Chunmei Ji

PhD student in the Department of Information Systems and Technologies,
https://orcid.org/0000-0002-9030-407X
Taras Shevchenko National University of Kyiv

RISK MANAGEMENT FOR THE FUNCTIONALITY COMPONENT OF AN AGRICULTURAL ENTERPRISE'S DECISION-MAKING SUPPORT INFORMATION SYSTEM

Abstract. *Ensuring food security and economic and social stability is a national issue for every state. The research examines the functional component of the information system model for supporting decision-making in the agrarian sphere in environmental uncertainty. This component includes those mathematical models and methods that ensure the functioning of the information system for supporting decision-making in the agricultural sphere in ecological uncertainty. The main assumptions of the study are that no activity can be avoided entirely, and there are no risks that cannot be managed. Risk management is considered in more detail as a process of taking measures aimed at ensuring an acceptable risk. A mathematical model of agricultural enterprise management is formalized, in which unclear input parameters, namely environmental and economic circumstances, are risk factors. Four stages of risk management are considered: identification, analysis, development of management measures, and operational risk management. The primary external and internal sources of risk in the activity of an agricultural enterprise have been identified. An algorithm for risk analysis is proposed, which consists of seven steps. A quantitative method implementing the risk analysis algorithm has also been developed. A fuzzy profit function of an agricultural enterprise is constructed. It is proposed to calculate the risk as a root mean square deviation. The method of risk management consists in minimizing risks.*

Keywords: agriculture; decision-making; risk management

Introduction

The problem of a reliable supply of the country with food and agricultural raw materials remains unsolved. The functioning of other industries that process and use its products depends on the sustainable development of agricultural production. Ensuring food security and economic and social stability is a national issue for every state.

From the point of view of prospects for the development of agricultural objects, there is a need to determine the regularities of their development, identify trends, and determine their parameters.

To improve the situation in agriculture, there is a need to apply new management methods based on system analysis. Let's consider the main approaches to managing the activities of agricultural enterprises: an approach based on risk management and multicriteria management methods.

The purpose of the article

The research objective is:

1. Develop a functionality component for an information system to support decision-making in the agricultural sector.

2. Explore scientific approaches to risk management.

Presenting main material

Let's consider the information system model supporting decision-making in the agrarian sphere in environmental uncertainty.

As indicated in the work [1], it is proposed to divide the information system into four components:

1. Component of goal setting.
2. Component of principles.
3. Functionality component.
4. Diagnostics component.

In this study, we will consider the functionality component in more detail. This component includes those mathematical models and methods that ensure the functioning of the information system for supporting decision-making in the agricultural sphere in environmental uncertainty. Namely, we will focus on the risk minimization model. The identification of risks is first carried out, which consists in compiling a complete list of risks that can positively or negatively affect the activity of an agricultural enterprise. For the considered model, all uncertain input parameters, namely environmental and economic circumstances, are risk factors. Next, there is an analysis of risk distribution

functions. Loss or profit functions are estimated in the event of a corresponding risky situation.

Among the researchers of risk theory, M. should be singled out. Power [2], Von Neumann [3], Kayis [4], Pan [5], and others. In these works, the authors defined the definite meaning of risk, revealed theoretical approaches to the division of risks according to classification features, substantiated methodological approaches to risk assessment, and determined its impact on business entities. These results can be applied to management in the agricultural sector.

Risk management involves the process of making optimal decisions and implementing measures aimed at ensuring an acceptable risk.

The Chinese character "risk" consists of two components: danger and opportunity (Fig. 1). This demonstrates a modern understanding of the essence of risk management: protection against the threat; use of options.

Figure 1 – Hieroglyph of the word "Risk."

The leading cause of risks is uncertainty. Risk can be considered as the uncertainty associated with the possibility of deviation from the goal of the enterprise (project), for the achievement of which a subjective decision was made.

The main signs of a risky situation are:

1. the decision-making person (DMP) is faced with the need to make one of several decisions;

2. at least one of the alternative decisions has non-deterministic consequences, and its final result cannot be reliably predicted;

3. the DMP considers itself aware of the consequences of each decision and arranges its values, giving preference to some outcomes over others.

The critical point that distinguishes a risky situation from an uncertain one is the presence of clear DMP advantages related to the enterprise's goals.

When risky situations arise, the following effects on the result are possible:

1. The development of the project has not been achieved at all;

2. the technical and (or) economic characteristics of the products turned out to be worse than those aimed at by the managers of the enterprise;

3. the project was implemented, but the costs significantly exceeded the estimate;

4. the goal of the project was achieved, but much later than initially planned.

When studying the risk to the functioning of an agricultural enterprise, it is essential to review all sources of risk, which can be divided into internal and external.

External sources of risk include:

1. Legislative policy of the state on the regulation of agricultural activity

2. Actions of state authorities and local self-government

3. Land taxation and subsidization of some branches of agriculture.

4. Relations with partners

5. Competition

6. Crime in the region.

7. Political situation

8. Scientific and technical progress, in particular genetically modified organisms and breeding achievements.

9. Economic situation in the country and industry.

10. 10 International events and military threats.

11. Logistical difficulties.

12. State of the surrounding natural environment.

The main assumptions of the study are that no activity can be avoided entirely, and there are no risks that cannot be managed.

The process of risk management can be divided into the following four stages (Fig. 2):

1. Identification of risks.

2. Analysis and assessment of risks.

3. Development of risk management measures.

4. Monitoring and operational risk management.

Signals	Signs	Development	Solution
Identification of risks			
	Risk assessment		
		Development of Risk Management measures	
			Risk Management

Figure 2 – Risk Management stages

In the first stage, risk criteria should be determined, risk identification methods should be developed, and a risk classification system should be formed.

In the second stage, it is necessary to form a list of possible risk situations, assess the degree and measure of risk for each case, and determine the priority of risks.

In the third stage, it is necessary to determine risk management methods, organize the risk management process and develop preventive measures for risks.

At the last stage, it is necessary to implement risk management methods, assess the effectiveness of risk management, and form a risk knowledge management system.

According to the estimates of "The World Economic Forum" [6]. The top global risks (Figure 3):

1. geopolitical instability;
2. problems of economic development;
3. insufficient measures to combat climate change;
4. negative consequences of loss of biodiversity;
5. inefficient development management technologies;

When assessing risks, it should be recognized that it is impossible to ultimately get rid of risk in most situations. Hence, it is necessary to determine the acceptable risk level – the level at which the danger ceases to threaten the enterprise.

According to ISO standards [7], risk assessment results from two procedures – risk analysis and measurement.

Risk analysis can be divided into a priori strategic, operational-tactical, and a posteriori systemic.

Risk measurement is related to the evaluation degree, risk measure, and risk price.

The degree of risk assesses an adverse situation's possibility and statistical frequency.

The measure of risk is an assessment of the level of unfavourability of a risky situation in case of its realization, which reflects its possible negative consequences.

The price of risk is the ratio of the maximum possible result to the degree of risk.

The risk analysis algorithm [8] consists of seven steps and is shown in Figure 4.

Consider the quantitative method that implements this algorithm: let f be the function of estimating losses or profits at a specific fixed value of some risk factor x. Then the overall expected effect of the activity of the agricultural enterprise can be calculated as a mathematical expectation:

$$M(x) = \int_0^1 f(x)\mu(x)dx.$$

And the risk of the activity is determined through the root mean square deviation.

$$\sigma(x) = \sqrt{\int_0^1 \left(f(x) - M\right)^2 \mu(x)dx}.$$

And the task is to minimize.
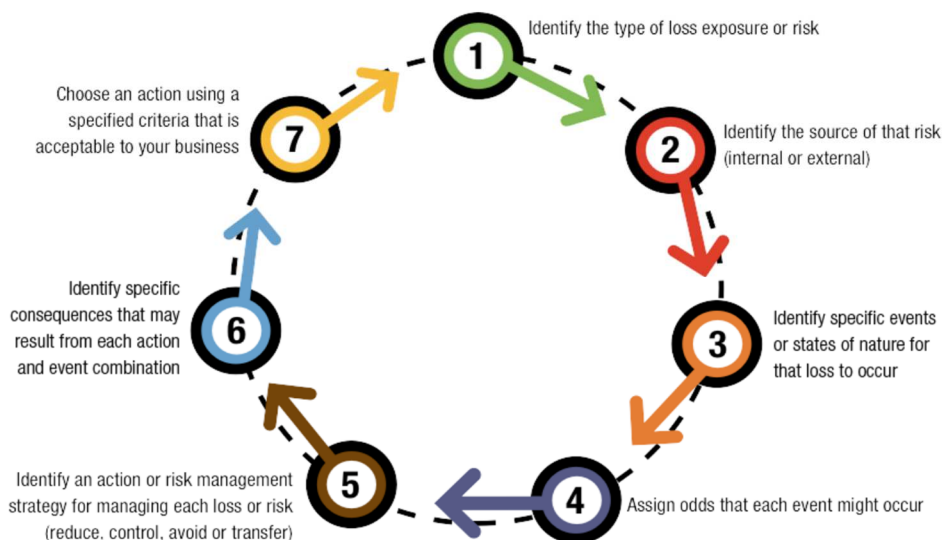

Figure 3 – Global risks [6]

Figure 4 – Risks analysis algorithm

Conclusions and perspectives of further research

So, as a result of this study, a functionality component was developed for the information system of decision-making support in the agricultural sector. Scientific approaches to risk management have been studied. Further research consists of the experimental implementation of risk management as part of functionality components for the information system of decision-making support in the agricultural sector.

References

1. Ji, C., Andrashko, Y., Biloshchytska, S. & Tsiutsiura, S. (2021). Conceptual Research Model of Developing the Decision Support System for Agriculture under Uncertainty. 2021 IEEE International Conference on Smart Information Systems and Technologies, 9465888.

2. Power, M. (2004). The risk management of everything. *The Journal of Risk Finance*, 5(3), 58-65.

3. Ahmed, A., Kayis, B. & Amornsawadwatana, S. (2007). A review of techniques for risk management in projects. *Benchmarking: An International Journal*, 14 (1), 22-36.

4. Von Neumann, J. & Morgenstern, O. (2007). Theory of games and economic behavior. In Theory of games and economic behavior. Princeton university press.

5. Pan, X. R., Yang, W. Y., Li, G. W., Liu, J. (1997). Prevalence of diabetes and its risk factors in China, 1994. *Diabetes care*, 20(11), 1664-1669.

6. McLennan, Marsh, SK Group & Zurich Insurance Group. (2021). The Global Risks Report 2021. https://www.weforum.org/reports/the-global-risks-report-2021/

7. ISO Standards. (2018). Risk management: Principles and guidelines (ISO 31000:2018). https://www.iso.org/iso-31000-risk-management.html

8. Ji, C. (2019). Management of the activity of agrarian enterprises for accounting risk management and multicriteria decision making. *Management of development of complex systems*, 38, 151–155, https://doi.org/10.6084/m9.figshare.9788633

Чунмей Жі
Аспірант кафедри інформаційних систем та технологій, *https://orcid.org/0000-0002-9030-407X*
Київський національний університет імені Тараса Шевченка, Київ

УПРАВЛІННЯ РИЗИКАМИ КОМПОНЕНТОМ ФУНКЦІОНАЛЬНОСТІ ІНФОРМАЦІЙНОЇ СИСТЕМИ ПІДТРИМКИ ПРИЙНЯТТЯ РІШЕНЬ АГРАРНОГО ПІДПРИЄМСТВА

Анотація Забезпечення продовольчої безпеки, економічної та соціальної стабільності є національно важливим питанням для кожної держави. В дослідженні розглянуто компоненту функціональності для моделі інформаційної системи підтримки прийняття рішень в аграрній сфері в умовах екологічної невизначеності. Ця компонента включає ті математичні моделі та методи, які забезпечують функціонування інформаційної системи підтримки прийняття рішень в аграрній сфері в умовах екологічної невизначеності. Основні припущення дослідження полягають в тому, що не існує діяльності, при реалізації якої можна було б повністю уникнути ризиків, і не існує ризиків, якими не можна управляти. Детальніше розглянуто управління ризиками як процес прийняття спрямованих на забезпечення прийнятного ризику. Формалізовано математичну модель управління аграрним підприємством, в якій нечіткі вхідні параметри, а саме екологічні та економічні обставини, є факторами ризику. Розглянуто чотири етапи управління ризиками: ідентифікація, аналіз, розробка заходів щодо управління та оперативне управління ризиками. Визначено основні зовнішні та внутрішні джерела ризику в діяльності аграрного підприємства. Запропоновано алгоритм аналізу ризиків, який складається із семи кроків. Також розроблено кількісний метод, що реалізує алгоритм аналізу ризиків. Побудовано нечітку функцію прибутку аграрного підприємства. Запропоновано розраховувати ризик як середньоквадратичне відхилення. Метод управління ризиком полягає у мінімізації ризиків.

Ключові слова: агропромисловість; прийняття рішень; екологія; управління ризиком