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V. KOSENKO

DECISION SUPPORT SYSTEM IN PLANNING INVESTMENT PROJECTS

The **subject matter** of the study is the processes of planning investment projects for the development of organizations. The **goal** of this article is to develop an algorithm and software product of the decision support system to select the method of attracting investment project funds. The following **tasks** were solved in the article: the model of complex planning was studied and the investment project was implemented, the method of selecting an optimal variant of investment project implementation was developed, the elements of the decision support system to select the investment method were specified. The following **methods** were used: the system analysis, the project approach, plural theoretical models, the heuristic methods of selection, production rules. The following **results** were obtained: it is shown that the efficiency of the investment process is related to the assessment and selection of the most attractive investment projects from a number of alternatives, which will provide the maximum profit in the future; the strategic tasks of investing in the development of organizations and enterprises are singled out; the main finances that can be involved in carrying out an investment project are considered; the concepts of an investment project, a subject and an object of the investment activity were defined; the above concepts were formalized using the theory of sets and the system approach; the basic conditions under which the project should be implemented are formulated; the generalized diagram of the investment project implementation is developed. While developing the method of selecting the optimal variant of the investment project, the types of source information about the project and the organization which will use the finances are involved are determined. The rules for selecting the preferred variants for attracting investment depending on project factors are presented as a table. The generalized iterative algorithm for selecting the method of investing is built. The main dialogue forms of the user interface of the decision support system are considered. **Conclusions.** The application of the proposed method and decision support system at the planning stage of the investment project will enable making sound decisions regarding the selection of an investment method depending on the main factors of the project and the object of investment.

Keywords: investment project; decision making; ways of financing; variant selection; user interface.

Introduction

Modern issues of the investment management are related to the need to implement unified principles of management at different levels of manufacturing and sales of products and services. Financial management in project management requires long-term decisions that are part of a development strategy and are based on the predictive assessment of project costs and revenues [1, 2].

Under modern economic conditions, an enterprise acting through its owners and senior management should take care of its future by solving all its strategic and tactical issues independently. Such activities in the field of investment planning should be specially organized and primarily depends on the policy of financial activity in the enterprise.

The issues of system optimization of investment projects

To determine the optimal directions of capital investments and to identify the most efficient ways of using it for a sufficiently long period of time, the investment strategy should be developed and successfully implemented. Decisions are identified and justified, alternatives to determine and assess the strategy are selected on the basis of the strategic analysis of the investment activity [3 – 5].

To manage investment projects, the situational approach is used. It involves making a decision on the basis of the situational analysis, which includes the preparation of a number of analytical methods, techniques and management mechanisms in case of the change of conditions in the future or under new situations that are different from the basic forecast ones [6].

While calculating the investment efficiency it is recommended taking into account the uncertainty associated with the probability of unfavourable situations and consequences in the course of project implementation [7]. The assessments of the investment project efficiency are based on the understanding risk as a probability of negative deviations and involve the use of non-average but moderately pessimistic estimates of indicators while creating the baseline scenario of project implementation.

To optimize decisions on an investment project, a financial-economic mechanism is used that includes the procedure for selecting indirect incentive methods and instruments (state-regulator) or direct financial support for investment activity of enterprises (state-investor) [8].

Problem statement

The efficiency of the investment process is related to the assessment and selection of the most attractive investment projects from a number of alternatives that will provide the future maximum profit.

Under actual management conditions, an investor has to consider a lot of investment issues related, for example, to the distribution of limited investment resources, to the assessment of investment projects both with the same and different terms of implementation. But a firm itself selects acceptable conditions for the implementation of investment projects, basing on its own financial management, perspective financial planning and overall financial policy, including the development of the entire organization.

But today there is no method that would enable assessing the efficiency of the investment project, taking into account different variants for attracting funds under different financing patterns and different scales of project objectives.

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The goal of the article is to develop an algorithm and software product of the decision support system to select the way of attracting the investment project funds. The following tasks are solved in the article:

1. The model of complex planning is studied and the investment project is implemented.

2. The method of selecting an optimal variant of investment project implementation is developed.

3. The elements of the decision support system to select the investment method are specified.

Models of complex planning on investments projects

Let us list the strategic investment objectives [9]:

- substantiating the investment project practicability;
- selecting the optimal project from possible alternatives;
- assessing the efficiency and ensuring the profitability of a project over a certain period;
- finding ways, means and reserves to maximize the investment efficiency.

To get a complex updated project plan, the budget of the project implementation should be calculated first, then the sources of investment financing should be selected and analyzed, the amount and patterns of financing should be determined, the project implementation should be simulated taking into consideration the probability of risky situations [10].

Consider the main types of funds that can be involved in implementing an investment project of an organization (enterprise):

1) internal funds – finances of an organization and its intercompany reserves;

2) loaned funds – finances attracted by selling shares or obtained as share contributions and other contributions of members of labour collectives, citizens, legal persons;

3) external funds:

- funds that are in the centralized possession of business associations;
- funds of extra-budgetary funds;
- funds of the State Budget;
- funds of foreign investors [11].

Let us note that own financial resources of an organization are used most often to finance small innovative development projects (to introduce the system of quality standards, to upgrade certain types of equipment, to modify products, etc.). Loaned funds involve payment for using with interest or without payment [12].

Making decisions to invest also depends on the size and sectoral affiliation of a company. Thus, portfolio investors are focused on obtaining a trading profit, therefore, they mainly invest in the shares of large enterprises [13].

Leasing is a type of financing fixed assets. In case of the operational lease, any property that can be attributed to fixed assets is leased. In case of financial lease, fixed assets are also leased but they are leased through special financial companies that act as a mediator between an owner and a renter paying the amount for the leased property to the owner immediately, while the renter pays lease payments to the financial company during the entire term of leasing [14].

To determine the sources and methods of financing investments, the following concepts should be singled out – an investment project, a subject and an object of the investment activity. Let us formalize the above concepts using the set theory and the system approach.

An investment project (IP) is understood as an investment activity that involves a number of measures (works) on an object that is in the state S0. A set of works on the project is designated as $U = \{U_i\}$. This refers to the use of a certain amount of financial resources from various sources. A set of financial sources is designated as $R = \{R_i\}$. To obtain the planned result – to change S_0 state for S_k state for achieving a certain goal Ω, a time period is given, that is the project term *T*.

Therefore, in the context of the general theory of systems, the investment project can be represented as the following model:

$$IP = \{\Omega, U, S_0, S_k, R, T\}. \quad (1)$$

The goal of the investment project Ω is to obtain the main financial result – profit *P* and a tangible result will be new or renovated key assets, that is the object state S_k.

Investments can be expressed both in the monetary equivalent If an as fixed, tangible, intangible and other types of assets Im.

The objects of the investment project are newly created and upgraded funds and current assets in all branches and spheres of economic activity, paper holdings, scientific and scientific and technical products and so on.

The subjects of the investment project, a set of which is designated as $V = \{V_m\}$, $m = 1..M$, are investors, є customers, work performers, project team, users of investment objects, as well as suppliers and legal persons.

Let us consider the investor V1 as the main subject of the investment project who invests own, borrowed and attracted funds and ensures their intended use by Ω. Customers V2 can be investors or other persons authorized to implement the investment project. The user of investment activities objects V3 can be an investor, organization, enterprise or other persons for whom an investment activity object is created.

The project must be implemented under the following conditions:

1) investment dynamics *I* (*t*) should provide the implementation of the project according to the term of the project *T* and financial constraints – profit *P* (*t*):

$$I(t): S_0 \to S_k | T, P(t); \quad (2)$$

2) the goal of the investment project Ω is to obtain the main financial result – profit and the tangible result S_k will be new or renovated key assets;

3) the maximization of profit $P \to$ max and risk reduction $Ri \to$ min of the project should be ensured by the appropriate structure and funding sources *VI* = {*Vi*}

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and certain organizational measures throughout the project $U(t)$.

Taking into consideration the above, the generalized diagram of the investment project implementation can be presented as follows (fig. 1):

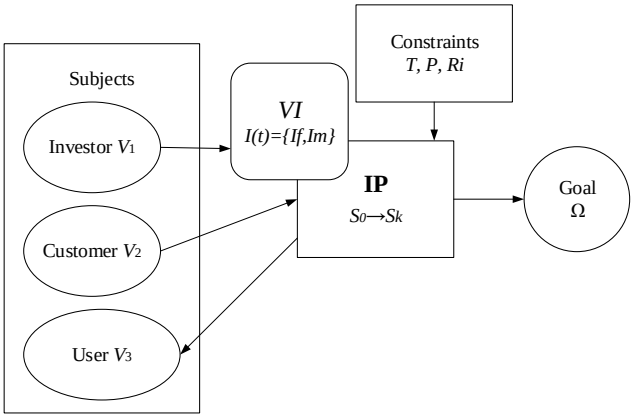

Fig. 1. The generalized diagram of the investment project implementation

The method of selecting the best variant for implementing the investment project

To determine the variant of investment attracting, information about a type of the organization resource shortage (that will be compensated financially), the necessary rate of financing and the levels of planning will be used [15]:

1) $R = Y$ – technological shortage; $R = Z$ – facilities shortage (equipment); $R = E$ – personnel shortage (labour resources); $R = M$ – the shortage of organizational resources (for management);

2) D = 1 – an advance plus payment at the end of the investment period; D = 2 – the receipt of funds at the beginning of the period; D = 3 – the receipt of funds at the end of the period; D = 4 – progress payment;

3) $T = d$ – a long-term project, $T = s$ – a medium-term project, $T = k$ – a short-term project, $TV = g$ – single investment.

The considered investment variants are presented in Table 1. The table shows the best investment variants depending on the values of the three project factors above. "1" means that the investment method can be used for a given factor value, "0" means that the method cannot be used. Based on the table, the production rules for making decisions on attracting funds are worked out.

The generalized algorithm for selecting the investment method is presented in fig. 2.

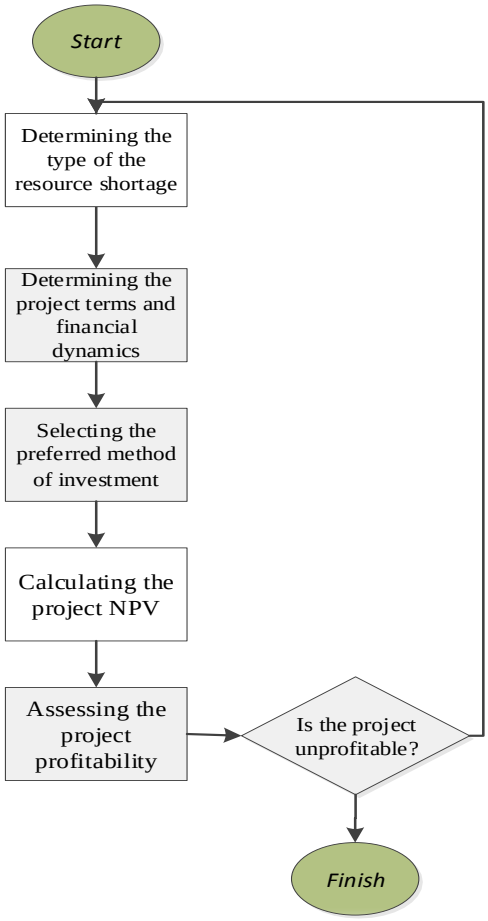

Fig. 2. The algorithm for selecting the investment method

Table 1. *The preferred options for attracting investment depending on the factors of the project*

Investment attraction method	Resource type, R				Planning level, T				Financial dynamics, D			
	Y	Z	E	M	d	s	k	g	1	2	3	4
1. Long-term loan	1	1	1		1	0	0	0	1	0	1	1
2. Instalment buying	0	1	0	0	1	1	1	1	1	0	1	1
3. Long-term lease	0	1	0	0	1	0	0	0	1	1	1	1
4. Medium-term loan	1	1	1	0	0	1	0	0	1	0	1	1
5. Medium lease		1	0	0	0	1	0	0	1	1	1	1
6. Short-term loan	0	0	1	1	0	0	1	1	1	1	1	1
7. Overdraft	0	0	0	0	0	0	0	0	0	1	0	1
8. Long-term shares	1	1	0	0	1	0	0	0	1	0	1	0
9. Long-term bonds	1	1	0	0	0	1	0	0	1	0	1	0
10. Short-term shares	0	1	0	0	0	0	1	0	1	0	1	0
11. Long-term bonds	1	1	0	0	1	0	0	0	1	0	1	0
12. Medium-term bonds	0	1	1	0	0	1	0	0	1	0	1	0
13. Short-term bonds, summer bonds	0	1	1	1	0	0	1	1	1	1	1	1

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The user interface of decision support system (DSS)

The basic components of the suggested system are the interface "user-system", database and the base of models (rules).

The interface "user-system" provides the connection of a user with each base and includes the software to manage the database, the base of models as well as to manage and generate the dialogue.

The user indicates the shortage value (in relative terms, for example, percentage), selects the level of planning and the dynamics of financing (fig. 3).

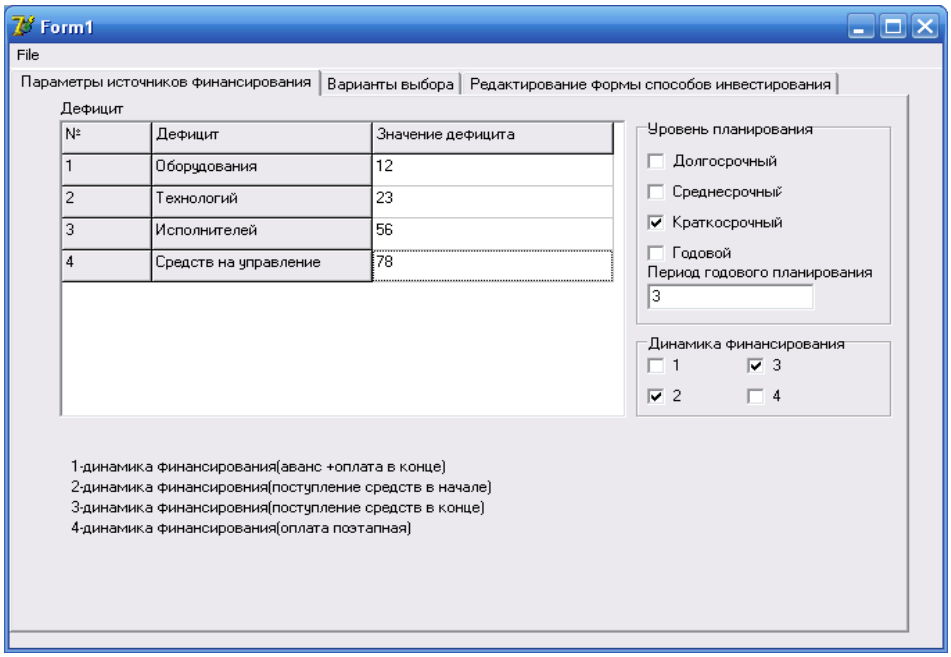

Fig. 3. Entering data on the organization and project parameters

Fig. 4 shows the dialogue interaction that includes the system of rules for certain investment methods. The system administrator can add or delete particular methods or correct the system of rules.

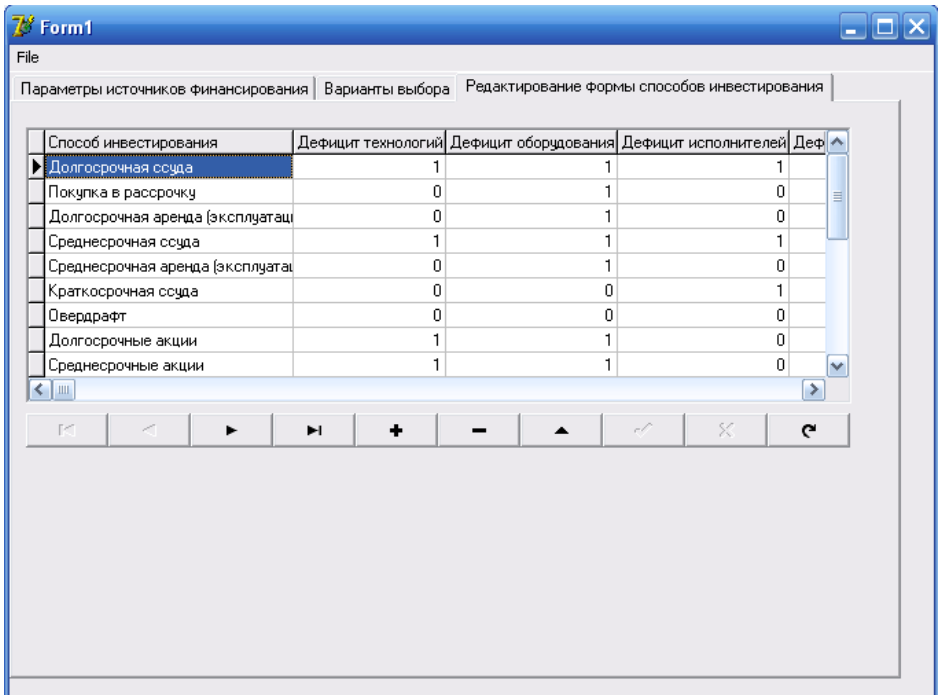

Fig. 4. Editing the investment forms and methods

Depending on the selection of parameters (chosen in fig.3), probable (recommended) financial methods are given in fig.5. The project performance indicator is approximately calculated at the final step of the suggested method (in the form of NPV – the values of discounted cash flow taking into consideration a certain capital structure). For this, the volume of the investment flow, the payment date and the discount rate must be set.

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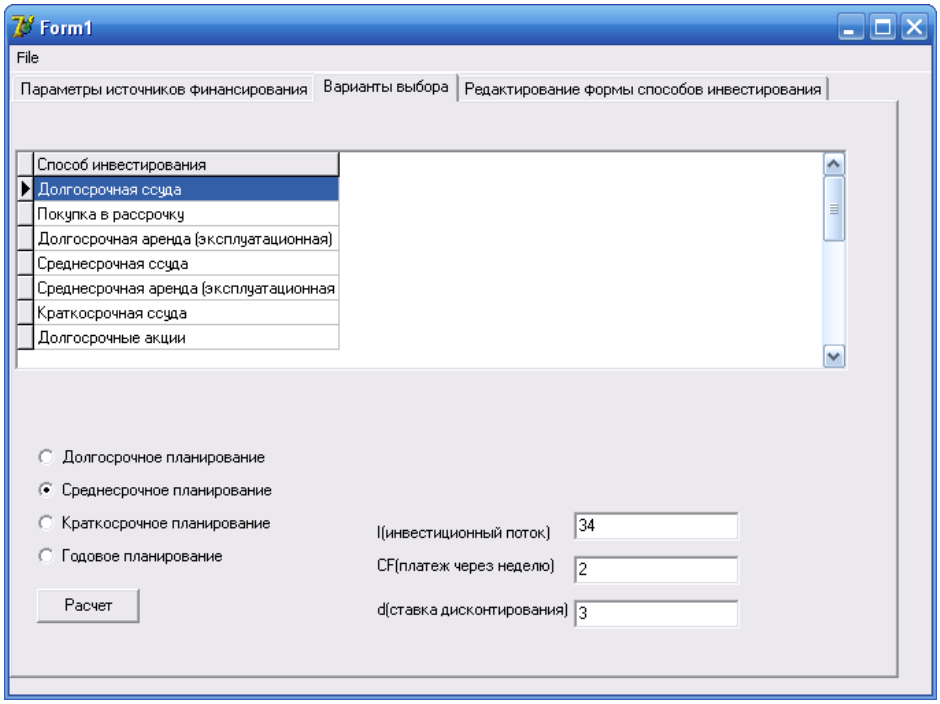

Fig. 5. Selecting the investment methods

Conclusions

The article deals with the issues and existing methods of the system optimization of investment projects. It is shown that the efficiency of the investment process is related to the assessment and selection of the most attractive investment projects from a number of alternative projects that would provide the maximum profit in the future.

The strategic tasks of investing in the development of organizations and enterprises are singled out. The main finances that can be involved in carrying out an investment project are considered. The concepts of an investment project, a subject and an object of the investment activity are defined. The above concepts are formalized using the theory of sets and the system approach. The basic conditions under which the project should be implemented are formulated. The generalized diagram of the investment project implementation is developed.

While developing the method of selecting the optimal variant of the investment project, the types of source information about the project and the organization which will use the finances are involved are determined. The rules for selecting the preferred variants for attracting investment depending on project factors are presented as a table. The generalized iterative algorithm for selecting the method of investing is built.

The main dialogue forms of the user interface of the decision support system are considered.

Applying the proposed method and decision support system at the planning stage of an investment project will enable making sound decisions relating the selection of an investment method depending on the main factors of the project and the investment object.

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Відомості про авторів / Сведения об авторах / About the Authors

Косенко Віктор Васильович – доктор технічних наук, доцент, Державне підприємство "Харківський науково-дослідний інститут технології машинобудування", директор, Харків, Україна; e-mail: kosv.v@ukr.ua; ORCID ID: https://orcid.org/0000-0002-4905-8508.

Косенко Виктор Васильевич – кандидат технических наук, доцент, Государственное предприятие "Харьковский научно-исследовательский институт технологии машиностроения", директор, Харьков, Украина.

Kosenko Viktor – Doctor of Sciences (Engineering), Associate Professor, State Enterprise "Kharkiv Scientific-Research Institute of Mechanical Engineering Technology", Director, Kharkiv, Ukraine.

СИСТЕМА ПІДТРИМКИ ПРИЙНЯТТЯ РІШЕНЬ В ПЛАНУВАННІ ІНВЕСТИЦІЙНИХ ПРОЕКТІВ

Предметом дослідження є процеси планування інвестиційних проектів розвитку організацій. **Метою** даної статті є розробка алгоритму та програмного продукту системи підтримки прийняття рішень по вибору способу залучення коштів інвестиційного проекту. В статті вирішуються наступні **завдання:** дослідження моделі комплексного планування та реалізації інвестиційного проекту, розробка методу вибору оптимального варіанта реалізації інвестиційного проекту, розробка елементів системи підтримки рішень по вибору способу інвестування. **Методи**, що застосовуються: системний аналіз, проектний підхід, теоретико-множинні моделі, евристичні методи вибору, продукційні правила. Отримано такі **результати**. Показано, що ефективність інвестиційного процесу пов'язана з оцінкою і вибором найбільш привабливих інвестиційних проектів з ряду альтернативних, які забезпечували б у майбутньому максимальний прибуток. Перелічено стратегічні завдання інвестування розвитку організацій та підприємств. Розглянуто основні види коштів, що можуть бути залучені для виконання інвестиційного проекту. Визначено поняття: інвестиційний проект, суб'єкт і об'єкт інвестиційної діяльності. Проведено формалізацію вказаних понять з використанням теорії множин і системного підходу. Сформульовано основні умови, за яких має бути реалізований проект. Розроблено узагальнену схему реалізації інвестиційного проекту. При розробці методу вибору оптимального варіанта реалізації інвестиційного проекту визначено види вихідної інформації про проект та організацію, для якої залучаються кошти. Правила вибору переважних варіантів способу залучення інвестицій в залежності від факторів проекту подано у вигляді таблиці. Сформовано узагальнений ітераційний алгоритм методу вибору способу інвестування. Розглянуто основні діалогові форми інтерфейсу користувача системи підтримки прийняття рішень. **Висновки**: застосування запропонованого методу та системи підтримки прийняття рішень на етапі планування інвестиційного проекту дозволить приймати обґрунтовані рішення щодо вибору способу інвестування в залежності від основних факторів проекту та об’єкту інвестування.

Ключові слова: інвестиційний проект; прийняття рішень; способи фінансування; вибір варіанту; інтерфейс користувача.

СИСТЕМА ПОДДЕРЖКИ ПРИНЯТИЯ РЕШЕНИЙ В ПЛАНИРОВАНИИ ИНВЕСТИЦИОННЫХ ПРОЕКТОВ

Предметом исследования являются процессы планирования инвестиционных проектов развития организаций. **Целью** данной статьи является разработка алгоритма и программного продукта системы поддержки принятия решений по выбору способа привлечения средств инвестиционного проекта. В статье решаются следующие **задачи**: исследование модели комплексного планирования и реализации инвестиционного проекта, разработка метода выбора оптимального варианта реализации инвестиционного проекта, разработка элементов системы поддержки решений по выбору способа

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инвестирования. **Методы**, которые применяются: системный анализ, проектный подход, теоретико-множественные модели, эвристические методы выбора, продукционные правила. Получены следующие **результаты**. Показано, что эффективность инвестиционного процесса связана с оценкой и выбором наиболее привлекательных инвестиционных проектов из ряда альтернативных, которые обеспечивали бы в будущем максимальную прибыль. Перечислены стратегические задачи инвестирования развития организаций и предприятий. Рассмотрены основные виды средств, которые могут быть привлечены для выполнения инвестиционного проекта. Определены понятия: инвестиционный проект, субъект и объект инвестиционной деятельности. Проведено формализацию указанных понятий с использованием теории множеств и системного подхода. Сформулированы основные условия, при которых должен быть реализован проект. Разработана обобщенная схема реализации инвестиционного проекта. При разработке метода выбора оптимального варианта реализации инвестиционного проекта определены виды исходной информации о проекте и организации, для которой привлекаются средства. Правила выбора предпочтительных вариантов способа привлечения инвестиций в зависимости от факторов проекта представлены в виде таблицы. Сформирован обобщенный итерационный алгоритм метода выбора способа инвестирования. Рассмотрены основные диалоговые формы интерфейса системы поддержки принятия решений. **Выводы**: применение предложенного метода и системы поддержки принятия решений на этапе планирования инвестиционного проекта позволит принимать обоснованные решения по выбору способа инвестирования в зависимости от основных факторов проекта и объекта инвестирования.

Ключевые слова: инвестиционный проект; принятие решений; способы финансирования; выбор варианта; интерфейс.