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Models of risk management in development projects for housing and utility service providers

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ABSTRACT

The effective work of housing and utility service providers is closely related to the development projects they implement. Anti-risk management is an important component of development project management. The analysis of mathematical, functional, and informational models of management of development projects of providers of housing and communal services, taking into account risks, was carried out. Mechanisms for integral evaluation of projects, priority allocation of company resources in the most promising directions are proposed. The limitations of the development projects of housing and utility service providers for further scientific research are indicated. An essential lever for increasing the effectiveness of anti-risk management in the development projects of providers of housing and communal services is the possibility of adjusting priorities regarding the implementation of development projects in real time due to the introduction of management automation and decision-making algorithmization, a process approach to risk management and management decision-making, and a dynamic organizational structure of project management development Automation of management and algorithmization of management decision-making allows all participants of development projects to be in one information system: to build a logical sequence of tasks, to determine the project path, to create an uninterrupted material flow with the minimization of necessary stocks, to establish transparency and control for stakeholders of development projects, etc. Algorithmization of decision-making allows timely prevention of project volume growth, low productivity, cost overruns, lack of time and resources, decision-making based on incomplete information, incompetence of development project participants. The dynamic organizational structure of management of development projects stimulates the coordination of actions and quick resolution of issues, education of the personnel reserve, establishment of communication, etc.

Keywords: Utilities; service providers; mathematical model; functional model; informational model; anti-risk management; development projects; organizational structure; decision making

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INTRODUCTION

Housing and communal management is an important area of the social and economic structure of society. The quality of its functioning on the basis of equal existence in this area of all forms of ownership allows creating a network environment for the implementation of the principles of a socially oriented market economy.
The development of housing and communal services has gone through several stages: from extensive to intensive, high-quality, which has been happening for the last twenty years [1, 2], [3]. Today, it faces the task of improving the technology of providing services, ensuring their quality, and improving the quality and efficiency of the engineering companies working in it.

FORMULATION OF THE PROBLEM

Housing and communal services at the same time combine the specifics of public service, energy distribution and accounting, construction, the oil and gas sector, and even information technologies (since it requires the collection, processing, and storage of a large amount of data on the owners of real estate objects, seals of strict reporting, meter readings, calculation of benefits, etc.).

Housing and communal services [1, 4] – the result of economic activity aimed at ensuring the living conditions and stay of persons in residential and non-

residential premises, houses and buildings, complexes of buildings and buildings in accordance with regulations, rules, standards and procedures. Production and implementation of housing and communal services are regulated by standards, regulations, norms and rules that establish a complex of qualitative and quantitative indicators and requirements, taking into account social, economic, natural-climatic and other conditions of regions and settlements.

To simplify the terminology, so as not to detail the various roles of participants in the housing and communal services market according to legislation and everyday understanding (executor, manufacturer, supplier, representative, provider), we will summarize all of them under the name "Provider" (from the English to provide): organization, which provides certain services. Providers include energy distribution companies, service companies, etc.

Improving the quality of housing and communal services, searching for reserves, control possibilities are considered at the state level, at the level of professional associations, domestic and foreign organizations. This direction is implemented by a number of relevant development projects implemented by providers of housing and communal services.

There is a relatively low sectoral quality of housing and communal services compared to the financial, industrial, or energy sectors. It is directly related to the percentage of successfully implemented development projects that performed completely and did not remain in a frozen state. Actual anti-risk management of development projects of housing and utility service providers will significantly help these companies to quickly respond to changes caused by risks. The number of successfully implemented development projects will increase and, as a result, housing and communal services will significantly improve.

LITERATURE REVIEW

Mathematical modeling of economic processes is an expression in the language of mathematics of the main properties of economic phenomena and processes in their interrelationship and functional dependence. Quantitative characteristics of economic processes in combination with qualitative ones are essential in mathematical modeling [5, 6].

The description of the mathematical model is performed in terms of quantitative characteristics-indicators (variables, unknowns), the value of which is subject to determination in the process of solving the problem and parameters whose values are known a priori. Any model of a classroom research problem includes variables, a system of constraints, and a goal. The goal is an objective function that is set on the set of admissible solutions D [7].

Mathematical logic, symbols and examples are detailed in [8].

Development projects of housing and communal services providers are schematically shown in Fig. 1 – distribution by direction and total number. They are a component of the conceptual model of anti-risk management in development projects of housing and utility service providers [9], which we arrived at through a few previous works [10, 11], [12].

In the works [13], [14, 15] proposed process and integrated management of deviations and uncertainties in projects, and in the work [16] considered approaches to modeling and integration, which will allow developing risk management models for development projects of utility service providers.

THE PURPOSE OF THE ARTICLE

The purpose of this work is to conduct a study of mathematical, functional, and informational models of management of development projects of housing and communal services providers from the point of view of risk management and other influential factors, ranking of priorities for the allocation of company resources to certain projects.

To achieve this aim it is necessary to complete the following objectives:

1) To conduct a study of mathematical, functional and information models from the point of view of their application in the process of risk management in development projects.

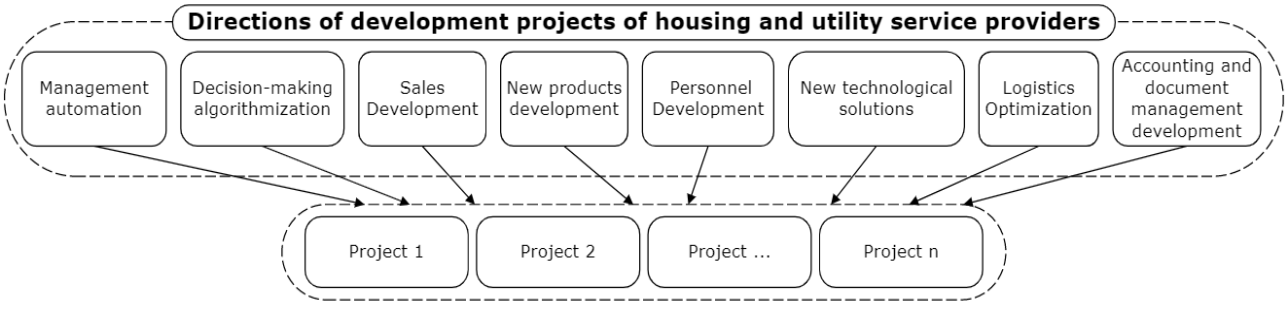

Fig. 1. **Visualization of development projects of housing and utility service providers for the mathematical model**

Source: ***compiled by the authors***

2) To substantiate the need for risk management of development projects of utility service providers.

3) To carry out mathematical, functional and informational modeling of risk management of development projects of providers services.

Mathematical model

The method of mathematical modeling helps researchers study real-world phenomena through mathematical models. To use it, it is necessary to translate the problem situation into the formal language of mathematics, solve the problem and interpret the obtained results.

A mathematical model can be developed in relation to a specific object as a whole or its individual constituent elements. With its help, it is possible to display either existing properties, functions of certain phenomena and processes, or their future development. There are static (the model is tied to a certain period of time) and dynamic (the relationship between the indicators of different periods is clarified) models.

Providers of housing and communal services are interested in development projects, that provide the company the highest income ($Inc \to \infty$) with minimum investment ($Inv \to 0$), as soon as possible ($t \to 0$) and with minimal risks ($Risk \to 0$). The integral assessment of the project based on such important components can be defined as:

$$Int = \frac{Inc}{Inv * t * Risk};\ Int \to Max,$$

where in the numerator is a positive factor, and in the denominator is the product of negative ones.

You can enter more such factors, but the logic will remain the same – the integral evaluation is calculated as the ratio of the product of all positive factors to the product of all negative factors. It is easy to compare projects among themselves by the size of their integral assessment.

The measure of the risk of an increase in the execution time and cost of implementation (in essence – losses for providers of housing and communal services) of the development project in quantitative terms is equal to:

$$Risk_i = \sum_{ij=1}^{b} P_{ij} * C_{ij},$$

where $Risk_i$ is total risk of the i-th development project; P_{ij} is the probability of the occurrence of the j-th risk in the i-th project; C_{ij} is economic losses in case of the possible occurrence of the j-th risk in the i-th project; b is the total number of risks in the i-th project.

The integral assessment of the i-th project will accordingly be defined as:

$$Int_i = \frac{Inc_i}{Inv_i * t_i * Risk_i};\ Int_i \to Max,$$

where Int_i is integral assessment of the *i*-th project; Inc_i is possible income of the provider of housing and communal services from the implementation of the *i*-th project; Inv_i is investment component of the *i*-th project; t_i is estimated duration of the *i*-th project; $Risk_i$ is the total risk of the *i*-th project.

For the most effective use of their resources (ROI – return on investment), housing and utility service providers should prioritize development projects with the maximum integral assessment, freezing development projects with a lower integral assessment.

An example of priority calculation (Pr_i – the priority of the *i*-th project) is given in Table 1. It uses the formula Integrated assessment = Income / (Necessary investments * Implementation periods * Possible losses due to risks).

Taking into consideration the riskiness of innovative projects (Fig. 2), they will not be in the first place in the priorities of providers of housing and communal services due to their relatively low integral assessment.

Table 1. **An example of prioritizing the allocation of resources of a housing and communal services provider for the implementation of development projects in accordance to their integral assessment**

Project No.	Income (UAN)	Investment Required (UAN)	Terms of implementation (month)	Possible losses on risks (UAN)	Integral assessment	Implementation priory
1	1000000	250000	13	200000	1.5385E-06	6
2	150000	120000	6	70000	2.9762E-06	5
3	200000	140000	8	50000	3.5714E-06	4
4	350000	120000	10	80000	3.6458E-06	3
5	480000	250000	3	120000	5.3333E-06	2
6	170000	70000	5	40000	1.2143E-05	1

Source: **compiled by the authors**

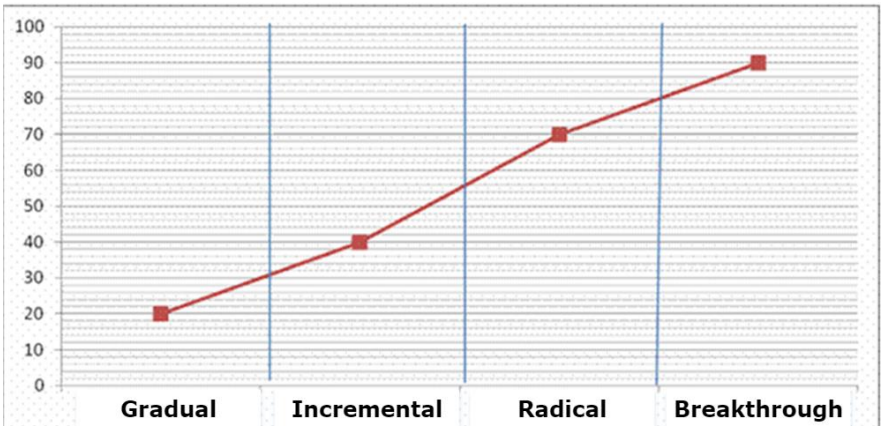

Fig. 2. **The degree of innovations' risk depending on their type**
Source: **compiled by the [13]**

It should also be kept in mind that in projects it is more expedient to focus on such a sequence of works that will lead to the smallest losses from risks [14]. As a priority, it is necessary to carry out work that is required for various development projects of the provider of housing and communal services at the same time.

Taking into consideration the constant change of the external and internal environment of development projects of housing and communal services providers (by analogy with [15]) with time (*t*), we understand that their integral assessment changes dynamically – $Int_i = f_i(t_i)$. It requires updating priorities ($Pr_i = fpr_i(t_i)$) for allocation of resources for their implementation. Such a dynamic change of emphasis in relationships is shown schematically in Fig. 3.

Functional model

A functional model is a model that makes it possible to study the functional features of certain processes, to determine the relationships between all internal and external elements [16].

The functional model is a "tree" of the main functions implemented at the enterprise. The model is built hierarchically – from the top level of functions to the bottom (through decomposition). At the highest level, the classification of business processes and their grouping is provided. A process is a complex function. Detailing of functions forms a hierarchical structure of their descriptions.

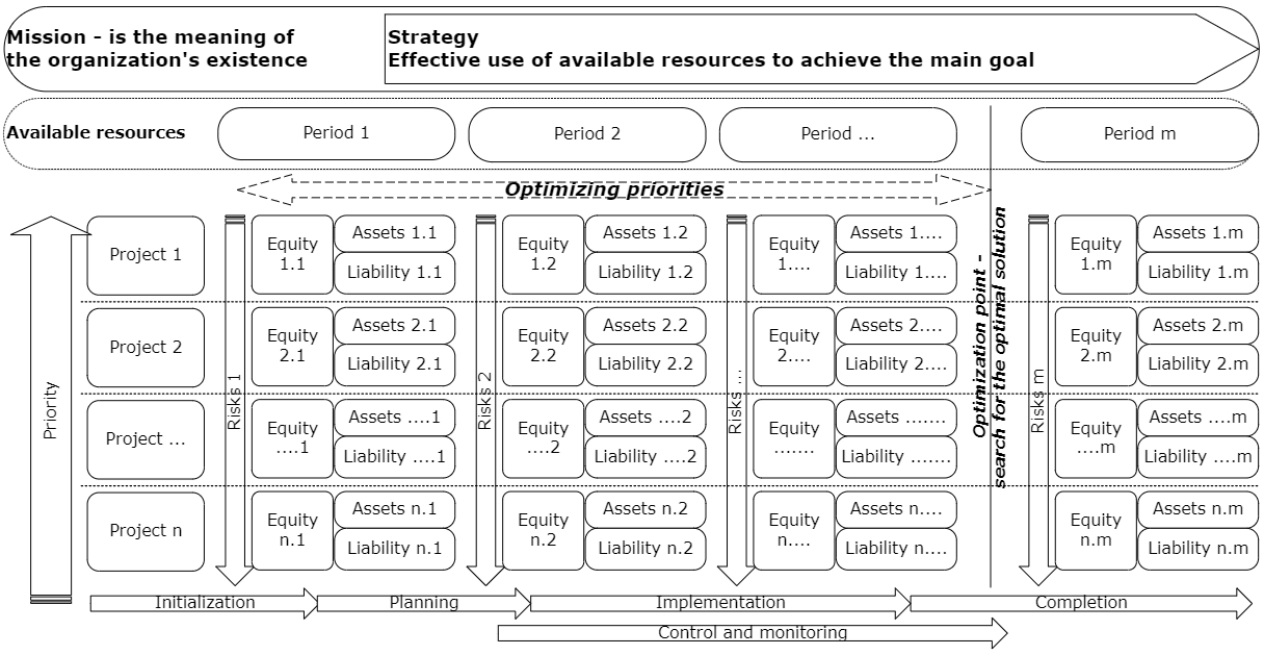

Fig. 3. **Changing the priorities of allocating resources of the housing and communal services provider to development projects over time, depending on migrating risks**
Source: **compiled by the authors**

In this work, we use the IDEF0 methodology [17] for functional modeling. It is based on the concept of a block that reflects some business function. The four sides of the block have different roles: the left side has the meaning of – "input", the right – "output", the upper – "control", the lower – "mechanism" (Fig. 4.).

The decision-making model (according to the IDEF0 methodology) for allocating the resources of the housing and communal services provider to the most promising projects, taking into consideration the risks, is shown in Fig. 5.

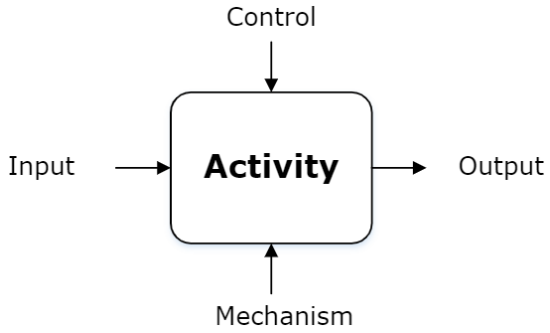

Fig. 4. **Business function according to IDEF0 methodology**
Source: **compiled by the authors**

Informational model

We consider the informational model in the Data Flow Diagram standard – design model with a graphical representation of data "flows" in the information system.

Contains four types of graphic elements:

1) processes (represent data transformation within the framework of the described system);

2) data storages (repositories);

3) entities external to the system;

4) data flows between elements of the three previous types [18].

Rules for constructing data flow diagrams [19]:

1) the process must have an input and output data streams;

2) data stores must also have input and output data streams;

3) data from external entities must necessarily go through a process to get to the storage.

DFD diagrams can be divided into several display levels [20]:

1) Conceptual – shows a general description of the process implemented during the data flow. Displays abstract data flows associated with various external entities.

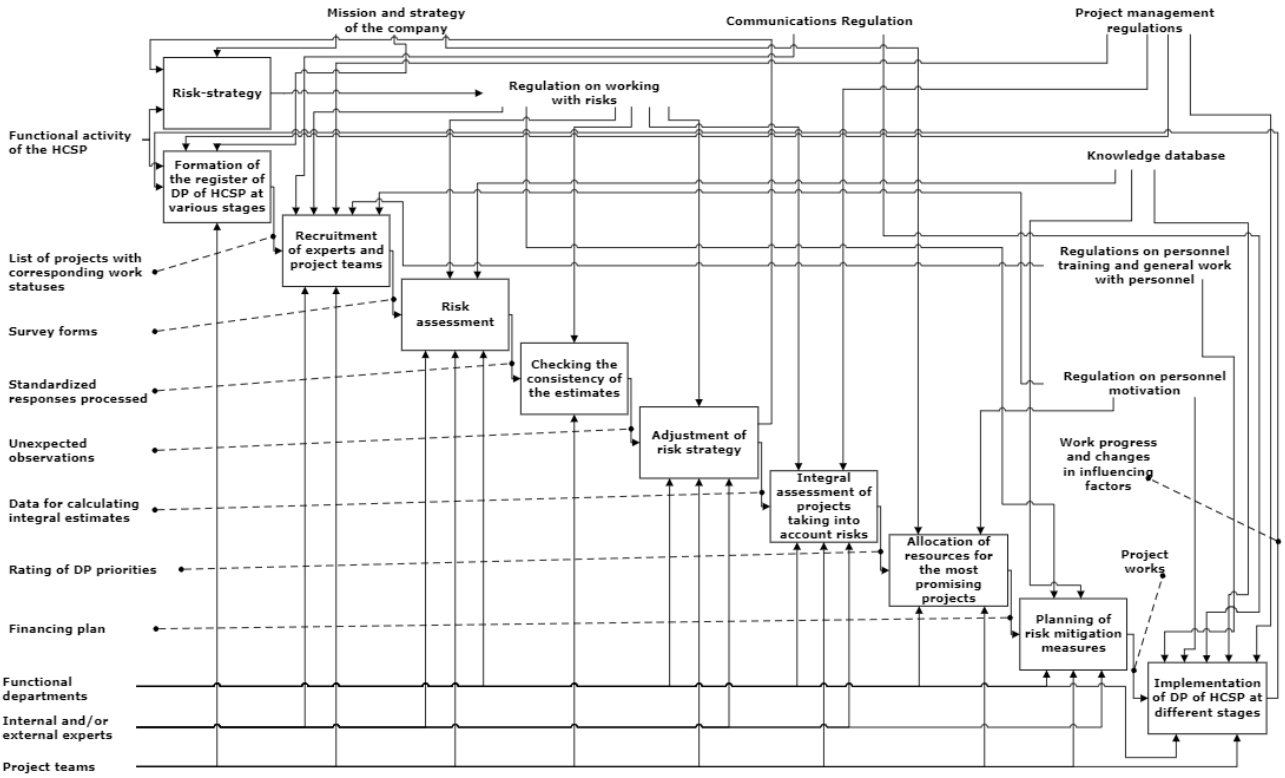

Fig. 5. **Increasing the effectiveness of anti-risk management of development projects of the housing and communal services provider by adjusting the priorities of resource allocation for their implementation.**
Abbreviations – DP-development projects; HCSP – housing and communal services provider
Source: **compiled by the authors**

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2) Logical – displays the logic of data transformation in the system in each process. You can see the input, intermediate, and output data in each process flowing from the external entity to the data stores.

3) Physical – exact display of data stores, names of data entities.

The Fig. 6 conceptual level of the informational model of anti-risk management of development projects of housing and communal services providers is shown. The main emphasis is that it is necessary to monitor the factors affecting project risks systematically – conducting a reassessment in accordance with internal and external changes in projects.

CONCLUSIONS

1. As part of the study, it was found that development projects are an important component of the effective and high-quality work of services providers. For this, the authors conducted a study of mathematical, functional and informational models from the point of view of their application in the process of risk management in development projects. This approach allows you to quickly model the impact of risks with the aim of the most efficient use of the provider's assets.

2. The need for risk management of development projects of services providers is substantiated. This will make it possible to carry out an integral assessment of the prospects of development projects of the provider of services, taking into account the risks, and to allocate resources to projects according to the highest priority.

3. Mathematical, functional and information modeling of risk management of development projects of providers services was carried out. As a result, mathematical, functional and informational models were developed, which will allow the limited resources of providers to be redistributed in a timely manner in more promising directions.

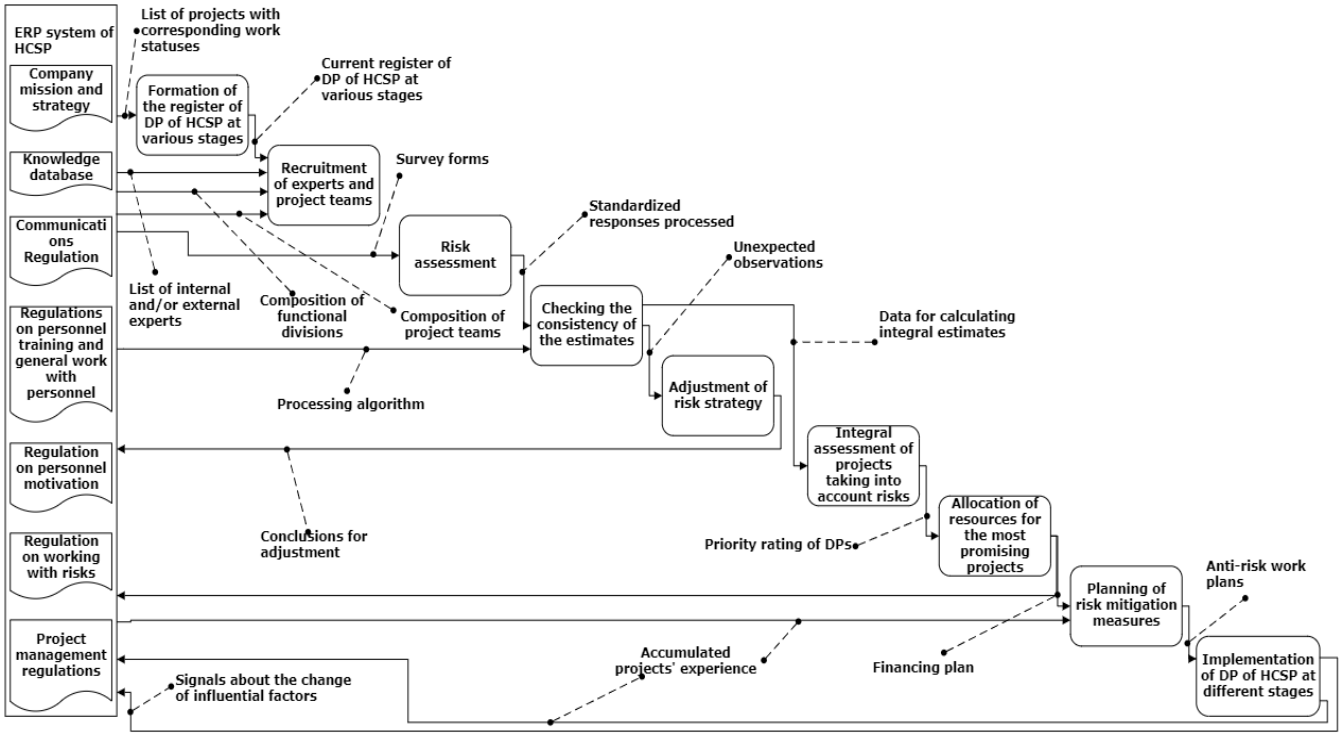

Fig. 6. **Informational model of anti-risk management of the housing and communal services provider due to cyclical monitoring of risk changes of development projects.**
Abbreviations:
DP – development projects;
HCSP – housing and communal services provider
Source: compiled by the authors

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Моделі протиризикового управління в проєктах розвитку провайдерів житлово-комунальних послуг

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АНОТАЦІЯ

Ефективна робота провайдерів житлово-комунальних послуг тісно пов’язана з проєктами розвитку, які вони реалізують. Важливою складовою управління проєктами розвитку є протиризикове управління. Проведено аналіз математичної, функціональної та інформаційної моделей управління проєктами розвитку провайдерів житлово-комунальних послуг з урахуванням ризиків. Запропоновано механізми інтегрального оцінювання проєктів, пріоритетності виділення ресурсів компанії в найбільш перспективні напрями. Наведено обмеження, в яких знаходяться проєкти розвитку провайдерів житлово-комунальних послуг для проведення подальших наукових досліджень. Суттєвим важелем підвищення ефективності протиризикового управління в проєктах розвитку провайдерів житлово-комунальних послуг є можливість коригування пріоритетів щодо реалізації проєктів розвитку в реальному часі за рахунок впровадження автоматизації управління та алгоритмізації приймання рішень, процесного підходу в управлінні ризиками та прийманні управлінських рішень, динамічною організаційною структурою управління проєктами розвитку. Автоматизація управління та алгоритмізація приймання управлінських рішень дозволяє знаходитись всім учасникам проєктів розвитку в одній інформаційній системі: будувати логічну послідовність завдань, визначати проєктний шлях, створювати безперебійний матеріальний потік з мінімізацією необхідних запасів, налагоджувати прозорість та контроль для стейкхолдерів проєктів розвитку тощо. Алгоритмізація приймання рішень дозволяє своєчасно запобігати розростанню обсягів проєктів, низькій продуктивності, перевищенням витрат, нестачі часу, ресурсів, прийняттю рішень, що ґрунтуються на неповній інформації, некомпетентності учасників проєктів розвитку. Динамічна організаційна структура управління проєктами розвитку стимулює узгодженість дій та швидке вирішення питань, виховання кадрового резерву, налагодження комунікації тощо.

Ключові слова: житлово-комунальне господарство; провайдери послуг; математична модель; функціональна модель; інформаційна модель; протиризикове управління; проєкти розвитку; оргструктура; приймання рішень

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