Developing a System to Support Banks in Making Investment Decisions when Organizing Project Financing

MARINA BATOVA
Department of Informatics and Management
Military University of the Ministry of Defense of the Russian Federation
Moscow, Bolshyaa Sadovaya st., 14
RUSSIA

IRINA BARANOVA
Department of Management and Region Development
Russian Presidential Academy of National Economy and Public Administration
Moscow, prospekt Vernadskogo, 82
RUSSIA

VYACHESLAV BARANOV
Department of Management and Region Development
Russian Presidential Academy of National Economy and Public Administration
Moscow, prospekt Vernadskogo, 82
RUSSIA

YASIN TAHA CELILOGLU
Department of Information Technology and Automation
Ziraat Bank (Moscow), the subsidiary Bank of the Turkish state-Owned Ziraat Bank
Moscow, Marksistskaya st., 16;
Doganbey Mah. Ataturk Boulevard No. 8 Ulus Ankara
RUSSIA, TURKEY

Abstract - The article deals with the development of an information system providing support for making investment decisions by Ziraat Bank in organizing project financing of innovative projects implemented within the machine-building cluster of the Republic of Tatarstan and its affiliated entities in the Russian Federation. A set of requirements for such a system was formulated and an appropriate mathematical model developed. The software implementation of the mathematical model was carried out in the Ziraat Bank's investment decision support system. An algorithm for system development was proposed, the practical implementation of which was performed using the theory of oriented graphs along with the schedule theory.

Key Words - Information system, investment decision support, innovative project, project financing, oriented graph theory, schedule theory.

Received: June 19, 2020. Revised: October 1, 2020. Accepted: October 23, 2020. Published: November 13, 2020.

1 Introduction

Transitioning to a digital format of development implies an intensification of innovative factors in the activities of economic actors. Development and application of technological innovations in relation to new products and their production technologies become the key tools in ensuring the competitiveness of these subjects.

Project activities in the innovation sphere are costly and require more than just improvement of previously approved investment mechanisms. There is a need to create and apply new tools and models that reflect the innovative modes of interaction among the participants in the investment process. This is particularly true of the relationship between enterprises that initiate comprehensive science and capital-intensive projects and banks that provide investment resources for such projects.

Project financing is one of the forms of cooperation between enterprises and banks in the investment sphere. In general project financing assumes that the source of repayment of financial resources, which were allocated by the bank, are cash flows generated by the investment project. Project financing differs radically from traditional bank crediting [1] because the cash flows generated by the project should be separated from the integral financial results obtained by the enterprise-project organizer. For this purpose, a management company is established which implements the project.

When project financing is used, the activity of the management company is focused on attracting substantial amounts of capital provided by the bank, the share of which in the total volume of financial resources of the project may reach 70-80% [2]. If the project efficiency potential is high, capital attraction proves to be fruitful. Primarily, it concerns the effects of production and financial leverage that arise in the course of project implementation.

Moreover, the project company, attracting financial resources from the bank on terms of project financing, does not provide either collateral or surety guarantees. The investment qualities of the project being implemented guarantee return on the investment for the bank. Therefore, the mechanism of project financing implies a detailed analysis of the project characteristics. It concerns not solely the economic parameters, but also technical, technological and organizational aspects of the project activity.

In order to make a balanced decision on participation in project financing, the bank first assesses the potential of the project, competing for the allocation of financial resources, and afterwards analyses in detail the cash flows generated by the project [3]. In project financing, these flows serve as the only source of repayment of financial resources allocated by the bank on a long-term basis. In this case, it is necessary to find alternative ways to protect the financial resources of the bank invested in the innovative project. One way to do that is to apply the economic, mathematical [4] and computer modelling to assess the funded project [5, 6-8, 9, 10, 11-13].

To do this, a detailed mathematical model is first developed, reflecting the relationship between the integrated economic results of the project and its technical, technological and organizational characteristics. Then, on the basis of the model, a software application is developed that allows modelling scenarios of project implementation with a high level of reliability. The expediency of creating the software product is conditioned by the fact that taking the managerial decisions, the financial institution faces the necessity to process large volumes of information in the context of uncertainty. It concerns both initial data and the final results of project implementation. (See Figure 1).

The essence of making investment decisions by the financial institution primarily lies in choosing the best innovative project from the set of potentially acceptable projects [14, 15, 16, 17]. From the point of view of the bank, as a strategic investor with significant project risks, it is important to control the progress of project implementation. Continuously monitoring implementation of the project allows the bank to quickly track the expenditure of allocated funds at various stages of its realization. On the basis of the results of its monitoring, the bank makes managerial decisions, adjusting the volume of investment financing and of current expenses at various stages of project implementation. Therefore, the development of original information systems that support the process of making investment decisions becomes an urgent task.

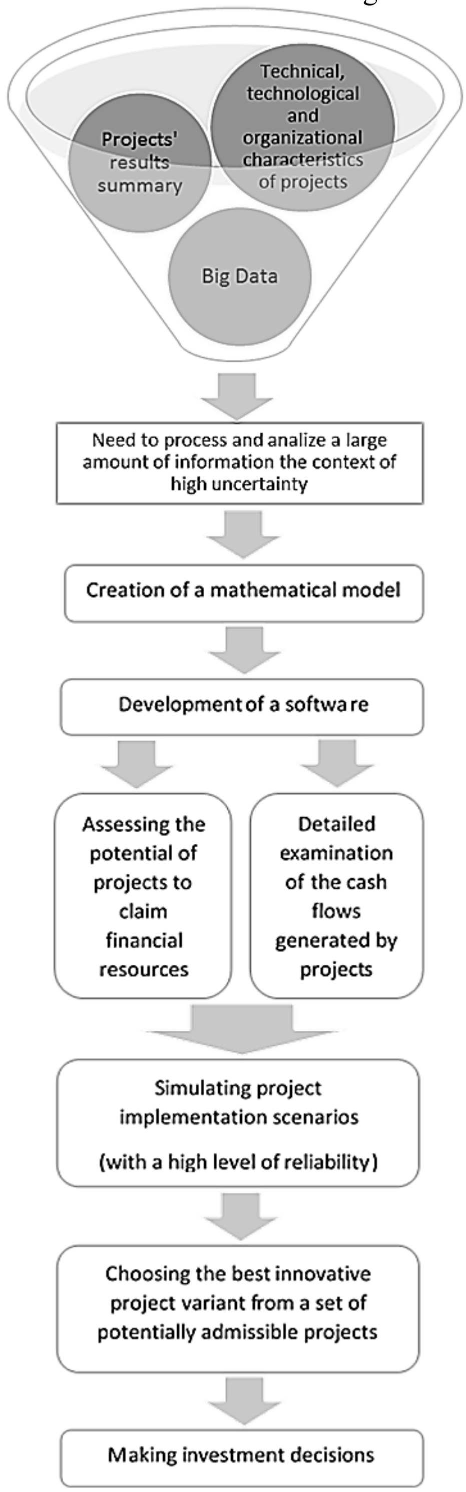

Fig.1 Scheme of project financing and decision-making by the Bank
Source: authors' research.

2 Problem Formulation

Russian and foreign software products currently available on the market [10, 12, 13, 18, 19] do not fully allow to solve the problems of automated selection of the best innovative projects, because the mathematical models underlying these products do not take into account the specific features of the concerned projects. Accordingly, the use of standard software products by the financial institution may lead to a number of problems for the bank as a strategic investor in the innovative project, since it is necessary to have detailed information about the project parameters and the impact of these parameters on integral performance indicators.

Thus, there is a need to develop a detailed mathematical model by changing the parameters of which it is possible to quickly track the impact of investment decisions made on the processes of formation of economic value added at each step of the project. On the basis of such model, an original information system is created that supports the financial institution in making various investment decisions (See Figure 1). Using such a system, the financial institution is able to implement computer modelling of project management scenarios, tracking within the framework of these scenarios the impact of the decisions made on the integral indices of project efficiency.

The article describes the results of the information system development and its use by Ziraat Bank (Moscow), which is a subsidiary of the Turkish State Ziraat Bank. The created system provides support for investment decisions made by the bank. The feasibility of developing such a system arose in connection with the package agreement concluded by the bank with the machine building cluster of the Republic of Tatarstan (Russia) on financing a number of innovative projects implemented within the machine building cluster and its affiliated entities in the Russian Federation.

3 Problem Solution

3.1 Composing requirements for the support system aimed at making investment decisions by Ziraat Bank

The design process was preceded by the stipulation of the requirements for the investment decision support system (see Figure 2). Here are the requirements formulated by the Ziraat Bank.

Firstly, the mathematical model underlying the investment decision support system should have a high level of detail of the variables reflecting the characteristics of the innovative project in question. The economic and mathematical models describing the innovative project should include a set of constraints. Otherwise, the model that forms the basis of the program product will not adequately reflect the realities of production and marketing of product innovations.

Secondly, cross-platform software, i.e. the possibility of its implementation in different operating systems, should be provided.

Thirdly, designing the system supporting the investment decision making, it was necessary not only to formalize the project in the form of a set of mathematical models, developing appropriate software, but also to create a user interface. The interface should be convenient for the management of Ziraat Bank, working with the information necessary to prepare managerial decisions on the bank's participation in project financing of innovative projects within the structures of the machine-building cluster of the Republic of Tatarstan, correction of capital investments at various stages of implementation of the innovative project, etc. The interface will allow the management of Ziraat Bank to obtain detailed information on intermediate and final results of the evaluation of the innovative project, as well as errors that occurred in the course of project implementation.

In addition, the creation and use of the information system should ensure a high level of reliability of investment decisions made by the management of Ziraat Bank, guaranteeing the cost savings in comparison with the purchase of a ready-made software product.

The substantive factor has a special place in managerial decisions by Ziraat Bank. This factor reflects the characteristics of the applied automated information system used to solve investment problems. It manifests itself through many aspects. The most significant of them are the interfaces of interaction between the software package and the user, the logic of the program, communication and service usability of the software package, etc.

To develop a software product that provides the choice of the best options for investment decisions, we analyzed the foreign and Russian software products available on the software market. The analysis involved foreign (Microsoft Project, Cobra, Oracle Primavera, COMFAR, PROPSPIN) and Russian (Project Expert, Alt-Invest, Investor, TEO-Invest) products [20, 21]. The considered packages of applied programs make it possible to assess, firstly, the financial feasibility of the project, and secondly, the economic efficiency of investment decisions.

The assessment of the functionality of the analyzed packages served as the basis for the requirements for the parameters of the created package. First, the software package should be based on a technique focused on modern methods for calculating economic efficiency. The range of tasks arising in project management is ultimately associated with the management of a high-tech enterprise making decisions about investments and disinvestment of funds. Modern methodological views suggest that the assessment of the effectiveness of investment decisions should be based on the use of dynamic (discounted) indicators and evaluation criteria.

Therefore, the software package designed for Ziraat Bank should:

- model real cash flows;
- make allowance for possible various scenarios for the implementation of the project, which should be considered as an information space for the formation of potential solutions;
- perform calculations subject to the constraints on the target efficiency function;
- focus on indicators, the consistency of which will ensure the reliability of decisions.

The calculations performed and the management decisions taken must be stored in the information system. This is necessary for further comparison of the considered scenarios and selection of the best management decisions and the optimal project option for practical implementation. The created package should be implemented in information systems, focusing on different operating environments, i.e. have the property of cross-platform.

The performed analysis also helped form a set of requirements for the user interface of the software package being created. The user-friendliness of the software package was found to go hand in hand with the minimization of the data input labor intensity. The analysis of existing software products also found that the created software package requires a protective mechanism of the software system against errors when entering data into the system. Important characteristics that reflect the convenience of the user interface should be, firstly, the visibility of the results of the implementation of the software package, and secondly, the amount of graphical information provided to the user, ensuring reliable management decisions.

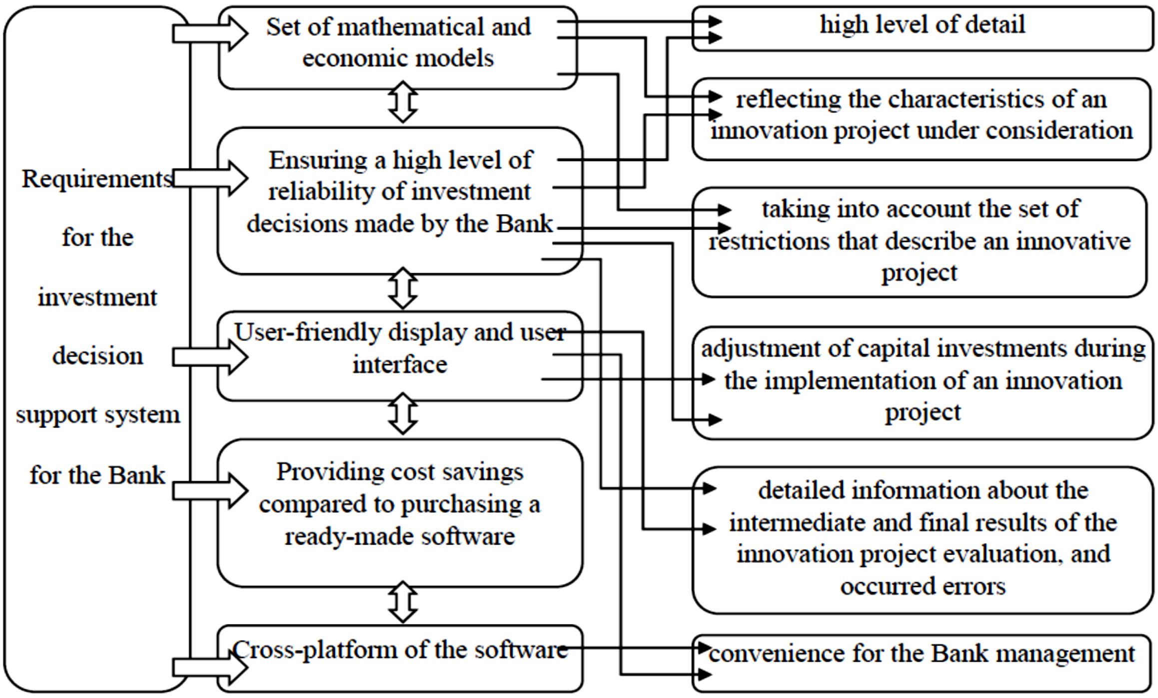

Fig.2 Scheme of the bank's requirements for the created system.
Source: authors' research.

3.2 Algorithm of development of the support system for making investment decisions by Ziraat Bank

The algorithm of development of the support system for making investment decisions and its implementation within the scope of the activities of Ziraat Bank takes a number of steps (see Figure 3).

- Step 1: The technical assignment for the development of an investment decision support system for Ziraat Bank within the scope of the bank's participation in the project financing of the machine-building cluster and its affiliated entities of the Republic of Tatarstan was received.
- Step 2: A project group was created, which formulated technical proposals in connection with the technical assignment for the development of an investment decision support system for Ziraat Bank within the scope of the bank's participation in the project financing of the machine-building cluster and its affiliated entities of the Republic of Tatarstan.
- Step 3: As a result of discussion of technical proposals with the management of Ziraat Bank, the technical assignment for the development of

an investment decision support system within the framework of financing innovative projects implemented by the entities of the machine-building cluster of the Republic of Tatarstan and its affiliates was adjusted.

- Step 4: An integrated mathematical model was developed, reflecting the peculiarities of innovation projects implemented by the entities of the machine-building cluster of the Republic of Tatarstan and its affiliates. The model was discussed at the meeting of the Ziraat Bank Council. It was approved by the Bank's management.
- Step 5: On the basis of the model, a software application was written and tested by the Bank.
- Step 6: Based on the test results, errors were eliminated and the bank's investment decision support system was handed over to Ziraat Bank management for practical application.

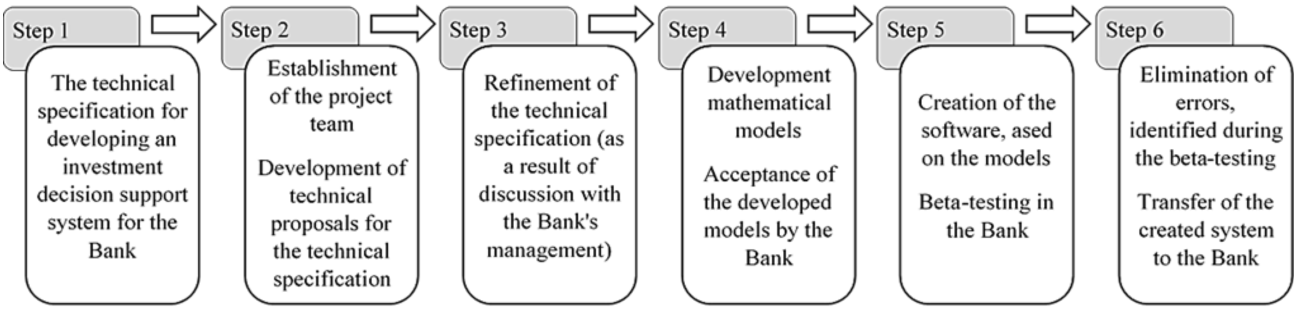

Fig.3 Algorithm of the development of the support system for making investment decisions by the bank.
Source: author's research.

The process of creating an information system providing Ziraat Bank with support in making investment decision was described in the form of an oriented graph [23-26], consisting of a finite number of vertices and oriented arcs. The arc of the oriented graph characterized the process of performing concrete actions during the development and implementation of the investment decision support system, and the moments of beginning ($T_{b,i}$) and end ($T_{e,j}$) of these actions were considered as the vertex of the graph. For each arc of the oriented graph, the duration of the work operation (D_{ij}) and the number of actors (P_{ij}) involved in its execution were determined (see Figure 4).

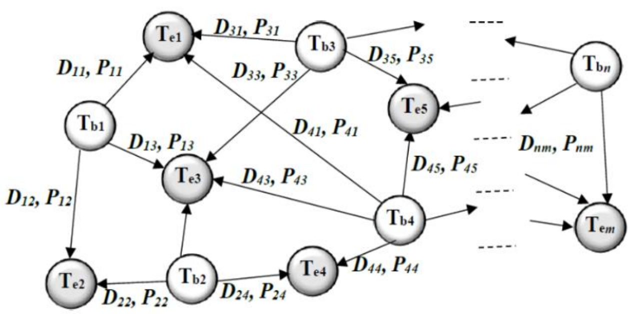

Fig.4 Fragment of a schematic description of the process of creating the information system for investment decision-making as an oriented graph.
Source: author's research.

The number of the working group that developed the investment decision support system was 4 persons.

Then, the parameters of the oriented graph that characterize the state in time of its vertices and arcs were calculated. For the purposes of managing the complex of work operations of the development of the investment decision support system, a schedule was created reflecting the relative start and end times of each work operation outlined in the oriented graph. The inclusion of the work operations in the schedule was preceded by the choice of heuristic preference rules as well as the construction of their hierarchy. The hierarchy created made it possible to prioritize each activity when it was included in the schedule.

Based on the calculated parameters of the graph, taking into account the heuristic rules of preference and their hierarchical model, the schedule of execution of the set of work operations for the creation of the investment decision support system was constructed and its duration was determined (38 weeks). In addition, resource losses caused by under-loading of the system developers were estimated. Analysis of the schedule showcased that these losses amounted to 28.9% of the total labor intensity of such a development.

3.3 Development of a mathematical model for the investment decision support system of Ziraat Bank

The mathematical model describing the business processes of formation and implementation of an innovative project has a number of features, including a high level of detailing of variables and inclusion of innovative development factors into the model [20-22] as well as the model's focus on modernization as a tool for digital transformation of the enterprise-project organizer.

The integrated economic and mathematical model divides all variables into three groups. The first group of variables reflects the characteristics of technological (process and product) innovations, while the second group combines the characteristics of organizational and production structures created as part of an innovative project. The characteristics of investments in modernization are presented in the third group of variables (see Table 1).

Table 1. The Variables of the integrated economic and mathematical model

№	Variable names	Symbols of variables
	First group of model's variables	
1.1.	Index of the types of products potentially admissible for production	i
1.2.	Volume of production of the *i*-th product in the year *t*	x_{it}
1.3.	Direct material costs of production of the *i*-th article	m_i
1.4.	Index of the group of structural elements, that are part of a product innovation	g
1.5.	Lower boundary of the output volume interval	b_{it}^{L}
1.6.	Upper boundary of the output volume interval	b_{it}^{U}
1.7.	Sale price of a product innovation	C_i
	Second group of model's variables	
2.1.	Group's number of an equipment	j
2.2.	Aggregate index that means the *r*-th level of automation of some element of the *j*-th equipment group	jr
2.3.	Number of acceptable levels of automation in the *j*-th equipment group	R_j
2.4.	Processing options of structural elements of the representative of the *g*-th group	k
2.5.	Processing cost of the *g*-th group of structural elements on the *j*-th group of equipment at the *r*-th level of automation according to the *k*-th variant of process innovation	Z^{k}_{gjr}
2.6.	Processing funding capacity of the representative of the *g*-th group of structural elements on the *j*-th group of equipment at the *r*-th level of automation according to the *k*-th variant of process innovation	α^{k}_{gjr}
2.7.	Allocated time in the year t of the technological equipment element of the *j*-th group, which has the *r*-th level of automation	f_{jrt}
2.8.	Amount of the equipment sought in the year *t*	y_{jrt}
2.9.	Equipment immediately available at the premises in the year *t*	Y_{jrt}
2.10.	Prime cost of one machine hour of operation of the technological equipment of the *j*-th group, having the *r*-th level of automation	d_{jr}
2.11.	Capital investments in the creation of one element of the *j*-th group of technological equipment, having the *r*-th level of automation for the year *t*	q_{jrt}
2.12	Expected average selling price of the equipment of the *j*-th group, having the *r*-th level of automation for the year t	ρ_{jrt}
	Third group of model's variables	
3.1.	Production space occupied by one element of the *j*-th group of technological equipment having the *r*-th level of automation	s_{jr}

3.2.	Sought value of the production space	S
3.3.	Available production space	P
3.4.	Capital investment in the creation of 1 m^2 of additional production space	φ
3.5.	Annual rent costs of 1 m^2 of production space	Π
3.6.	Current annual maintenance and operation costs of 1 m^2 of production space	ψ
3.7.	Enterprise investments in the development or acquisition of technological innovation in the year *t*;	K_t^{TechIn}
3.8.	Total additional capital investments in production	K
3.9.	Maximum allowed value of attraction of capital investments from outside	Q
3.10	Annual discount rate	E
3.11.	Annual norm of payment for use of capital investments from the outside	ε
	Boolean model's variables	
V_{it}	$V_{it} = \begin{cases} 1, if\ b_{it}^L \le x_{it} \le b_{it}^U; \\ 0, if\ x_{it} < b_{it}^L\ or\ x_{it} > b_{it}^U \end{cases}$	(1)
δ_{jrt}	$\delta_{jrt} = \begin{cases} 1, if\ y_{jrt} \le Y_{jrt}; \\ 0, otherwise \end{cases}$	(2)
π	$\pi = \begin{cases} 1, if\ S > P; \\ 0, otherwise \end{cases}$	(3)

The restrictions of the model are set in terms of production and implementation of product innovations, time 'stocks' of the equipment, production space and investment in the innovative project. In the adopted designations the limitations of the economic mathematical model assume the following form:

1) By the volume of product innovation's implementation and sales:

$$x_{it} - V_{it} b_{it}^L \ge 0, i = \overline{1,I}, t = \overline{1,T} \quad (4)$$
$$x_{it} - V_{it} b_{it}^U \le 0, i = \overline{1,I}, t = \overline{1,T} \quad (5)$$
$0 \le V_{it} \le 1$, $i = \overline{1,I}$, V_{it} are integer. (6)
$x_{it} \ge 0$ $i = \overline{1,I}$, $t = \overline{1,T}$, x_{it} are integer. (7)

2) By allocated usage time of equipment groups:

$$\sum_i \sum_j \sum_k \sum_r \sum_g \left(a_{gjr}^k \cdot p_{gi} \cdot x_{it} - f_{jrt} \cdot y_{jrt}\right) \le 0 \quad (8)$$

where: $Y_{jrt} \ge 0$, $j = \overline{1,J}$, $r = \overline{1,R}$, $i = \overline{1,I}$, $t = \overline{1,T}$, $g = \overline{1,G}$ are integer.

3) By production space:

$$\sum_j \sum_r s_{jr} \cdot y_{jrt} - S \le 0 \quad (9)$$

where $t = \overline{1,T}$.

4) By volume of additional capital investments:

$$K_t^{TechIn} + \sum_j \sum_r [\delta_{jrt} \cdot (y_{jrt} - Y_{jrt}) \cdot q_{jrt} - (1 - x_{jrt}) \cdot (Y_{jrt} - y_{jrt}) \cdot \rho_{jrt}] - K = 0 \quad (10)$$

where $t = \overline{1,T}$.

$$Y_{jrt} - y_{jrt} \cdot \delta_{jrt} \le 0, j = \overline{1,J}, r = \overline{1,R}, t = \overline{1,T} \quad (11)$$

$Q - K \ge 0$, $0 \le \delta_{jrt} \le 1$, δ_{jrt} are integer (12)

The maximum value of Net Present Value is taken as a criterion of optimality for the considered options [27], provided that in each of these options the non-negative value of Net Present Value is achieved [20-22].

The optimality criterion is quite complex. Therefore, this criterion is more convenient to consider in parts. Table 2 shows a calculation algorithm for current, investment costs and net present value of the project.

Table 2. A calculation algorithm for current, investment costs and net present value of the project.

№	Parameter	Calculation formula
1.	*Prime Cost of Production*	
1.1.	Direct material costs of an enterprise in terms of its annual output of product innovations	$m_i x_i$
1.2	Current enterprise costs in the year *t* for maintenance and operation of equipment	$\sum_j \sum_r d_{jr} \cdot f_{jrt} \cdot y_{jrt}$ (13)
1.3	Current company costs for maintenance and operation of the existing and leased production area, as well as the actual costs of the possible lease	$S\psi + \pi(S - P)\varPi$ (14)
1.4	Payment for use of borrowed funds by the enterprise	$\varepsilon \cdot Q$
2	*Capital investments*	
2.1	Capital investments of the enterprise in the *t*-th year in the production process of using the technological innovation without taking into account the circulating assets	$MK_t = K_t^{TechIn} + \left(\sum_j \sum_r y_{jrt} \cdot q_{jrt}\right)_t + P\psi$ (15)
2.2	Total capital investment of the enterprise in the creation of production spaces and organizational and production structures for the entire period of technological innovation (*T*)	$MK = \sum_{t=1}^{T} \frac{MK_t}{(1+E)^t}$ (16)
3	*Project efficiency*	
3.1	Target function of efficiency	$NPV = \left[\left(\sum_{t=1}^{T} \frac{R_t - W_t}{(1+E)^t}\right) - MK\right] \rightarrow max$ (17)
3.2	Economic evaluation of the results of the use of technological innovation by the company in the *t*-th year	$R_t = \sum_n \sum_i C_{it} \cdot x_{it}$ (18)
3.3	Current costs of applying the technological innovation in the year *t*	$W_t = \sum_i m_i x_{it} + \sum_j \sum_r d_{jr} \cdot f_{jrt} \cdot y_{jrt} + S\psi + \pi(S - P)\varPi + \varepsilon Q$ (19)
3.4	Difference between the results and costs of the project implementation for the *t*-th year	$R_t - W_t = \sum_n \sum_i C_{it} \cdot x_{it} - \sum_i m_i x_{it} - \sum_j \sum_r d_{jr} \cdot f_{jrt} \cdot y_{jrt} - S\psi - \pi(S - P)\varPi - \varepsilon Q$ (20)

Thus, in the created mathematical model we took into account the structure of project financing, the cost of attracting various instruments of the capital market and the weighted average cost of capital, which forms the norm of discount of the project.

Describing product innovations produced within the framework of the project, we took into account, firstly, their composition, detailing it to the level of assembly units and separate parts, and secondly, possible changes in the price of realization of product innovations within the project life cycle interval. The mathematical model also details the parameters and process innovations. In particular, such variables as the level of automation of different equipment groups, prime cost and stock capacity of product innovations processing are used to describe technological processes.

3.4 Description of the software for the Investment Decision Support System of Ziraat Bank

The software package is based on our proposed economic and mathematical models, adjustable due to their agility. Adjustment is performed based on changes in the external and internal conditions of the project. The software package contains the function of automatic updating of the initial data after carrying out the model correction. This, firstly, minimizes the execution time of a set of iterative calculations for various options and scenarios, and secondly, provides a correct analysis of changes in the results obtained.

The developed software product is designed to solve the problems of investing Ziraat Bank funds in modernization projects. As part of addressing these issues, the software package provides support for the totality of managerial decisions by Ziraat Bank.

This set includes decisions that are associated with the choice of:

a) product innovations to organize their release; manufacturing technologies (process innovations);
b) the composition of equipment (basic and robotics) of the designed organizational and production structures;
c) suppliers of material resources and consumers of product innovations.

In terms of integrity, the range of the listed solutions represents a decision on the best option for a modernization project.

The applied automated information system provides, first, the calculation of the Net Present Value for the options under consideration. Secondly, it performs a criterial assessment of the calculated values obtained. Thirdly, it makes it possible to drill down the calculations. This is an important feature of the proposed software package that distinguishes it from commercial software solutions. This feature is implemented by introducing a set of variables into the mathematical model, including a detailed description of technological innovations. For product innovations, it is their composition, which is structured up to individual units and parts. For process innovation, it is the composition of technological transitions. Organizational and production units (units) in the model are structured to the level of individual equipment units.

Detailing and introduction of detailed variables into the mathematical model allows the user, having received the values of integral performance indicators, to subject them to analysis and identify dominant factors. In case the values of these factors change, a range of managerial decisions is made that affect the indicators of the economic efficiency of the project.

To meet all the formulated requirements for the created software package, we chose Java high-level programming language [28-31]. Several factors influenced the choice of language. The most significant factor was the cross-platform nature of the package being created. The software can be implemented on different operating systems. This is provided by using the Java Virtual Machine – JVM [32, 33]. In turn, the Java Virtual Machine acts as the main element of the Java runtime system, executing Java bytecode. This code is first compiled from the source code of the Java program by the Java compiler.

The Java software package was implemented in IntelliJ IDEA [28, 29, 34, 35]. The choice of the environment was due to a number of its advantages such as functionality and ergonomics of the environment, the ability to analyze tasks solved in the process of developing software applications, and automation of the performance of these tasks.

IntelliJ IDEA, a multifunctional integrated development environment, is compatible with widely used free software among software developers. First of all, this concerns such tools as CVS, Subversion, Apache Ant, Junit, etc. The sixth and subsequent versions of the IntelliJ IDEA product contain the integrated tools necessary for the development of a convenient graphical user interface. Also, IntelliJ IDEA effectively implements intuitive auto-complete. IntelliJ IDEA also contains modern software debugging tools.

The software package is developed based on JavaFX [36, 37], a platform for software applications with a rich graphical user interface. This platform has wide functionality. In particular, JavaFX provides for the design of unified graphical user interface applications to run from under operating systems and in browsers.

The user interface of the offered Ziraat Bank software is developed with Scene Builder 2.0. In JavaFX, Scene Builder 2.0 [36, 37] is a tool used to graphically construct and then save various windows. Scene Builder 2.0, using the obtained result, constructs fxml files containing a formal description of the user interface of the created software application.

The architecture of the software package created to support the process of managerial investment decisions by Ziraat Bank, covering many software elements, is quite branched. The elemental composition of the architecture is focused on the Model-View-Controller (MVC) design pattern [22].

Model covers a collection of domain classes. Controller in the structure of the software package acts as a connector of Model and View. View as an element of a software application provides the convenience of the user interface.

Each class is a description of a set of objects with the same attributes, operations, relationships, and semantics. The architecture of a software application has a UML diagram of classes. Unified Modeling Language (UML) [38-40] covers the notation used for object-oriented design purposes and subsequent analysis.

The language contains various types of diagrams, the most significant of which are class diagrams. These diagrams show a set of classes and interfaces and the relationships that arise between them. Class diagrams, with a unique and straightforward graphical notation, provide a visual representation of the static state of a system. The classes of the model are `Listed`, `Content`, `Project`, `ProductInnovation`, `ProcessInnovation`, `GroupElements`, `ProjectChecker`, and `Parser`.

`Listed` is a dynamic array of objects. `Content` reflects the content of the model. The inclusion of these classes in a software application implements code dedupe.

`ProductInnovation`, `ProcessInnovation`, and `GroupElements` that represent the editable entity are created as inheriting from the abstract `Content` class. `Project`, `ProductInnovation`, `ProcessInnovation`, `GroupElements` are needed to describe options for projects and strategies, product and process innovations, and the structure of product innovations.

In deep detailing, these are groups of elements (nodes and parts). Project was created as a `Listed` descendant. First, the management of Ziraat Bank compiles a list of projects. Project is then generated from this list.

`ProjectChecker` is required to check the generated variants of projects and strategies for completeness and consistency of data. It allows the users to get information about whether the project meets the given constraints. `ProjectChecker` in the software application acts as an entity informing the user about the compliance of the project under consideration with the restrictions imposed on the objective function of the economic and mathematical model, which is embedded in the created software package.

The software implementation of the mathematical model gave rise to the need to create a `Parser` class, which, by combining two static methods, does not contain private or public fields. `Parser` allows you to create new classes of objects.

For the practical application of the software package that supports Ziraat Bank in its managerial decisions on investment problems, there was a need for an interface that should guarantee the user of the software package maximum convenience. To a large extent, the comfort of the interface concerns the display of those initial data and the operations performed on their basis, which are decisive in terms of influencing the decision-making process.

This applies to operations of forming:

- lists of projects potentially suitable for implementation;
- characteristics of product and process innovations;
- parameters of organizational and production structures for each element of the structure, including basic, control and measuring equipment, robotics;
- indicators of sales of product innovations for all items of the range. Range items and volumes of products sold for these items on the terms of a commodity credit to consumers (the number of receivables) are separately reflected;
- indicators of supplies of material resources for all items of the range. Separately reflected are the items of the nomenclature and the volumes of deliveries for these items of the nomenclature on post-payment terms (the number of accounts payable arising within the framework of the project from the designer).

This, in turn, updates the editing operations for each parameter included in the initial data and the generated list of operations performed by the software application using this data. The process of practical implementation of the created user interface is focused on the appropriate algorithm for obtaining the results of calculating the performance indicators of the considered project options.

First, the manager of Ziraat Bank compiles a list of projects, introduces characteristics of product and process innovations, parameters of elements of organizational and production structures, indicators of sales of product innovations for all items of the range, indicators of supply of material resources for all positions of the range of supplies, etc. Additional project variants or radical changes to existing variants mean adding new elements to the list of projects. This operation is performed using the “Add project” function. Accordingly, for the reverse operation (removal from the list that is irrelevant for the implementation of the project), the function “Delete project” is provided for. After changing the list of projects, the user of the software application for the newly generated project variants forms the initial data.

When implementing the project management strategy, the project manager of Ziraat Bank has to deal with editing. This operation is applied in relation to both the list of projects itself and the initial data in the list of projects. To implement such an operation, the designed user interface of the software application has an editing window and the “Edit project” function.

Further, the algorithm fills in each project. This is done by forming a set of initial data. This operation is also performed by the project manager of Ziraat Bank. An operation, for example, may involve introducing characteristics of product and process innovations into a software application.

By analogy with changing the list of projects, the list of technological innovations (product and process) is also processed.

Changing the initial data, including data on product and process innovations added to the list, is performed by analogy with the "Create a list of projects" operation.

Working with the developed software application, the project manager of Ziraat Bank, in addition to the already considered data, enters into the program a set of other data. For example, simple data reflects the integer values of the variables of economic and mathematical models underlying the program. In addition, the program provides for the possibility of detailing the characteristics of product and process innovations. To save the detailed characteristics of innovations entered into the program, the user interface provides for the "Update" function.

Once all the initial data of the considered options are entered into the software application, the program, using a mathematical model, calculates the values of cash flows and performance indicators. To calculate performance indicators and compare them with the criteria set in the model, the project manager of Ziraat Bank must choose the "Calculate" function in the main program window. If for some reason the software application does not perform the calculations, then a window automatically opens with detailed information about errors in calculations or data entry. If the project manager of Ziraat Bank enters the entire set of initial data into the software application correctly, then after all calculations have been completed, the "Statistics" window opens. This window displays all the calculated indicators of the options under consideration.

Thus, the architecture of the information system software application that supports investment decisions made by Ziraat Bank's management covers three major components: model, controller and view**.** The model encompasses a set of domain classes. The view provides a user-friendly interface. The controller links the model and the view.

The software application developed by us has a high level of compactness. It takes into account a greater number of factors that influence the decision to invest Ziraat Bank's funds in the project than other existing software developments on the Russian market. It has a user-friendly interface. The system is based on the mathematical model that takes into account the impact of investment resources, product, process and organizational and economic innovations on the efficiency of an innovative project.

4 Discussion of results

The developed software package has a number of main features and significant advantages over Russian and foreign commercial software products (see Figure 5).

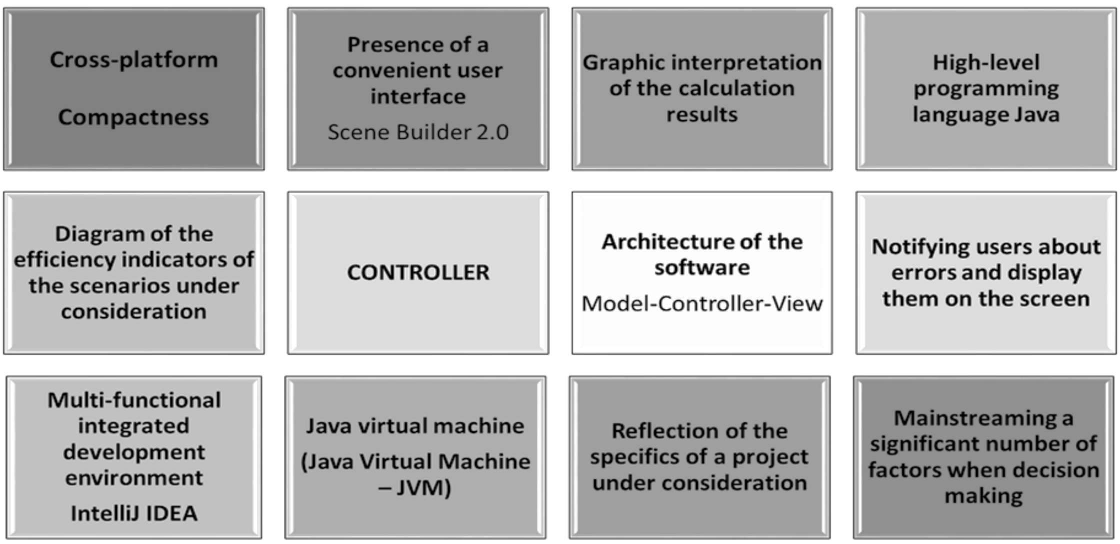

Fig. 5 Diagram of main features of the developed software.
Source: author's research.

These advantages lie, firstly, in the possibility of making adjustments to the mathematical model embedded in the program. Secondly, the package is functionally expandable. This is its important property, which dictates the need to integrate additional modules into the applied automated information system. The design of such modules is necessary when new non-trivial tasks arise within the framework of the project.

The developed software application meets the requirements of international standards for evaluating the effectiveness of investment decisions, considers the features and specifics of the activities of the designer. The created software product can be used not only to provide decision-making support for tasks already formed within the framework of the project but also for new emerging tasks. This primarily concerns the robotization of technological operations, which, along with informatization, acts as the foundation for digital industries.

The software product provides modeling of both investment and operating expenses and income. Their modeling can be tied both directly to the project, and to the mechanism for forming relationships with consumers of product innovations and suppliers of material resources. At the same time, the process of analyzing the modeled cash flows is aimed at the centers of formation of the fundamental value of the designer.

The developed software application, which provides support for managerial investment decisions by Ziraat Bank, can function in various operating environments. For example, such widespread platforms as Windows, Linux, Mac OS (Macintosh Operating System), and several others can be used.

5 Conclusion

Following the implementation of the investment decision support system, positive changes occurred in the activities of Ziraat Bank. Before the adoption of the system, it was necessary to constantly adjust the initial data related to the projects under consideration as the incompleteness of such data, due to the lack of detailed design and technological characteristics of the project, required additional calculations of the integral efficiency indicator of the evaluated project to be performed. That is why there was a risk of making an incorrect investment decision within the project evaluation system. This could result in a decrease in the efficiency of using the bank's capital.

Expert evaluations have shown that the use of the created software ensures a 5-7% reduction in the total time spent on making investment decisions on three projects, the implementation of which is currently nearing completion. These are projects that are being implemented by the various entities of the machine building cluster of the Republic of Tatarstan and its affiliates within the framework of mega-projects of the Kamskaya agglomeration:

- Construction of a plant for the production of batteries in the Alabuga Special Economic Zone (design engineering by LLC "Bars Technology", Naberezhnye Chelny, Russia);
- Construction of a plant for the production of automotive vacuum loaders and stationary vacuum plants (design engineering by PJSC "RIAT", Mendeleevsk, Russia).
- Construction of a plant for the production of spare parts for oil and gas production equipment (design engineering by PJSC "Grand", Naberezhnye Chelny, Russia).

Application of the results of this research allowed Ziraat Bank to minimize the risks that arose due to improper management decisions in the field of investment activities. The success of these projects cooperationing with the bank confirms the scientific and practical importance of this research. The results obtained can be extrapolated for other banks and projects as well as various financial institutions globally.

Acknowledgment

We would like to express gratitude to Artur Shindyapin for timely assisting our team with translating and proofreading the article in English.

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