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MODERN APPROACHES TO THE EVALUATION OF INVESTMENT PROJECTS UNDER UNCERTAINTY: A CASE OF HOTEL AND TOURISM INFRASTRUCTURE

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The article examines the theoretical and practical aspects of analyzing and evaluating investment projects under conditions of uncertainty and risk. The relevance of improving methodological approaches to selecting effective investment decisions in the context of post-COVID economic transformation, intensifying global competition, and enhancing the competitiveness of domestic producers in the Republic of Kazakhstan is substantiated.

Modern methods of investment project evaluation, sensitivity analysis, risk assessment, and fuzzy set theory are examined, with particular attention to their application under conditions of uncertainty. Particular attention is paid to investment risk management in the construction industry and the hotel and tourism infrastructure sector. The study also reveals the specific features of applying ESG factors and modern portfolio investment concepts in developing an investment strategy.

As a result of the research, key criteria for selecting effective investment projects were identified, and approaches to optimizing the investment budget, reducing uncertainty, and enhancing the sustainability of investment decisions were proposed. The study concludes that there is a need to introduce flexible financial instruments and improve investment financing mechanisms in Kazakhstan.

Keywords: investment project, uncertainty, risk, investment efficiency, investment analysis, fuzzy set theory, ESG factors, investment financing.

БЕЛГІСІЗДІК ЖАҒДАЙЫНДА ИНВЕСТИЦИЯЛЫҚ ЖОБАЛАРДЫ БАҒАЛАУДЫҢ ЗАМАНАУИ ТӘСІЛДЕРІ: ҚОНАҚҮЙ-ТУРИСТІК ИНФРАҚҰРЫЛЫМ МЫСАЛЫНДА

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Мақалада белгісіздік пен тәуекел жағдайындағы инвестициялық жобаларды талдау және бағалаудың теориялық әрі практикалық аспектілері қарастырылады. COVID-тен кейінгі экономикалық трансформация жағдайында, жаһандық бәсекелестіктің күшеюі мен Қазақстан Республикасындағы отандық өндірушілердің бәсекеге қабілеттілігін арттыру қажеттілігі аясында тиімді инвестициялық шешімдерді таңдаудың әдіснамалық тәсілдерін жетілдірудің өзектілігі негізделген.

Инвестициялық жобаларды бағалаудың, сезімталдықты талдаудың, тәуекелдерді бағалаудың заманауи әдістері және анық емес жиындар теориясы қарастырылады, бұл ретте оларды белгісіздік жағдайында қолдануға ерекше назар аударылады. Құрылыс саласы мен қонақүй-туристік инфрақұрылым секторындағы инвестициялық тәуекелдерді басқару мәселелеріне ерекше назар аударылған. Сонымен қатар, инвестициялық стратегияны қалыптастыру барысында ESG факторлары мен заманауи портфельдік инвестициялау тұжырымдамаларын қолдану ерекшеліктері айқындалған.

Зерттеу нәтижесінде тиімді инвестициялық жобаларды іріктеудің негізгі критерийлері анықталып, инвестициялық бюджетті оңтайландыруға, белгісіздік деңгейін төмендетуге және инвестициялық шешімдердің тұрақтылығын арттыруға бағытталған тәсілдер ұсынылған. Қазақстанда икемді қаржылық құралдарды енгізу және инвестицияларды қаржыландыру тетіктерін жетілдіру қажеттілігі туралы қорытынды жасалған.

Түйін сөздер: инвестициялық жоба, белгісіздік, тәуекел, инвестиция тиімділігі, инвестициялық талдау, көмескі жиындар теориясы, ESG факторлары, инвестицияларды қаржыландыру.

СОВРЕМЕННЫЕ ПОДХОДЫ К ОЦЕНКЕ ИНВЕСТИЦИОННЫХ ПРОЕКТОВ В УСЛОВИЯХ НЕОПРЕДЕЛЁННОСТИ: НА ПРИМЕРЕ ГОСТИНИЧНО-ТУРИСТИЧЕСКОЙ ИНФРАСТРУКТУРЫ

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В статье рассматриваются теоретические и практические аспекты анализа и оценки инвестиционных проектов в условиях неопределенности и риска. Обоснована актуальность совершенствования методологических подходов к выбору эффективных инвестиционных решений в условиях постковидной экономической трансформации, усиления глобальной конкуренции и необходимости повышения конкурентоспособности отечественных производителей Республики Казахстан.

Рассматриваются современные методы оценки инвестиционных проектов, анализа чувствительности, оценки рисков и теория нечётких множеств, при этом особое внимание уделяется их применению в условиях неопределённости. Особое внимание уделено вопросам управления инвестиционными рисками в строительной отрасли и сфере гостинично-туристической инфраструктуры. Также раскрыты особенности применения ESG-факторов и современных концепций портфельного инвестирования в процессе формирования инвестиционной стратегии.

В результате исследования были определены ключевые критерии отбора эффективных инвестиционных проектов, а также предложены подходы, направленные на оптимизацию инвестиционного бюджета, снижение уровня неопределенности и повышение устойчивости инвестиционных решений. Сделан вывод о необходимости внедрения гибких финансовых инструментов и совершенствования механизмов инвестиционного финансирования в Казахстане.

Ключевые слова: инвестиционный проект, неопределенность, риск, эффективность инвестиций, инвестиционный анализ, теория нечетких множеств, ESG-факторы, инвестиционное финансирование.

Introduction. In the modern post-COVID period, a significant role should be assigned to enhancing the competitiveness of national producers. In this regard, the President of the Republic of Kazakhstan, Kassym-Jomart Tokayev, places considerable emphasis in his speeches on the development of a competitive domestic economy.

As an integral component of economic activity, uncertainty underlies many complex and important phenomena in production processes. The diversity of situations and problems arising in enterprises of different scales and sectors tends to lead to associating each source of uncertainty with a particular type of risk.

The problem of selecting effective investment projects becomes especially important amid the development of market-based management methods, including competitive financing of investment projects.

Risk management issues exist in every sector of the economy. The inevitability of risk in many business situations explains its prevalence in economic activity. The relevance of this topic is determined by both external and internal factors. External factors include the intensification of globalization processes and the resulting growth of increasingly rigid competition, the shortening of product life cycles, and the individualization of consumer preferences. Internal factors include an inability to adapt to change, a lack of realistic forecasting, insufficient strategic focus, and fragmented information systems. A properly structured risk management system can partially help overcome these problems.

Particular importance is attached to evaluating efficiency and selecting optimal projects under conditions of uncertainty and risk. Risk accompanying the process of investment decision-making is a characteristic feature of a market economy.

The problem of selecting effective projects becomes considerably more complicated when they are evaluated against multiple performance indicators. Such indicators may include economic effect, payback period, profitability index, and others. The best investment alternatives identified using different efficiency indicators often do not coincide. As a result, an additional layer of uncertainty arises when selecting effective decisions based on a combination of indicators.

The main objective of this study is to examine approaches to assessing the efficiency and risk of an investment project involving the construction of a multifunctional hotel and tourism complex under

conditions of uncertainty, using sensitivity analysis, scenario analysis, and risk analysis.

The research question is formulated as follows: How can modern methods for assessing the efficiency and risk of investment projects be applied under conditions of uncertainty? The study focuses on an investment project to construct a multifunctional hotel and tourism complex. The study aims to systematize and substantiate methodological approaches to assessing the efficiency and risks of an investment project under conditions of uncertainty. The expected result is to identify the key factors affecting the efficiency and risk of the investment project and to substantiate the use of analytical methods under conditions of uncertainty.

Certain aspects of the analysis of investment projects under conditions of uncertainty and risk have been examined by such scholars as Redhead K., Hughes S., Holt R.N., and Sharpe W. This issue has also been considered in the studies of Kazakhstani researchers, including Baimuratov U., Saparbayev Z.A., Klyshbayeva Z.A., Kuchukova N., Sembekov S., Zholdasbayev S., Akbayev E.T., and others.

Problems related to the analysis of investment projects under conditions of uncertainty remain insufficiently studied. At present, there is a need for a scientific justification of methodological approaches to investment project analysis under uncertainty, the development of an effective analytical system, mechanisms for optimizing protective measures, and criteria for decision-making on the implementation of such measures.

Modern investment management is based on contemporary portfolio theories and the concept of responsible investment that considers ESG factors.

Portfolio investment theories are closely connected with the company's securities portfolio as a source of financing investment projects. These include the theory of H. Markowitz, the theory of J. Tobin, Sharpe's CAPM model, and others.

Currently, the application of classical portfolio theory (Markowitz), Tobin's model, APT, and CAPM to form an effective investment portfolio does not achieve the required level of efficiency due to several limitations and assumptions. Each model has advantages and disadvantages; therefore, these models should be combined with modern optimization methods and innovative digital tools to identify effective solutions.

Most foreign experts, including Gerhard Halbritter, Gregor Dorfleitner, Stuart L. Gillan, Andrew Koch, Laura T. Starks, and others, emphasize that applying ESG factors is both a necessary and sufficient condition for analyzing environmental, social, and corporate risks and identifying development opportunities [1].

The concept of sustainable development encompasses three major dimensions (Figure 1).

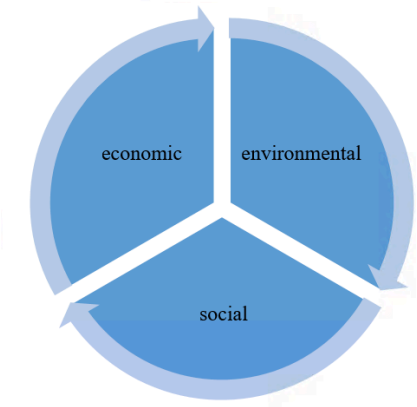


Fig. 1 - Structure of the Sustainable Development Concept

Based on an analysis of official open sources and the systematization of available materials, it has been determined that there are currently no unified standards for measurement and reporting in sustainable finance. As a result, there is a lack of consistent, comparable ESG-related data needed for investment decision-making and analytical assessment.

The scientific novelty of the study lies in the comprehensive examination of sensitivity and scenario analyses, expert assessments, and approaches based on fuzzy set theory, as applied to evaluating investment projects under uncertainty, with particular attention to hotel and tourism infrastructure projects. In this study, the fuzzy set theory–based approach is considered a methodological framework for accounting for uncertainty rather than a fully calibrated empirical model for the project under investigation.

The study focuses on applying methodological approaches to assess investment projects under uncertainty, with particular attention to sensitivity analysis, scenario analysis, expert assessment, and fuzzy-set approaches.

Materials and Methods. During the research process, general scientific and special methods for analyzing investment projects under conditions of uncertainty and risk were used. The theoretical basis of the study was formed by the works of domestic and foreign scholars in the fields of investment management, risk management, portfolio investment, and sustainable finance.

For a comprehensive study of the problem, the systems analysis method was applied, enabling consideration of the investment project as a complex

economic system operating in a changing external environment. The comparative analysis method was used to compare traditional and modern approaches to evaluating the efficiency of investment projects and to study different methods of investment risk management. Economic and statistical methods were also applied to assess the effectiveness of investment projects. To assess the sustainability of investment decisions under uncertainty, a sensitivity analysis was conducted to evaluate the impact of changes in key factors on the final project results.

To model investment processes under conditions of incomplete and uncertain information, the fuzzy set theory method was applied. The use of this method enabled consideration of both quantitative and qualitative parameters in evaluating investment decisions. The expert assessment method was used to determine the risk level and the probability of achieving the target project indicators. In addition, a scenario-based approach was used to analyze alternative development options for investment projects in response to changes in macroeconomic conditions and market conditions.

During the processing and interpretation of the research results, methods of scientific generalization, graphical presentation, and tabular representation of data were used. This made it possible to systematize the results obtained and formulate practical recommendations to improve the efficiency of investment financing and enhance the investment risk management system.

The analysis is based on data characterizing the internal and external environment of the investment project, including projected revenues, operating and investment costs, sales volumes, and other financial parameters. The initial information was obtained from project-related materials and publicly available official sources relevant to the construction and hotel-tourism sector. These data were used as the basis for the sensitivity and scenario analyses and for assessing the impact of changes in key parameters on project performance.

Results and Discussion. The main objective of analyzing and evaluating an investment project is to calculate its efficiency and assess its risk level. The optimal decision is made based on two main parameters: efficiency and risk [2].

One of the modern approaches is the method based on fuzzy set theory (FST). This theory was developed by Lotfi Zadeh, a professor at the University of California and an American mathematician and logician. Currently, fuzzy set theory is widely studied by researchers and applied in such fields as economics, management, computer science, higher mathematics, and others [3].

In investment analysis, fuzzy set theory can be applied under conditions of uncertainty, where the membership function of an element takes values within the range of [0;1].

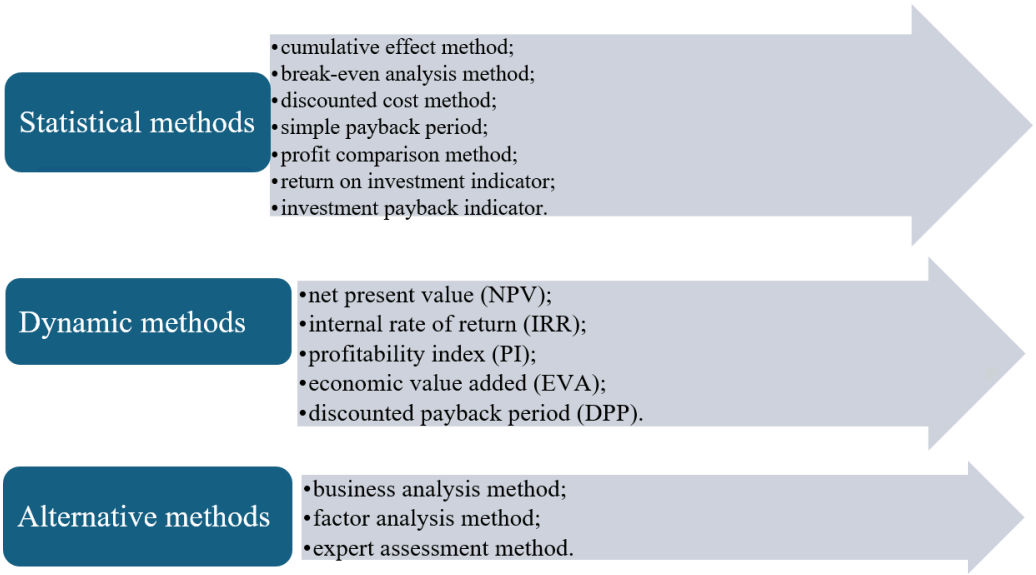


Fig. 2 - Indicators of the main methods for evaluating the efficiency of investment projects

For decision-making under conditions of uncertainty and for evaluating the efficiency of investment projects, fuzzy set theory (FST) offers several approaches. The main objective is to provide the initial fuzzy data with a formalized representation, while the key function is to achieve maximum project efficiency using fuzzy intervals. At the same time, the introduction of

any interval is accompanied by a certain degree of uncertainty.

This method enables the development of expert systems and knowledge bases that can store fuzzy information. The main advantage of the method is that, in the decision-making process, both quantitative and qualitative factors are taken into account, including those without a specific numerical value. As a result, an approximate yet effective method for describing complex and weakly formalized systems is obtained. A distinctive feature of this method is its flexibility in determining the degree of decision accuracy in accordance with established requirements and available information [4].

Let us present Formula (1):

$$NPV = -I + \sum_{t=1}^{n} \frac{CFt}{(1+i)^t} \quad (1)$$

where:

I - initial investment volume;

n - number of planned intervals of the investment process;

CF_t - total cash flow for the period t;;

i - discount rate.

It should be noted that the variables presented in Formula (1) contain a certain degree of "fuzziness," meaning that their exact planned values are uncertain.

In this case, for the initial data, a triangular fuzzy number of the following form is used:

$$A = \left(a_{\min}, a_{\text{cp}}, a_{\max}\right)$$

Consequently, for evaluating the efficiency indicators of an investment project, a set of fuzzy numbers is formed (Figure 3).

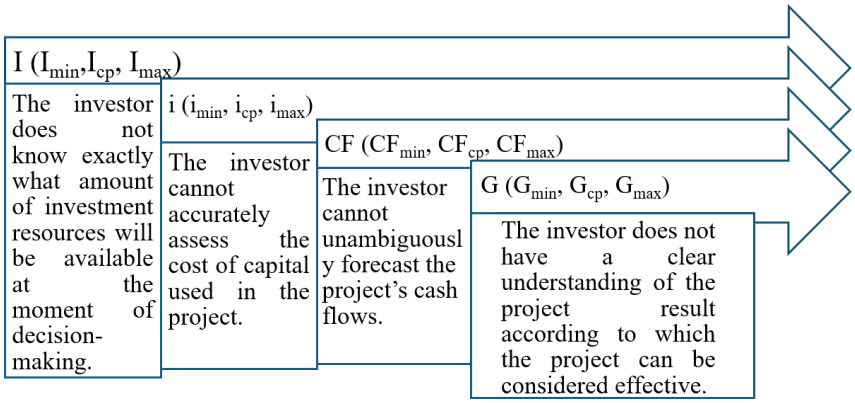


Fig. 3 - Set of Fuzzy Numbers

If one of the criteria A is defined precisely or specified unambiguously, then the fuzzy number A transforms into a real number under the condition: $a_{min} = a_{cp} = a_{max}$. In this case, the essence of the method remains unchanged [4].

Within the fuzzy-set approach, several membership levels (α) can be defined to represent the uncertainty of the final NPV value. Then, for each level (α), the interval thresholds of each individual parameter are calculated. By substituting these threshold values into Formula (2), the boundary values for NPV_1 and NPV_2 are calculated for the corresponding membership levels.

$$\begin{aligned} \text{NPV}_{\min}, \text{NPV}_{\max} &= -[I_{\min}, I_{\max}] + \sum_{t=1}^{n} \left[\frac{CF_{t\ \min}}{(1+i_{\max})^t}, \frac{CF_{t\ \max}}{(1+i_{\min})^t} \right] = \\ &= \left[-I_{\max} + \sum_{t=1}^{n} \left[\frac{CF_{t\ \min}}{(1+i_{\max})^t} \right], -I_{\min} + \sum_{t=1}^{n} \left[\frac{CF_{t\ \max}}{(1+i_{\min})^t} \right] \right], \end{aligned} \quad (2)$$

If the value of the integral indicator exceeds the specified project-level threshold G, the investment project can be considered effective. The efficiency of the investment project can be assessed using a threshold value for the efficiency indicator G established by the investor. The intersection point of the efficiency parameter function and the NPV curve is located on the ordinate at point (α_1). Next, let us arbitrarily define the membership level (α) and calculate the intervals [NPV_1, NPV_2] for it:

- if $\alpha > \alpha_1$ and $NPV_1 > G$, then the project is considered effective and the risk of investment inefficiency equals 0;

- if α_1 is defined as the upper threshold of the risk zone, then at $0 < \alpha < \alpha_1$, the project may be either effective or ineffective.

Since all implementation variants of NPV at this membership level α have identical values, then:

1. NPV ≥ G — the project is effective (blue line);
2. NPV < G — the project is ineffective (red line).

Let us consider in more detail some of the most common indicators of dynamic and statistical methods: NPV, IRR, PI, DPP, and PP.

Business activity is always associated with various types of risk. For effective business operations, an entrepreneur should be ready to implement new technological solutions and make bold, original decisions, which, in turn, increase risk. In this regard, it is necessary to accurately assess the risk level and manage it effectively to achieve more successful market outcomes.

Let us consider the basic criteria for determining the structure of investment project management using the example of the investment project structure for the construction of a multifunctional hotel and tourism complex (Table 1) [5].

Table 1 - Criteria for Selecting the Organizational Structure of an Investment Project for the Construction of a Multifunctional Hotel and Tourism Complex

Selection Criterion	Functional Structure	Matrix Structure	Project Structure
Level of uncertainty	Low	Medium	High
Technology	Standard	Complex	Innovative
Complexity	Low	Medium	High
Duration	Short	Medium	Long
Level of interconnection between project components	Low	Medium	High
Importance of the time factor (presence of critical deadlines)	Low	Medium	High
Dependence on higher-level management structure	High	Medium	Low

Note - compiled by the author based on source [6].

A multicriteria problem and such a project are reflected in formal modeling.

Schematically, this decision-making model can be represented as the following function:

$$G = (T, K, X, S, F, P, R)$$

where:

T - the defined task;

K - a subset including all criteria;

X - a subset including scales;

S - a subset of all possible alternatives;

F - mapping of possible alternatives into a set of vector evaluations;

P - a parameter reflecting the preferences of the decision-maker;

R - the main rule according to which the decision is made.

The sequence of decision-making during the construction stage of a multifunctional hotel and tourism complex can be presented as follows:

1. Development of the investment project idea, formulation of goals and objectives, and analysis of existing investment alternatives.
2. Formulation of project implementation criteria corresponding to the current situation.
3. Development of a system for evaluating criteria using special scales.
4. Formation of a set of alternatives and sensitivity analysis of all existing project alternatives.
5. Evaluation of alternatives using the developed scales.
6. Analysis of the preferences of responsible persons or formation of a collective opinion (human factor).
7. Formulation of the main decision-making rule.
8. Ranking of alternatives.
9. Analysis of the ranking results.

In order to optimize residential construction, it is necessary to identify and analyze the main criteria: technical and economic criteria; investment criteria; personal criteria (preferences of project participants); marketing criteria; parameters related to the taxation system.

Of course, the importance of analyzing the above-mentioned parameters is widely recognized. Nevertheless, it is very important to remember the need to consider multiple factors when making decisions in residential construction, especially under the current economic downturn and financial crisis.

The residential construction sector was not chosen accidentally to demonstrate the analysis of all aspects of investment projects. This is due to the specific features of this area and the many factors that may influence decision-making in this field.

The features of hotel construction became especially noticeable during the 2009 crisis. The crisis had little impact on commercial construction, which at that time mainly depended on the availability of financing sources. Regarding residential construction, especially the economy-class segment, it can be noted that due to its multifactor nature, it has become an ideal area for investors to implement truly successful projects. Such success was supported by factors including changes in the target segment, in which many development companies, due to the economic situation, decided to reposition business-class projects as more affordable economy-class projects, as well as the optimization of construction staff and other measures [6].

To better understand the problem, it is necessary to present a classification of risks associated with multifunctional hotel and tourism residential

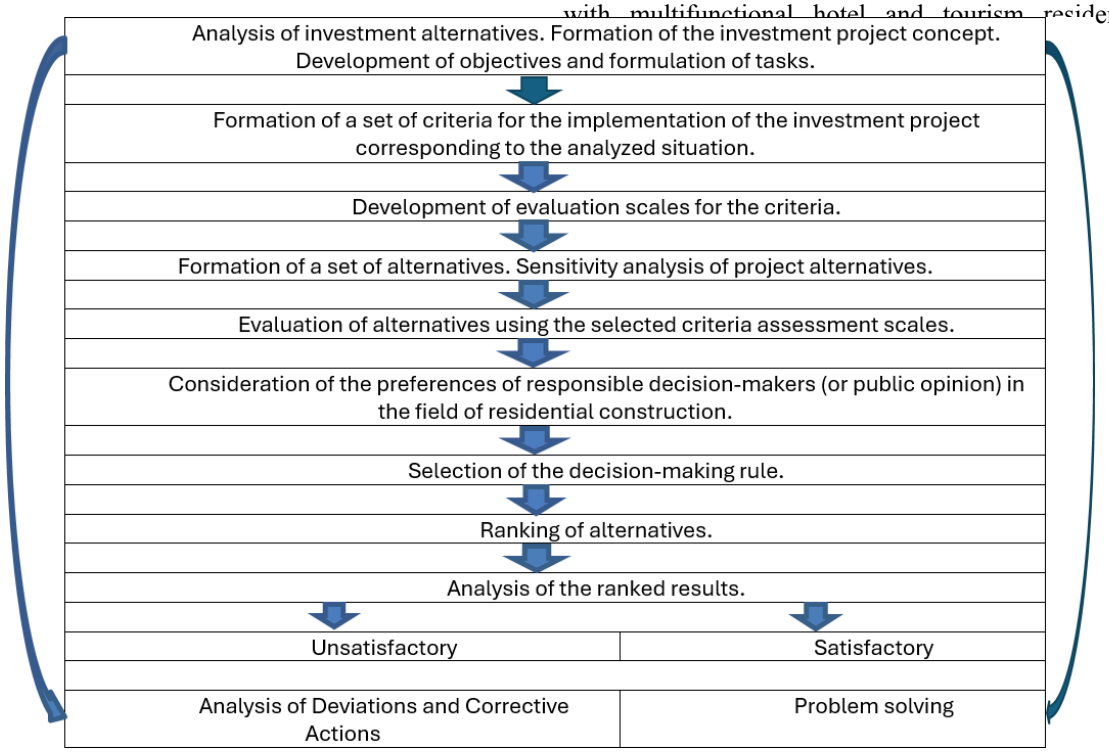


Fig. 4 - Sequence of Solving a Multicriteria Problem in Investment Decision-Making for the Construction of a Multifunctional Hotel and Tourism Complex

Note - compiled by the author.

Technical and Economic Aspects. In order to assess the possibility of developing a project with specific technical and economic parameters, four main criteria should be considered:

- the project must be physically feasible;
- the project must be economically justified;
- the project must comply with current legislation;
- it is desirable that the project generates the maximum possible profit.

In the real estate market, there is a need to acquire land plots for construction purposes.

Calculation of the Investment Budget of the Project.

Optimizing the investment budget is one of the most complex tasks, as it requires close, continuous interaction among all project participants, including general contractors and design organizations, as well as all investors involved in the construction process.

At the investment design stage, it is very important to determine the minimum possible costs below which reducing construction expenses becomes impractical due to the possible deterioration in the quality of the future project.

In order to achieve optimal cost indicators for the project, the following aspects should be carefully considered:

- preliminary tender procedures are necessary in order to determine the supplier of works and services offering the most appropriate pricing proposal. This makes it possible to conclude agreements under the most favorable conditions for all project participants. During the tender selection process, it is important to consider not only low service costs, but also the company's experience, implementation periods, and other obligations;
- competent evaluation of prices for required services and construction materials is essential;
- in order to prevent possible construction cost overruns, agreements should provide the most beneficial and economically justified methods of settlements with contractors;
- due to constant fluctuations in the national currency exchange rate, when concluding foreign currency contracts, it is necessary to determine in advance the influence of currency value changes on payment amounts ("price sliding");
- because of permanent fluctuations in construction material prices, contracts should include all possible scenarios related to changes in material costs;
- if a long-term construction contract is concluded, it is strongly recommended to include all possible risks (loss or damage to the construction object, theft of construction materials and other property, etc.);
- contracts for construction works must necessarily include settlement methods with contractors corresponding to the actual market price level and preventing unreasonable increases in construction costs.

It is well known that construction delays also increase project costs and delay the object's market entry. In the future, such delays may lead to a significant increase in expenses and a decrease in the value of the completed project [7].

Project Participants. Within the framework of activities related to the implementation of construction projects, the composition of project participants should be optimized. Before the 2009 crisis, citizens' financial resources accounted for a significant share of investment; however, after the economic changes in Kazakhstan, their role in residential construction declined significantly.

The composition of project participants is determined by various financial organizations, including credit institutions participating in the implementation of residential construction projects. Optimization of economic activity should aim to create the best possible conditions for attracting borrowed funds for construction.

It is important to note that under pre-crisis conditions, the loan period may be shorter than the construction period. This was because most apartments were sold during construction. Currently, due to economic changes, it has become necessary to secure loans for periods that exceed the construction timeframe. This is caused by two main factors: the low pace of sales of completed apartments and the slow repayment of loan obligations resulting from it.

To optimize the composition of participants, it is necessary to maximize efficiency in the interaction among all parties involved in construction. Control over efficiency may be assigned to both development companies investing their own funds in the project and other participating organizations.

Marketing Strategy for Project Implementation. During the project's implementation, it is necessary to develop the most profitable marketing strategy to accelerate the sale of apartments and other premises.

The main objectives of the marketing strategy are:

- development of an optimal pricing policy that takes into account all project characteristics and the profile of the potential buyer;
- assessment of the strengths and weaknesses of competing projects and attracting buyers to
- the advantages of the implemented project through effective advertising;
- creation of a sales scheme considering both the features of the completed object and consumer preferences;
- introduction of sales stimulation measures such as advertising campaigns, discounts, installment plans, and others.

For example, consider the method of selling apartments in elite residential buildings, where sales begin with those on lower floors. In this case, the developer aims not only to attract additional investment into construction but also to sell the least liquid properties as quickly as possible. At the same time, to create an artificial deficit, many developers do not open sales of more-liquid apartments until the less-liquid ones are sold.

Summarizing the above, it can be noted that the analysis of all the above-mentioned parameters, such as the current economic situation, investment flow analysis, characteristics of the construction object, and others, makes it possible to make more accurate and justified decisions during the implementation and promotion stages of the project. The development potential of a company lies precisely in its ability to take into account the current problems of the modern market.

This is especially relevant for companies operating in the residential construction sector.

Conclusion. The implementation of investment plans to construct a multifunctional hotel and tourism complex has always been considered a profitable venture. However, while for an investor this business plan primarily generates profit, for the future owner or user of the facility, this investment project contributes to improving living conditions and social needs. This means that implementing such projects carries significant social importance. New buildings expand the urban landscape (in the case of construction within city boundaries) and contribute to the modernization of regional infrastructure. Multifunctional hotel and tourism complexes are in demand because they are among the main indicators of a country's tourist attractiveness, while also creating favorable living conditions and social facilities near such developments.

To determine the level of risk exposure, sensitivity analysis of the project is usually applied. This analysis evaluates the project's sustainability under unstable economic conditions in the country, including price increases, financial crises, instability in the industrial sector, and other factors [8].

The level of project stability with respect to future changes is generally determined using break-even parameters, including maximum production limits, the cost of goods or services produced, and other indicators [9]. In most cases, the break-even limit is necessary for determining the production volume. This limit is important during the implementation of the main works and is defined as the break-even point [10].

Analysis of the flexibility and liquidity of the project. The flexibility of the analyzed investment project refers to the ability to reorient the project or change its functional purpose if it fails to achieve its initial objectives, as well as the possibility of converting the project into cash [11].

The liquidity of investment costs in this investment project reflects the likelihood of quickly recovering the resources invested and converting them into cash at various stages of project implementation.

This means that the given construction complex may be reoriented into: a residential apartment building, office premises, a training center, an apartment hotel, and other facilities.

The main objectives of investment marketing include analyzing the profitability of invested funds, selecting an appropriate investment strategy, and accurately justifying actions taken during the development of projects and plans. Investment marketing enables a deeper study of investment project development and implementation processes, for example, when investments are directed toward the real estate sector.

In general, investment in residential construction represents capital investment in a real asset.

Such assets are characterized by stable price growth, high predictability of changes in profitability, and relatively weak dependence on global economic fluctuations. As a result, investments in construction projects are considered to be highly secure [12].

Another distinctive feature of this type of investment is its long-term nature, since the payback period usually occurs no earlier than after one year. The characteristics of the final product, specific labor conditions, the diversity of technical equipment and technologies used, as well as the specifics of organizing the production process and material-technical support determine the features of construction activity, types of risks, and methods of analysis [13].

In our opinion, the most appropriate methods for assessing risks in residential construction are briefly described in Table 3.

Risk minimization and increasing the investment attractiveness of projects consist of several important measures:

- application of proven experience, advanced technologies, and conducting business based on franchising principles;
- involvement of successful foreign consultants and managers; obtaining state support for the project and government guarantees;
- participation of reputable shareholders in the project; presence of reliable project partners;
- existence of a client base and concluded agreements for the supply of future products or services;
- presence of a competent project management team and a transparent procurement system for goods and services;
- availability of a preliminary approved project and architectural-planning assignment;
- in the case of construction projects, availability of preliminary technical conditions for connection to engineering and communication networks;
- availability of highly qualified employees and other factors.

Table 2 – Methods for Assessing Risks of an Investment Project for the Construction of a Multifunctional Hotel and Tourism Complex

Method for Investment Project Risk Assessment	Characteristics of the Method
Analogy method	Analysis of all available data on similar and less risky projects is carried out, as well as an assessment of the consequences of adverse factors affecting them, to determine the potential risk during the implementation of a new project.
Expert assessment method	This method is based on the experience of experts in investment project management. Experts evaluate the project and its individual components according to the degree of risk impact.
Discount rate adjustment method (risk premium)	The essence of this method is to adjust the discount rate to the expected level of project risk.
Sensitivity analysis of efficiency criteria	The purpose of the method is to compare the influence of various investment project factors on the key efficiency indicator, for example, the internal rate of return.
Scenario method	This method determines the impact of simultaneous changes in all major project variables that characterize its cash flows on the project's efficiency criteria.
Decision tree	The method is based on constructing a directed graph in which vertices represent individual decisions, and arcs represent the consequences of their implementation.
Simulation modeling (Monte Carlo method)	The essence of this method lies in constructing a mathematical model for a project with uncertain parameter values. The distribution of project profitability can be obtained by knowing the probability distributions of project parameters, as well as the relationship between parameter changes (correlation).

Note – compiled by the author

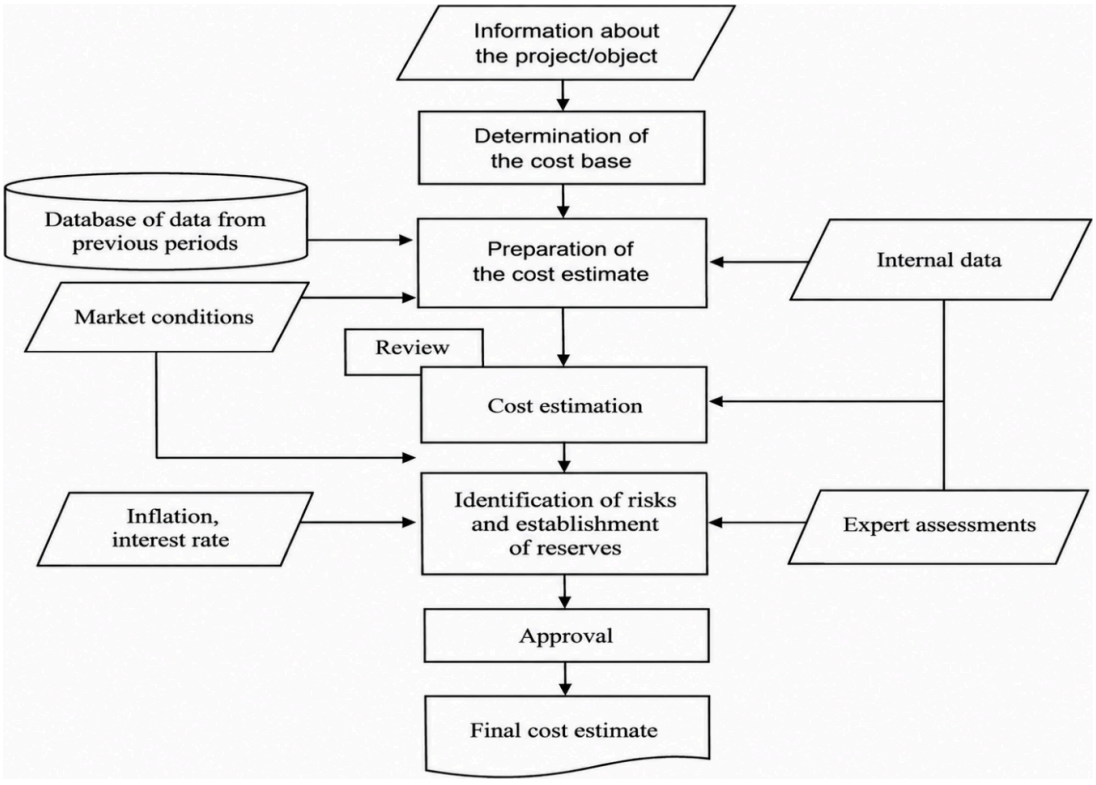


Fig. 5 -Algorithm for Evaluating Project Costs Based on Risk Accounting in the Investment Project for the Construction of a Multifunctional Hotel and Tourism Complex

The cost estimation process is presented in Figure 5. Each assessment level may require specific data, methods, and tools.

A mandatory component of this stage is the preparation of a detailed project description, including assumptions and possible exclusions. This documentation should be continuously used during project implementation, as well as during risk assessment, especially if external experts are involved in the evaluation process.

The stage of risk measurement and reserve formation is considered the most complex. Under the traditional approach, a factor-based assessment of uncertainty in the construction process is conducted. As a rule, this approach is based on expert opinions and existing experience. At the same time, reserves may weaken the project's position. In contrast to the traditional approach, risk measurement in this case strengthens the project's position, since it focuses not on individual risks but on the overall degree of uncertainty.

The data required for assessment are collected from both internal and external environments. The so-called communication approach to information gathering determines how information should be transmitted, who should send and receive it, as well as how and when it should be delivered [13].

The total construction period of the facility (T;) follows a normal distribution law as the sum of normally distributed durations of individual project stages.

The probability density function has the following form:

$$f(T) = \frac{1}{\sigma\sqrt{2\pi}} e^{-\frac{(T-M)^2}{2\sigma^2}} \quad (3)$$

where:

T - construction period of the facility;

σ - standard deviation;

M - mathematical expectation.

Given the specific nature of investment projects, construction duration can be considered one of the significant sources of uncertainty affecting project implementation. Applying a probabilistic approach to estimating construction duration makes it possible to account for potential deviations from the project schedule and use the resulting information in project risk assessment.

The analysis confirms that sensitivity analysis, scenario analysis, expert assessment, and fuzzy-set approaches can be used as complementary tools for evaluating investment projects under uncertainty. Their combined application makes it possible to identify the key factors affecting project performance and to support more informed decisions concerning project implementation and risk management.

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