the formation of economic sustainability of engineering enterprises.

The formation of a modern model of economic development based on the new industrialization as a prerequisite for the transition to the fourth industrial revolution depends on the

effective functioning of innovation-oriented engineering enterprises. The discrepancy between the level of development of such enterprises and the needs of the real sector of the economy, caused by both low innovative activity and the lack of a system of current economic and innovative industries, reduces their ability to fulfil their functional purpose. Separate use of the development methodology and methodological principles of the functioning of innovation-oriented enterprises does not ensure the implementation of the tasks of the functioning process in terms of the systematic reproduction of dynamic abilities for development. At the same time, the transformation of market relations, economic instability, the uncertainty of economic conditions, and the variability of innovations give rise to variability in key success factors and reduce the effectiveness of using the methodology of strategic development management. This causes an objective need to revise the classical scientific provisions and actualizes the need to form one's vision of assessing the risks of investing in this industry.

The main purpose of the study is to form a theoretical and methodological model for assessing the risks of investing in engineering enterprises in the context of the development of the knowledge economy.

2. LITERATURE REVIEW

Analyzing the scientific and practical literature, Aven [1], Islam et al. [2], Vlek and Stallen [3] summarize and argue that by investing money, material, or intellectual values in any project, we plan to get a certain amount of profit or achieve certain social consequences. Every person working in the financial sector is well aware that the planned profit or result will be different from the actual one obtained at the end of the project. A situation where we cannot be completely sure of future results is a situation of uncertainty that gives rise to risk. Regardless of how much the actual result deviated from the planned one, the resulting consequences will have a negative impact on the investor. The desire to get the planned profit forced investors to analyze the impact of risk on investment processes and create methods to reduce its impact. But theoretical approaches are not always valid in practice. We agree with this and believe that uncertainty breeds risk. Risk is one of the most important concepts accompanying any active human activity. At the same time, this is one of the vague, ambiguous, and confusing concepts.

In general, the number of existing risks of investing in an enterprise is practically no limit. For example, longing for those only known and presented in the scientific and practical literature Kryshtanovych et al. [4], Jiang and Liu [5], Lorincová et al. [6], we can talk about almost 200 such risks. Among them, there are systematic, arising at the macro level and not dependent on the activities of the economic entity, and non-systemic risks, which the enterprise can influence in a certain way. From the standpoint of probability, the loss of investment is divided into acceptable, critical, and catastrophic risks. Depending on the stages of the life cycle, there are risks arising in the pre-investment, investment, and operational phases.

It should be noted that most scientists Mouras and Badri [7], Ancillo et al. [8] consider investment risks, as a rule, from the position of an abstract strategic investor, who is aimed at an accelerated and most efficient way to make a profit.

This approach is universal and can be used to study the investment climate of any country. It should be noted that investment risks and potential vary in different countries of the world depending on the level of their economic development.

Pinto et al. [9] consider the risks of investing from the macro level and the position of public administration. From the point of view of public administration, the investment climate, in particular its components such as investment risk and investment potential should be considered a dynamic phenomenon, constantly smart. Given this, public authorities, during the investment policy of the state, should take into account the results of ratings that assess the investment climate, and one or another.

Taking into account the analysis of scientific and practical literature and changes in the modern introduction of the activities of engineering enterprises, we can talk about the relevance of the chosen topic and the need for further research. We do not attempt to replicate or replace existing research on this topic. Our goal is to present our vision of the process of assessing the risks of investing in engineering enterprises.

3. METHODOLOGY

The modeling process is a special stage and involves the application of a number of methods that together form our research methodology. For example, we cannot start modeling without first reviewing the scientific and practical literature. In this case, we are talking about the importance of applying methods of systematizing information. Application of an abstract method for its generalization and the formation of appropriate conclusions.

The basis for our methodology is the method of decomposition modeling and graphical notation of processes. It provides a better picture of the key elements of the entire process of assessing the risks of investing in engineering enterprises and serves as a basis for the development of the knowledge economy.

It should be noted that as the practice and scientific findings of many scientists show, the assessment of investment risks should be divided into internal and external. Thanks to our modeling methodology, it is possible to depict this appropriately at work.

So, according to our methodology, the first step will be the vector of formation of the main goals of decomposition. Here we have the main goal - to assess the risks of investing in an engineering enterprise. To do this, we divide our tasks into two models: assess the internal risks of investing; assess the external risks of investment. For further simplicity, we will give them an abbreviated information designation - R and N (Figure 1). Thus, in these two models, there is one mathematical representation - risk assessment of investing in engineering enterprises in the context of the development of the knowledge economy. At the same time, the content of these two models is different, since one deal with external risks, and the other with internal ones.

To better facilitate the process of forming models for our decomposition, we should swear by the application of the diagrammatic method to achieve our goals. This method also, through a graphical demonstration, allows us to show the reader and the management of the engineering enterprise what will be the input and output of our model. So, only thanks to the graphical method, we have the opportunity to demonstrate all the paths, processes, and results of decomposition. The implementation of the graphical method was carried out using

specific software, followed by visualization of the results.

This should be considered part of the overall methodology. This kind of diagram for our study is shown in Figure 2.

It should be noted that the additional elements of the diagram (Y_n, T_n) are auxiliary components aimed at achieving the set goals and keeping them within certain acceptable limits.

As for (G_n, F_n), they represent what needs to be brought in to achieve the maximum socio-economic effect from this process and what we should get as an output, ultimately carrying out this or that process (in our case, this process represents risks assessment). In order not to complicate the understanding of this model, we have chosen only the main elements (G_n, F_n) in which all the elements that can be attributed to these groups have been summarized.

The advantage of this type of modeling is the formation of a decomposition that allows to resent of a graphical notation of the author's intentions regarding a particular process (in our case, this process is an assessment of external and internal risks of investing in engineering enterprises).

All subsequent results and models presented below were performed using the software of the applied model for constructing vector diagrams and models - Microsoft Visio.

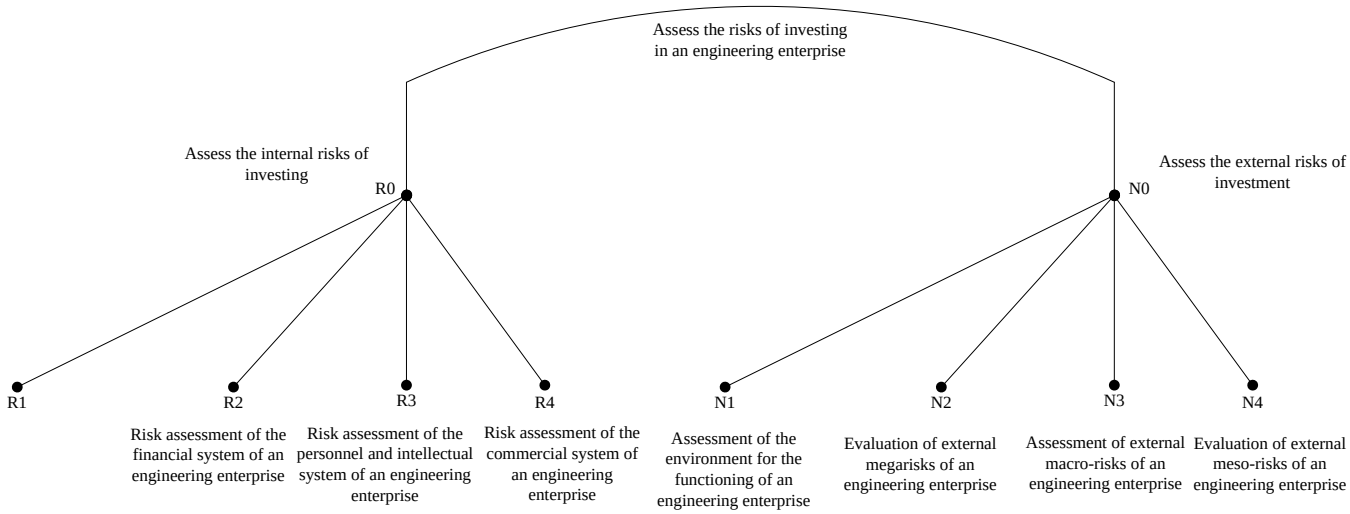

Figure 1. Vector information about the achievement of set goals according to the application of modeling methods (developed by the authors)

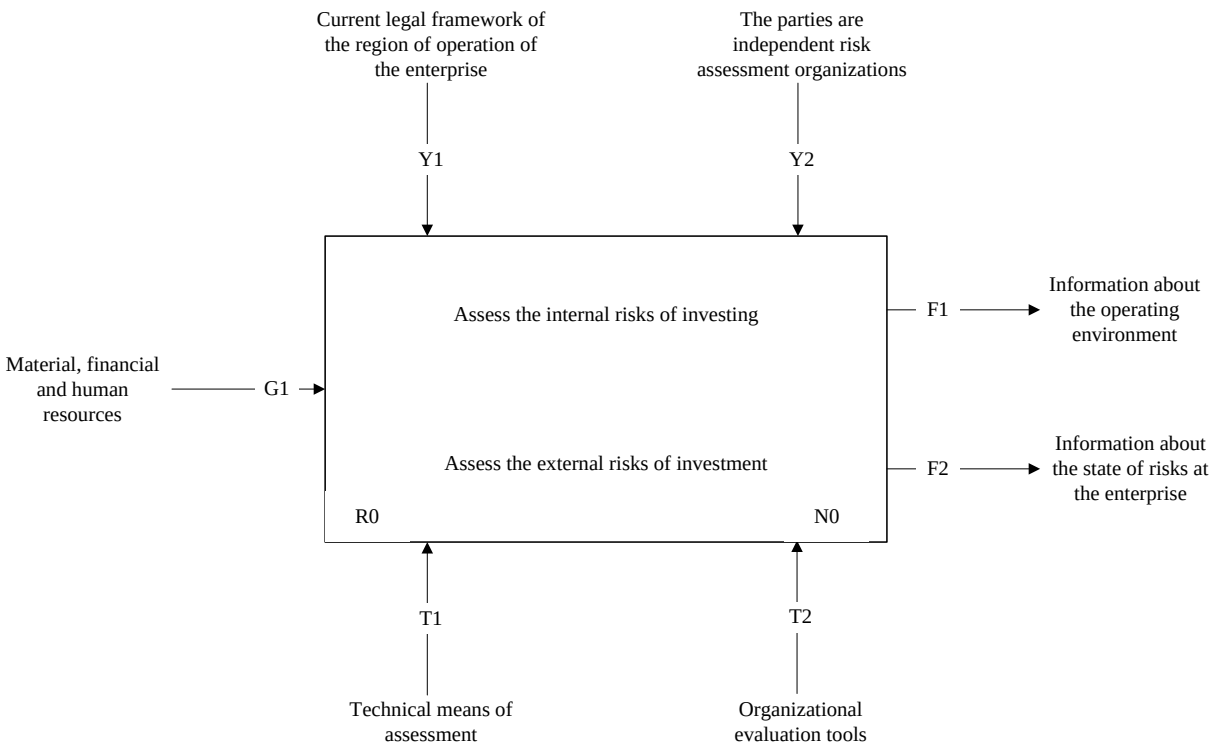

Figure 2. Diagram of the main elements of achieving the goals of the decomposition of both models (developed by the authors)

4. RESULTS OF RESEARCH

So, as a result, according to our decomposition, we should have two models. The first model of graphical notation for assessing the internal risks of investing in an engineering enterprise is shown in Figure 3.

Let us characterize the process of assessing the internal risks of investing in an engineering enterprise according to the generated model:

R_1 - Risk assessment of the production and technical system of an engineering enterprise. The risks specific to this subsystem are associated with equipment failure, downtime, inefficient use, production failures, aging equipment, non-compliance with modern conditions, violation of technology, low quality, and inefficient use of raw materials, materials, and labor. In our work, the emphasis is on a qualitative assessment of the risks of investing in an engineering enterprise. Quantifying the risks of investing in an engineering venture is a difficult question, as the question can be asked when it comes to financial risk. Not all risks are effectively quantified.

In addition, we highlight the risk of accidents due to wear and tear of equipment, non-compliance with technologies; the risk of producing low-quality products; increase in production costs The use of unique equipment or technology by an engineering enterprise may lead to the emergence of specific types of risk. For an engineering enterprise, it is extremely important to observe engineering security.

R_2 - Risk assessment of the financial system of an engineering enterprise. The financial system of an engineering enterprise should include planning, accumulation, distribution, and efficient use of various financial resources. The group of risks characteristic of this system is characterized by the probability of loss of financial resources in the course of financial transactions, failure to fulfil obligations to creditors, investors, and a decrease in the financial stability of an engineering enterprise.

R_3 - Risk assessment of the personnel and intellectual system of an engineering enterprise. This system includes the quantitative and qualitative composition of the personnel, their abilities, competence, productivity, and efficient work. This system has risks associated with the incompetence of personnel and their conscious or unconscious influence. These include the risk of erroneous goal setting, the risk of ineffective management, the risk of unprofessional personnel, the risk of understaffing, staff turnover, loss of key specialists, disclosure of confidential information, decrease in labor productivity, the risk of strikes, the risk of improper performance or non-performance of duties within certain functions.

R_4 - Risk assessment of the commercial system of an engineering enterprise. The commercial subsystem determines the marketing and supply policy of the engineering enterprise and depends on the risks associated with the sale of finished products and the purchase of raw materials from materials such as the risk of shortage of raw materials; changes in delivery conditions (price, terms, quality, quantity); the risk of untimely provision of resources; the risk of rising production costs due to rising prices; the risk of disruption in production as a result of problems with suppliers; changing consumer needs and priorities; risks of an erroneous choice of product and pricing strategy of an engineering enterprise.

The second model of graphical notation for assessing the external risks of investing in an engineering enterprise is shown in Figure 4. In our opinion, these two types of risks of investing in an engineering enterprise will influence each other in one way or another, but within the framework of one study, it is difficult to work out such a significant amount of information and build even more models of influence. Given this, determining the level of influence of these two risks of investing in an engineering enterprise will be the topic of our next research.

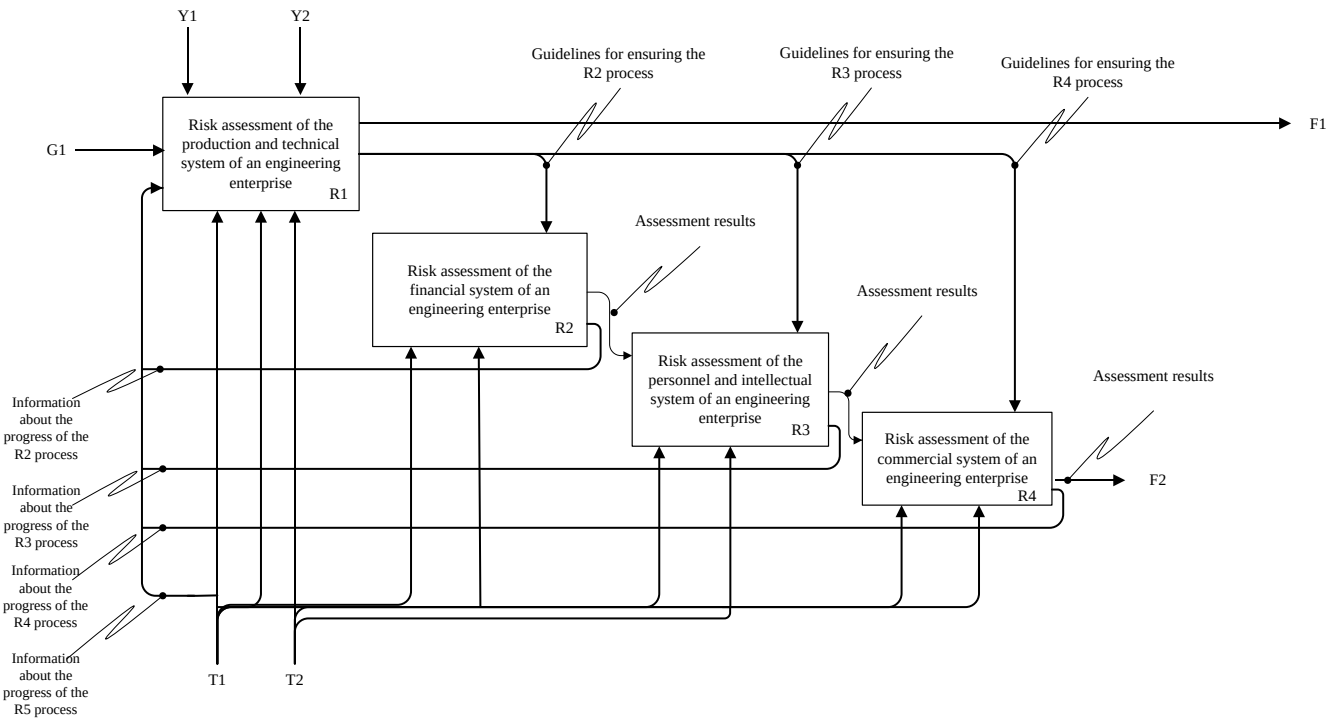

Figure 3. Model for assessing internal risks of investing in an engineering enterprise (developed by the authors)

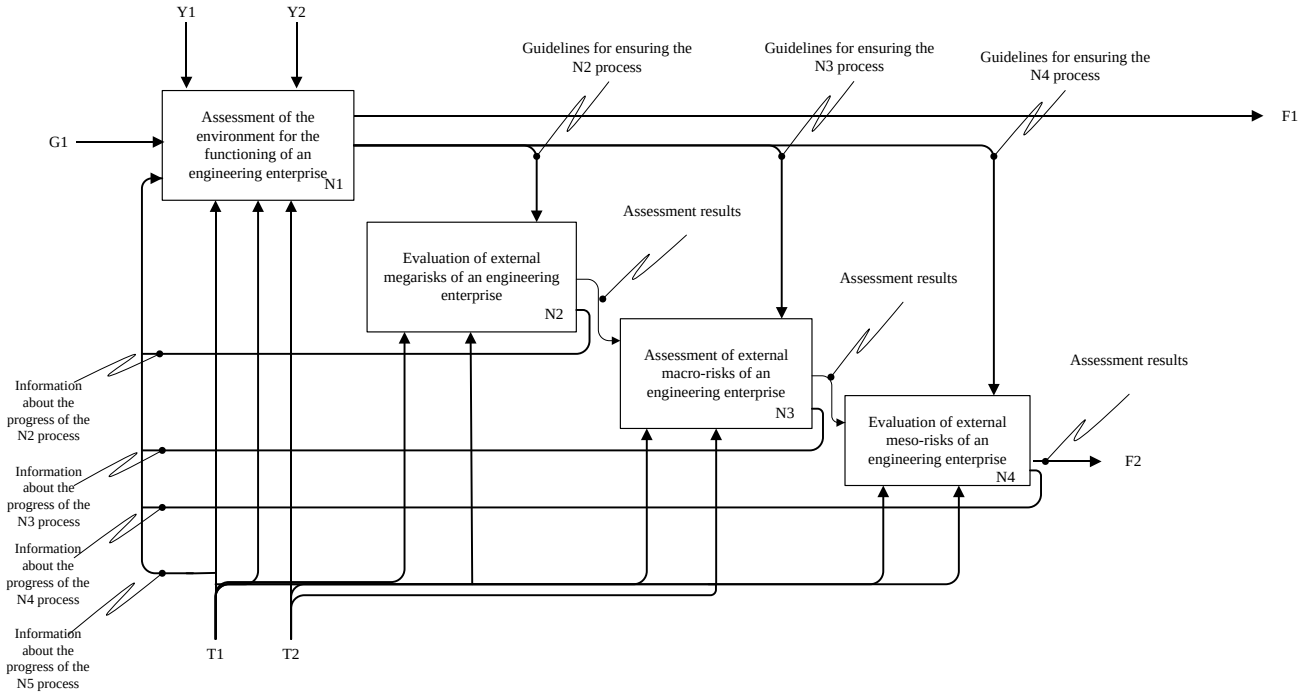

Figure 4. Model for assessing external risks of investing in an engineering enterprise (developed by the authors)

Let us characterize the process of assessing the external risks of investing in an engineering enterprise according to the generated model:

N_1 - Assessment of the environment for the functioning of an engineering enterprise. One of the main components of the external environment of the activity of an engineering enterprise is the market in which the enterprise operates. The market should be subject to regular monitoring. By them, market research is of no value if it is not related to managerial decision-making. Therefore, the result of market observations is information that answers questions of interest to market participants. In market research, general economic or economic conditions and the conditions of individual markets are usually singled out. The study of market conditions covers a wide range of various issues of industrial, commercial, technical, and economic nature, which makes it possible to identify the main directions of economic development of each subject of market relations and the situation that has developed at a certain point in time as a result of the interaction of various market-forming factors.

N_2 - Evaluation of external megarisks of an engineering enterprise. Megarises characterize the activities of an enterprise on the scale of the global community; these risks may be associated with changes in the global market conditions and relations between countries.

N_3 - Assessment of external macro-risks of an engineering enterprise. Macro-risks exist at the level of an individual country and are associated with unexpected changes in policy, legislation, lending, taxation, etc. Thus, often political situations entail the emergence of problematic moments for cooperation with other countries, for example, exports, which negatively affect the activities of engineering enterprises. In turn, political and economic instability in the state affects the impossibility of foreign investment due to a lack of confidence in the return of funds.

N_4 - Evaluation of external mesorisks of an engineering enterprise. Mesorisks are present at the level of a certain industry, and micro-risks exist in the environment of the engineering enterprise itself. It is the ability to limit the impact of risks on the work of an engineering enterprise, to take into account risk factors promptly when making managerial decisions, and to adapt to changing market conditions of management, that is the key to the functioning, effective development, and achievement of a high level of competitiveness of engineering enterprises.

In general, we propose to carry out the risks assessment itself, subject to the following equality (1):

$$\sum_{i=1}^{K} = p_i * w_{pi} \quad (1)$$

where, P_i is directly one of the risks of the general group of risks of a separate system; K is number of risks in the group.

We calculate the group of risks using (2):

$$\sum_{i=1}^{K} = s_{pi} * w_{pi} \quad (2)$$

where, S_i is group of risks of a separate system in an engineering enterprise; W_{pi} is the weight of individual risk of one or another group; W_{si} is the weight of an individual group of risks.

The integral indicator of the risk group assessment is calculated using the following equality (3):

$$\sum_{i=1}^{K} = I_s * W_{si} \quad (3)$$

where, I_s is an integral value for each risk group of the engineering enterprise system.

It should be noted that the top risk management and management of the engineering enterprise can determine what risks they have today for each of the selected system groups.

This can be done by potential or real investors as well. The importance of each risk and group should be determined by the involvement of leading experts in the field of risk management or the activities of engineering enterprises.

5. DISCUSSIONS

Discussing the results of the study, we would like to note that to establish how informative, understandable and flexible our model is, we presented it to two categories of people: the management of one of the engineering enterprises in Eastern Europe and a group of students majoring in "Investment" to understand the importance of a methodological approach for knowledge economy development.

The management of one of the engineering enterprises reacted positively to the current model, noting its informational importance for the work of risk management (Figure 5).

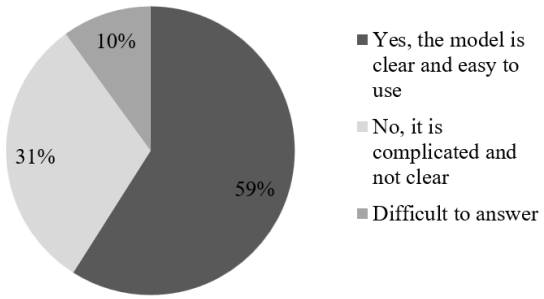

Figure 5. The results of a survey of the risk management of an engineering enterprise on the subject of "Simplicity and clarity of the methodological approach" (developed by the authors)

Students of our higher educational institution noted its integrity, comprehensibility, and ease of use (Figure 6).

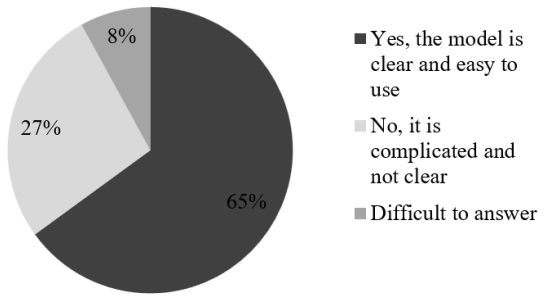

Figure 6. The results of a survey of the students of our higher educational institution on the subject of "Simplicity and clarity of the methodological approach" (developed by the authors)

It should be noted that the answers received do not carry professional or expert analysis, but were intended to form initial data on whether our model is relevant and whether it has the right to life.

Avanesova and Chuprin [10], Rushchyshyn et al. [11], Stasytyte and Aleksienė [12] focus on the fact that the risks for the activities of enterprises are normal and they only need a correct assessment and effective risk management. We agree here, and therefore, also during our study, we did not try to show that risk is a terrible problem. With proper risk management, all investment risks can be reduced to a minimum.

Bazyliuk et al. [13] in their study tried to present an assessment system for engineering enterprises through modeling and eventually forming a certain model. However, our study is distinguished by the emphasis on the fact that there should be two models and that risks should not be assessed all at once.

Discussing the issues of the modeling process itself to achieve the set goal in the article, Drobyazko et al. [14], Sylkin et al. [15], Kryshtanovych et al. [16] note that in this way it is possible to graphically express the vision of the process of solving the set tasks. The threat assessment process is ideal for simulation.

Chen and Zhang [17] in his study reveals the features of risk assessment in enterprises, however, we focus on what risks are for the investment process and the activities of engineering enterprises. That is, we try to narrow the scope and objects of research.

Considering the scientific achievement of many scientists in such studies, it should be noted that we have presented our own vision of how, through the proposed methodological approach, two models can represent the decomposition of assessing both external and internal risks of investing in engineering enterprises in the context of the development of the knowledge economy. Despite this, it is possible to evaluate the advantages of our model only in practice. Since the period of practical testing will take a significant period of time, the results and the level of effectiveness of our model will be presented in future studies.

6. CONCLUSIONS

Based on certain conclusions, we have the opinion that engineering enterprises are one of the most important branches of the national economy, which produces not only goods for consumers, but also products aimed at the production of goods and services by enterprises of other branches. That is why engineering enterprises must produce competitive products and be competitive. Engineering enterprises should remain one of the most high-tech branches of industry. It is the engineering enterprises that play the main role in ensuring the innovative development of the economy. At the same time, in recent years, the state of development of engineering enterprises needs significant improvement and has significant opportunities to form new and strengthen existing competitive advantages both in foreign and domestic markets, which can be the basis for establishing further sustainable development.

Investments in engineering enterprises should be aimed at the active use of human and scientific and technical potential; creating a competitive environment; establishing an investment process.

Summarizing certain results of our analysis, it should be noted that based on the results we have formed a theoretical and methodological decomposition of a two-variant type of modeling of both external and internal risks. The study has limitations and, first of all, they relate to the narrow level of the practical application of the model. Its current state implies a theoretical presentation of the possibilities of informing investors about the state of external and internal risks in the activities of engineering enterprises. Further research will include expanding the modeling process and tasks.

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