

# Decision support system for set-up of investment portfolio as a part of company development program

Valentina Moskalenko  
*Department of Software Engineering and Management  
Information Technologies  
National Technical University «Kharkiv Polytechnic  
Institute»  
Kharkiv, Ukraine  
valentinamosk17@gmail.com*

Svitlana Kachanova  
*Department of Software Engineering and Management  
Information Technologies  
National Technical University «Kharkiv Polytechnic  
Institute»  
Kharkiv, Ukraine  
ksvetlana13.96@gmail.com*

**Abstract**—The analysis carried out in this paper describes the functionality of existing investment decision support systems. A business process for the formation of an investment portfolio as part of the company development program was proposed. The portfolio consists of three parts: a portfolio of development projects of the company, a portfolio of projects of other companies and a portfolio of securities. The architectural solution for the software implementation of the decision support system in the field of portfolio investment is presented. It is proposed to present the DSS for the formation of an investment portfolio in the form of five containers, in which the corresponding tasks are performed: evaluation of investment projects; evaluation of securities; Assessment of the importance of investments for the development of the company; allocation of the company investment funds between portfolios; formation of the company investment portfolio. This decision support system is associated with Enterprise Performance Management systems which are designed for information and analytical support of strategic company management processes. Implementing of DSS that the user can solve package investment problems for making certain investment decisions and solve them in package for implementing the company development program during the strategic period.

**Keywords**—*investment, decision support system, software architecture, service-oriented architecture.*

## I. INTRODUCTION

The investment program is the mean of the company's strategic plan implementation. The investment program is the whole of investment projects and amounts of their financing within the strategic period. The plan for implementing a set of investment projects is determined by the company investment policy, which, in turn, depends on the strategic objectives of the company. The investment program of the company also covers the determination of the size and structure of the capital necessary for its implementation. Since the formation and implementation of the investment program involves the collection and analysis of a large number of heterogeneous information, with the solution of a multitude of tasks, decision support systems are being introduced into the investment management system. The software market offers various systems that support the processes of managing companies' investments in information and analytics. However, in the conditions of a dynamic investment market, with the advent of new mechanisms and sources of financing for the activities of various

companies, there is a need to use new information technologies and to revise the structure of such systems. In this paper, an architectural solution for a decision support system is proposed. It will allow implementing of DSS in the form of a software package in such a way that the user can solve package investment problems for making certain investment decisions and solve them in package for implementing the company development program during the strategic period..

## II. LITERATURE REVIEW

Not only advanced information technologies in the field of collection, storage and analysis of data on investment objects are used in modern DSS, but also new models, methods for solving investment problems, for example, investment valuation, investment portfolio set-up, etc. This is due to the fact that the objects of investment, the nature of the factors affecting the investment attractiveness of these facilities, etc. change. In the conditions of the modern investment market functioning some questions arise with regard to attracting investments for social projects For example, the decision-making model for participation in social venture capital (SVC) was proposed in [1]. The evaluation is carried out using this model for various aspects related to investment decisions. The investment attractiveness of a company that needs investments is assessed in terms of the following aspects: previous experience of the investor with the company (past); financial condition of the company and its intangible assets (present); a proposed project for investment, which is assessed on the basis of financial and social criteria (future). As a result, the investment object is estimated using 26 criteria and 160 indicators, their priorities are determined by the process of the variant analysis method (AHP). This, on the one hand, makes it possible to simplify the difficult task of assessment through hierarchical analysis, but, on the other hand, subjective judgments of experts are used, which cannot always reflect the real situation. The models of mathematical programming are most often used for the investment portfolio forming. The task of forming project investment portfolios is traditionally considered as the multi-criteria problem. For example, the DSS proposed in [2] is based on single-criterion and multi-criteria optimization models with the possibility for an investor to choose different criteria for profitability and risk for project selection. Methods of mathematical programming

are also widely used to form a portfolio of securities [3, 4]. Multi-criteria decision-making technology is used in [5]. The choice of an investment object is simplified if you use the AHP method. As a result, the system allows you to create a rating of criteria for selecting securities by the user, and then evaluate them and make investment decisions. This approach is appropriate only for making decisions on the purchase of a individual securities, it will be difficult to form an investment portfolio for a long period with the help of this system. Many scientific references pay great attention to the analysis of information about the object of investment. The three-layer structure of DSS is proposed in [6] and consists of Analysis, Synthesis and Investment Decision Support System. The multidimensional dynamics of the investment market is determined at the first level. Multidimensional dynamics is synthesized to reflect real and potential market situations at the second level. The support for making investment decisions is based on traditional methods of solving investment problems at the third level. Conclusions can be made on the basis of analysis of structures and analytical-algorithmic support of investment decision-making processes. The systems that were offered are mainly intended for analysis and decision making on one type of investment object - either securities or investment projects, in some cases - real estate objects [7]. A number of studies most often contemplate an investment object on the basis of indicators of profitability and risk. Investments invested in projects or securities are not analyzed from the perspective of the development of an investor company which makes it difficult to use such systems for making long-term decisions, for the formation of a development program for the company.

### III. PURPOSE AND OBJECTIVES OF THE RESEARCH

#### A. *Business process of investment portfolio formation*

We will assume that all projects, that are included in the investment program, relate to the activities of the enterprise in the field of external and internal investment. By internal investment we will understand the investment of the company funds for its own development, for example, modernization and expansion of production capacities, introduction of new technologies, etc. External investment involves investing in the company securities and projects that are implemented by other organizations, companies, etc. The goal of external investment can be not only obtaining investment profit, but also, for example, merging enterprises within the strategy against competitors, the strategy of horizontal or vertical integration of related enterprises, etc. The strategy, investment policy and investment portfolios are developed for each type of investment activity. Thus, within the framework of the investment policy it is necessary to form:

- investment projects portfolio of company development;
- real and financial investment portfolios within the framework of external investment activities.

Then the business process of forming an investment portfolio is proposed to be presented in the form of the following basic procedures (Fig. 1).

A1. Allocation of investment resources to the types of investment portfolios. For this, an algorithm is used that implements the mechanism of proportional allocation of a homogeneous resource. The utility function is proposed as the allocation criterion. The utility function includes the criteria of profitability and risk, as well as a criterion for estimating investments in an object in terms of the importance of such an investment for the company development prospects.

A2. Formation of an investment projects portfolio which will be implemented in this company as a part of the enterprise development program. The general process of the formation of this program is presented in [8]. This process is built on the concept of strategic alignment [9, 10]. The plans of the divisions are formed over the years of the strategic period. Based on the decomposition of strategic objectives and cascading key performance indicators. The key indicators that characterize the company investment activity are also determined. Investment projects are evaluated in terms of their significance for the development of the enterprise. This portfolio is a set of projects for the years of the strategic period.

A3. Portfolio of external investment is formed by a preliminary analysis of investment projects that will be implemented by other companies. The portfolio of projects is formed on the basis of this analysis, and the formation of portfolios is carried out over the years of the strategic period according to the model of multi-criteria optimization. The following criteria are considered as criteria: maximizing the profitability of investments, minimizing risks, and maximizing the importance of investing investment funds in a project for the development of an investor company.

A4. Preliminary selection is carried out during the implementation of the procedure for forming a portfolio of securities which are important for the company from the perspective of its development prospects. Then, models of financial portfolio formation are used, which use the criteria for maximizing the profitability of investments and minimizing their risks.

A5. The company total investment portfolio is formed as a combination of three portfolios. Here, the overall yield of the portfolio, the risks and the significance of future investments for development are analyzed. Key indicators of investment activity were determined during the development program, they will form the basis for deciding whether to approve or revise the portfolio of investments [8].

Therefore, it is possible that it will be necessary to reconsider the importance of selection criteria for investment objects – securities and projects, after analyzing the formed portfolios. Next, it will be necessary to implement this process again, beginning with procedure A 1.

Thus, as a result of the iterative process, the portfolio of investments will be formed; such a portfolio will be implemented by the company within the framework of investment activities in the strategic period.

*B. The software package architecture that implements the DSS for investment portfolio formation*

Software packages that have different architectures: monolithic; modular; component; client-server; service-oriented, are used to solve investment problems [11]. Applications of monolithic architecture are applicable for solving individual investment problems, for example, assessing the effectiveness of investment projects, forming a portfolio of securities. This limits the use of such

architecture for the implementation of DSS in the field of investment management of the company.

Software products with a modular or component architecture assume the decomposition of the application into several parts that can be used multiple times. Such architecture makes it possible to build multifunctional software packages, so it is often used for DSS development. However, the modules must be universal and all together represent a localized softwarepackage.

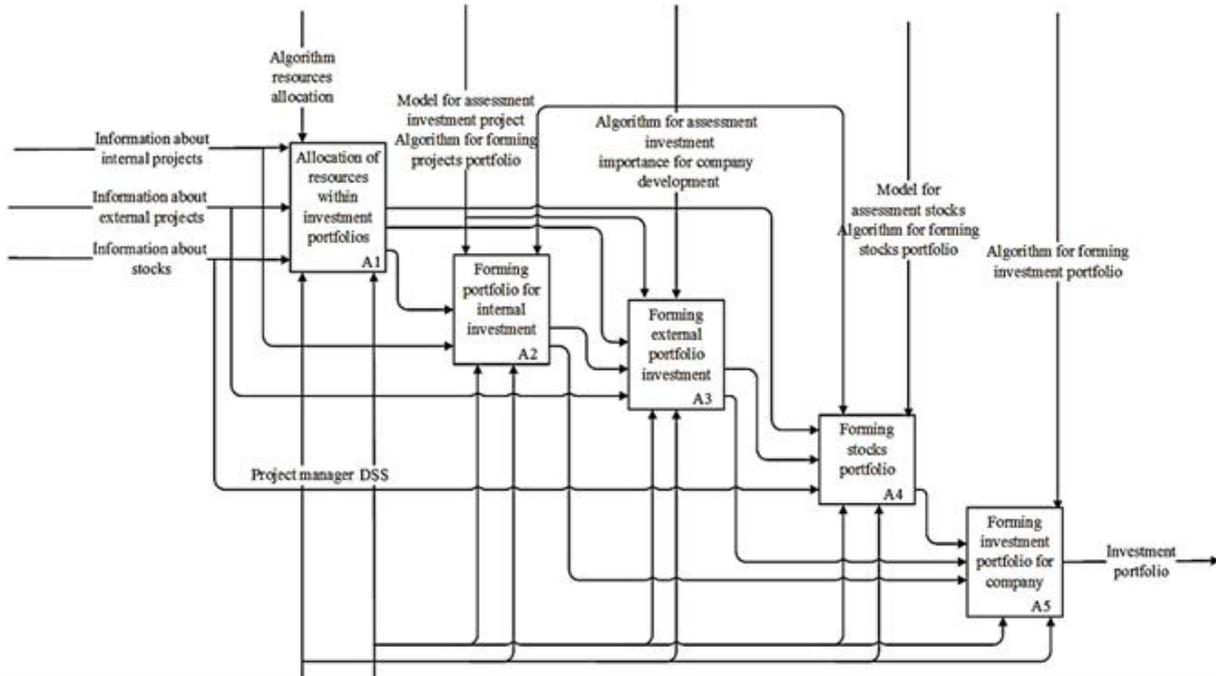


Fig. 1. Business process for the formation of the company investment portfolio

Number equations consecutively. Equation numbers, within parentheses, are to position flush right, as in (1), using a right tab stop. To make your equations more compact, you may use the solidus (/), the exp function, or appropriate exponents. Italicize Roman symbols for quantities and variables, but not Greek symbols. Use a long dash rather than a hyphen for a minus sign. Punctuate equations with commas or periods when they are part of a sentence, as in:

Client-server architecture implements the logic of clients' autonomous work with a certain business application that interacts with the server part - the DBMS or the file server. Here, heterogeneous modules interact through information and communication networks. DSS for the formation of an investment project portfolio is built with this architecture according to investment estimates, etc. In service-oriented architecture (Service Oriented Architecture), the interaction of two or more allocated software modules is most fully realized. SOA is used to build package allocated information systems based on the integration of Web services. Since the specifics of large companies, that are engaged in different types of investment, involves the use of different data servers, standalone applications that solve individual investment problems and must be combined together logically into one system for supporting investment decision-making. Therefore, based on the analysis of architectural solutions

of software products in the field of investment, it was concluded that SOA is the most acceptable solution for building DSS for investment within the company development management system [12]. SOA allows you to establish links with micro-services, which are focused on solving individual business problems. It is proposed to present the DSS for the formation of an investment portfolio in the form of five containers, in which the corresponding tasks are performed (Fig. 2): evaluation of investment projects; evaluation of securities; Assessment of the importance of investments for the development of the company; allocation of the company investment funds between portfolios; formation of the company investment portfolio. This decision support system is associated with Enterprise Performance Management (EPM) systems which are designed for information and analytical support of strategic company management processes [12]. EPM is a process and software system designed to help companies link their strategies to their plans and their implementation. The objective of EPM is to ensure that strategic goals and objectives are clearly communicated and understood by managers, and are reflected in their budgets and plans. Getting all of the various departments of an organization aligned around goals and objectives is a critical starting point.

#### IV. CONCLUSIONS

- 1) The analysis of the existing investment decision support systems functionality was conducted.
- 2) The business process for an investment portfolio formation as part of the company's development program was proposed. The portfolio consists of three parts: a

portfolio of the company's development projects, a portfolio of other companies' projects and a portfolio of securities.

- 3) The architecture for software that implements a decision support system in the field of investment portfolio was proposed.

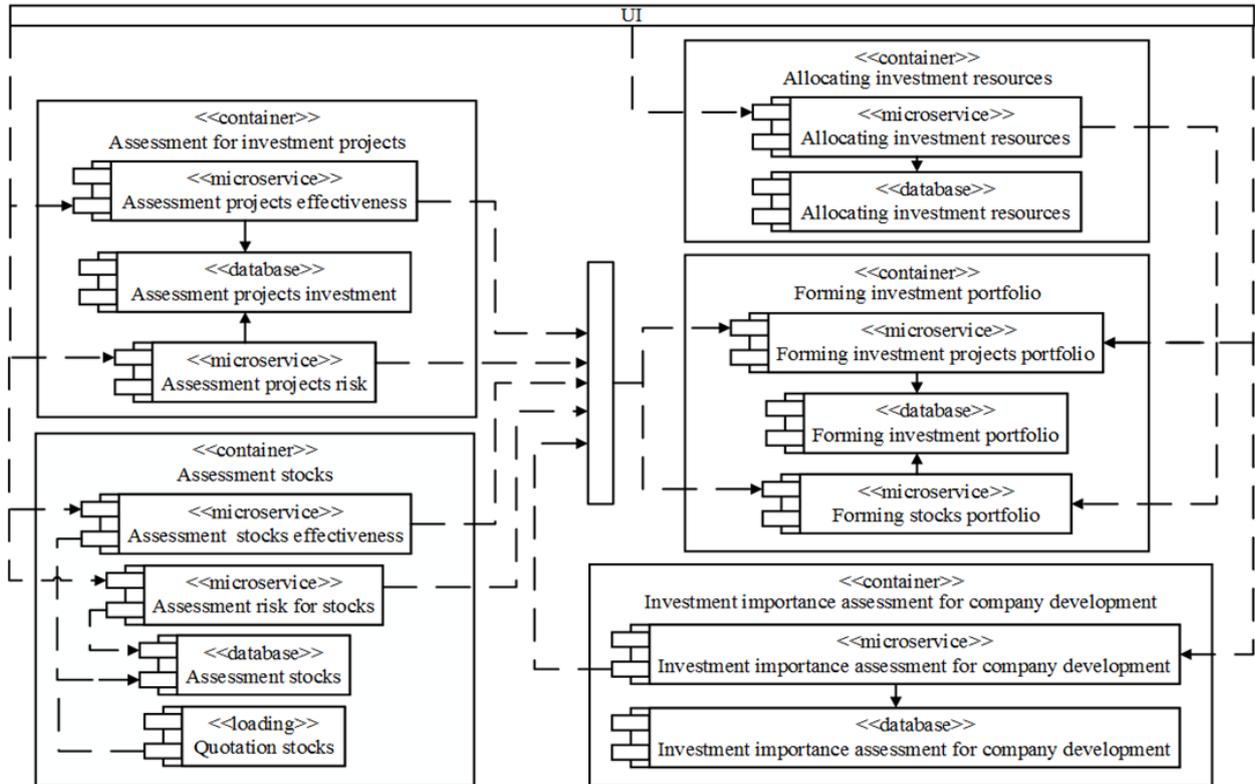


Fig. 2. The software package structure that implements DSS for formation investment portfolio

#### REFERENCES

- [1] C. Serrano-Cinca, and B. Gutiérrez-Nieto, "A decision support system for financial and social investment", in *Applied Economics*, Taylor & Francis Journals, vol. 45(28), 2013, pp. 4060-4070.
- [2] H. C. Caballero, and Schmidt, E. K., "Decision support system for portfolio components selection and prioritizing", Paper presented at PMI® Global Congress 2014 – North America, Phoenix, AZ, Newtown Square, PA: Project Management Institute.
- [3] M. Mansoury, B. Mansoury, and S. A. H. Golpayegani, "Enhanced decision support system for portfolio management using financial indicators", in *International Journal of Business Information Systems Strategies (IJBISS)*, 2012, vol. 1, pp. 1–9.
- [4] Keerti. S.Mahajan, R. V. Kulkarni, "Stock Market Prediction and Investment Portfolio Selection Using Computational Approach", in *Journal of Computer Engineering*, V. 17, Issue 3, Ver. VII (May – Jun. 2015), pp. 53–62.
- [5] P. Songsangyos, "The Decision Support System for Hierarchical Portfolio Management", in *International Journal of Information and Education Technology*, vol. 4, No. 4, August 2014, doi: 10.7763/IJNET.2014.V4.423.
- [6] W. Chen, L. Cao, and Z. Qin, "An Investment Decision Support System (IDSS) for Identifying Positive, Neutral and Negative Investment Opportunity Ranges with Risk Control in Stock Markets", in *International Journal of Intelligent Systems Technologies and Applications*, vol. 4, May 2008, pp. 239–253.
- [7] R. Valverde, "An adaptive decision support station for real estate portfolio management", in *Journal of Theoretical and Applied Information Technology*, 2009, pp. 84–86.
- [8] V. V. Moskalenko, T.V. Zakharova, and N.G. Fonta, "Technology of formation of development program as a system of company's annual plans based on key performance indicators", in *European cooperation Scientific Approaches and Applied Technologies*, Vol. 2(2), 2015, pp. 108–124.
- [9] H. L. Wang, and A. Ghose, "On the foundations of strategic alignment", *The Proceedings of the 2006 Australia and New Zealand Academy of Management Conference*. Dunedin, New Zealand, December 2006.
- [10] J.Walter, F. W. Kellermanns, S. W.Floyd, J. F. Veiga, and C. Matherne, "Strategic alignment: A missing link in the relationship between strategic consensus and organizational performance", in *Strategic Organization*, 11(3), 2013, pp.304–328.
- [11] B. J. Sovetov, A. I. Vodjaho, V. A. Dubeneckij, and V. V. Cehanovskij, "Architecture of information systems", *Izdatel'skij centr "Akademija"*, Moscow, 2012, 288 p. (In Russ.)
- [12] V. V. Moskalenko, and Y. S. Berezenko, "The concept of an architectural solution for the service intended to build an enterprise strategy map", in *Bulletin of NTU "KhPI"*, Series: System analysis, control and information technology, vol 55 (1276), 2017, pp. 45–50.