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MASTER'S THESIS
APPLICATION OF THE METHOD OF REAL OPTIONS TO ASSESS THE EFFECTIVENESS OF IT-PROJECTS

on the basis of the educational programme for preparing master's students
38.04.02 - Management
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INDIVIDUAL ASSIGNMENT

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purpose of the study: is to test the ROA method for assessing the effectiveness of IT projects under conditions of uncertainty

research objectives:

1) to consider the essence, peculiarity and classification of IT - projects;

2) investigate the factors of uncertainty and risks in the implementation of IT-projects;

3) conduct a comparative analysis of the basic methods for evaluating the effectiveness of IT-projects;

4) to evaluate the effectiveness of implementation of IT-project "UMKA" with financial, qualitative and probabilistic assessment methods;

5) to develop an algorithm for evaluating the effectiveness of IT-project, taking into account the metamodel of risk in the concept of "Lean Startup" and ROA;

6) provide recommendations for adjusting the IT-project "UMKA" taking into account the results of performance assessment based on the presented algorithm.

object of study: is the IT project "UMKA".

subject of study: the application of methods for assessing the effectiveness of IT projects: financial, qualitative and probabilistic.

№	**Content of the assignment** *(list of sections and expected results)*	**Time of performance**
1.	Principles and methods for assessing the economic efficiency of IT projects under conditions of uncertainty.	25.03.2021
2.	Factors of uncertainty and risks in implementation of IT-projects.	05.04.2021
3.	Basic methods and approaches to assessing the economic efficiency of IT projects.	19.04.2021
4.	The method of real options and evaluation of the effectiveness of an investment project.	4.05.2021
5.	Develop and test a methodology for evaluating the effectiveness of IT projects under conditions of uncertainty and risk.	17.05.2021
6.	Comprehensive evaluation of the «UMCA» IT project	02.06.2021

Date of issuance of the individual assignment: «25» 03 2021 г

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Scientific advisor __________ *(signed):* __________ *(NAME, SURNAME, position)*

Abstract

The issues of assessing the effectiveness of projects in the IT sphere are becoming increasingly relevant in the light of the transition to a digital economy. A distinctive feature of an IT project is that it contains information technology that is not tangible and has no intrinsic value. A high degree of uncertainty and risk factors, a variety of business solutions, the need for managerial flexibility in the design and implementation of an IT project create a problem in assessing the effectiveness of investment in the project. Therefore, the development of progressive methods of investment evaluation of IT project remains relevant.

The aim of the study is to test the ROV method to assess the effectiveness of IT-project implementation under conditions of uncertainty.

The study developed and tested the method of performance evaluation on the example of IT ecosystem "UMKA" based on the risk metamodel business model "Lean Canvas", binomial method of real options and matrix "Uncertainties - Risks - Real Options".

The results of testing the ROV method in the evaluation of IT-project showed that this method does not reject the ideas of traditional evaluation methods, it allows to quantitatively assess the opportunities available in the project and thus include them in the calculation of the cost of the investment project.

The proposed method of assessing the effectiveness of IT project in the context of uncertainty, helps you choose the most appropriate assessment tools, whether ROV or DCF, in each case, depending on the parameters of a particular IT project.

This study is the basis for further study of the ROV method not only as a model for assessing the effectiveness of IT projects, but also as a tool for strategic analysis.

Keywords: real options, IT project, Lean Canvas model, performance evaluation, risks.

Аннотация

Вопросы оценки эффективности проектов в IT-сфере приобретают все большую актуальность в свете перехода к цифровой экономике. Отличительной особенностью IT-проекта является то, что он содержит информационные технологии, которые не материальны и не имеют свойственной стоимости. Высокая степень факторов неопределенности и рисков, множество вариантов бизнес-решений, необходимость управленческой гибкости при разработке и реализации IT-проекта создают проблему при оценке эффективности инвестиционных вложений в проект. Поэтому разработка прогрессивных методов инвестиционной оценки IT-проекта сохраняет свою актуальность.

Цель проведенного исследования – апробация метода ROV для оценки эффективности реализации IT-проекта в условии неопределенности.

В исследовании разработана и апробирована методика оценки эффективности на примере IT-экосистемы "UMKA" на основе метамодели рисков бизнес-модели "Lean Canvas", биномиального метода реальных опционов и матрицы "Неопределенности - Риски - Реальные опционы".

Результаты апробации метода ROV при оценке IT -проекта показали, что данный метод не отвергает идеи традиционных методов оценки, он позволяет количественно оценить имеющиеся в проекте возможности и тем самым включить их в расчет стоимости инвестиционного проекта.

Предложенная методика оценки эффективности IT-проекта в условиях неопределённости, помогает выбрать наиболее подходящий инструментарий оценки, будь то метод ROV или DCF, в каждом отдельном случае в зависимости от параметров конкретного IT-проекта.

Данное исследование является базой для дальнейшего изучения метода ROV не только как модели оценки эффективности IT- проектов, но и как инструмента стратегического анализа.

Ключевые слова: реальные опционы, ИТ-проект, модель Lean Canvas, оценка эффективности, риски, факторы неопределенности.

CONTENTS

Introduction

Topicality of the research. The issues of development and implementation of innovative projects in the IT-sphere are becoming increasingly relevant in the light of the transition to the digital economy. Under the conditions of rapidly developing information technologies, the growing number of high-budget IT projects, the problems of assessing the effectiveness of their implementation are of particular importance. Currently, traditional methods of assessing the economic efficiency of IT projects based on the concept of discounted cash flows are widely used in practice. Economic efficiency, calculated by these methods, cannot take into account such aspects as future growth opportunities, positive risk effects, the possibility of changing the decision based on new information, i.e. the inherent characteristics of any IT project.

One of the promising methods for evaluating IT projects is the real options analysis (ROA) method, which has been widely used in various high-tech areas to evaluate innovative projects characterized by a high degree of risk and uncertainty.

The theoretical foundations of methods of valuation of real options are considered in the works of S. Myers, F. Black, R. Brailey, M. Brennan, A. Damodaran, A. Dixit, J. Cox, R. Merton, R. Lindike, S. Ross, E.K. Clemons, B. Weber, M. Scholes and several other foreign researchers.

The development of the theory of application and valuation of real options is presented in the works of such authors as L. Archambeault, M. Brennan, J. Peppard, J. Kiesinger, P. E. Cloeden, D. Lautier, F. A. Longstaff, J. Paddock, R. S. Pindyke, D. Siegel, D. Sutivong.

Among domestic authors engaged in research in this area, it is worth noting the works of A.V. Bukhvalov, V.O. Klyuchnikov, A. Mertens, E.Y. Pesotskaya, etc. The issues of adapting the method of real options to assess the effectiveness of IT projects are presented in the works of V. Davidovsky, Y.V. Lukasheva, Y. Tsygalov, etc.

Researchers have noted the problems of classical methods of evaluation of IT projects and the need to develop ROA methodology.

The purpose of the work – is to test the ROA method for assessing the effectiveness of IT projects under conditions of uncertainty.

The object of the study – is the IT project "UMKA".

Subject of the study – the application of methods for assessing the effectiveness of IT projects: financial, qualitative and probabilistic.

To achieve the goal, the following tasks were solved:

– to consider the essence, peculiarity and classification of IT - projects;

– investigate the factors of uncertainty and risks in the implementation of IT-projects;

– conduct a comparative analysis of the basic methods for evaluating the effectiveness of IT-projects;

– to evaluate the effectiveness of implementation of IT-project "UMKA" with financial, qualitative and probabilistic assessment methods;

– to develop an algorithm for evaluating the effectiveness of IT-project, taking into account the metamodel of risk in the concept of "Lean Startup" and ROA;

– provide recommendations for adjusting the IT-project "UMKA" taking into account the results of performance assessment based on the presented algorithm.

The structure includes the introduction, 3 paragraphs, conclusion, list of references, appendices. In the first chapter the features of development and implementation of IT-projects, basic methods of assessment of economic efficiency of their realization are considered. The second chapter considers the theoretical foundations of the method of real options to assess the effectiveness of IT-projects. The third chapter analyzes the object of the study and provides recommendations.

1. Principles and methods for assessing the economic efficiency of IT projects under conditions of uncertainty

1.1. IT-projects: peculiarities of development and implementation

Project management in the modern management concept is considered as an area of activity aimed at achieving the goal, taking into account the balance of such parameters as the amount of work, resources, time, quality and risks (standard ANSI PMBoK). The distinctive features of project management from the traditional production activities are manifested in the orientation on the creation of an innovative product; focus on achieving the goal; the presence of limitations on time, resources and finances; the interconnectedness of a large number of processes at different levels. The project from the production system is distinguished by a one-time, non-cyclical activity and is considered as a whole. There are different types of investment projects, distinguished by the presence of different stages of the life cycle and a set of related activities (Figure 1.1).

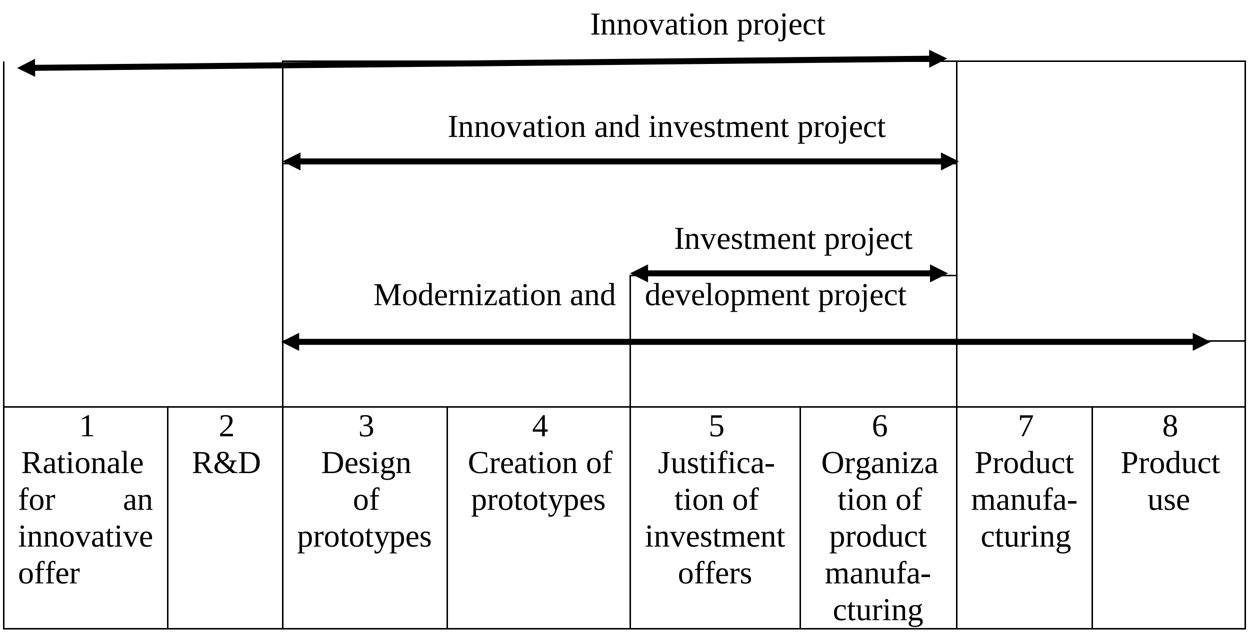

Figure 1.1 - Types and stages of project life cycle [39]

Investment project contains two stages of the life cycle: the stage of justification of investment proposal and the stage of production of the product, which allows it to be considered as a justification of economic feasibility, the amount and timing of capital investments (design and estimate documentation), as well as a description of practical actions to implement investments (business plan).

The life cycle of an innovative project includes six stages: from the stage of justification of an innovative proposal to the stage of production of the product. The presence of the R&D stage in the life cycle of an innovation project is due to the presence of factors of great uncertainty of the innovation project, both in terms of timing and the results of economic efficiency of the project. Conducting R&D can be considered as a scientific preparation of production, the main part of the design and technological preparation of production. Uncertainty of the innovation project cannot be reduced only to one stage of R&D, as high uncertainty is also present at the stages of implementation (the primary stage of idea development, project selection, project implementation) and commercialization of the product, as a completely new product enters the market. In addition, the variety of goals and objectives of innovative development defines many varieties of projects.

The peculiarities of an innovation project allow considering it as a system of interrelated goals and programs to achieve them, representing a set of research, development, production, organizational, financial, commercial and other activities, linked by resources, timing, performers (availability of project documentation), providing an effective solution to a specific problem and leading to innovation.

With the development of the digital economy, the issues of development and implementation of innovative projects in the IT-sphere are becoming increasingly relevant. The peculiarity of IT-projects manifests itself in the fact that they are used as tools to support the functioning of the innovation process in companies in other industries. Despite the fact that IT-innovations have become a distinctive feature and condition of development of modern economy, the conceptual apparatus of this phenomenon is still underdeveloped and causes a number of discussions. Since IT innovations take the form of information systems, software products, IT services and information technology, the question of dividing IT innovations into product innovations and process innovations, as is common in other industries, is debatable. Thus, V.Y. Shvakin, L.L. Kulikova note: "... that software products and information technology do not exist separately from each other. ... new information technologies .... are embodied through a specially designed software product or automated system. New IT services are also always accompanied by software products". By IT innovations the authors propose to understand the final result of innovation activity, embodied in the form of a fundamentally new or improved IT product (information system, software product, IT service, information technology), which is promoted in the form of goods on the market or is implemented at the enterprise by own efforts [35].

As part of our study, an IT project is considered as a project containing information technology aimed at the creation, development and support of information systems. Information technologies are a set of methods, production processes and software and hardware, combined into a technological chain, providing collection, storage, processing, output and distribution of information to reduce the labor intensity of the processes of using information resources, increasing their reliability and efficiency.

IT-projects are classified according to different grounds and criteria. Depending on the motivation for their development there are problem-oriented and innovation-oriented investment IT-projects. So, the first are aimed at identifying and developing the most cost-effective combination of information technology and business changes that contribute to improving business processes and solving specific problems. The latter, introduce a combination of technological, organizational and business innovations to create a fundamentally new solution/product. The peculiarity of their development is the use of an iterative approach, as it is difficult to assess the benefits of their implementation, as well as the company's capabilities and readiness for the necessary changes. Large IT projects tend to be mixed in nature, simultaneously solving problems and introducing innovative technologies.

The main criteria for classifying IT projects are such characteristics as size and complexity, and duration of project implementation. Depending on the composition and structure, projects are divided into monoprojects, multiprojects, and megaprojects. Depending on the scope of project implementation, technical, organizational, economic, social and mixed projects are distinguished. According to the nature of the subject area, there are: investment, research, educational and mixed projects. By the criterion of time of implementation projects are divided into: short-term, medium-term and long-term. Depending on the functionality: software, computer programs (relevant documentation relating to the functioning of the information system); IT-products, focused on online use; various applications, usually a commercial orientation. In addition to the classification attributes there are special characteristics: the scale of the IT-project, the territorial spread of the project, the level of influence of the interface development process on the project as a whole. The presented classification system allows to determine the type of the developed IT-project, methods of planning and implementation of projects.

Features of the innovation process as applied to IT innovations, despite the fact that the general scheme of the process coincides with the generally accepted: the preparatory stage; implementation of IT innovation; innovation management, is manifested in the content of each of these stages (Table 1.1)

Table 1.1 - Key stages of IT project development and implementation [34]

1. Initiation	2. IT project development	3. Entering the market	4. Evaluation
Idea generation; Marketing research; Feasibility study; Investor search; Investment planning.	Project organization; Requirements formulation; Designing; Implementation.	Implementation; Promotion; Business development; User training.	Evaluation of results; Development of further strategy; Entering a new market; Modification; Completion of the work.

At the stage of initiation of an IT project: the idea must be substantiated by the results of market research, feasibility study of development, search for investors, investment planning.

The development stage involves a set of measures for the design and implementation of the IT project. Subsequent stages of innovative IT-project contain a set of activities related to innovation management processes: analysis of market entry results, assessment of the actual effectiveness obtained and the decision on further actions. Thus, the main conditions for launching an innovative IT-project are: assessment of economic efficiency of the IT-project; availability of investors.

The main problem of IT-projects implementation is that the assessment of economic efficiency of investment in this sector does not correspond to the standard assessment considered within the framework of enterprise economics, because they have a high uncertainty factor for a number of key parameters. The main reason is that information technology is not tangible and has no intrinsic value. Ownership of information technology itself does not create any benefits or value (unlike, for example, real estate). Benefits and value are created as a result of their effective organizational use. The effect of implementing an IT system is difficult to quantify (monetary). Therefore, strategic IT investments often lend themselves only to qualitative evaluation [29].

The uncertainty of the impact of an investment IT project on the performance of the company is due to the lack of clear cause-and-effect relationships between the use of the IT system and its impact on production processes and the performance of the company as a whole. For successful implementation of an IT project, it is necessary to coordinate the objectives of project and strategic management, as the impact of the IT project extends not only to the physical infrastructure (the technology itself), but also human capital, and the structure of the company as a whole. The high degree of uncertainty of IT projects is due, on the one hand, to the fact that the project implementation process is significantly influenced by different organizational elements of the company, and on the other hand, there are different options for implementing IT projects (operational model, sequential prototyping, waterfall method, outsourcing), which differ in the number of stages and the amount of costs. The choice of one of these alternatives largely determines the evolution of the project in the future.

Along with the factor of high uncertainty of implementation, IT projects are characterized by managerial flexibility - a project characteristic that ensures a high degree of]. First, we should note the flexibility of information systems themselves, because unlike such tangible assets (equipment, buildings, land), which have a limited range of applications, IT products can be used in a huge number of business solutions in different areas. For example, "standard packages" of IT solutions come in a variety of configurations and with a large number of optional applications, because they have a relatively low cost of replication and upgrades. Secondly, the degree of flexibility of IT projects can not be predetermined, as the company is able to increase it by providing additional versatility and scalability. The same IT project flexibility is due to different ways of delivering IT solutions, as well as the way the solution is created: from buying a "ready-made" package with its subsequent modification to self-development; from developing a solution jointly with consultants and system integrator companies to outsourcing.

The dual nature: uncertainty and the corresponding managerial flexibility inherent in IT projects allows us to talk about high risks of their implementation, which is one of the most problematic characteristics of IT investment projects. In a broader sense, IT risk can be formulated as the probability of an unsatisfactory result of the project as a whole or some of its components/processes. It can be defined in several dimensions, and primarily through the change in income from the use of the IT asset and the degree of uncertainty in the value of future opportunities [10].

The creation of a quality IT-product is primarily the creation of complex systems of interaction between the elements of the product at all stages of the project life cycle. The task of the project approach in this case is to ensure such interaction at a qualitatively high level with maximum effect. The main features of software IT project management are manifested in that:

- the IT product is not material, it cannot be seen in the development process and promptly affect its implementation;
- the IT product lifecycle in the existing standards is described in general terms, it is necessary to adapt them to the type and type of project;
- non-standard life cycle, which may include test, warranty and post-warranty development stages;
- the need to make quick changes at the testing stage, which creates difficulties and delays the scheduled completion dates of the project (70% of IT-projects do not meet the deadlines, which leads to exceeding the project budget);
- an IT-product as a result of creative work does not lend itself to precise evaluation in terms of time and budget parameters;
- cost-effectiveness is predictable due to the volatile and iterative process of working on an IT-product.

A successful IT project is a product of huge efforts of the whole project team and requires sufficient competence and exceptional professional skills, including the ability to plan and evaluate IT projects under conditions of high uncertainty and risk. The next paragraph of the Master's thesis is devoted to the consideration of these issues.

1.2. Uncertainty factors and risks in the implementation of IT projects

The peculiarities of the implementation of IT projects are a high degree of uncertainty and risks in decision-making, a variety of possible scenarios, a large number of input data and information that is poorly formalized.

The concept of "uncertainty" is associated with the certainty of information. In C. Shannon's statistical (probabilistic) method of measuring information, the quantity of information is regarded as a measure of uncertainty in the state of the system, removed as a result of receiving information. Obtaining information (increasing it) simultaneously means reducing ignorance or information uncertainty (entropy). F. Knight, distinguishing between measurable and unmeasurable uncertainty, believes that measurable means "some quantity available for measurement. Measurable uncertainty, or "risk" proper, is so different from unmeasurable uncertainty that it is essentially no uncertainty at all.

According to the criterion of certainty of information regarding the implementation of projects, there is a distinction between decisions made under conditions of certainty and uncertainty-risk. Conditions of project implementation, in which there is complete and accurate information, are called deterministic, such situations are rare.

Uncertainty manifests itself in the parameters of information at all stages of its processing in the development of management decisions, and the risk is associated with their implementation, i.e. the result. The risk is due to uncertainty, since incomplete or inaccurate information about the values of various parameters on the conditions of the project leads to negative consequences of its implementation.

In connection with the relevance of the issue of assessing the phenomenon of uncertainty, the consultants of McKinsey & Company proposed the concept of "four levels of uncertainty" [8].

According to this concept, competition is considered in the future, as at present it is already won or already lost. Regarding the future state of the phenomenon, the authors distinguish two components: the unknown and the unknowable, and introduce the concept of residual uncertainty, which remains of the initial uncertainty after all the analytical tools have been applied to it.

The key factors of residual uncertainty are the factors of competitive dynamics - the dynamics of demand and consumer preferences, technological (in the broad sense) innovation, changes in the forms and methods of government regulation and the actions of competitors and other actors whose behavior affects the state of competition, as well as macro factors. The residual uncertainty has four levels of uncertainty (Figure 1.2).

1. The first level of (residual) uncertainty is clear enough future. Influence of factors of external environment can be with more or less accuracy predicted. The "traditional" set of analytical tools for strategy development is used.

2. The second level of uncertainty – alternate futures. The situation can develop in one of several possible directions. The directions themselves are clear, but the variant of development of the situation remains unclear. Analytical tools used at working out of strategy – the analysis of decisions, models of an estimation of variants, the game theory.

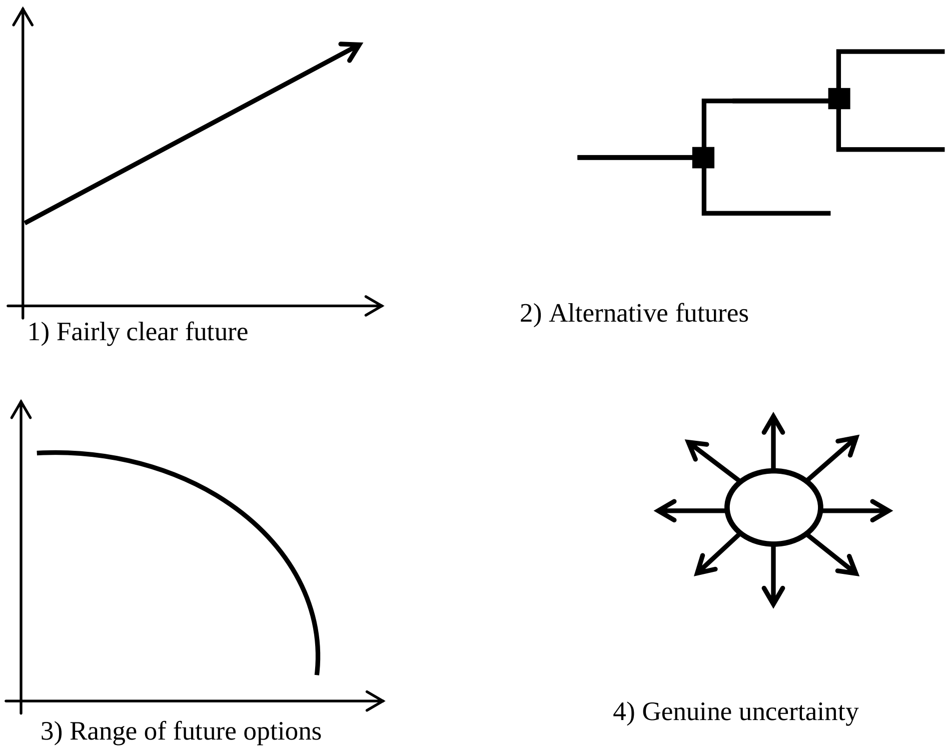

Figure 1.2 - The concept of "four levels of uncertainty" [37]

3. The third level of uncertainty is a range of futures. The actual aspect of this or that business will be in this or that "corridor". The number of variants can be infinite, but all of them will be in a known limited range (the level of the price of oil in the range). Analytical tools used at strategy development - research of latent demand, forecasting of technologies development, scenario planning.

4. The fourth level of uncertainty – true ambiguity. We cannot specify the range within which this or that actual circumstance related to a particular business will be. We cannot say anything about the future. We use analogy and pattern recognition methods, non-linear dynamic models. Such a state of uncertainty does

not last long and evolves to the second or third level of uncertainty. The situation in the second and/or third level of uncertainty is most probable.

It should be noted that uncertainty cannot be interpreted as a lack of any information about the conditions of project implementation, we are talking only about the incompleteness and inaccuracy of available information. Uncertainty can refer not only to information about the future conditions of project implementation, but also to actual information: in the preparation of background information for project development; evaluation of the results of project implementation; in adjusting the course of project implementation on the basis of incoming new information;

Uncertainty can manifest itself:

- in the form of probability distributions (the distribution of a random quantity is known precisely, but it is unknown what specific value the random quantity will take);
- in the form of subjective probabilities (distribution of a random value is unknown, but the probabilities of particular events that are determined by expert judgment are known);
- in the form of interval uncertainty (distribution of a random variable is unknown, but it is known that it may take any value within a certain interval).

The main difference between projects developed and evaluated with risk and uncertainty factors in mind, and projects developed and evaluated in relation to a certain situation, is that the conditions of the project and the costs and results corresponding to them are unknown and the entire range of their possible values must be taken into account.

The fundamental difference between a situation of uncertainty and a situation of certainty is the need to use new criteria and evaluation indicators. The main questions in the evaluation of projects: How to take into account the uncertainty in the calculation of the effectiveness, if the costs and revenues in different cases may be different? What indicators should be used to evaluate the effectiveness of a project?

Under conditions of high level of uncertainty, the main parameters of a project are exactly uncertain and it is necessary to take into account the whole range of their possible values. The fundamental difference in the situation of uncertainty is the need to use new indicators to assess the effectiveness of the project - the indicators of expected effectiveness, reflecting all possible options for revenue and costs of the project. In a situation of uncertainty, an integral part of the calculations of effectiveness becomes an assessment of the sustainability of the project and the development of measures to ensure its sustainability [16]:

- a project is considered absolutely sustainable if it is effective under all scenarios, and possible adverse effects are eliminated by the measures provided by the organizational and economic mechanism of the project;
- a project is considered sufficiently sustainable if it proves ineffective only under those possible scenarios that have a sufficiently small "probability of realization".

Any new technologies are implemented under conditions of great uncertainty, especially it is relevant for IT projects to which it is difficult to apply standard management methods. The uniqueness of IT project goals generates uncertainty regarding the choice of new technologies, the definition of methods and means of achieving the goal, and the adoption of a particular methodology.

The task of IT-project risk management is the timely identification of factors that can adversely affect the implementation of the project. The choice of risk classification depends on the specifics of the IT project, including its functional orientation. Thus, the risk groups differ in content for different activities and different types of IT-projects, for example, the implementation of information technology in the activities of the company and the implementation of IT-projects focused on online use and IT applications.

IT project risk management in the implementation of information technology in the activities of the company, firstly, is always tied to the strategic (innovation) objectives of the company, and secondly it is coordinated with the overall risk management system of the company. For this purpose, the size and goals of the business are determined, and all types of business processes related to decision-making are covered by all available consequences.

Two theoretical approaches to the study of IT project risks should be noted. The first approach considers the risks of the socio-technological model of organizational change and the risks associated with the control of project costs [23]. The organization is viewed as a multi-parameter system consisting of four interacting elements - tasks, structure, actors and technology. The focus is on internal risk factors and its scope is limited to the design and development phases of the project.

The second approach examines risks that exist outside the product development phase [7]. The organization is considered as an open system, interacting with the external environment, as well as risk factors associated with the competitive environment and market conditions. In terms of the life cycle of IT projects, risks arising during the creation of the "right" product - product risks, as well as during operation, after successfully completed development are considered.

Thus, the following groups of risks internal, competitive and market risks at all stages of the life cycle of IT projects are distinguished for IT projects for the implementation of information technology in the activities of the company.

1. Internal risks are caused by the uncertainty of endogenous factors (specific to an individual company) and determine the company's ability to successfully implement the investment project. This group includes monetary, structural, functional and organizational risks that arise from uncertainty about the availability of timely financing of long-term and capital-intensive projects; the necessary skills of the company's employees; the appropriate organizational structure of the company, etc.

2. Competitive risks associated with the activity of competitor companies and reflect the likelihood of losing the feasibility of the project. These factors correspond to the uncertainty about the behavior of competitors, their ability to create an advantage faster by implementing innovative solutions or simply by copying and improving developed technologies.

3. Market risks, caused by the uncertainty of exogenous factors (the same for companies in the same market segment) and determine the company's ability to obtain in full the originally planned benefits. This group includes environmental, system and technological risks that arise from the uncertainty of future demand (capacity, market saturation, activity of products of substitutes), business profitability, as well as the lack of maturity of technologies used in the implementation of the project.

During the implementation of IT projects focused on online use and for IT applications risk assessment in the analysis of the business model of the project is carried out using an iterative metamodel in which the risks are distributed across the elements of Lean Canvas model and divided into 3 categories: product, customer and market (Figure 1.3).

<table>
<tr><td rowspan="2">Problem
P
Alternatives</td><td>Solution
P</td><td rowspan="2">Unique offer
P</td><td>Hidden advantage
M</td><td rowspan="2">User segments
C</td></tr>
<tr><td>Metrics
P</td><td>Channels
C</td></tr>
<tr><td colspan="3">Expenses
M</td><td colspan="2">Revenue
M</td></tr>
</table>

Figure 1.3 - IT project risk assessment model [24]

Product risks (creating the "right" product) are presented in the sections: problem; unique proposal; solution; metrics. To eliminate them, it is necessary to accurately identify the problem, form the smallest possible solution - IAP, test it on a small scale, and move on to scaling the project.

Customer risks (channel of communication with users) are presented in sections: user segments; channels; early adopters. You need to clearly define the channels to reach customers and the number of early adopters who need a solution to their problem right now.

Market risks (building a viable business) are presented under: latent advantage; existing alternatives; costs and revenues. It is necessary to analyze the competitive environment for existing alternatives, to determine the market price, to optimize the cost structure of the project.

Structured interview with AIDA[1] method is used to estimate IT project risks as the main channel of customers attraction is personal meetings, information from which is used to develop and adjust minimal actual product, marketing strategy formation, calculation of financial models (conversion, customer lifetime value, etc.) and project effectiveness determination.

The analysis showed that the risks in the design and implementation of IT projects in conditions of high uncertainty can be quite different - it all depends on the focus of the proposed project, options for its solutions, implementation of individual areas of each project, etc.

Development and implementation of innovative IT-projects, as well as the process of investing in the IT-sphere are carried out in an environment of high uncertainty and risks. Their effectiveness is expressed ambiguously and often difficult to measure values, which actualizes the need for further study and development of progressive methods of investment evaluation of IT projects.

1.3. Basic methods and approaches to assessing the economic efficiency of IT projects

Assessment of IT projects efficiency is carried out using qualitative, financial, probabilistic and comprehensive assessment methods. Each of the methods has its own advantages and limitations, but given the complexities of assessing the economic efficiency of IT projects, their use allows more fully take into account the specifics of their development and implementation.

1. Financial methods for assessing the effectiveness of IT-projects. These methods of assessment are based on the classical theory of evaluation of the

[1] AIDA method sequentially describing the stages of consumer interaction: Attention, Interest, Desire, Action.

economic efficiency of investment projects. A feature of this method is the use of common financial evaluation criteria, which require accuracy.

1.1 The concept of discounted cash flows.

Dynamic methods for evaluating the effectiveness of IT projects are based on the discounted cash flows (DCF) model. Discounting involves bringing the value of the cash flow (CF) of a project at different times for a specific period of time, using a discount rate (RD), which depends on the risk associated with the future cash flow. The meaning of DCF is that money loses its purchasing power, i.e. money in the future period is cheaper than in the present period. Discounted valuation methods take into account inflation, changes in interest rates, rates of return, etc. These indicators include methods of profitability index (ROI), net present value (NPV), internal rate of return (IRR), payback period (PP).

1.1.1. Net present income (NPV).

$$NPV = \sum_{1}^{n} \frac{P_t}{(1+d)^t} - I_0, \qquad (1)$$

where *Pt* – the amount of cash in period t, generated by the project;

d – discount rate;

n – duration of the period of the IT project in years;

I_0 – initial investments in IT.

The indicator reflects the change in investor's assets during project implementation, but has a dependence on the subjectively chosen value of the discount rate and does not take into account the risks of the project.

1.1.2. Return on investment index (ROI).

$$ROI = \frac{PV}{I_0} = \frac{1}{I_0} \sum_{k} \frac{p_k}{(1+r)^k} \qquad (2)$$

ROI index allows a comparative assessment of alternative investment projects, which differ in cost and income, but does not take into account the risks of the investment project.

1.1.3. Internal Rate of Return (IRR).

$$NPV = -IC + \sum_{t=1}^{N} \frac{CF_t}{(1+IRR)^t} = 0 \tag{3}$$

IRR is the value of *d* - discount rate.

This method allows you to determine the boundary between profitability and unprofitability of the project and choose the discount rate for alternative areas of investment. Does not take into account the cost of capital, great dependence on the accuracy of planning of future cash flows.

1.1.4. Payback period (*PP*).

$$PP = \frac{I_0}{P} \tag{4}$$

where *RR* – payback period of the project;

I_0 – initial investments in IT.

P – net cash flow for the year from the implementation of the investment IT project.

The payback period of an investment begins when the investment project generates such cash income that NPV> 0.

ROI, NPV and *IRR* are different versions of the concept of discounting and are interrelated (correlated) with each other:

1) if NPV> 0, then ROI> 1 and IRR> r;

2) if NPV <0, then ROI <1 and IRR <r;

3) if NPV = 0, then ROI = 1 and IRR = r.

Necessary and sufficient condition of profitability of the investment project is also expressed through each of these indicators: NPV> = 0; ROI> = 1; IRR> = r (if IRR is the only positive root of the equation NPV = 0).

1.1.5. Total Cost Ownership (TCO), developed by Gartner.

$$TCO = ПР + Кр^1 + Кр^2 \tag{5}$$

where *PR* – direct costs (capital and maintenance costs for IT hardware and software);

Kr^1 – group 1 indirect costs (operating costs for acquisition of office equipment, maintenance, training);

Kr^2 – 2nd group indirect costs (operating costs: administrative expenses, energy costs, etc.).

The method of TCO allows to analyze the structure of direct and indirect expenses on information technologies and to define their total cost. Direct costs for IT includes 10 groups of costs and each of them has its own specific types of calculations (capital costs, costs for IT management, technical support, development of application software, outsourcing, communication services, etc.). The most time-consuming group is the calculation of management costs (design, network administration, special project management, system configuration). Indirect costs are not included in the IT budget, but they play an important role and are the second most important criteria for evaluating the effectiveness of IT solutions.

1.1.6. Economic Value Added (EVA), developed by Stern Stewart & Co.

$$EVA = (P - T) - IC*WACC = NP - IC*WACC = (NP/IC - WACC) * IC \qquad (6)$$

where P – profit from the main activity of the company;

T – mandatory payments, including taxes;

IC – investment capital;

$WACC$ – weighted average cost of capital;

NP – net profit.

The EVA method allows us to determine the difference between net operating profit and all costs incurred by the company for IT infrastructure.

1.2. Cash flow multiplier models for the Internet economy (unit economy). This method is widely used in practice for the calculation used in the implementation of IT projects focused on online use and IT applications.

Unit economics is a method of economic modeling which allows to estimate profitability of business through calculation of business unit profitability (a unit of goods or one customer). Financial model is based on metrics (indicators) of Internet analytics and principles of management accounting and microeconomics.

The multiple of cash flow growth model allows you to assess the feasibility of scaling the business through paid user engagement, i.e. active use of advertising. The key question is: What do we scale - profit or loss - when we invest in advertising? The first equation of the cash flow multiple growth model of the unit economy:

$$CPA < (ARPPU - COGS) \quad (7)$$

where *CPA* – the cost of one attracted user to the landing page.

ARPPU – revenue per paying user minus costs.

COGS – the cost per sale.

Estimation of net profit flow from IT project implementation:

$$(ARPPU - COGS) - CPA = Profit \quad (8)$$

where *CPA* – the cost per user attracted.

ARPPU – revenue per paying user minus costs.

COGS – the cost per sale.

Profit – net streaming profit.

The use of models and calculations of unit economy provides flexibility in developing IT projects and is a tool for making managerial decisions. The methodology allows you to predict the profitability and assess the prospects of the IT project at the idea stage, evaluate the effectiveness of sales channels, find the breakeven point, determine the return on investment, the number of clients and the cost of attracting them.

2. Qualitative methods for assessing the effectiveness of IT projects.

A common feature of qualitative methods for assessing investments in IT projects is a basic system of goals, priorities and indicators for them. Qualitative methods allow you to analyze all the possible factors of a project efficiency, taking into account the strategic priorities of the company. The disadvantage is subjectivity in the development of a system of goals and indicators, which imposes high requirements for the level of knowledge of specialists in the field of innovation management and the IT-sphere.

2.1. The method of information economics involves the formation of a system of strategic priorities for company development and project criteria. Each IT project is evaluated for compliance with these criteria, including its importance, potential benefits and risks for the main business processes of the company. As a result, it is possible to compare the expected effect of the IT project with the achievement of the target values of the strategic priorities for the development of the company. To reduce the level of subjectivity, this method is combined with the method of IT-project portfolio management, which allows to apply project criteria to the entire portfolio of IT-projects as a whole.

2.2. Project portfolio method for IT-projects is used in the development of large projects for the development of IT-strategies. Implementation of this method involves the development (optimization) of IT-projects plan for 1-3 years (in accordance with business requirements for IT), IT budget, optimization of project parameters (benefits, costs, risks), as well as setting up a portfolio management of IT-projects.

The main stages of IT project portfolio formation include measures to assess projects according to the selected criteria; comparison of IT projects among themselves and their distribution into groups based on their efficiency and importance; implementation of IT projects according to their priority in the project portfolio; control and correction of the project portfolio. This method allows you to increase business benefits from the use of IT projects, optimize costs and improve IT project management. The method is universal and applicable to companies in all sectors of the economy and, above all, to manufacturing and service companies.

2.3. The IT scorecard method (BITS) was developed by Harvard economics professors D. Norton and R. Kaplan.

The application of this method involves a step-by-step implementation:

1. The choice of balanced projections (perspective) within which to assess the impact of IT projects on the company's business processes. For example, the

classic methodology uses the following balanced projections: business value; customer service; internal IT-processes; learning and growth.

2. You define goals and targets for each balanced projection, which allows you to evaluate the value and impact of the IT-project on the business processes of the company.

3. A causal strategic map is developed.

4. The strategic map defines key performance measures (KPI) and sets their target values (targets).

5. Smart tasks (initiatives), defining a set of measures to achieve the planned KPIs, are formed.

The main task is to provide management with the necessary information, which should be presented in a structured form, in the form of a system of indicators, reflecting the state of the basic balanced projections in the activities of the company.

The condition for defining balanced projections is that they are the most important factors in creating value. The system of BITS indicators uses financial (profit, cash flow, return on equity, etc.) and non-financial indicators (number of customers, average order completion time, staff turnover, the number of rationalization proposals, etc.). In this case, taking into account changes in the external environment, the choice and number of balanced projections and indicators may vary. Using not only financial information, but also information on the market situation, time, cost and quality of company's processes, and information about employees is the realization of the idea of "balance". The authors of the BITS methodology believed that any indicator used should represent a link in the chain of cause-and-effect relations aimed at achieving the strategy (the optimal number of indicators is 25) [2].

The problem of using the methodology is the ability of specialists to adequately reflect the company's strategy in the system of indicators. The basic balanced projections make it possible to achieve a balance between long-term and short-term goals, between results and factors of their achievement. The organizational unit for BITS is a market segment, which is distinguished by certain criteria [9].

The application of this technique makes it possible to assess the company's strategy through a system of interrelated indicators, showing the dynamics of the factors that create competitive advantages of the company.

3. Probabilistic methods for assessing the effectiveness of investments in IT projects.

3.1. The applied information economics (AIE) method was developed by D. Hubbard, head of Hubbard Ross.

The idea of the method is to evaluate a portfolio of projects by factors and criteria of strategic value. For evaluation, a rating system is developed to assess the level of significance (qualitative effects) and risk of changes from the implementation of the IT project. Based on the results of the rating, priority areas for investment are determined. The AIE method has different modifications, one of which assumes that for each of the IT-project objectives the probability of its achievement is determined. For this purpose, the most important characteristics of the IT-project are determined and significance coefficients are used to establish the correlation between the important characteristics of the IT-project. This approach can be used to evaluate explicit and implicit factors of IT project efficiency, justify the significance of obtained qualitative changes from additional automated functions or tasks, from the implementation of an information system, any of its modules or the development of its functionality [39].

To evaluate IT projects using the rating approach, the method of expert evaluations is used, which consists of experts conducting an intuitive logical analysis of the problem with quantitative evaluation of judgments and formal processing of the results. The most common is the Delphi method, the characteristic feature of which is the decreasing scatter of estimates and the increasing consistency of experts, in subsequent iterations of the estimation. The main disadvantage of the AIE method is the subjectivity of the evaluation, in fact it is a modification of the method of information economy.

3.2 The real options pricing (ROV) method was developed by F. Black and M. Scholes based on the Nobel Prize winning option pricing model (Black-Scholes Option Pricing Model, OPM).

The ROV method looks at the project from the perspective of project risk management. Five project parameters are distinguished: project revenue; project cost; project complexity; project support cost; the life cycle of the IT project being implemented and the extent to which these parameters are affected during the project is assessed. The more flexible the project, the more you can change these parameters (i.e. reduce project costs or complexity) during the project, the lower the project risks and the higher the project score. Obviously, each company has its own criteria and scale for evaluating the degree of influence on project parameters.

The ROV method provides an opportunity to make real investments, as it allows quantifying the company's ability to adapt to changes, which allows reducing losses caused by uncertainty. According to the theory of systems, adaptation is the most important property of open systems, which allows to compensate losses caused by uncertainty. Thus, the presence of sufficient capacity for adaptation can fully compensate for the negative impact of uncertainty – the "plateau effect" (Figure 1.4).

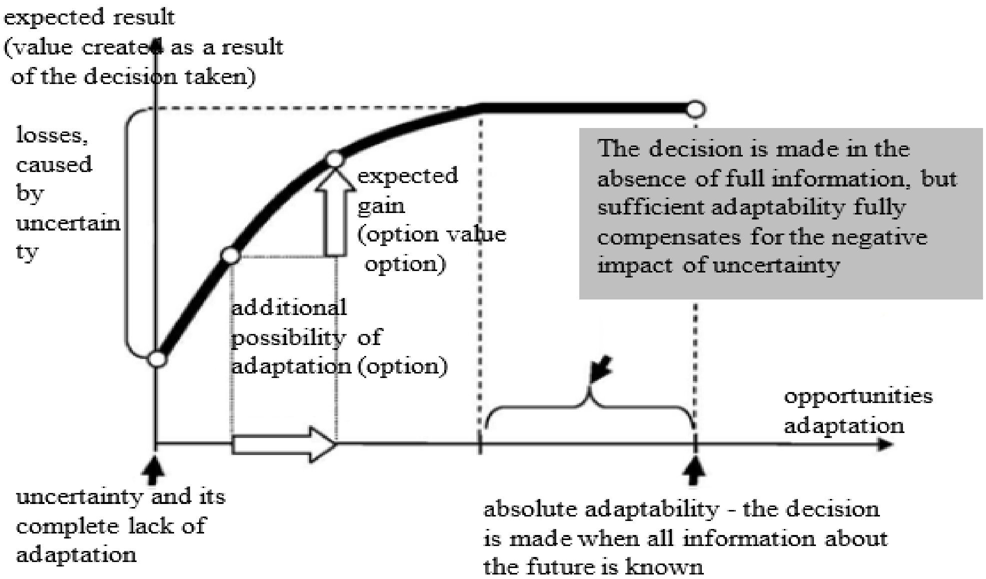

Figure 1.4 - "Plateau effect" [25]

Evaluating a real option[2], we get an answer to the question - what is the price of this or that possibility to adapt the project to unknown future conditions. Real options are considered from two positions: the tools for evaluation and justification of capital investment objects (the application of financial option theory to real assets (traditional approach); objectively existing universal management process (strategy in its dynamics), which need to learn how to manage consciously. Thus, the real option is the ability to make flexible decisions in conditions of uncertainty or the ability to use the flexibility built into the investment project.

An option is the right (opportunity) to buy (or sell) a certain asset, called an underlying asset, at a fixed price in the future. The price at which an asset can be bought (sold) is called the strike price.

A call option is beneficial if the actual price of the underlying asset is greater than the strike price. The option holder's return at the time of exercise (T) can be represented as:

$$max \{ST - X, 0\} \qquad (9)$$

where ST – the actual price (value) of the underlying asset at the time of exercise;

X – exercise price;

if $ST > X$ – the option will be exercised, otherwise it will not.

The market price of an option is not known today, but if there is a positive probability that the actual value will exceed the strike price - it will be profitable to exercise the option.

Four methods for evaluating real options are used in practice: the Black-Scholes model, the binomial method, the Monte Carlo method, and the decision tree method. The Black-Scholes model and the binomial method are mainly used to solve simple structures with a single source of uncertainty. In the framework of our study we will focus on the consideration of these methods.

[2] The price of the option is influenced by a number of factors: current value of the underlying asset; strike price; time to expiration; volatility; (riskless interest rate.

In practice, the Black-Scholes model and the binomial option pricing model (developed by W. Sharpe, J. Cox, S. Ross, and M. Rubinstein) are used to value options. The Black-Scholes model allows us to identify relationships and dependencies of option pricing factors.

The binomial method is based on the construction of a binomial tree, i.e. a diagram showing different variants of the price of the underlying asset during the term of the option. This method is based on the assumption that the price of a stock obeys the laws of random walk. At each time step there is a certain probability that the price of the underlying asset will increase or decrease by some relative value. Since an option gives you the right, not the obligation, to make an investment, the option is only exercised if it is positive and not exercised if it is negative (Figure. 1.5).

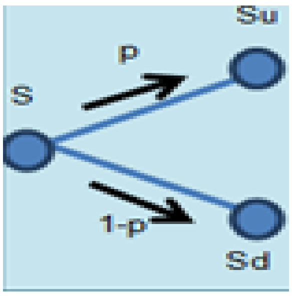

Figure 1.5 - Binomial lattice nodes

The binomial model requires a significant amount of input data.

Monte-Carlo simulation method (Monte-Carlo Simulation) includes methods of sensitivity analysis and scenario analysis based on probability theory. This is a complex technique, has only computer implementation, it requires:

– define the main variables of the investment project;
– define all possible values of the selected main variables;
– determine the probability of occurrence of each value;
– build a model that characterizes the relationship between the main variables of the project, the errors in their estimates and the performance indicator.

The computer randomly selects a value for each of the main variables, based on the theory of probability of their occurrence, and calculates the set of possible values of NPV of the project. After a large number of such iterations (calculation cycles), the most probable NPV value and the distribution of all its possible values with an indication of the probability of their occurrence are determined. This makes it possible to assess the risk posed by the implementation of a given investment project using the statistical apparatus of variation assessment.

Risk analysis of investment projects by the Monte Carlo method involves the study of risk profile graphs showing the probability of each of the possible outcomes:

– if the cumulative risk profiles of two alternative projects do not overlap at the same point, then the project whose risk profile is on the right should be chosen;

– if the cumulative risk profiles of alternative investment projects overlap, then the decision depends on the investor's risk appetite.

The ROV method is quite difficult and time-consuming to analyze, but it allows us to apply quantitative approaches to investment decisions where traditional methods do not work. This means the possibility of a more adequate analysis of strategic decisions.

3. Comprehensive methods for assessing the effectiveness of IT projects, include financial, qualitative and probabilistic methods for assessing the economic efficiency of the IT project.

3.1 Total Economic Impact (TEI), developed by Forrester Research.

The implementation efficiency of IT projects is assessed using four indicators: costs, benefits, flexibility and risk. In assessing the total economic impact, the costs, benefits, and flexibility of a project are analyzed by taking into account the risk for each of the indicators. The cost analysis uses the TCO method as an internal IT assessment, while the benefit analysis assesses the commercial value of the project and its strategic contribution beyond the IT project.

To evaluate flexibility with the TEI method, probabilistic ROV models or the Black-Scholes model are used. The availability and stability of vendors, products, architecture, corporate culture, project size and timing are considered as risks.

3.2. Rapid economic justification (REJ), developed by Microsoft.

The REJ method includes five consecutive steps containing financial and qualitative methods of project evaluation:

1) linking IT project goals and key metrics to the company's business goals (BITS methodology);

2) selecting a solution from a list of "required capabilities" (similar to the TEI methodology indicator analysis stage);

3) profit and cost estimates using the "total cost of ownership" methodology (TCO methodology);

4) assessment of project risks by criteria of correspondence of the selected solution to the initial project, implementation of the selected solution, its operation and financial risk;

5) calculation of financial indicators of the project NPV, IRR, EVA, ROI.

The REJ method requires: developing a roadmap, identifying stakeholders, critical success factors and key performance indicators; working with stakeholders to determine how technology can impact success factors; performing a cost-benefit equation; and identifying potential risks, representing the likelihood and impact of each.

Summarizing the first chapter of the study, it should be noted that the investment-innovation IT project is a project containing information technology aimed at the creation, development and support of information systems. The main problem of IT-projects implementation is that the evaluation of economic efficiency of project investments does not correspond to the standard evaluation of investments. Information technologies are not tangible and have no intrinsic value, and the benefits and value from their implementation are created as a result of their effective organizational use. The main features of the implementation of IT projects:

1. Uncertainty of the impact on the efficiency of the company's activities, which is due to:

– the lack of clear cause-effect relationships between the use of the IT system and its impact on the production processes and performance of the company as a whole;

– the impact of the IT project not only on the physical infrastructure (technology itself), but also human capital and the structure of the company as a whole;

– the presence of different options for implementing IT projects, differing in the number of stages and the amount of costs.

2. Managerial flexibility and a high degree of dependence of project implementation on the decisions made by management, which is due to:

– flexibility of information systems themselves (a huge number of business solutions in different areas);

– the company's ability to increase the flexibility of the project by providing additional versatility and scalability;

– different ways of delivering and creating IT solutions (from the purchase of a "ready-made" package to self-development).

3. High implementation risks, which is one of the most problematic characteristics of investment IT-projects. The presence of a wide range of risks, which is due to the dependence on the focus of the project, options for its solution, the implementation of individual areas of the project, etc. 4. Cost-effectiveness is predictive because of the volatile and iterative development process. Evaluation of the effectiveness of IT projects is carried out using qualitative, financial, probabilistic and comprehensive evaluation methods, which have their own advantages and limitations. Often companies use several assessment methods at once, since the effectiveness of IT projects is expressed ambiguously and is often difficult to measure values.

A high degree of uncertainty and risks, a large number of possible solutions, a large number of input data, availability of poorly formalized information, the need for management flexibility in the implementation of IT projects actualizes the need for further research and development of advanced methods for investment evaluation of IT projects, including the use of real options tool. The application of which allows you to quantitatively assess the possibilities available in the project for its adjustment and include them in the calculation of the value of the project when taking a management decision. The next paragraph of Master's thesis is devoted to consideration of this question.

2. The method of real options and evaluation of the effectiveness of an investment project

2.1. Real options: concept, peculiarities of application

The term "real options" was first used by Stuart Myers in 1977, defining the essence of real options as follows: "Many corporate assets, particularly growth opportunities, can be viewed as Call options. The value of such "real options" depends on the reasonableness of investments which will be made by the firm in future" [26].

Since the theory of real options uses the methodology of financial options, let us consider the basic concepts of financial options.

Option (choice, right of choice) – a contract, according to which the owner, or the holder of the option, receives the right to buy or sell a certain underlying asset at an agreed price within a certain period of time. The buyer of an option has the right to buy or sell the asset. The seller must fulfill the contract if the buyer decides to exercise its right to [28].

The peculiarity of the option is the absence of negative consequences for its holder, because at any time it is possible to cancel its execution. After the conclusion of the contract all the risk associated with adverse price changes are on the seller, to whom the buyer pays the premium or price of the option.

The main characteristics of the option:

1) Type of option (depending on the buy/sell action):

Call option - the right of the owner to buy the underlying asset at a certain price within a certain period of time;

Put option - the right of the holder to sell the underlying asset at a certain price within a certain period of time.

2) Underlying asset. According to the nature of the underlying asset options are subdivided into [19]:

− stock options. Underlying asset – securities (ordinary shares; various types of financial instruments – depositary receipts);

− index options. Underlying asset – market indicators (indices). An index is a measure of the market value of some group of securities or other stock instruments;

− currency options. The right to buy and sell one currency at a price denominated in another currency;

3) Expiration date:

− american option. Any time before its expiration date;

− european option. For a specific period of time before expiration;

Despite the fact that the theory of real options uses the methodology of financial options, there are significant differences between them. The specifics of the former are related to the peculiarities of investing in industrial business assets, which have their own differences.

A real option is an investment in tangible assets, human capital and growth prospects of the company, which give the opportunity to benefit from any random events in the future.

The real options value (ROV) method offers a fundamentally different approach to evaluating investment projects. The project is implemented step by step and adjusted depending on previous results. This allows for flexibility of management decisions and faster achievement of goals. ROV method allows to consider alternative variants of project implementation instead of making absolutely accurate forecasts. Real option is the ability to make flexible decisions in conditions of uncertainty or the ability to use the flexibility built into the investment project.

Depending on market conditions and the stages of project implementation, the following types of real options are distinguished:

− deferral option – used if there is insufficient information at the current point in time to make an investment decision;

− option to change the scale of the project – the option consists in the fact that management can increase or decrease the scale of the project;

– opt-out option – allows the company to abandon the project if market conditions deteriorate sharply. The company can limit its investment to the initial stage, sell assets, and recoup some of its losses;

– option to adjust sales strategy – based on the results of market research, adjustments to the strategy taking into account new information, which will lead to different cash flows;

– switching option - a change in technology in a project.

A compound option is an option that uses another option as the underlying asset. When a compound option is exercised, its buyer has the right to buy or sell the original (inside) option at the strike price.

The main differences between financial and real options:

1. Financial options have a shorter term of execution (for financial options the time until their expiration is usually several months, for real options - measured in years).

2. The owners of financial options cannot influence the rate of a financial asset, while the value of the investment project can be changed.

3. Financial options are cheaper (tens or hundreds of dollars) than real options (thousands and millions of dollars per strategic option).

The method of real options allows taking into consideration the uncertainty factors, variability of main parameters of models and the possibility of management intervention. Besides the owner of financial option cannot influence the value of the option while the value of real option can vary as under the influence of external factors so as a result of internal interference.

Proceeding from this, the real options are considered from two positions:

– tools for appraisal and substantiation of investment objects (the application of financial option theory to real assets (traditional approach);

– objectively existing universal management process (the strategy in its dynamics), which you need to learn how to consciously manage.

Identification and consideration of real options in the process of evaluation of investment projects allows you to make, on the one hand, more reasonable decisions and, on the other hand, do not limit the manager to one direction of business development.

2.2. The Black-Scholes model for option valuation

In early 1970s F. Black (Fisher Black), M. Scholes (Myron Sc-holes) and R. Merton (Robert Merton) made a fundamental discovery in the theory of option pricing (the Nobel Prize in Economics).

The value of an option in the model depends on the main parameters: the price of the underlying asset (S); the strike price (X); the time until exercise (t); the risk-free rate of return (r); the volatility of the underlying asset price in annual terms (σ).

The Black-Scholes model determines the value of a European option:

$$C = SN(d_1) - Xe^{(-rT)}N(d_2) \tag{10}$$

$$d_1 = \frac{\ln(S/X) + (r + \frac{\sigma^2}{2})T}{\sigma\sqrt{T}} \tag{11}$$

$$d_2 = d_1 - \sigma\sqrt{T} \tag{12}$$

where *C* – theoretical value of the call option (to buy), i.e., the premium that the buyer is willing to pay for the right to buy the asset at time *T* at price *X*;

S – current price of the underlying shares;

T – time left to expiration (option period), expressed as a fraction of a year (number of days to expiration date/365 days);

X – option exercise price;

r – interest rate on risk-free assets;

N(x) – cumulative standard normal distribution;

e – exponent (2.7183);

σ – annual standard deviation of the price of the underlying shares (calculated by multiplying the standard deviation of the price for several days by the square root of 260 (the number of trading days in the year).

In order to apply the Black-Scholes model to the evaluation of real options, it is first necessary to interpret the parameters of the company's investment opportunities in terms of this model (Table 2.1).

Table 2.1 - Interpretation of Black-Scholes model parameters for valuation of real options

Parameter	Financial options	Real options
S	Current stock value	Present value of free cash flows for the project
X	Execution price	Volume of investment expenses
T	Option term	Project realization period
r	Risk-free rate	Risk-free rate
σ	Standard deviation of share price	Market value of the project
S - X	The difference between the current value of the asset and the option exercise price	NPV net present value of the solution

Quantitative assessment of the Black-Scholes model, has difficulties with the definition of some parameters: the risk-free rate; variance estimation; determination of the expiration date of the option.

When assessing the volatility in the market of project implementation it is possible [25]:

– using data on similar investment projects that have been implemented in the past (not applicable to innovative projects);

– to use data on the volatility of the market value of the assets of similar companies, calculated on the basis of the dynamics of prices on the stock market;

– to use as a substitute for the volatility of key parameters affecting the project's cash flows, e.g., market prices of products and/or raw materials.

The accuracy of the model's results depends on the accuracy of its parameter estimates and assumptions. Despite its complexity, the Bleck-Scholes model is widely used in practice.

2.3 Binomial option pricing model

The binomial approach developed by W. Sharpe, J. Cox, S. Ross, M. Rubinstein is an alternative to the Black-Scholes model. In Black-Scholes formula it is assumed that the basic asset has lognormal distribution. The binomial method assumes that the value of the underlying asset can take only one of two values in each time period. According to the standard binomial tree method, the option value is determined using: increasing ($u = e^{\sigma\sqrt{\Delta T}}$) and decreasing ($d = 1/u$) coefficients for each time period. A condition is needed:

$$d < (1 + r) < u \tag{13}$$

where r – risk-free rate of return.

Time and spread of the asset value are key factors for the value of an option. The binomial tree shows the allowable changes in the value of the asset given the current uncertainty (Figure 2.1).

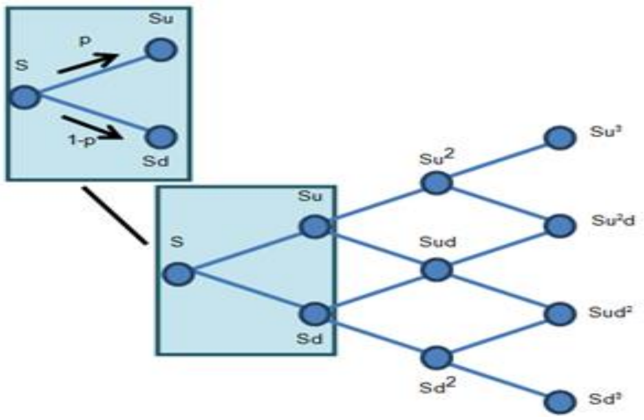

Figure 2.1 - Binomial tree, project time three years

S_0 – current price of the underlying asset.

The price moves to the price Su with probability p and down to the price Sd with probability $1 - p$ in any period of time.

In order to make calculations on the basis of this approach, the following input data are needed:

S_0 – current price of the underlying asset;

X – option exercise cost;

σ – volatility of cash flows;

T – term of execution;

r – risk-free rate.

The binomial approach involves performing calculations in stages [32]:

– creating a lattice for evaluating the underlying asset by multiplying its current value by growth and decline coefficients (node formation);

– constructing a real option value tree and determining the values of the nodes of this tree on the basis of the previously constructed value tree of the underlying asset (by backward induction - from right to left);

– successive winding up of the real option value tree to the final point - the desired value of the real option.

– applying the basic risk-neutral probability approach, which involves constructing a grid of cash flows and discounting them at a risk-free rate;

– determining the value of real options (the difference between the estimated effect of the project with options and the base effect without options).

The method of "decision tree" is used to evaluate the project under the conditions of risk and the presence of various options for its implementation (usually three scenarios - the base, pessimistic and optimistic scenario) and provides:

– assessment of the sequence of phases of the life cycle of the investment project and their composition;

– definition of events affecting the implementation of the project and the timing of their possible occurrence;

– the formation of a list of investment decisions for each possible event;

– estimation of probability of occurrence of each event and acceptance of each of possible investment decisions (for all possible reactions to one certain event their sum is equal to 1);

– estimation of cost of realization of each of possible investment decisions and volumes of expected cash flows as a result of realization of each of them.

"Decision tree" is a graphical model of the investment project development, in which the events affecting the investment project correspond to node points, and possible investment decisions for these events correspond to "branches" - an arrow. Each scenario of the investment project development is displayed on the "decision tree" as a set of decisions in chronological sequence of events occurrence (Figure 2.2).

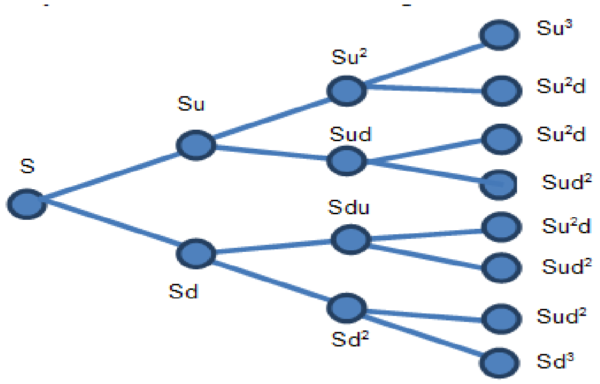

Figure 2.2- Binomial decision tree method, project time four years

The binomial method allows you to go back from the end date (t_3), where the possible value of the option is calculated, to today (t_0) to obtain the present value of the option. In this case, the calculation of the values in the option value grid starts from period t_2 (in period t_3, the possible option payout is determined based on the resulting value of the underlying asset). The risk-free rate is used as the discount rate in this case. The basic method of the risk-neutral probability approach includes the construction of a grid of cash flows and their discounting at a risk-free rate.

Risk-neutral probability is determined by the following formula:

$$P = 1+r-d / u-d \tag{14}$$

where *r* – risk-free rate.

The obtained value of the risk-neutral probability is used to calculate the expected value of the option in period t0 using the following formula:

$$ROV = (p\ (S_o u) + (1-p)(S_o d))/(1+r) \tag{15}$$

The indicator of the value of the investment project can be represented as the sum of the NPV indicator calculated according to the traditional methodology and the value of the management options concluded in the project:

$$NPV_{exp} = NPV_{tr} + ROV \tag{16}$$

where *NPVexp* – expanded net present value of the investment project;

NPVtr – net present value calculated by the traditional method;

ROV – real options value.

The main conclusions from the results of the study of the method of real options in the evaluation of investment projects:

1. Real options is a valuation approach. Unlike financial options, real options are not contracts between parties. They are called options for the similarity of the idea: the manager has the right (but not the obligation!) to take some action in the future - to postpone the project, expand or withdraw from it. While financial options insure financial risk, real options insure strategic risk.

2. The theory of real options does not reject the ideas of traditional methods of evaluation, it allows you to quantify the opportunities available in the project and thus include them in the calculation of the value of the investment project. To quantify the concept of real options uses the same indicators as the classical theory.

3. The theory of real options is most in demand in knowledge-intensive, high-tech resource-producing industries, as well as in industries with high marketing and promotion costs of new products. The scope of the option approach is unlimited and wherever there is uncertainty, real options can be used.

4. Among the disadvantages of the method should be noted: the variability of the approach to business processes can be accompanied by a loss of relevance to the strategic plans of the company; reduced employee involvement in a particular project, due to frequent changes in regulations and objectives for current activities.

Development and implementation of IT projects in conditions of a high degree of uncertainty and risks, the presence of a variety of possible solutions, the need for managerial flexibility actualizes the need to consider the peculiarities of the method of real options to assess the effectiveness of IT-projects. The next paragraph of the master's thesis is devoted to the consideration of this issue.

3. Develop and test a methodology for evaluating the effectiveness of IT projects under conditions of uncertainty and risk

3.1 Assessment of risks and uncertainties of IT project based on "Lean Canvas" business model

When developing online-oriented IT projects, companies cannot work according to a generally accepted business plan, they are forced to constantly test hypotheses, taking into account consumer feedback, forming a so-called "minimum relevant product" (hereinafter referred to as "MAP"). According to the Lean Startup Concept (hereinafter referred to as the Concept), there are 3 stages in IT product development: problem/solution fit; product/market fit; scaling up [4].

The main task at the transition from Stage 1 to Stage 2 of project development is information gathering, business model study, and determination of the direction of project development to achieve the Product/Market matching point, which is the main and determines the strategy and tactics of IT project implementation. In the transition from stage 2 to 3 of project development - optimization and scaling of business.

The peculiarities of IT project development are as follows: the presence of untested hypotheses (fixed in the business model template); project development with the help of consumers; flexible development (turning to new hypotheses).

1) Development of a hypothesis of the project is carried out with the help of a business model template "Lean Canvas" (Figure 3.1), which involves holding meetings with potential customers and working out the following questions: What problem does the project solve? Does the customer want the problem solved? Is he willing to pay to solve it? Is the problem solvable?

<table>
<tr><td rowspan="2">Problem

Alternatives</td><td>Solution</td><td rowspan="2">Unique offer</td><td>Hidden advantage</td><td rowspan="2">User segments</td></tr>
<tr><td>Metrics</td><td>Channels</td></tr>
<tr><td colspan="3">Expenses</td><td colspan="2">Revenue</td></tr>
</table>

Figure 3.1 - Business model "Lean Canvas" [24, p 35]

2) Development with the help of consumers, involves constant testing of the hypothesis, taking into account feedback from potential customers. Taking into account the information obtained, the idea is tested, adjusted or changed, i.e. a "U-turn" to new hypotheses is made. Product development takes place in short cycles - iterations.

3) Flexible development. Sequential step-by-step product development and obtaining a "minimum viable product".

The assessment of risks with the help of iterative metamodel in which risks are distributed on elements of "Lean Canvas" is considered by us in paragraph 1.2. of research. Let us consider the main risks at each stage of IT project development.

In the first phase (Product/Market) of IT project development:

1.1 The risk of an incorrectly defined consumer problem "problem - user segment". The main measures to reduce the likelihood of this risk occurring are adjusting the hypothesis of the IT project to the consumer needs and existing alternatives aimed at solving consumer problems.

1.2 The risk of incorrect launch of the IT-project due to a demo version. The main measures to reduce the likelihood of this risk are to adjust the minimum set of features of the IT-product to the needs of early adopters and the price the consumer is willing to pay.

1.3 The risk of the product not meeting the needs of users due to the inaccuracy of the trial MAP. The main measures to reduce the likelihood of this risk occurring are to adjust the minimum set of IT product features (landing page; user activation process; website usage problems).

In the second stage (Optimisation/Project Scaling) of the IT project development:

2.1 Risk of limited project user demand due to "limited" project promotion channels. The main measures to reduce the probability of this risk is the adjustment of channels of project promotion as well as consideration of the feasibility of introducing new functions and services to the IT-project.

2.2 The risk of limited supply of IT-project due to poor quality of services. The main measures to reduce the probability of occurrence of this risk is to adjust and improve the quality of services to meet the requirements of users.

2.3 Risk of low efficiency of the project due to failure to achieve an equilibrium price of the services provided. The main measures to reduce the probability of this risk occurrence is the adjustment of the price of the provided IT services to achieve market equilibrium.

Application of business model and risk assessment according to "Lean Canvas" template metamodel provides flexible IT project development, identifying risks and adjusting the project at all stages of its development and implementation. Application of binomial method of real options to assess IT-project efficiency along with the "Lean Canvas" business model will enable you to evaluate and calculate the cost of opportunities available in the project and determine the best option for its adjustment under the existing uncertainty.

Features of the application of real options tool to the evaluation of IT-projects developed on the basis of "Lean Canvas" business model will be considered in the next paragraph of the study.

3.2. Construction of the Uncertainties-Risks-Real Options matrix for assessing the effectiveness of IT project implementation

The proposed methodology for the evaluation of IT projects oriented towards online use (applications, IT platforms) implies

– a stage-by-stage review of IT - project development, taking into account the identification of factors and types of risks for each stage and possible project adjustment measures to address them;

– construction of the matrix "Uncertainties - Risks - Real Options" which provides interrelation of types of uncertainties and risks, factors of project flexibility and types of real options

– constructing a binomial lattice and estimating the value of an option; deciding whether to adjust the project in the light of the results on option values.

It is supposed to apply the methodology to IT-project evaluation in stages:

Stage 1 of IT - project development. The main task is to find a solution to the actual consumer problem (problem/solution).

1.1. Development of the IT-project hypothesis is based on the business model template "Lean Canvas" (Figure 3.2).

1.2. The testing of the IT project hypothesis is performed using the AIDA structured consumer interview method: Attention, Interest, Desire, Action.

<table>
<tr><td colspan="2">a) Identification of the problem</td><td colspan="2">b) Optimal solution</td><td colspan="2">c) Structure of the minimum relevant product</td></tr>
<tr><td>Greetings
2 minutes. Brief introduction</td><td rowspan="3">Introductory part

Identification of early adopters</td><td>Greetings
2 minutes. Brief introduction</td><td rowspan="3">Introductory part

Identification of early adopters</td><td>Greetings
2 minutes. Brief introduction</td><td>Introductory part</td></tr>
<tr><td>Demographics
2 minutes. Customer segment test</td><td>Demographics
2 minutes. Customer segment test</td><td>Display landing page
2 minutes. Unique selling proposition test</td><td rowspan="2">Test of the engagement process</td></tr>
<tr><td>Your story
2 minutes. Define the context of the problem</td><td>Your story
2 minutes. Define the context of the problem</td><td>Showing the price page
3 minutes. Price test</td></tr>
<tr><td>Importance of the problem
4 minutes. Problem testing</td><td rowspan="2">Problem test</td><td>Showing
15 minutes. Solution test</td><td>Problem test</td><td rowspan="2">Subscription and activation
15 minutes. Solution test</td><td rowspan="2">Test of the activation process</td></tr>
<tr><td>Customer's point of view
15 minutes. Problem testing</td><td>Price test
3 minutes. Revenue side</td><td>Problem test</td></tr>
<tr><td>Completion
2 minutes. Save contact</td><td>Permission to re-contact</td><td>Completion
2 minutes. Save contact</td><td>Permission to re-contact</td><td>Completion
2 minutes. Save contact</td><td>Permission to re-contact</td></tr>
<tr><td>Documenting results
5 minutes.</td><td>Documenting results</td><td>Documenting results
5 minutes.</td><td>Documenting results</td><td>Documenting results
5 minutes.</td><td>Documenting results</td></tr>
</table>

Figure 3.2 - Structured interview a) problem identification; b) optimal solution; c) MAP structure [24, p.60]

The results of the AIDA consumer problem identification interview should confirm the "problem - user segment" hypothesis; identify uncertainties and types of risks.

The results of the AIDA problem solving interview should rank the identified problems by priority; evaluate existing alternatives for solving problems; select the best solution for consumer problems; determine the price the customer is willing to pay and assess the viability of the project.

The results of the AIDA launch interviews should identify the uniqueness of the project compared to existing alternatives; the minimum set of project features to address the consumer problem; and the risks in developing the MAP.

1.3. Construction of the Uncertainties-Risks-Real Options Matrix.

To make a decision on the choice and application of real options (changes and adjustments to the project) and assess their impact on the project, it is useful to compare the uncertainties with the factors and types of risks of the project ("Lean Canvas" risk metamodel) and determine the type of real options (Figure 3.3), the application of which will eliminate or reduce the impact of risk factors on the project.

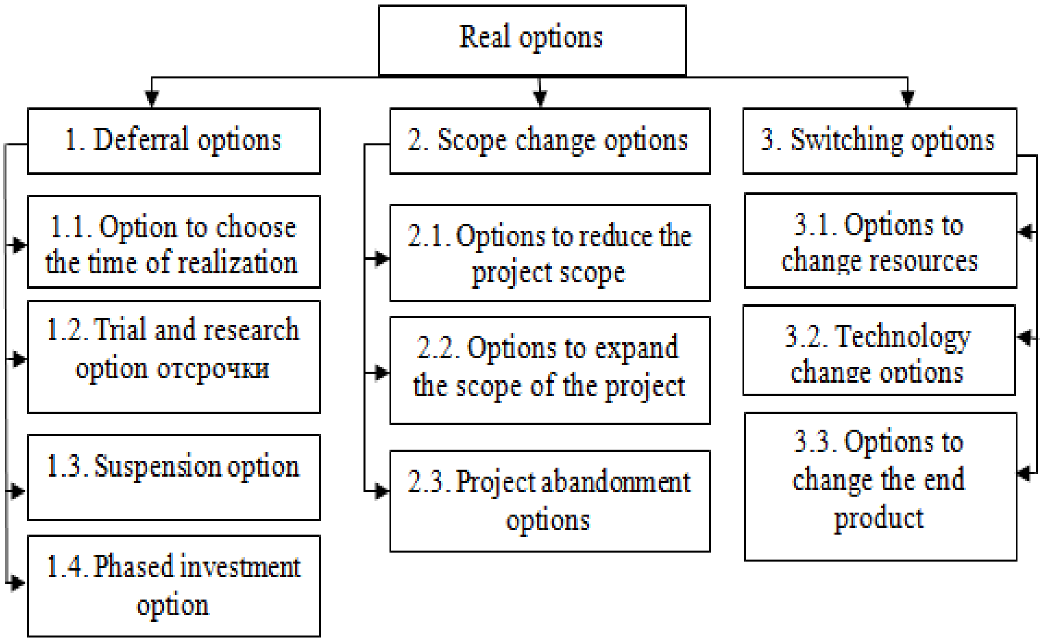

Figure 3.3 - Classification of real options [32]

The structure of the Matrix "Uncertainties - Risks - Real Options" is presented in Table 3.1.

Table 3.1 - Matrix "Uncertainties - Risks - Real Options"

Type of uncertainty	Risk factors	Types of risk	Real options									
			1.1	1.2	1.3	1.4	2.1	2.2	2.3	3.1	3.2	3.3

In practice, exogenous and endogenous factors are used as types of uncertainty. Exogenous (external) uncertainty factors include uncertainty in the economic and political situation, social uncertainty, etc., endogenous (internal) uncertainty factors include factors due to the nature of the technological process [5].

Risk factors in the matrix take into account the stages of IT project development in accordance with the "Lean Canvas" business model, the types of risks are defined in accordance with the "Lean Canvas" risk model: P - product risks; C - customer risks; M - market risks.

Taking into account the peculiarities and objectives of the first stage of IT-project development according to "Lean Canvas" business model, the basic uncertainty of the project at this stage of its development is the project uncertainty, which implies the possibility of adjustment of the hypothesis, the basic parameters of the project and its minimum actual product (MAP), and one of the basic options is the option to switch and change MAP of IT-project.

Stage 2 of the IT -project development. The main task is to determine the optimum project option and move to its scaling (optimization/scaling). For the second stage of IT-project development the basic uncertainty is the market uncertainty, which implies the possibility of adjustment of channels of project promotion; change of technology and list of provided IT-services; determination of equilibrium market price of IT-services.

1.4. Selecting real options based on the Uncertainties-Risks-Real Options matrix

1.5. Constructing a binomial Real Options Tree (ROV).

1.6. Estimation of option value - the value of the underlying asset (IT platform), taking into account the application of real options to the IT project.

1.7. Selection of options to apply real options aimed at adjusting the project based on the results of real options value estimation.

Let us evaluate the effectiveness of the IT project "UMKA" based on the business model "Lean Canvas" and binomial model of real options under uncertainty and risk.

3.3 Performance evaluation of the IT project "UMKA" using a binomial option pricing model

The IT-project "UMKA" is a decentralised labour exchange based on blockchain technology. A multifunctional platform for job and employee search, team building and project implementation. UMKA features digital passports for participants, whose data is also stored in blockchain, as well as unique "flexible" Agile Smart Contracts that guarantee secure transactions. The main problem that the development of the UMKA project aims to solve is the lack of human resources for IT companies.

The unique selling proposition (USP) of the project: Qualitative selection of specialists for IT-companies is carried out by teachers and supervisors of business-practices. The business model and main parameters of the UMKA project are presented in Appendix A.

In 2020 the world faced a severe crisis associated with a pandemic that had a great impact on the state and further development of all spheres of the global economy. The global economic recession has led to a shift in priorities for IT companies: an increase in spending on "critical" technologies and services that contribute to growth or business transformation. IT spending is down 8% (to $3,4 trillion); data centre systems, 9,7%; electronic devices (computers, smartphones), 15,5%; IT services, 7,7%; and enterprise software, 6,9%. Due to the mass shift of companies to remote working, spending on public cloud servers increased by 19%; cloud telephony and messengers, 8,8%; and videoconferencing 24,3% [37].

After coming out of quarantine, many companies started to implement the transition to a new employment relationship - the remote working system.

Taking into account the context and the demand for IT services for the company was the question of the feasibility of transforming the educational IT - platform "UMKA" into a decentralised IT - ecosystem to organize remote working, job search and recruitment in IT and innovative technologies, getting education on a remote basis and a comprehensive set of tools to make all this possible. Calculation of investment attractiveness indicators of the IT ecosystem "UMKA" and monetization points of its main elements is presented in Appendix C.

Construction of the matrix "Uncertainties - Risks - Real Options" for IT-project "UMKA" using iterative risk metamodel and "Lean Canvas" business model, allowed to determine the real option - switching option (the number of real options of this group has the highest value - 13, taking into account the risk factors of the project), where market uncertainty is the basic uncertainty (Table 3.2).

Based on the results of the Uncertainties-Risks-Real Options matrix, two options were identified:

1) Switching option. In case of the optimistic scenario (A1) in the 1st year of the project implementation, it was planned to change the final product to a decentralised IT ecosystem (extending the functionality of the platform: 1) labour exchange, 2) freelance exchange, 3) educational platform).

2) Exit option. In case of low demand for the services of IT platform "UMKA" and realization of the pessimistic scenario (A2) in the 1st year of the project implementation it was planned to sell the platform for 15 million rubles.

Table 3.2 - Matrix "Uncertainties – Risks – Real Options" for the IT project "UMKA"

Type of uncertainty	Risk factors	Types of risk	Real options									
			Deferral Options				Change of scale			Switching option		
			1.1	1.2	1.3	1.4	2.1	2.2	2.3	3.1	3.2	3.3
Project uncertainty	Inconsistency of MAP with the idea of the project	P		+							+	+
	Mismatch of "problem-user segment"	P/C		+	+				+		+	+
Organizational uncertainty	Lack of staff qualifications	P	+							+		
	Poor coordination of project participants	P/ C			+							
	Provision of substandard services	P/M				+				+		
Financial uncertainty	Insufficient resources to scale the project	M	+		+	+	+					+
Market uncertainty	Limited channels of project promotion	M/C					+			+		
	Availability of alternative solutions for the consumer	M/C/P										
	Failure to reach the equilibrium market price for the project services	M	+							+		
Social uncertainty	Decrease in the solvency of the population	C			+		+		+			+
	Change in consumer preferences	M/ C/P			+		+		+			+
Legislative uncertainty	Change in the tax system	M							+		+	+

The binomial tree shows the projected demand for the project from IT companies by years with the probability of occurrence of each of the scenarios. The main two branches of the tree, correspond to optimistic and pessimistic forecasts (Figure 3.4).

As the development of an IT project involves constant interaction and interviews with potential project users, the hierarchy analysis method, a mathematical tool for the systems approach to complex decision-making problems, was used to determine the likelihood of each scenario occurring. This method does not prescribe a decision maker any "right" decision, but allows him to interactively find an option (alternative) that best suits his understanding of the problem and the requirements for its solution. The main criteria for the evaluation of a UMKA IT project by means of hierarchy analysis are:

1. The staffing requirements of the IT company;
2. The quality of the services provided by the IT platform;
3. The level of complexity of the cases presented on the IT platform.
4. Main areas of specialization presented on the IT platform.

IT companies rated each of the criteria for the optimistic and pessimistic scenarios on a ten-point scale. The probability of the optimistic scenario in the first year of project implementation was estimated at 80% and the pessimistic scenario at 20% (Appendix B). The probability of scenarios for the 2nd and 3rd year of the project implementation is determined by the same method.

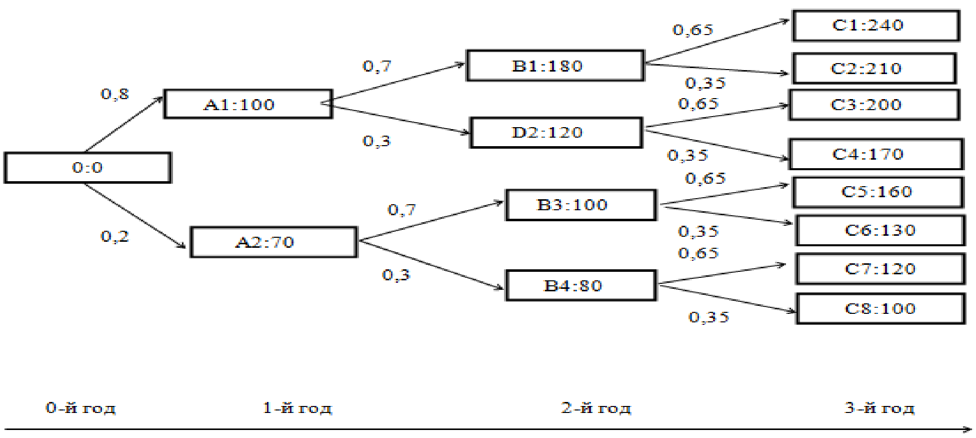

Figure 3.4 - Forecast of IT companies' demand for the IT project "UMKA"

The results of the project cash flow forecast: projected revenues - costs in each node of the binomial lattice (without options) are shown in the figure 3.5.

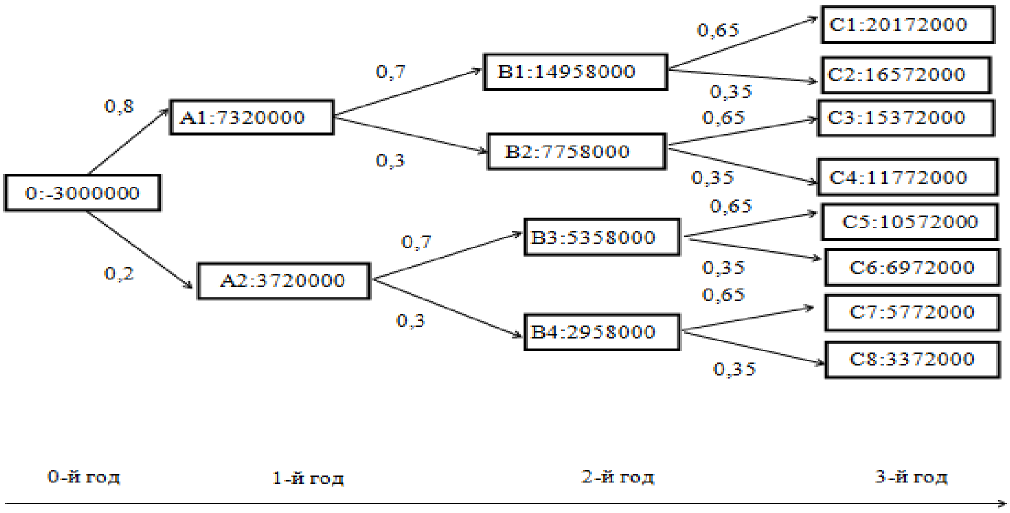

Figure 3.5 - Projected project cash flow (without options), rubles

In order to forecast project cost for three years of its implementation, its cost in each node of the binary tree was estimated. In the last nodes of the tree (B1:B8) project cost will be equal to its cash flows. At intermediate nodes (B:A), the value of the project equals the total present value of all subsequent flows, taking into account their probability plus the current flow.

The discount rate for calculating the value of the project has been determined using the cumulative method. Yield on government bonds of Tomsk Oblast (project location) with circulation term of four years was taken as risk-free rate. Current issue number RU25063TMSO, annual coupon rate is 7,7% [33]:

$$rэф = (1+ rн /100*4)^{4} = (1+7,7/100*4)^{4 =} 00,079252 \qquad (17)$$

To determine the risk premium, we consider the types of risk according to a metamodel where, depending on the project parameters, the total risk premium will be estimated [18]. In this case, the risk premium for each type of risk = 1%.

Table 3.3 - Types of risk and risk premium

Type of risk	Risk premium, %
Consumer risks	2
Customer risks	2
Market risks	2
Total	6

$$R_{discount} = R_{risk\ free} + R_{risk} = 7.92\% + 6 = 13{,}92\% \quad (18)$$

$$V(Б1) = CF(Б1) + \frac{V(В1)*0{,}65+V(В2)*0{,}35}{(1+r)} = 14958000 + \frac{20172000*0{,}65+16572000*0{,}35}{1+0{,}1392}$$
= 31 559 123 rubles.

$$V(Б2) = CF(Б2) + \frac{V(В3)*0{,}65 + V(В4)*0{,}35}{(1+r)} = 7758000 + \frac{15372000*0{,}65 + 11772000*0{,}35}{1+0{,}1392}$$
= 20 145 640 rubles.

$$V(Б3) = CF(Б3) + \frac{V(В5)*0{,}65 + V(В6)*0{,}35}{(1+r)} = 5358000 + \frac{10572000*0{,}65 + 6972000*0{,}35}{1+0{,}1392}$$
= 13 532 157 rubles.

$$V(Б4) = CF(Б4) + \frac{V(В7)*0{,}65 + V(В8)*0{,}35}{(1+r)} = 2958000 + \frac{5772000*0{,}65 + 3372000*0{,}35}{1+0{,}1392}$$
= 7 287 353 rubles.

$$V(А1) = CF(А1) + \frac{V(Б1)*0{,}7 + V(Б2)*0{,}3}{(1+r)} = 7320000 + \frac{31559123*0{,}7 + 20145640*0{,}3}{1+0{,}1392}$$
= 32 017 224 rubles.

$$V(А2) = CF(А2) + \frac{V(Б3)*0{,}7 + V(Б4)*0{,}3}{(1+r)} = 3720000 + \frac{13532157*0{,}7 +7287353*0{,}3}{1+0{,}1392}$$
= 13 954 123 rubles.

$$V(0) = NPV = CF(0) + \frac{V(А1)*0{,}8 + V(А2)*0{,}2}{(1+r)} = -3000000 + \frac{32017224*0{,}8+ 13954123*0{,}2}{1+ 0{,}1392}$$
= 21 933 815 rubles.

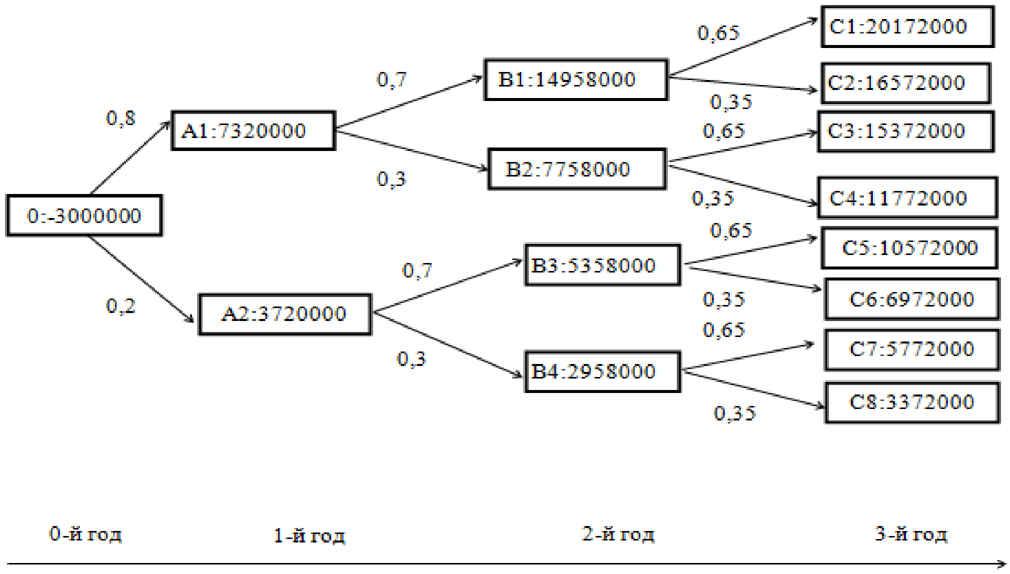

Figure 3.6 - Projected value of the project (without option), rubles

Conclusion: NPV= 21 933 815 roubles. The IT project "UMKA" is profitable, in the first year of the project the switching option for the optimistic chain scenario is applicable: A1:B1:C1. The projected costs and revenues of the IT ecosystem "UMKA" are shown in Appendix C. The one-off cost of changing the project parameters is 950 000 roubles in year 1 of the optimistic scenario, the annual cost of running the IT ecosystem is 22 986 000 roubles.

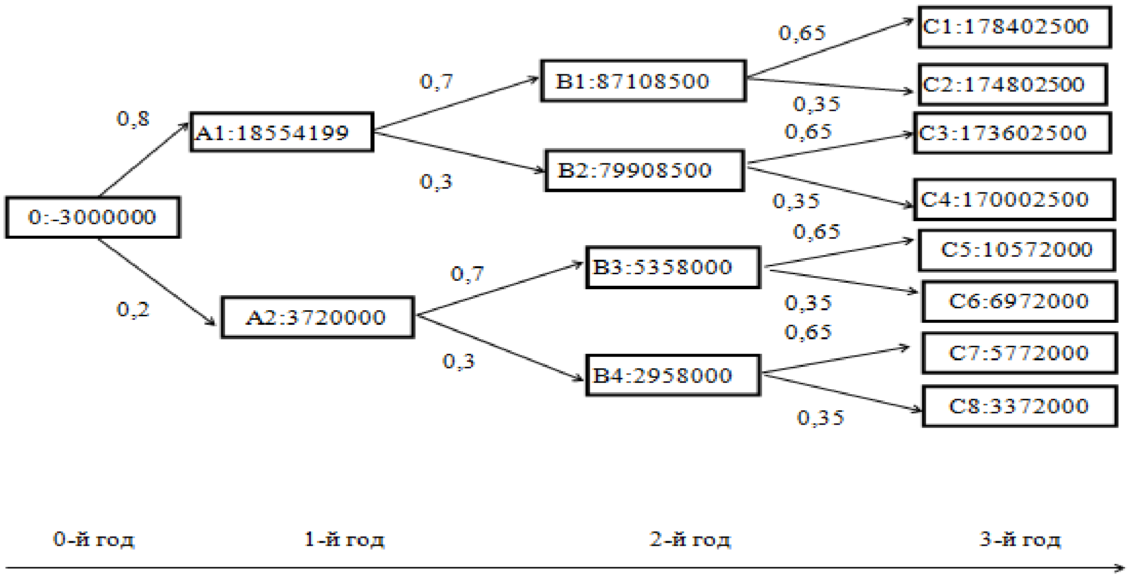

Figure 3.7 - Projected cash flows of the project with switching option, rubles

$$V(Б1) = CF(Б1) + \frac{V(В1)*0,65+V(В2)*0,35}{(1+r)} = 87108500 + \frac{178402500*0,65+174802500*0,35}{1+0,1392}$$

= 242 605 778 rubles.

$$V(Б2) = CF(Б2) + \frac{V(В3)*0,65+V(В4)*0,35}{(1+r)} = 79908500 + \frac{173602500*0,65+170002500*0,35}{1+0,1392}$$

= 231 192 295 rubles.

$$V(Б3) = CF(Б3) + \frac{V(В5)*0,65 + V(В6)*0,35}{(1+r)} = 5358000 + \frac{10572000*0,65 + 6972000*0,35}{1+0,1392}$$

= 13 532 157 rubles.

$$V(Б4) = CF(Б4) + \frac{V(В7)*0,65 + V(В8)*0,35}{(1+r)} = 2958000 + \frac{5772000*0,65 + 3372000*0,35}{1+0,1392}$$

= 7 287 353 rubles.

$$V(A1) = CF(A1) + \frac{V(Б1)*0,7 + V(Б2)*0,3}{(1+r)} = 7320000 + \frac{242605778*0,7 + 231192295*0,3}{1+0,1392}$$

- 950000 = 216 325 874 rubles.

$$V(A2) = CF(A2) + \frac{V(Б3)*0,7 + V(Б4)*0,3}{(1+r)} = 3720000 + \frac{13532157*0,7 +7287353*0,3}{1+0,1392}$$

= 13 954 123 rubles.

$$V(0) = NPV = CF(0) + \frac{V(A1)*0,8 + V(A2)*0,2}{(1+r)} = -3\,000\,000 + \frac{216325874*0,8+ 13954123*0,2}{1+ 0,1392}$$

= 151 364 047 rubles.

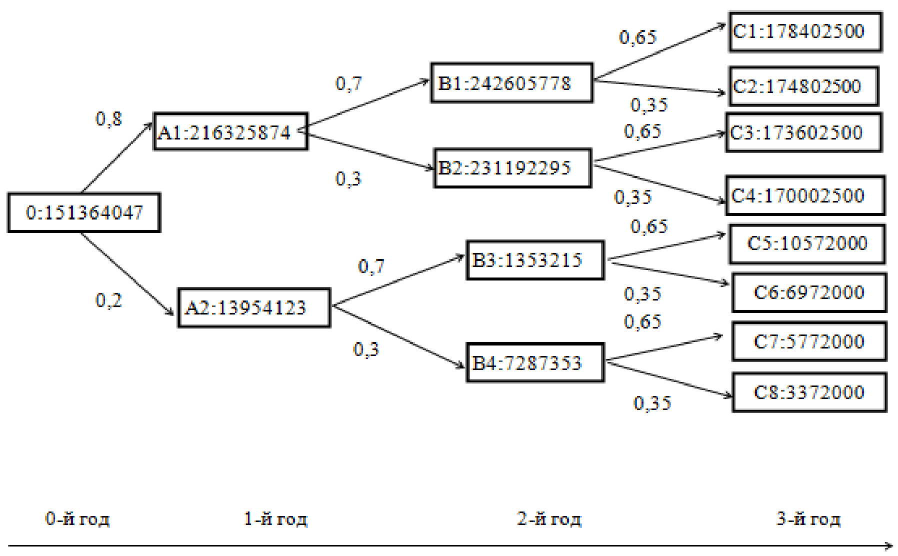

Figure 3.8 - Projected project cost with switching option, rubles

$$NPV_{exp} = NPV_{tr} + ROV = 21\,933\,815 + 129\,430\,232 = 151\,364\,047 \text{ rubles.}$$

The value of the UMKA IT ecosystem project including the switching option was NPV $_{exp}$ = 151 364 047 rubles, the value of the project without options NPV $_{tr}$ = 21 933 815 rubles. The value of the switching option was ROV = 129 430 232 roubles.

2. Option to exit the project under option A:2, in case of low demand for the services of the IT platform "UMKA" of the 1st year of the project. The sales value is 15 000 000 roubles.

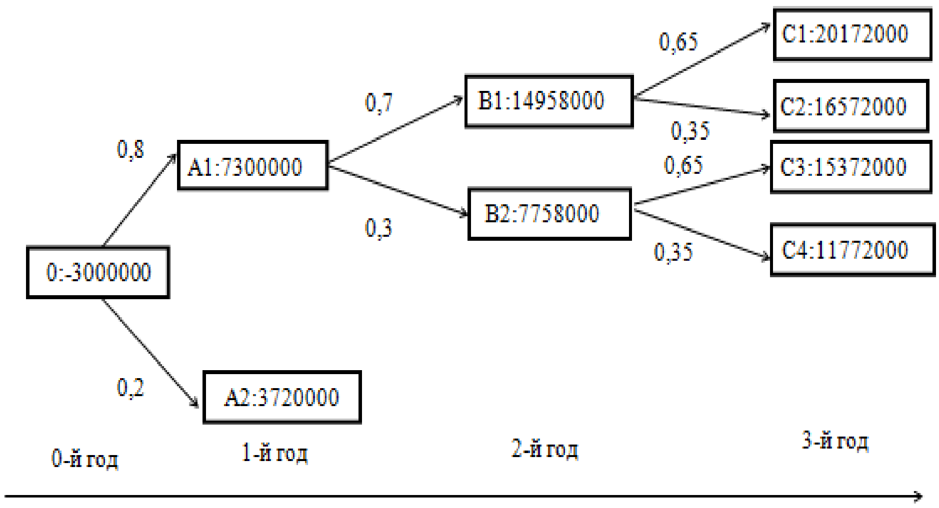

Figure 3.9 - Projection of project cash flows with exit option, rubles

$$V(Б1) = CF(Б1) + \frac{V(B1)*0{,}65+V(B2)*0{,}35}{(1+r)} = 14958000 + \frac{20172000*0{,}65+16572000*0{,}35}{1+0{,}1392}$$
= 31 559 123 rubles.

$$V(Б2) = CF(Б2)+ \frac{V(B3)*0{,}65 + V(B4)*0{,}35}{(1+r)} = 7758000 + \frac{15372000*0{,}65 + 11772000*0{,}35}{1+0{,}1392}$$
= 20 145 640 rubles..

$$V(A1) = CF(A1) + \frac{V(Б1)*0{,}7 + V(Б2)*0{,}3}{(1+r)} = 7320000 + \frac{31559123*0{,}7 + 20145640*0{,}3}{1+0{,}1392}$$
= 32 017 224 rubles.

V(A2) = CF(A2) + 15 000 000 = 3720000 + 15000000 = 18720000 rubles.

$$V(0) = NPV = CF(0) + \frac{V(A1)*0{,}8+V(A2)*0{,}2}{(1+r)} = -3\,000000 + \frac{32\,017\,224*0{,}8+18720000*0{,}2}{1+0{,}1392}$$

= 22 770 522 rubles.

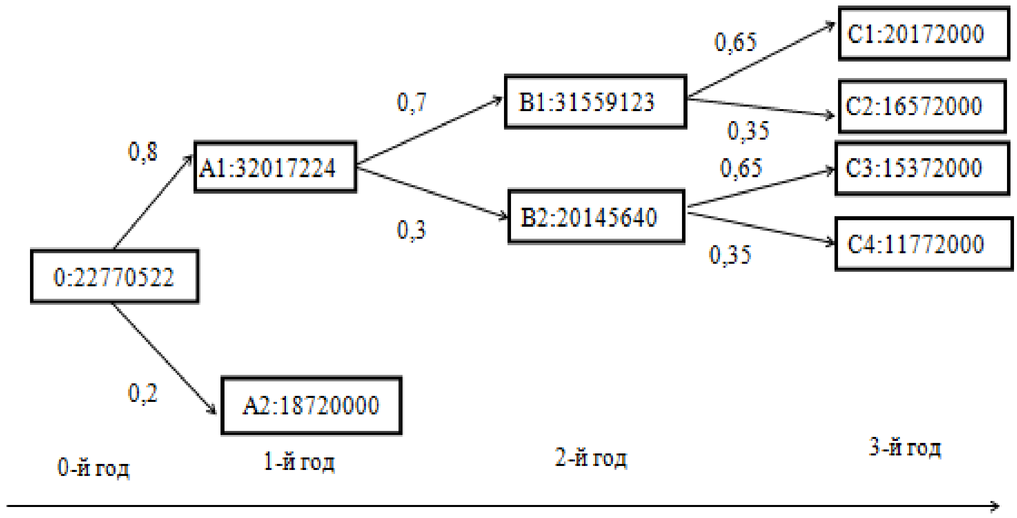

Figure 3.10 - Projected project cost with exit option, rubles

The value of the UMKA IT project including the exit option in year 1 was NPV_{exp} = 22 770 522 rubles, which is 3.8% higher than the value without options NPV_{tr} = 21 933 815 rubles. The value of the exit option was ROV = 836 707 rubles.

2. The Black-Scholes model for the evaluation of real options.

To apply the Black-Scholes model for the evaluation of real options, let us present the parameters of the IT investment project "UMKA" in terms of this model (Table 3.4). Calculation of the project cost was carried out in MS Excel, where to find N (d1) and N (d2), function NORM.RASP (Appendix D).

Table 3.4 - Estimation of the cost of real options of the project by the Black-Scholes model

Parameters of the project	Real Options Model	Project with an option to switch	Project with exit option
S	Present value of project cash flows	154 364 047	25 770 522
X	Volume of investment costs	3 950 000	3 000 000
T	Project period	3	3
r	Risk-free rate	13,92	13,92
σ	Validity	6,15	6,15
C	Cost of the project with an option	150 485 059	22 824 455
$C - NPV_{tr}$	Value of option, rubles	128 571 130	890 640

The results of the valuation of the UMKA educational IT platform and the UMKA IT ecosystem by discounted cash flow (DCF), binomial real options tree, and Black-Scholes are presented in Table 3.5.

Table 3.5 - Results of IT project cost estimation using DFC, ROV and Black-Scholes models, rubles

Project	DFC	ROV	Black-Scholes
IT platform "UMKA"	6 853 180	21 933 815	
IT ecosystem "UMKA"	148 626 936	-	-
IT platform "UMKA" with a switching option	-	151 364 047	150 485 059
The cost of a switching option	-	129 430 232	128 571 130
IT platform "UMKA" with the exit option	-	22 770 522	22 824 455
Exit option value	-	836 770	890 640

The main advantage of the option approach to assessing the effectiveness of IT project development and implementation during continuous testing and adjustment of the project business model, is the ability to consider the specifics of development, to build flexibility into the planning and management process, to assess its cost, to make optimal decisions at key moments on the project. The method of real options allows you to look at uncertainty in a different way, and to see in this situation not only the threat of losses in the implementation of the IT project, but also new opportunities to generate revenue.

Conclusion

To approve the method of real options (ROV) in assessing the effectiveness of the IT-project under the condition of uncertainty, the tasks set when writing a master's thesis were consistently solved.

A distinctive feature of an IT project is that it contains information technology that is not tangible and has no intrinsic value. The assessment of the cost-effectiveness of IT project investments does not correspond to the standard evaluation of investments.

The presence of uncertainty and risk factors, a multitude of possible solutions (a huge number of business solutions in different areas), a large number of input data, the presence of poorly formalized information, the need for management flexibility in the design and implementation of IT - project create a problem in assessing the effectiveness of investment in the project.

A comparative analysis of the main methods for assessing the effectiveness of IT-project implementation: qualitative, financial, probabilistic and complex methods showed the advantages and limitations of each of them.

The results of the study showed that the method of real options (ROV) makes it possible to quantify the available options in the project to adjust it and calculate the cost of the project, developed on the basis of "Lean Canvas" business model. According to the results of IT-project "UMKA" assessment methodology is offered, including:

Stage-by-stage development of IT - project according to "Lean Canvas" business model; testing of IT project hypothesis by AIDA method; assessment of risk types according to "Lean Canvas" risk metamodel.

Construction of the matrix "Uncertainties - Risks - Real Options". Correlation of uncertainty factors with types of project risks and types of real options will allow for flexible development, identification and elimination of risks, calculation of the cost of the project's available opportunities for its adjustment in conditions of uncertainty.

The choice of the method of real options to assess the IT-project, taking into account its characteristics. The binomial option pricing model and the decision tree method allow the evaluation of an IT project with high accuracy of results under a large number of management decision periods and several sources of uncertainty.

Estimating the value of options and deciding whether to adjust the project based on the results. The Black-Scholes model and the binomial decision tree model were applied to evaluate the effectiveness of the educational IT platform "UMKA" by considering the value of the switching option under the optimistic option (creation of a stand-alone IT ecosystem "UMKA") and the option to exit the project under the pessimistic option of project implementation. According to the evaluation results the most profitable in terms of investment efficiency is the project of IT platform "UMKA" taking into account the two options in the first year of the project NPVexp = 152200754 rubles. Thus, the embedding of these options in the project will provide a cost estimate of the flexibility of decisions depending on the conditions of the project.

The results of the research and testing of the method of real options in the evaluation of IT project showed that the theory of real options does not reject the ideas of traditional methods of evaluation, it allows you to quantify the opportunities available in the project and thereby include them in the calculation of the cost of the investment project. This method is most in demand in knowledge-intensive, high-tech resource-producing industries, as well as in industries with high marketing and promotion costs of new products, which is typical for the IT industry.

The main result of the study is to propose a methodology for assessing the effectiveness of IT projects in the face of uncertainty, which helps to choose the most appropriate assessment tools, whether it is a method of real options or traditional DCF-model, in each case, depending on the parameters of a particular IT project.

This study is the basis for further study of the real options method not only as a model for evaluating the effectiveness of IT projects, but also as a tool for strategic analysis. The issues of applying the methods of the theory of real options to assess the economic efficiency of innovative projects require further research and development.

List of references

1. Abramov G. Evaluation of investment projects using real options [Electronic resource] / G. Abramov, K. Malyuga // Internet-journal "Naukovovedenie". - 2014. - № 2. - URL: http://publ.naukovedenie.ru (accessed 15/04/2021).

2. Anshin V. Innovation Management: concepts, multi-level strategies and mechanisms of innovation development / V. Anshin, A. Dagaeva. - M.: Delo, 2010. - 584 p.

3. Basic metrics and calculations of unit economy models. What is unit economy. [Electronic resource] - URL: https://www.uplab.ru (accessed: 21/04/2021).

4. Blank S. Lean Startup [Electronic resource] / S. Blank // Harvard Business Review. - 2013. - URL: https://hbr-russia.ru/management/strategiya/a11618 (accessed: 11/01/2021).

5. Brautigam J. Uncertainty as a Key Value Driver of Real Options / J. Brautigam, Ch. Esche // European Business School. [Электронный ресурс] - 2003. - URL://http://www.realoptions.org/papers2003/BraeutigamUncertainty.pdf (accessed: 03/04/2021).

6. Budylin M. Application of real options for evaluation of investment projects / M. Budylin // Bulletin of Siberian State Aerospace University named after Academician M.V. Reshetnev. - 2007. - P.15-160.

7. Clemons E. Strategic Information Technology Investments: Guidelines / E. Clemons, B. Weber // Journal of Management Information Systems. - 1990. - № 2. - P. 9-28.

8. Courtney H. 20/20 Foresight: Crafting Strategy in an Uncertain World / H. Courtney // Harvard Business School Press. [Electronic resource] - URL: http: hbswk.hbs.edu (accessed: 21/04/2021).

9. Damodaran A. Investment Assessment. Tools and techniques of valuation of any assets. / A. Damodaran. - M.: Alpina Business Books. - 2010. - 1342 p.

10. Davidovski V. Techno-economic features of innovation and investment in the field of information technology / V. Davidovski // Economics: Scientific and Technical Bulletins of SPbSPU. - 2011. - № 2. - P.152-155.

11. Economic efficiency of investments in IT: the optimal method of evaluation. / Yu. Tsygalov / [Electronic resource] - URL:// http://www.pcweek.ru/idea/article/detail.php?ID=68331 (accessed: 06/05/2021).

12. Egorova O. Problems and Opportunities of Practical Application of the Theory of Real Options in the Evaluation and Management of Investment Projects / O. Egorova // Bulletin of South Ural State University. - 2010. - № 39. - P. 37- 41.

13. Ghassan F. Economic Efficiency Analysis for Information Technology in Developing Countries. / F. Ghassan, S. Hussain, H. Al-Bahadili // Journal of Computer Science. - 2009. - 5 (10). - P. 751-759.

14. Ginzburg M. Problems of applying the method of real options in the assessment of investment projects on the example of the binomial model / M. Ginzburg, N. Pronchatova-Rubtsova // Financial analytics: problems and solutions. - 2002. - 18 (108). - P. 14-18.

15. Herdiansyah M. IT Strategy Alignment in University Using IT Balanced Scorecard Framework. / M.Herdiansyah, S. Kunang, M. Akbar // Advanced science letters. - 2014. - Vol. 20. - № 10-12. - P. 2038-2041.

16. Ilyenkova S. Innovation management [Electronic resource]. - URL: //http://biglibrary.ru/category38/book67/part13 (accessed: 27/04/2021).

17. IT Market Volatility by Software (System & Application) Sector for 2020 [Electronic resource] - URL: http://pages.stern.nyu.edu/~adamodar/New_Home_Page/datafile/optvar.html (accessed: 07/05/2021).

18. Kamnev I. Methods of substantiation of the discount rate. / I. Kamnev, A. Zhulina. // Problems of Accounting and Finance. - 2012. - № 2. - P. 30-35.

19. Kilyachkov A. Securities market and exchange business. / A. Kilyachkov, L.Chaadaeva - M.: Jurist, 2000. - 704c.

20. Klyuchnikov, V. Real options in the projects of information technologies / V. Klyuchnikov // Russian entrepreneurship. - 2011. - № 12 (2). - P.118-124.

21. Klyuchnikov, V. Risk identification of IT projects / V. Klyuchnikov // Public administration. - 2009. - № 20. - P. 1-7.

22. Lukashova, Y. Features of assessing the effectiveness of innovative projects in the field of information technology / Y. Lukashova // Management of Innovation and Innovative Activity. – 2016/ - №7. - P.71-75.

23. Lyytinen K. Attention Shaping and Software Risk A Categorical Analysis of Four Classical Risk Management Approaches / K. Lyytinen, L. Mathiassen, J. Ropponen // Information Systems Research. - 1998. - № 9/3. - P. 233-255.

24. Maurya A. Running Lean [Electronic resource] - URL: http://www.e-puzzle.ru (accessed: 03/04/2021).

25. Mertens A. How to evaluate the opportunities? Real options in strategic decisions [Electronic resource] - URL:// https://docviewer.yandex.ru (accessed: 21/04/2021).

26. Myers S. Determinants of Corporate Borrowing / S. Myers // Journal of Financial Economics. - 1977. - Vol. 5, Issue 2. - P. 147-175.

27. Odintsov B. The level of uncertainty as an information resource / B. Odintsov // Information Resources of Russia. - 2014. - №2. - P. 16-19.

28. Option. [Electronic resource] - URL:// https://ru.wikipedia.org/wiki (accessed: 21/04/2021).

29. Peppard J. Managing the realization of business benefits from IT investments / J. Peppard, J. Ward, D. Elizabeth // MIS Quarterly Executive – 2007. - P. 51-59.

30. Pesotskaya E. Risk management when introducing IT-projects / E. Pesotskaya // Advances of Modern Natural Science. - 2008. - № 1 - P. 47-49.

31. Rychkov, I. Effectiveness of implementing IT at high-tech enterprises / I. Rychkov // Proceedings of the MSTA: electronic journal. [Electronic resource] - URL: http://do.gendocs.ru/docs/index-320803.html (accessed: 22/04/2021).

32. Safonova L. Using the theory of real options in practice of making investment decisions / L. Safonova, G. Smolovik // Investitsii. -2006. - №3. - C.62-68.

33. Securities of Tomsk region [Electronic resource] - URL: http://www.depfin.tomsk.gov.ru (accessed: 21/04/2021).

34. Shurygina I. Economic evaluation of investments in IT-projects [Electronic resource] / I. Shurygina, A. Dorogova / Corporate Finance Management. - 2010. - №2. - URL: http://www.ibts.ru/articles/index.php?ELEMENT_ID=541 (accessed: 21/04/2021).

35. Shvakin V. On some aspects of investment and innovation processes in the field of information technology / V. Shvakin, L. Kulikova // Information Systems and Technologies. - IrGTU, - 2013. - №5. – P. 25-30.

36. Simon V. Options. / V. Simon // Full course for professionals. - M.: Alpina Publisher, 2003. - 416 p.

37. Stasev V. Innovations in Russia: Illusions and Reality / V. Stasev, A. Zabrodin, E. Chernykh / [Electronic resource] - URL:// http://innocrowd.ru/innovation-project (accessed: 06/05/2021).

38. Trends in the global IT market / Tadviser [Electronic resource] - URL:https://tadviser.ru https://www.tadviser.ru/index.php/ (accessed 03.03.2021).

39. Types and stages of the life cycle of projects [Electronic resource]. - URL: http://projectimo.ru/upravlenie-proektami/innovacionnyj-proekt.html. (accessed: 03/01/2021).

40. Vasilieva E. Methods of Expert Evaluations in Applied Information Economics to Justify the Advantages of Information Systems and Technologies / E. Vasilyeva, E. Deeva // Economics of the XXI Century. - 2017. - № 4. - P.14-22.

41. Yakimova O. Methods of Efficiency Evaluation of Corporate Information Management Systems / O. Yakimova // Modern Science-Intensive Technologies. - 2006. - № 3. - P. 95-98.

Appendix A: Evaluation of educational IT platform "UMKA" based on "Lean Canvas" business model

<table>
<tr>
<td rowspan="2">PROBLEM:
- Lack of quality recruitment of specialists to work in the IT - field;
- Lack of connection between education and business needs;
- employment of young specialists.

EXISTING ALTERNATIVES:
Headhunter</td>
<td>SOLUTION:
- identifying talent;
- teachers supervise the project groups;
- employer participates in the work of the project group;
- the employer has access to student testing data;
- platform solves faculty compensation and tax issues.</td>
<td rowspan="2">UNIQUE OFFER:
Now quality recruitment of specialists for your company is carried out by teachers and business practice supervisors;

Opportunity to link theory and practice.</td>
<td>HIDDEN ADVANTAGE:
User Community: "Dream Team."</td>
<td rowspan="2">CUSTOMER SEGMENTS:
IT companies

Teachers - project supervisors

Students</td>
</tr>
<tr>
<td>METHODS:
Attraction:
- website registration.
Activation:
- business case study offerings;
- student and instructor choice of practice.
Retention:
- submission of practice feedback.
Dissemination:
- inviting other participants
Payment:
- payment after the placement of the practice.</td>
<td>CHANNELS:
Face-to-face meetings
SMM
Friends
Teachers</td>
</tr>
<tr>
<td colspan="3">EXPENSES:
Costs for managers - 30 thousand rubles.
Costs for smm - 60 thousand rubles.</td>
<td colspan="2">EXPENSES:
Business fees - 10 thousand rubles; Teachers - 0 rubles; Students - 0 rubles.</td>
</tr>
</table>

Figure A.1 - Business model of the project "UMKA"

Main parameters of the project:

1) Development and launch of the IT platform - 6 months.

2) Initial promotion of the IT-product (advertising, meetings with potential consumers) - 1st year.

3) Consolidation of positions on the market of Tomsk region and expansion to other regions - 2nd year.

4) It is planned to attract 2 000 clients over three years under the optimistic scenario, including IT companies, teachers, and students.

5) Under the optimistic scenario in the 3rd year of the project is planned to involve 240 IT-companies, (monthly fee 10000 rubles) and 20 people teachers (1 year - 10 people, 2nd year - 15 people, 3rd year - 20 people), who will advise and evaluate the students (the average payment 30 000 rubles per month).

6) Initial investment for the development of the IT-platform – 3 000 000 roubles.

7) Personnel costs for the 1st year - 1,080,000 rubles. As the number of users grows, expenses will increase by 15% annually: 2nd year - 1 242 thousand rubles, 3rd year - 1 428 thousand rubles.

Estimation of investment attractiveness of the project by discounted cash flow method.

2. Evaluation of the investment attractiveness of the project using the discounted cash flow method.

The project is long-term, which allows you to use the assessment of future cash flows arising from the implementation of capital investments when assessing its investment attractiveness. The main indicators of the investment attractiveness of the project and their values are presented in Table A.1.

Table A.1 - Indicators of investment attractiveness of the IT-project "UMKA"

	Indicator	Value
1	Net discounted income (NPV)	6853180 rubles
2	Internal rate of return (IRR)	56%
3	Payback period (PP)	3 years 8 months
4	Discounted payback period (DPP)	4 years 1 months
5	Return on investment index (PI)	3,3

Conclusion: NPV = 6 853 180 rubles. UMKA project is profitable under the given conditions and is attractive from an investment point of view.

Appendix B: Estimation of probability of scenarios of IT project development

Table B.1- Criteria importance rating scale

	К1	К2	К3	К4	К5	К6	К7	Average geometric
IT staffing requirements	8	8	9	9	9	9	8	8,55
Quality of services provided on the IT platform	9	8	8	8	8	7	7	7,83
Level of complexity of IT cases presented on the IT platform	7	6	7	7	6	6	6	6,41
Main areas of specialization presented on the IT platform	6	9	6	7	7	8	9	7,33
Amount								30,12

Table B.2 - Evaluation matrix and criterion weight

Criteria Priorities	IT staffing requirements	Quality of services provided on the IT platform	Level of complexity of IT cases represented on the IT platform	Main areas of specialization represented on the IT platform	Average geometric	Weight
IT staffing requirements	1,00	1,09	1,33	1,16	1,13	0,28
Quality of services provided on the IT platform	0,91	1,00	1,22	1,06	1,04	0,26
Level of complexity of IT cases represented on the IT platform	0,74	0,81	1,00	0,87	0,84	0,21
Main areas of specialization represented on the IT platform	0,85	0,93	1,14	1,00	0,97	0,24
Amount					3,98	1,00

Table B.3 - Scenario Criterion №1 Significance Rating

IT staffing requirements	К1	К2	К3	К4	К5	К6	К7	Average geometric
Optimistic scenario	10	9	10	8	7	10	8	8,78
Pessimistic scenario	4	2	3	3	2	2	2	2,48
Amount								11,26

Table B.4 - Scenario Criterion №2 Significance Rating

Quality of services provided on the IT platform	К1	К2	К3	К4	К5	К6	К7	Average geometric
Optimistic scenario	10	8	7	9	8	9	8	8,38
Pessimistic scenario	2	2	1	2	3	2	4	2,12
Amount								10,50

Table B.5 - Scenario Criterion №3 Significance Rating

Level of complexity of IT cases represented on the IT platform	К1	К2	К3	К4	К5	К6	К7	Average geometric
Optimistic scenario	10	8	7	10	8	9	8	8,51
Pessimistic scenario	3	2	4	1	2	2	1	1,92
Amount								10,43

Table B.6 - Scenario Criterion №4 Significance Rating

Main areas of specialization presented on the IT platform	К1	К2	К3	К4	К5	К6	К7	Average geometric
Optimistic scenario	9	9	8	9	8	10	9	8,83
Pessimistic scenario	3	2	2	1	2	4	2	2,12
Amount								10,95

Table B.7 - Matrix of evaluation of criterion №1 on scenarios

IT staffing requirements	Optimistic scenario	Pessimistic scenario	Average geometric	Criterion weight according to the scenario
Optimistic scenario	1,00	3,54	1,88	0,78
Pessimistic scenario	0,28	1,00	0,53	0,22
Amount			2,41	1,00

Table B.8 - Matrix of evaluation of criterion №2 on scenarios

Quality of services provided on the IT platform	Optimistic scenario	Pessimistic scenario	Average geometric	Criterion weight according to the scenario
Optimistic scenario	1,00	3,95	1,99	0,80
Pessimistic scenario	0,25	1,00	0,50	0,20
Amount			2,49	1,00

Table B.9 - Matrix of evaluation of criterion №3 on scenarios

Level of complexity of IT cases represented on the IT platform	Optimistic scenario	Pessimistic scenario	Average geometric	Criterion weight according to the scenario
Optimistic scenario	1,00	4,43	2,11	0,82
Pessimistic scenario	0,23	1,00	0,47	0,18
Amount			2,58	1,00

Table B.10 - Matrix of evaluation of criterion №4 on scenarios

Main areas of specialization represented on the IT platform	Optimistic scenario	Pessimistic scenario	Average geometric	Criterion weight according to the scenario
Optimistic scenario	1,00	4,17	2,04	0,81
Pessimistic scenario	0,24	1,00	0,49	0,19
Amount			2,53	1,00

Table B.11 - Probability of events based on criterion evaluation

	IT staffing requirements	Quality of services provided on the IT platform	Level of complexity of IT cases represented on the IT platform	Main areas of specialization represented on the IT platform	Probability of events
Criterion weight	**0,28**	**0,26**	**0,21**	**0,24**	
Optimistic scenario	0,78	0,80	0,82	0,81	0,80
Pessimistic scenario	0,22	0,20	0,18	0,19	0,20

Appendix C: Calculation of financial indicators of the IT ecosystem "UMKA" and monetization points of its main elements

1. Cost and types of services of the main elements of the IT ecosystem of "UMKA":

1) Staff search service. A potential employer, by purchasing access to the resume database, places a vacancy. The employer gets the opportunity to find a highly qualified employee of suitable competence.

Table C.1- Cost of subscription to the personnel search server, rubles

Access period	Price, rubles.
1 week	9 000
1 month	35 000
3 months	90 000
6 months	130 000
1 year	220 000

2) Freelance Exchange - Teams of freelance development professionals.

Table C.2 - The cost of services on the freelance exchange

Type of service	Cost, rubles/week	Cost, rubles/month.	Cost, rubles/ 3 months
Premium account: Highlighting the account among the others	6000	20000	50000
Featured Extended contacts database	1500	3000	5000

3) Educational online platform in the direction of IT.

The average cost of the course - 50 thousand rubles. Terms of cooperation with course owners: 5-15% of the purchase price of the course for one purchase.

1. Cost of development and technical support of IT - ecosystem "UMKA":

Table C.3 - Fixed costs of the project, rubles

Type of costs	rubles/month	rubles/year
Salaries of six programmers	600 000	7 200 000
Salaries marketer	50 000	600 000
Salaries targeter	50 000	600 000
Salaries three managers	150 000	1 800 000
Rent of space	200 000	2 400 000
Marketing	I half a year - 600 000 II half a year - 400 000	6 000 000
Taxes:		
PIT (13%)	110 500	1 326 000
Insurance premiums (30%)	255 000	3 060 000
Total:	**2 415 500**	**22 986 000**

Table C.4 - One-time costs of the project, rubles

Type	rub.
Purchase of equipment for programmers (computer, table, chair)	600 000
Equipment for managers (computer, table, chair)	350 000
Total:	**950 000**

3. Projected demand for the services and functionality of the IT ecosystem "UMKA":

1) Point of monetization - UMKA as a staff search service. Assume that:

10% of companies buy a weekly subscription (9000 rubles);

10% of companies buy a 1-month subscription (35000 rubles);

30% of companies buy a subscription for 3 months (90000 rubles);

30% of companies buy a 6-month subscription (130,000 rubles);

20% of companies buy a 1-year subscription (220,000 rubles).

2) Point of monetization - UMKA, as a freelance exchange. Assume that:

- 30% of all companies purchase a premium account:

20% of companies purchase a weekly subscription (6,000 rubles);

30% of companies buy a monthly subscription (20000 rubles);

50% of companies buy a subscription for 3 months (50,000 rubles).

- 70% of the total number of companies purchases an extended database:

10% of companies purchase a weekly subscription (1,500 rubles);

20% of the companies buy a monthly subscription (RUR 3,000);

70% of the companies buy a subscription for 3 months (5000 rubles).

3) Point of monetization - UMKA, as an educational online platform in the direction of IT.

The average cost of the course - 50 thousand rubles.

Terms of cooperation: 15-20% of the purchase amount of the course for 1 purchase.

Projected number of purchases - 350 (1 year); 700 (2 year); 1500 (3 year). The average receipt from the purchase of the client course - 7500 rubles.

Table C.5 - Projected demand for courses

Year	Number of course purchases, units
1 year	350
2 year	700
3 year	1500

Table C.6 - Expected cash flow from the project, rubles

Year	Amount, rubles
1 year	34220199
2 year	92736500
3 year	178816500
Total	305773199

4. Financial indicators of investment attractiveness of IT-ecosystem "UMKA".

The discount rate to calculate the cost of the project is defined by cumulative method. As a risk-free rate adopted the yield on government bonds with a maturity of four years. Number of the current issue RU25063TMSO, annual coupon rate - 7.7%:

$$r_{эф} = (1+ \text{гн} /100*4)^4 = (1+7,7/100*4)^{4\,=}\ 00,079252$$

Rэф=7,92%

To determine the risk premium, let's consider the types of risk according to the metamodel, where depending on the parameters of the project, the total risk premium will be estimated. In this case, the risk premium for each type of risk = 2%. Inflation in RF at the end of 2020 will be 5.19%.

Table C.7 - Types of risk and risk premium

Type of risk	Risk premium, %
Consumer risks	2
Customer risks	2
Market risks	2
Total	6

Rdisk. = R bezr. + Rrisk + Rinf. = 7,92 + 6 + 5,19= 19,11%

Table C.8 - Indicators of project investment attractiveness

Indicator	Value
Net discounted income (NPV)	148 626 936 rub.
Payback period (PP)	2,5
Discounted payback period (DPP)	1 year 2 months
Return on investment index (PI)	1 year 5 months

Calculation of the net present value of the project (NPV):

$$NPV = (-60\,000\,000) + \frac{42\,206\,500}{(1+0{,}19)} + \frac{93\,936\,500}{(1+0{,}19)^2} + \frac{180\,016\,500}{(1+0{,}19)^3} = 148\,626\,936 \text{ rub.}$$

Calculation of the project profitability index (PI):

$$PI = \frac{148\,626\,936}{60\,000\,000} = 2{,}5$$

Payback period (PP) = 1 year 2 months

Discounted Payback Period (DPP) = 1 year 5 months.

Assessment of the IT ecosystem "UMKA" and monetization points of its main elements showed that its investment attractiveness is much higher than the investment attractiveness of the educational IT platform "UMKA":

The NPV value of the IT - ecosystem "UMKA" is 20 times higher than the educational IT - ecosystem "UMKA"; and the payback period is 3 times less.

It is advisable for the company to make adjustments to the project, taking into account the IT market and demand for IT services.

Appendix D: Black - Scholes model calculation

Table D.1- IT platform "UMKA" with a switching option

Parameter	Financial option	Real option	Value	Unit of measure	
Asset value	S	CF	154 364 047	million rubles	
Volatility	σ		6,15	%	0,0615
Execution price	X	Investment costs	3 950 000	million rubles	
Period	T		3	years	
Risk-free rate	r	Rate on TO bonds	0,1392	%	0,1392

ln (so/x)	3,644892872	(r+σкв/2)*T	0,19832608	σ√T	0,10652
d1	36,07940644				
N(d1)	1				
d2=d1-σ√T	35,97288532				
N(d2)	1				
C =N(d1)*S0-N(d2)*Xe-rT	**150 485 059**	руб.			

Table D.2 - IT platform "UMKA" with the exit option

Parameter	Financial option	Real option	Value	Unit of measure	
Asset value	S	CF	25 770 522,00	million rubles	
Volatility	σ		6,15	%	0,0615
Execution price	X	Investment costs	3 000 000	million rubles	
Period	T		3	years	
Risk-free rate	r	Rate on TO bonds	0,1392	%	0,1392

ln (so/x)	2,150618992	(r+σкв/2)*T	0,19832608	σ√T	0,10652	
d1	22,05144829					
N(d1)	1					
d2=d1-σ√T	21,94492716					
N(d2)	1					
C=N(d1)*S0-N(d2)*Xe-rT	**22 824 455,55**	руб.				

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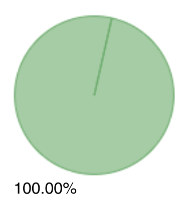

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