

This work considers the optimization and development of business processes in investment. The conditions for the digitalization of the economy actualize the issue of introducing information technologies at all its levels and links. It is proved that information technology is an effective tool for reducing the time for the implementation of individual business processes and in investment. Its use expands the possibilities of exchanging information and its dissemination to the general public, improves the quality of investment tasks and the objectivity of investment decision-making results. Experimental studies have confirmed that the result of its application is the efficiency of obtaining, processing, and analyzing information when making management decisions. The visual content of the results of investment analysis, obtained using automation technologies, facilitates the perception of information, improves the quality of its transmission, and the value of ideas. The continuous development of information technologies in the field of investment is the basis for further scientific and practical research in this area. Based on such considerations, the feasibility of modifying the methodical toolkit of financial calculations in the process of analyzing the effectiveness of investment implementation is justified. Models of the modified internal rate of return on investment and the rate of return on financial management are proposed. Based on their definition, the objectivity of evaluating investments increases, the effectiveness of cash flow management during their implementation is proved. Strengthening the manifestation of crisis phenomena actualize the study of the nature of the occurrence of risks and the degree of their controllability. The approach to assessing investment risks using the β coefficient, the calculation technology, which is a universal tool for assessing the impact of systemic risks at the macro and micro levels, is substantiated

Keywords: *business processes in investment, information technology, rate of return, financial calculations, β coefficient*

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1. Introduction

A full-scale war in Ukraine is reflected in its economy by significant losses, from which all types of business suffer. The consequences of the war include [1]:

- decrease in demand for products of Ukrainian companies by 75 %;
- funding crisis. 40 % of companies need working capital, which they lack due to the almost complete cessation of bank lending. 36 % of enterprises are actively looking for funding. The program “Affordable Loans at 5–7–9 %” was used in 2022 by only 4 % of the surveyed companies;
- logistical problems due to significant destruction of infrastructure. 44 % of enterprises experience difficulties related to logistics and transportation.

Moreover, this is not a complete list of the problems faced by Ukrainian business. The fact is the axiom in which the restoration, functioning, and further formation of the economy will depend on investment. Noting the scale of risks that may accompany the processes of investment implementation in Ukraine, the civilized world does not give up the

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OPTIMIZATION OF BUSINESS PROCESSES IN INVESTMENT USING AUTOMATION TECHNOLOGY, FINANCIAL CALCULATIONS, AND RISK ASSESSMENT METHODS

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opportunity to invest in the reconstruction of the economy. According to the Ministry of Economy of Ukraine [2], the steps to attract foreign capital included:

- development of a unique electronic platform Advantage Ukraine, which brings together more than 500 investment projects and opportunities in 10 sectors of the economy;
- Ukraine received USD 30 million from the Multilateral Investment Guarantee Agency (MIGA), which belongs to the World Bank Group, for the implementation of a project to insure investments during the war;
- AT AKB Lviv raised USD 15 million from the US Development Finance Corporation (DFC) and the United States Agency for International Development (USAID) to cover the credit risks of Ukrainian business;
- On December 12, 2022, the Cabinet of Ministers in Paris signed an agreement with a division of the World Bank Group, IFC Corporation, which would become a strategic adviser, supporting the government in creating conditions for increasing private sector investment for reconstruction purposes;
- The European Bank for Reconstruction and Development invested EUR 1.7 billion in Ukraine in 2022 and

mobilized another EUR 200 million through partner banks under the EUR 3 billion support program for Ukraine by the end of 2023.

Efficient and effective actions for the development of potential investments actualize the need for generalization and systematization of technological, analytical, informational, economic, mathematical, and methodological tools for the implementation of business processes in investment. Along with the Russian aggression, the Ukrainian business environment received restrictions on the use of business process support software, for example, “1C: Entrepreneurship”, “Alt-invest”, “ProjectExpert”. On the other hand, it prompted the creation and introduction of purely Ukrainian products and the expansion of opportunities for foreign proposals to automate business processes in investment. Thus, investment processes, despite the difficult economic situation of the country during military aggression, do not disappear as a type of economic activity but continue their development. New platforms are being designed, the market for investment products and access to them is expanding, both in the country itself and abroad.

The dissemination of investment proposals requires the improvement of methods, approaches, and tools for managing them. Optimization of business processes in investing implies perfection, improving quality and efficiency, reducing the cost of time and resources. This is an intensive path of development, which aims to change a number of methods and technologies for performing work by investment specialists, under the influence of which the order, rules, instructions for the implementation of their competencies change. The decisive place in the investment process is given to the stages of initiation and proving the expediency and efficiency of investment implementation. These are the stages during which decisions are made whether an investment process is to start. The needs for investment capital are determined, forecasts are formed regarding future cash receipts, and sales risks are assessed. Thus, automation of the processes of obtaining an analytical and information base for making an investment decision reduces the time for its receipt. Improving technologies and methods for determining key indicators of investment efficiency and risk parameters increases its validity and quality. Some types of investment risks are difficult to avoid or minimize. Nevertheless, the possibilities of their evaluation provide advantages in adapting to their impact in the implementation of investments.

2. Literature review and problem statement

Automation of investment decision-making processes is not a new phenomenon and has a significant number of technologies developed and implemented in business processes. An exhaustive list of such software packages, with the definition of their advantages and disadvantages and opportunities for adaptation of use in the conditions of Ukrainian legislation, is covered in works [3, 4]. It should be noted that the relevance of the introduction of many of them is lost due to the country affiliation of their developers. Other limitations are used for planning and developing only large investment projects. It should be noted that the above sources do not provide recommendations for a clear choice of software system for work. Many of them are offered only on

a commercial basis, which narrows the possibilities of assessing their functionality and usability.

Among the well-known foreign software products for investment design is the COMFAR program (UNIDO). This is a universal tool for describing and calculating the key positions of the business plan of an investment project. With the help of this software product, the processes of calculating the investment costs of the project, the cost of production, the benefits and costs of the project, indicators of its effective implementation are automated. The disadvantage of its use is the complexity of working with the program interface, closed algorithms for calculating indicators, the high cost (more than USD 4000).

From the point of view of automating the scheduling processes of the project implementation, the Microsoft Office Project software has been widely used. It has the functions of planning the workload of labor resources and costs, as well as monitoring the progress of work. The disadvantage is the lack of ready-made tools for drawing up operational and financial plans for the project.

Programs that contribute to the automation of portfolio project management processes are Welcom Suite (a single integrated database system for a set of projects), Artemis (a system for supporting the selection of investment projects), IBM SPSS Modeller (data preparation and detection system, predictive analytics, and model management). The practice of using the IBM SPSS Modeller software product is given in [5], considering the application of predictive analysis methods in investment decision-making processes. Decisive for these software products is the scope of their application, namely for the needs of decision-making in the field of management of a large number of projects.

The importance and necessity of improving the methodological support of investment activities through the automation of investment decision-making processes is indicated by the author of work [6]. According to the results of the study, he concludes that when choosing a software product, it is advisable to take into account that for certain purposes of analyzing investment decisions, all the tools of certain software products are not needed. The purchase of software products with optimal functionality will save on their cost. It is impossible not to agree with this conclusion and it is advisable to choose as a criterion for optimizing investment processes in terms of automating decision-making.

Studies [7, 8] into the use of information technology in investment processes consider robotic financial management. Such management involves the introduction of artificial intelligence into traditional financial consulting services instead of a person who helps clients manage financial affairs. But in [7] more attention is paid to the technical features of the functioning of “robo-consultants”. The problem of minimizing the risks of decision-making made on the basis of artificial intelligence advice is being solved. Work [8] analyzes the effect of the advice of “robo-consultants”, which consists in improving the individual investment decision. However, issues regarding the regulation of financial information in the network space remain underdeveloped. The objective reason for preventing the introduction of robo-consultants in investment activities is the strengthening of the psychological obstacles of the investor. The Ukrainian investment

market has also faced certain limitations in the use of artificial intelligence when making investment decisions. The first investment robo-platform was launched in 2020, so, its short operating time is accompanied by a cautious and distrustful state to its application. Therefore, the solution of the issue of automation of investment decision-making processes is justified by the use of software products that create the basis of the analytical and information base for their adoption.

Investment activity plays a decisive role in ensuring the development of a business entity. When reviewing scientific works that address issues of strategic development, not always due attention is paid to the investment activity of a business entity. Thus, in work [9], the authors make a significant contribution, revealing the techniques and methods of strategic management. As a result, we have an effective economic and mathematical toolkit for optimizing management processes from the standpoint of identifying and overcoming risky factors in the activities of business entities. It is determined that the profitability of the activity of a business entity depends on the state of the real value of the property. However, little attention, in the formation of its development strategy, is paid to effective investment measures that ensure the growth of the production potential of the business entity. Compliance of the existing management system, the company's investment management itself, the strategic directions of its development, is covered by the authors of article [10]. It is recommended to evaluate the investment management system of the enterprise by an expert method. With this approach, its effectiveness can be assessed; the level of their own views on management activities; availability of personnel potential of investment management; use the company's management system to improve internal standards. However, in the study, preference is given to a qualitative assessment of the investment management system. Quantitative indicators that determine the amount of need for investment resources, optimization of sources of their formation, minimization of the manifestation of risks of investment activity through the assessment of the probability of their occurrence are not taken into account.

Quantitative analysis of the effectiveness of the investment management system of business entities is considered in work [11]. The authors substantiate the significance of estimating the temporal, spatial, and value consistency of cash flows from operating and investment activities. The emphasis for this kind of analysis was made on the absolute performance indicators of business entities, namely the net cash flow studied in dynamics. This does not take into account the influence of relative indicators of changes in the value of cash flow under the influence of time factors. Classical approaches to assessing the effectiveness of investment implementation related to various spheres of economic activity are proposed for use in works [12, 13]. The authors make a significant contribution to the development of methodological tools for evaluating the parameters and criteria for the effectiveness of investment implementation. Work [12] is aimed at justifying the feasibility of obtaining an additional effect from the energy efficiency of investment real estate. Work [13] substantiates the value of the discount rate for the effectiveness of investment implementation. Among these works, the effect of rational financial management of

net cash income from investments remains insufficiently taken into account.

The works that consider the analysis and assessment of investment risks [14–17] are multifaceted from the standpoint of identifying the factors of their manifestation and are saturated with diverse theoretical and methodological support. From the standpoint of making an investment decision, in article [14], attention is paid to such a group as psychological factors. On the basis of factor analysis, a hypothesis is proved about the positive impact of the effect of risk perception and negative – risk appetite. At the same time, the authors of article [14] emphasize the need to take into account other factors of manifestation of investment risks but do not investigate them in their work. As part of financial risks, investment risks and their identification at the macro-, meso-, and microeconomic levels are investigated in [15]. We get a powerful toolkit for diagnosing risks with the possibility of further justification of the feasibility of using a larger range of investment risks in assessing a larger range of investment risks. On the one hand, the use of different approaches to determining the level of manifestation of risk factors justifies the objectivity of their assessment, on the other hand, complicates the process of their analysis for each level of the economic system. Article [17] reveals the issues of analysis and assessment of investment attractiveness at the level of the state and region according to the criterion of environmental and economic efficiency. It is decisive that the analysis is based on ten indicators for determining the investment attractiveness of the region. However, the assessment economic risks is carried out through the determination of the share of profitable enterprises in the region. From the standpoint of taking into account the life cycle of an enterprise, the global manifestation of force majeure circumstances of the external environment, the unprofitability of activities in a separate period does not argue the level of its riskiness.

Intelligent information systems and technologies contribute to the automation of investment decision-making processes. With the help of their application, time is reduced and the process of choosing the optimal solution is simplified. The large number of software applications sets the task for the analyst to choose those that will give the maximum effect from the use of their capabilities. Functionality, availability, and effectiveness of the use of some of them gives rise to the presence of unresolved problems.

Our analysis of literary sources reveals that the issues of optimization of business processes in investment, for the most part, are considered from the standpoint of creating conditions for investment through the achievement of a high level of investment attractiveness of the object. The results of how investment decisions to automate production processes lead to their efficiency are determined. Either separately organizational, or technical, or analytical measures to improve the investment process are being improved.

Therefore, there is reason to believe that ensuring the optimization and development of business processes in investment is not limited to the improvement of a separate subprocess. A set of actions to improve the quality of the investment management system based on the systematization of methods, tools, and technologies for their implementation is subject to improvement. As a result, their efficiency, validity, and objectivity increase, strategic directions for

minimizing risks on the way to optimizing the effect of investments are determined.

3. The aim and objectives of the study

The aim of this study is to optimize business processes in investing using automation technologies, financial calculations, and risk assessment methods. This will provide an opportunity to improve the investment management system, contribute to improving quality and efficiency, reducing the time and resource spent.

To accomplish the aim, the following tasks have been set:

- to analyze the development of automation technologies for the processes of development, maintenance, and implementation of investments;
- to substantiate the methodological tools for the implementation of financial calculations in the process of analyzing the effectiveness of investment implementation;
- to modernize the list of investment risks and propose methods for their assessment.

4. The study materials and methods

The object of our research is business processes in investment. The subject is information, technological, and methodological-practical tools for the implementation, support, analysis, and evaluation of investment projects.

National programs to support and develop investment processes [2, 18] became the basis for the study of methods for optimizing business processes in investment, the purpose of which is to ensure the efficiency and efficiency of potential investment. Global development trends in the formation of the digital economy of many countries of the world, by optimizing business processes, determine the introduction of information technologies in all areas of activity. The diversity and variety of investment support software: ProjectExpert, COMFAR, Invest for Excel, Microsoft Office Project, Welcom Suite, Artemis, IBM SPSS Modeller, Robo-advisors, Investment Tracker, etc., formed the need to justify the expediency of their application, depending on the needs and capabilities of the investor.

The experience and existing justified shortcomings [19, 20] in the use of a generally accepted set of criteria for proving the effectiveness of investment adoption indicate the need to expand the methodological tools of financial calculations of the effectiveness of investments.

The emergence and strengthening of the manifestation of global risks in the economic environment caused by the consequences of the COVID-19 pandemic, military aggression, natural disasters, requires their consideration and evaluation in the implementation of investments.

The study was conducted at the theoretical and empirical levels using the following methods. When studying the essence and patterns of development of information technologies for optimizing business processes in investment – abstract-logical and system analysis: when proving the need to use digital technologies – applications «Diia», MS Excel (USA), and software product of DataPartner (Finland) – Invest for Excel.

Tools of financial mathematics based on methods of discounting and compounding cash flows are used in models for determining the rate of return on investment.

The method of analogy and modification is used to substantiate methodological approaches to assessing the level of investment risks of project implementation.

5. Results of research on the systematization and development of methods, tools, and technologies for the implementation of business processes in investment

5.1. Analysis of the development of automation technologies for the development, maintenance, and implementation of investments

The use of information technology is no longer the strategic advantages of a business, it is the everyday life of its functioning. The obvious result of its application is the efficiency of obtaining, processing, and analyzing information when making management decisions. Expected result: reduction of time – minimization of costs – increase of profits – improvement of quality, which are the determining goals of any business entity in general and its investment activities in particular.

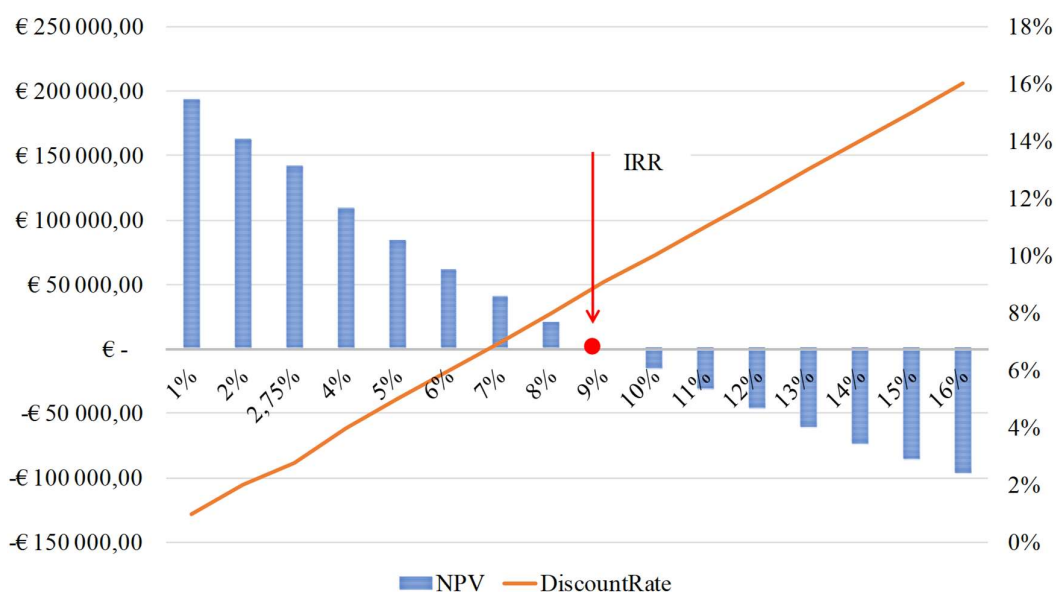
Information technologies create opportunities for the implementation of investment activity by the population of Ukraine. Already more than 18.6 million citizens are users of the Diia application. According to official information [18], the budget attracted, in dollar terms, 225.18 million through the purchase of military bonds. That is, the use of this technology has allowed a rich circle of people of different age categories, professions, existing skills and abilities to become investors. In this case, as novice investors, they were guided more by psychological factors when making investment decisions. It has been practically proven [15] that non-professional investors, first of all, are exposed to emotions when making such decisions. The presented Ukrainian statistics can confirm the results of previous conclusions that the fact of perception of the risk of non-return of invested capital for investors – holders of military bonds of Ukraine – had a positive impact on the decision to invest in order to obtain the expected result.

The next, publicly available technology for automating investment processes, is the use of financial functions of the software product MS Excel. Financial functions simplify the procedure for determining estimated indicators of the effectiveness of investment implementation, respectively, reduce the circle of consumers of such information, to investors who, when making decisions, are guided by certain analytics and understand the criteria for matching indicators to the expected result. Figure 1 visualizes the results of the application of the financial function MS Excel to determine and analyze the indicator of the internal rate of return on investment (IRR).

To describe the process of creating and implementing an investment project, simulation models are used. The existing market presents a number of investment management software products, different by country of origin, in class, cost, coverage of the tasks to be solved. One of these products is the DataPartner company's software, Invest for Excel [21]. The purpose of the program is to automate the analysis of capital investments, financial modeling and business valuation operations using Microsoft Excel. This allows managers to develop customizable business models, set resource requirements, define accounting periods, and create customer acquisition goals.



a



b

Fig. 1. Results of applying the financial function MS Excel to determine and analyze the indicator of the internal rate of return on investment: a – the use of the IRR function in the MS Excel environment; b – break-even analysis of investment realization

Accessible interface, ease of use and speed, unlimited possibilities in achieving the expected results and analysis options expand the circle of users. The need to analyze the investment project with obtaining key indicators of its effectiveness (NPV, IRR, payback period, MIRR, etc.) is achieved using a demo version of this software (Fig. 2, 3).

The basis for the formation of a cash flow statement are intermediate tables that are filled in the Invest for Excel environment. These include profit/loss report and the amount of working capital of the project. The profit report includes a product sales plan, a list of variable and fixed costs, the amount of marginal profit; EBITDA, EBIT, income tax, net profit, value added, and return on assets.

Automatic processing of incoming information on an investment project is formed by the results of its implementation through evaluation indicators. Additionally, the program visualizes the assessment of the sensitivity of the project with the variable of any key factor (discount

factor, total investment, income level, types of expenses, etc.) (Fig. 3).

The developers of MS Excel are expanding opportunities for investors with a new tool Investment Tracker [22]. The Microsoft 365 cloud platform, the work of which is based on online data exchange, allows you to update information non-stop, which contributes to the prompt decision-making to optimize the investment portfolio. This affordable investment tracking spreadsheet template is perfect for tracking a stock portfolio and gives a simple overview of the current portfolio with current prices and asset structure formation details.

Thus, information technology is an effective tool to reduce the time for the implementation of individual business processes. It allows for expanding the possibilities of information exchange and its dissemination to the general public, improving the quality of investment tasks and the objectivity of investment decision-making results.

BASIC VALUES					
Project description	INVEST PROJECT_FinAccount				
Calculation term, years	5 years				
Interval length, months	12				
Number of intervals	5				
	(MM/YYYY)				
Calculation term begins	01/2023	(in the beginning of period)			
Calculation point	01/2023	(in the beginning of period)			
Calculation term ends	12/2027	(in the end of the period)			
Figures (1/1000/1000000)	1				
Currency	EUR				
Discount rate (per annum)	2,75 % (required rate of return)				
Income tax %	2023	2024	2025	2026	2027 ->
	27,7	27,7	27,7	27,7	27,7

a

INVESTMENTS (-) / REALIZATIONS (+)

Imputed depreciation	1/2023	12/2023	12/2024	12/2025	12/2026	12/2027	Residual (12/2027)
Months per interval		12	12	12	12	12	
1 Land	-100 000						100 000
Depreciation (straight line)							
2 Building	-400 000						350 000
Depreciation (straight line)	2,50%		-10 000	-10 000	-10 000	-10 000	
3 Equipment		-30 000					0
Depreciation (straight line)	20,00%		-6 000	-6 000	-6 000	-6 000	
4							0
Depreciation (straight line)							
5							0
Depreciation (straight line)							
6							0
Depreciation (straight line)							
7							0
Depreciation (straight line)							
8							0
Depreciation (straight line)							
9							0
Depreciation (straight line)							
10							0
Depreciation (straight line)							
Investments	-500 000	-30 000	0	0	0	0	
Realizations	0	0	0	0	0	0	450 000
Depreciation	0	-16 000	-16 000	-16 000	-16 000	-16 000	
Realization profit (+) / loss (-)	0	0	0	0	0	0	0

b

CASH FLOW STATEMENT

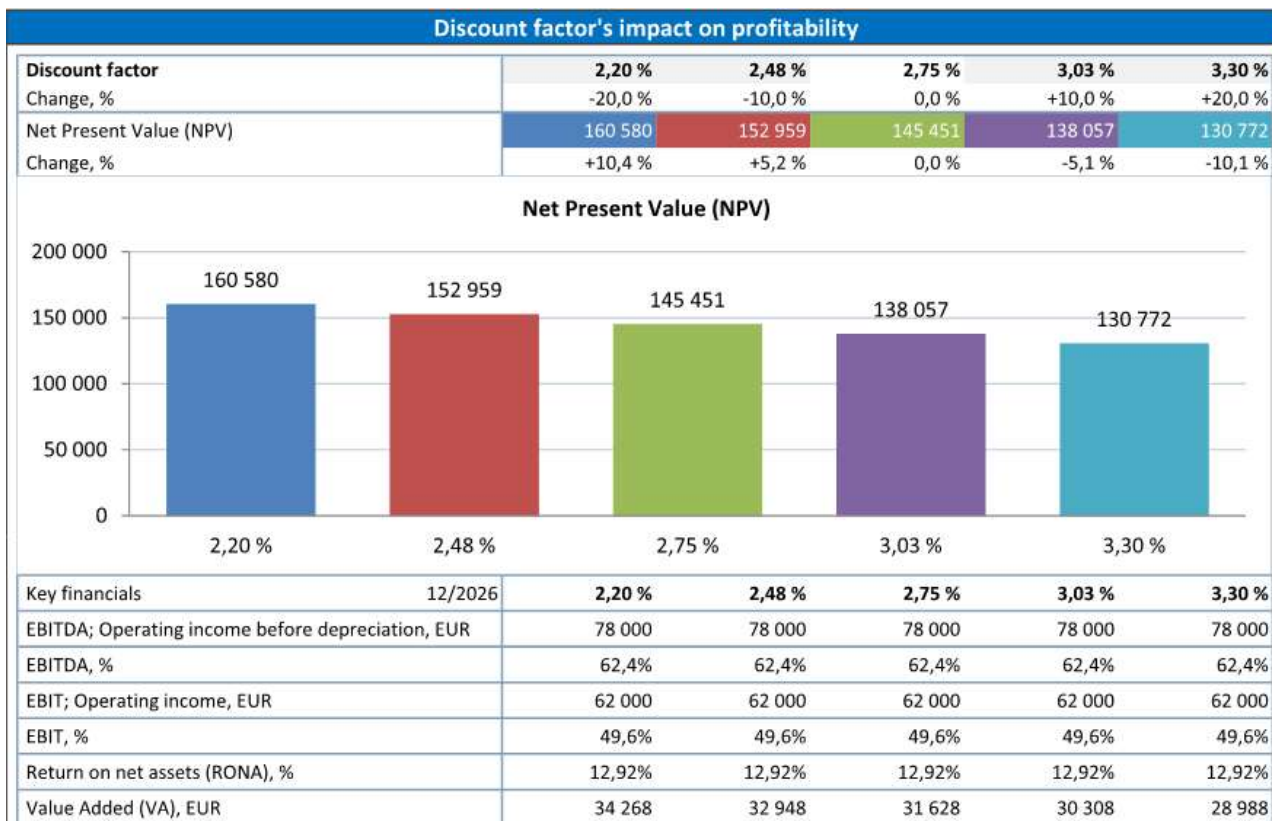
EUR	1/2023	12/2023	12/2024	12/2025	12/2026	12/2027	Residual (12/2027)
Months per interval		12	12	12	12	12	
Cash flow from operations							
Income	0	125 000	125 000	125 000	125 000	125 000	0
Variable costs	0	-35 000	-35 000	-35 000	-35 000	-35 000	0
Fixed costs	0	-10 500	-11 000	-11 500	-12 000	-12 500	0
Extraordinary income & expenses	0	0	0	0	0	0	0
Income tax	0	-17 590	-17 451	-17 313	-17 174	-17 036	0
Change in working capital	0	-5 931	0	0	0	0	5 931
Cash flow from operations	0	55 980	61 549	61 188	60 826	60 465	5 931
Asset investments and realizations	-500 000	-30 000	0	0	0	0	450 000
Free cash flow (FCF)	-500 000	25 980	61 549	61 188	60 826	60 465	455 931
Discounted free cash flow (DFCF)	-500 000	25 285	58 298	56 405	54 571	52 795	398 098
Cumulative discounted free cash flow	-500 000	-474 715	-416 417	-360 012	-305 441	-252 646	145 451
Information							
Financial cash flow							
Financial income and expenses	0	0	0	0	0	0	0
Correction of income tax for financial items	0	0	0	0	0	0	0
Long-term debt, increase (+) / decrease (-)	0	0	0	0	0	0	0
Changes in short-term borrowings							
Equity, increase (+) / decrease (-)	0	0	0	0	0	0	0
Total cash flow	-500 000	25 980	61 549	61 188	60 826	60 465	455 931
Cumulative total cash flow	-500 000	-474 020	-412 471	-351 284	-290 458	-229 993	225 938

c

Fig. 2. Formation of initial data for analyzing the effectiveness of the investment project in the Invest for Excel environment: a – identification of the project; b – justification of the size of investment capital and the depreciation program of fixed assets; c – cash flow statement

PROFITABILITY ANALYSIS			
Project description	INVEST PROJECT_FinAccount		EUR
Nominal value of all investments	530 000	Discounted investments	529 197
Required rate of return	2,75 %		
Calculation term	5,0	years	1/2023 - 12/2027
Calculation point	1/2023	(In the beginning of period)	
<u>Present value of business cash flows</u>	<u>Nominal</u>	<u>PV</u>	<u>Notes</u>
± PV of operative cash flow		276 551	
+ PV of residual value	455 931	398 098	
Present value of business cash flows		674 649	
- Present value of reinvestments	0	0	
Total Present Value (PV)		674 649	
<u>Investment proposal</u>	<u>Nominal</u>	<u>PV</u>	
- Proposed investments in assets	-530 000	-529 197	
+ Investment subventions	0	0	
Investment proposal	-530 000	-529 197	
Net Present Value (NPV)		145 451	>= 0 -> profitable
NPV as a monthly annuity		2 595	
Internal Rate of Return (IRR)		#Н/Д	
Modified Internal Rate of Return (MIRR)		8,13%	>= 2,75 % -> profitable
Profitability Index (PI)		1,27	>= 1 -> profitable
Payback time, years		-	- Based on discounted FCF
Return on net assets (RONA), %		12,7 %	Average 5 years
Value Added (VA)		31 648	Average 5 years
Discounted Value Added (DCVA)		145 985	

a



b

Fig. 3. Results of the analysis of the effectiveness of the investment project in the Invest for Excel environment: a – key parameters of the project’s effectiveness; b – analysis of the sensitivity of the project under the influence of a change in the discount factor

5.2. Methodological tools for the implementation of financial calculations in the process of analyzing the effectiveness of investment implementation

When making investment decisions on the implementation of the project, developers are guided by a generally accepted set of criteria. This is the compliance of the parameters of the effectiveness of the implementation of investments:

- excess of incoming cash flows on the project over outgoing (Net Present Value, NPV);
- ensuring return on investment by the predominance of income over expenses (Profitability Index, PI);
- compliance with the Discounted Payback Period (DPP);
- maximization of the internal rate of return on investment (Internal Rate of Return, IRR).

The practice of analyzing investment projects proves the advantages of using dynamic methods of evaluating investments over static ones. Such indicators are determined based on the use of discounting methods for the most part, rather than compounding. These methods allow the use of a wide variety of tools of financial mathematics, which are based on the concept of changes in the value of money over time. The list of these parameters of the effectiveness of the investment project implementation mostly becomes exhaustive when developing a business plan for the project and making decisions by theorists and practitioners.

Existing practice and experience indicate the need to expand the methodological tools for financial calculations of the effectiveness of the investment project. In the presence of existing shortcomings, investment evaluation indicators are proposed to be introduced into their number of modified indicators [19, 20]. The achievements of the authors of these works emphasize the need to use and even replace the indicator of the internal rate of return on investment (IRR) with the indicator of the modified Internal Rate of Return (MIRR). The practice of applying the indicator MIRR and the difference between its parameter and the value of IRR are proved by the results of the study shown in Fig. 1, *a*, 3, *b*.

The shortcomings of the IRR criterion outlined in works [19, 20] encourage analysts to use the MIRR indicator in evaluating an investment project. Its definition allows us to justify the expediency of choosing the only best investment project from many possible; apply for the analysis of extraordinary monetary; take into account the rationality of discounting reinvested funds under the project. At the same time, the IRR indicator, having its advantages, cannot be replaced or excluded from the investment analysis process. In addition, it is possible, based on its results, to assess the conditional break-even point of the project implementation, that is, the level of the discount rate at which the income on the project covers all its costs, and therefore NPV takes zero. Based on the IRR parameter, in conditions of rapid change in the state of the financial market, it is possible to determine the margin of financial strength of the project. Following the example of data in Fig. 1, *b*, the margin of financial stability of the project is a value of 6.35 %. This means that the fact of rising rates will not affect the unprofitable result of the project until the rate has an increase that exceeds the rate of 6.35 % (the difference between the discounting rate of the project is 2.75 % and the IRR value of 9.1 %). Determining the probability of the projected change in rates gives grounds for assessing the percentage risk of the project.

To eliminate these shortcomings, it is proposed to expand the results of the analysis of the effectiveness of the investment project with indicators of the modified internal

rate of return on investment (MIRR) and the rate of return of financial management (Financial Management Rate of Return, FMRR). These indicators, respectively, eliminate the shortcomings that accompany the interpretation of the results of the IRR definition.

The logic of determining these indicators is that positive cash flows for the project are reinvested at a rate different from IRR. Accordingly, such processes lead to the provision of an NPV value greater than zero.

The application of MIRR and FMRR indicators is based on the logic of calculating the capitalization rate, which consists of two parts: the rate of return on investments and the norms of their return. Similar to the return on investment rate, which differs in the way the income is reinvested, differences in the parameters of MIRR and FMRR are obtained.

The modified internal rate of return (MIRR) is the rate of return at which the final value of the net cash flows of the project is equal to the present value of investment costs [19]. The final cost is characterized by the amount received from the reinvestment of proceeds from the project.

According to the MIRR model, it is assumed that the reinvestment rate is a rate not lower than the weighted average cost of capital (WACC), the discount rate of the project:

$$\text{MIRR} = \sqrt[n]{\frac{\sum_{i=1}^n CF_i \times (1+r)^{n-i}}{\sum_{j=0}^n \frac{IC_j}{(1+r)^j}}}, \quad (1)$$

where CF_i – net cash receipts in the i -th period;

IC_j – investment costs in the j -th period;

r – discount rate;

n – duration of the project.

Reinvestment of capital is reproduced to speed up the process of reimbursement of invested capital, and efficiency is ensured by its most favorable conditions. Based on this assumption, the FMRR indicator is used. The scope of its application is determined by the assessment of the effectiveness of investments in real estate and it refers to the real estate investment fund (Real Estate Investment Trust, REIT). However, there are reasons to consider it appropriate to use it in relation to other investment projects of real investment.

The rate of return of financial management using financial computing technology is similar to that of MIRR. The difference is that the reinvestment of capital is assumed at a rate higher than the reinvestment rate of the initial cash costs of the project. Hence, in calculating this indicator, two different rates “risk-free” and “circular” (capitalization rate) are used. There is another name for the FMRR indicator – the rate of return of the financial manager. Accordingly, provided that the rationality and efficiency of the implementation of competencies of the financial manager of the project may be affected by increasing the profitability of using cash flow revenues.

The risk-free rate assumes that the funds needed to cover negative cash flows bring interest at an easily achievable rate and can be withdrawn when necessary instantly (i.e., within a day after the deposit in the account). In this case, the rate is “risk-free”, as the funds are highly liquid and safely available with minimal risk when necessary.

The reinvestment rate, the “circular” rate, includes the rate that will be received when positive cash flows are reinvested in a similar intermediate or long-term investment

with comparable risk. The reinvestment rate is higher than the risk-free rate because it is not liquid (i.e. applies to another investment) and therefore requires a higher risk discount rate.

The FMRR model takes the following form:

$$FMRR = \sqrt[n]{\frac{\sum_{i=1}^n CF_i \times (1+k)^{n-i}}{\sum_{j=0}^n \frac{IC_j}{(1+r)^j}}}, \quad (2)$$

where CF_i – net cash receipts in the i -th period;

IC_j – investment costs in the j -th period;

r – discount rate;

k – “circular” rate, capitalization, reinvestment ($k > r$);

n – duration of the project.

Summing up, we have an effective tool for assessing the effectiveness of investment implementation, built on effective cash flow management. Financial calculations are carried out using financial mathematics technologies, a reasoned concept of the time value of money, methods of discounting and compounding income and expenses for the project, reasonableness, and proof of the level of discount rates, reinvestment, capitalization.

5. 3. Types of investment risks and methods of their assessment

Business processes in investing are inextricably linked with risks. From the direction of implementation of the investment project, its scale, belonging to the country of the investor and the initiator of the project, the expected result, many more criteria, the quantity and quality of investment risks are multiplied exponentially.

Fig. 4 shows a matrix for identifying investment risks, which are the most identical for many investment projects.

We have the risk of force majeure circumstances and the risk of the country, the most extended and influential on all other types of risk. The sphere of their occurrence is the external environment, the state of which, regardless of the project, affects its results. A large-scale manifestation of such risks is observed in the period of late 2019–early 2023. Following the example of military aggression in Ukraine, the devastating consequences of the earthquake in Turkey, the COVID-19 pandemic, these risks with a powerful force will affect the volume of investments. The consequences of such risks increase the degree of manifestation of all other types of risks, including financial: credit, inflationary, systemic, market. The latter types of risks arise in the focus of both the external and internal environment. The effectiveness of their management depends on the approved decisions regarding the conditions for the implementation of the investment project. And if the risk of force majeure and the country’s risk are difficult to predict, then these types of risks can be predicted, assessed, minimized, or adapted to them.

The following types of risks: operational, behavioral, and risk management are formed under the influence of most internal factors. Management risk and behavioral can be equated with subjective factors that directly depend on the competencies of individuals who make investment decisions. They are the most manageable but the manifestation of global risks also systematically affects their management methods.

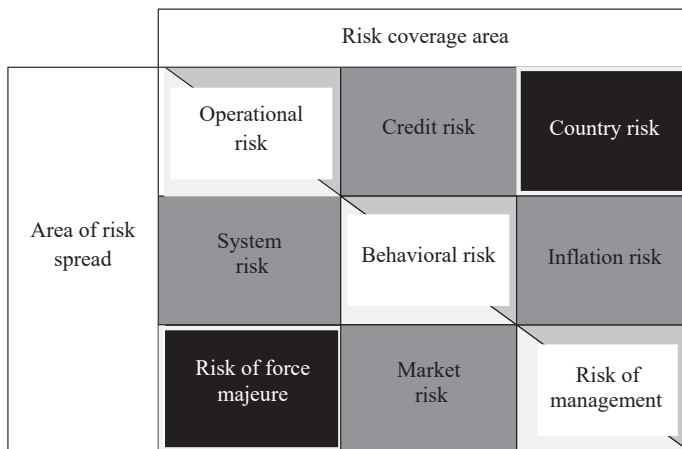


Fig. 4. Matrix of identification of investment risks: ■ – risks, the coverage area of which are all types of investment projects and those that are distributed and have a causal relationship with other types of risks; ■ – risks, the coverage area of which are certain types of investment projects (industry feature, type of investment, sources of investment capital formation) and those that are distributed and have an indirect connection with other types of risks; □ – the risks inherent in a particular project depend on the features of implementation and management methods, manifested in the internal environment

The validity of the investment decision largely depends on the adequacy of assessing the likelihood of a risk. According to the preliminary analysis of literary data, we determine a wide range of methods and approaches to risk assessment: strategic analysis [9, 10], factor [14–16], integral, graphic, and statistical [14–17]. The list of application of expert methods for evaluating investment decisions is inexhaustible.

We propose to carry out a quantitative analysis of investment risks using beta coefficient analysis. Classically, the β coefficient is used to determine the sensitivity of changes in the exchange rate of a particular stock instrument (security) in relation to the dynamics of the stock index of the market. Mathematically, the β coefficient determines the correlation between the rate of change in stock market indices with the rate of return of a particular type of stock. Having adapted the statistical and mathematical tools for finding the β coefficient, we can apply it to other objects of risk influence. Namely: countries; individual sectors of the economy; bank; individual company, its own or debt capital [23–26].

A country’s risk measurement can be determined through a beta coefficient based on the Morgan Stanley Capital International World (MSCI) investment index. This is the most commonly used benchmark for the market capitalization of company shares the purpose of which is to measure the performance of the securities market in developed countries. With this index, a total of 23 countries are represented.

The model for calculating industry risk will take the form:

$$\beta = \frac{COV(Y_{GDP}; Y_{industry})}{VAR(Y_{GDP})}, \quad (3)$$

where COV means covariance of the growth rate of GDP of the country and the growth rate of sales of a particular industry (type of economic activity);

VAR – variance (measure of deviation of the indicator) of GDP growth rates;

Y_{GDP} – GDP growth rate;

$Y_{industry}$ – growth rate of sales in a particular industry (type of economic activity).

It is proposed to use the β coefficient to measure fluctuations in the activities of the industry in relation to the results of the national economy, which is a type of systemic risk, namely industry [24].

The sensitivity ratio β measuring the systemic risk of a bank shows the relationship between the bank's profitability and the profitability of the banking system. It makes it possible to assess to what extent (as intensive) the bank's profitability will change, relative to changes in the profitability of the banking system. The greater this variability, the greater the risk of the bank. In addition, we have two alternative options for determining the β coefficient, based on changes in return on assets (Return on Assets, ROA) or return on equity (Return on Equity, ROE) [25, 26]:

$$\beta = \frac{COV(Y_{ROA_{bank, syst}}; Y_{ROA_{bank}})}{VAR(Y_{ROA_{bank, syst}})}, \quad (4)$$

where COV means covariance of the growth rate of ROA of the banking system and the growth rate of ROA of an individual bank;

VAR – variance (measure of deviation of the indicator) ROA of the banking system;

$Y_{ROA_{bank, syst}}$ – growth rate of ROA of the banking system;

$Y_{ROA_{bank}}$ – the growth rate of the ROA of an individual bank;

$$\beta = \frac{COV(Y_{ROE_{bank, syst}}; Y_{ROE_{bank}})}{VAR(Y_{ROE_{bank, syst}})}, \quad (5)$$

where COV means covariance of the growth rate of ROE of the banking system and the growth rate of ROE of an individual bank;

VAR – variance (measure of deviation of the indicator) ROE of the banking system;

$Y_{ROE_{bank, syst}}$ – growth rate of ROE of the banking system;

$Y_{ROE_{bank}}$ – growth rate of ROE of an individual bank.

To determine the β coefficient in conditions where shares are not listed in the free market or there is not enough other important information, it is possible to use the expert method. Then the assessment of the coefficient for a particular company can be obtained from the analysis of those indicators of its activities on which the magnitude of the risk of the activities of this company depends. The system of factors for assessing the riskiness of a company's activities has criteria for multidimensionality, depending on the needs of the analysis, and may include internal indicators of the company's activities of the economic, financial, management areas of analysis; industry; macro-economic, etc.

The general criteria for determining the level of investment risk are the following values: the β coefficient is equal to 1, the risk of the asset is considered average, exceeding 1 – high and, accordingly, for the value of the indicator less than 1 – the risk is considered low.

As a result, we have a universal methodological approach to assessing investment risks, regardless of the focus of their manifestation. The application of the method of modification of partial indicators for determining the β coefficient provides the basis for assessing the systemic risk of a country; sectors of the economy; bank; company activities; risk of the company's own or debt capital.

6. Discussion of research results on optimization of methods, tools, and technologies for the implementation of business processes in investment

The systematization and development of technologies for automating the processes of development, maintenance and implementation of investments was carried out in the current work. These conclusions are confirmed by experimental examples of the use of information technologies for evaluating the effectiveness of the use of the software product Invest for Excel [21], (Fig. 2, 3). For non-professional users of analytical and information support for the implementation of investment processes, publicly available technologies are justified (Fig. 1), [2, 18]. The criteria for substantiating the proposed information technologies for automating business processes in investment are functional capabilities, operational and technical characteristics, interface, and cost of the application. Unlike others, they implement an integrated approach to solving various aspects of investment analysis, are compatible with standard MS Office applications, have an accessible and easy-to-use interface, clear economic content of the results, are quick to learn, and have low maintenance costs.

Reasonable models for evaluating the effectiveness of the investment project under MIRR and FMRR (1), (2) were obtained. As a result, in addition to analyzing the feasibility of implementing the project, the experience of determining the effectiveness of management decisions on the optimal use of free cash flow for the project is given.

A positive direction in the development of the study should be considered the actualization and modernization of the types of investment risks as of the period 2019–2023. Emphasis is placed on the manifestation of global risks of influence on the implementation of investments (Fig. 3). Standard types of risks of investment processes [14–17] are considered from the standpoint of the strength of the influence of risk factors for the occurrence of force majeure circumstances (Fig. 4). The manifestation of the latter implies the need for their evaluation using universal, modified indicators [23–26], (3) to (5). Based on the application of beta coefficient analysis, it is proposed to measure the level of risk of a country, individual sectors of the economy, a bank, an individual company, its own or debt capital. A unified approach to the use of statistical and mathematical tools to assess the centers of occurrence of systemic risks allows us to increase the objectivity of their assessment and the effectiveness of processing.

The use of modified indicators for determining the rate of return on investment and assessing systemic risks makes it possible to strengthen the objectivism of the use of individual software products in the implementation of investment processes. The studied types of technologies are available, understandable, and easy to use. The best practices of developed countries in the field of robotization of investment decision-making processes are not sufficiently implemented in developing countries. Psychological obstacles of Ukrainian investors are also determined by restraining factors: distrust, fears, and risk appetite. Therefore, the emphasis in the work was placed on the available tools for creating an analytical and information base for making an investment decision. It is proved that the advantages of using information technologies are the efficiency of obtaining, processing, and analyzing information when making management decisions. Expected result: reduction of time – minimization of costs – increase of profits – improvement of quality.

The methodological tools for evaluating the effectiveness of investments have been expanded. In addition to the existing, classical approach to investment analysis, the use of modified models for determining the rate of return on investment is proposed. Their analysis provides an opportunity to assess the level of efficiency of financial management of cash receipts from the project, the ability of the manager to increase capital.

The matrix built (Fig. 4) made it possible to trace the cause-effect relationship between their more common types. It is proved that environmental risks most often increase the impact and cause other types of risks. The vast majority of them are classified as systemic risks. This made it possible to justify a unified methodological approach to their assessment, regardless of the center of manifestation. Mathematically, the β coefficient determines the correlation between the rates of change of one indicator (the entire system) in relation to the rates of change of the same indicator determined for the object of analysis. Thus, modifying the partial indicators of the calculation of β coefficient, we can provide an assessment of the systemic risks of both macro and micro subjects based on the use of a single approach.

The use of Invest for Excel and Investment Tracker software products is carried out on a fee basis, which in a certain way limits the possibilities of advanced investment analysis.

The research is practically interesting for investors who are engaged in the implementation of direct investments and participate in the developed business plan of the investment project. The theoretical value of the study is interesting to researchers who are engaged in improving the methodological support for determining the effectiveness of investments.

When assessing investment risks, emphasis is on determining the manifestation of systemic risks. It is indicated that they have a causal relationship with the internal risks of investment. Systemic risks exacerbate their adverse effects. From this position, the methods of analysis and assessment of internal risks and the strength of the influence of systemic risks on them remained unexplored in the current work. The effectiveness of investment management is based on taking into account the manifestation of risks of both the internal and external environment. The advantage of the proposed approach is the universality of assessing systemic risks that arise externally and have an impact on the outcome of investments. The low correlation of the rate of changes in economic indicators of the external environment with the pace of economic shifts of an individual entity does not prove the absence of risks in the implementation of the investment process. It is expedient in this regard to apply methods of factor analysis and expert assessment of risks. Factor analysis will allow us to determine the factors of risk, expert assessment – the strength of their manifestation.

The areas of further research are the expansion of the experience of using information technologies in investment activities. An interesting fact of the already functioning automatic platform Robo Advisor in Ukraine encourages us to evaluate the effect of its work on the Ukrainian market.

7. Conclusions

1. It is proved that information technology is an effective tool for reducing the time for the implementation of individual business processes. Its application allows one to expand the possibilities of information exchange and its dissemination to the general public. It reveals opportunities for the implementation of investments, improve the quality of investment tasks and the objectivity of investment decision-making results. The proposed software products for automating business processes in investment benefit according to the criteria “functional opportunities/price/availability”.

2. An effective tool for assessing the effectiveness of investment implementation, built on effective cash flow management, has been designed. Financial calculations are carried out using financial mathematics technologies, a reasoned concept of the time value of money, methods of discounting and compounding income and expenses for the project, reasonableness, and proof of the level of discount rates, reinvestment, capitalization. The inclusion of MIRR and FMRR indicators in the analysis of investment performance demonstrates the effect of rational financial management of net cash income from investments based on pro-reinvestment processes. Reinvestment of capital is reproduced in order to speed up the process of reimbursement of invested capital, and efficiency is ensured by its most favorable conditions.

3. A universal methodical approach to the assessment of investment risks is proposed, notwithstanding the focus of their manifestation. The application of the method of modification of partial indicators for determining the coefficient provides the basis for assessing the systemic risk of the country; individual sectors of the economy; systemic risk of the bank; the company’s activities, in the absence of a stock instrument in circulation; risk of equity or debt capital of the company. Unified approach and mathematical tools for evaluating system investment risks simplifies the process of their analysis and provides an objective interpretation of the results for each level of the economic system.

Conflicts of interest

The authors declare that they have no conflicts of interest in relation to the current study, including financial, personal, authorship, or any other, that could affect the study and the results reported in this paper.

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Data availability

The manuscript has associated data in the data repository.

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