# METHODOLOGICAL ASPECTS OF MANAGEMENT OF PORTFOLIOS OF INVESTMENT PROJECTS FOR REAL ASSETS OF BUSINESS ORGANIZATIONS

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**Abstract:** The article aims to present the potential of the classical portfolio theory and the possibilities for its application in the formation and selection of a portfolio of investment projects for investment in real assets. For this purpose, it reviews and summarizes the views of various authors on key concepts, such as investment, project, investment project, etc. The essential conceptual characteristics of portfolio theory are defined in terms of its methodological and mathematical toolbox and subsequently adapted to a conceptual model (methodological framework) for selection of a portfolio of investment projects for real assets and its optimization according to key criteria set by the management. Finally, its draws conclusions regarding the main advantages and the related constraints of the methodological model.

**Key words:** investment, projects, portfolio management, optimization, model.

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## Introduction

Investment analysis and portfolio management help the management of business organizations (companies) to gain in-depth insight into the essential characteristics of various investment projects they implement and are used as appropriate methodological tools for making sound investment decisions. It goes without saying that this process is far from easy and requires a good knowledge not only of the types of investment assets and investment theories, but also of the theoretical tenets of investment portfolio management. The fundamental theoretical investment concepts and the theory of portfolio management are based on financial investments and allow us to analyse the investment process and make decisions for managing investments on a much broader range. However, based on the presumption that a large part of the investments of business organizations (enterprises) are in real rather than financial assets, we put forward an adaptation of the classical portfolio theory of Harry Markowitz (1959) for the purposes of managing portfolios of investments in real assets. To achieve this goal, the author has reviewed the theoretical aspects of investments, projects, investment projects and portfolio management. Emphasis was put on a methodological framework for selecting a portfolio of real-asset investment projects and its stage sequence and effectiveness.

## 1. Theoretical aspects of the terms *project*, *investment project*, and *investment projects portfolio*

Projects play an important role in the economic development of any company (business organization). From the moment of their establishment and through all phases of their life cycle (growth, development, maturity, restructuring), business organizations invest significant resources (money, time, labor) in various projects related to real assets, raw materials, management, transportation and logistics, production, education, etc. to improve the socio-economic position of the company and create conditions for its growth and development. These projects are designed in such a way as to ensure that they are managed efficiently and result in outcomes that ensure the future development of the company using its own and/or borrowed resources.

Although many people and organizations have come up with their own definitions of the term *project*, the most accurate by far seems to be the definition of BS 6079 Project management - principles and guidance for the management of projects, according to which a project is a „unique process, consisting of coordinated and controlled activities with start and finish dates, undertaken to achieve an objective conforming to specific requirements, including constraints of time, cost, and resources." This definition shows that the term *project* has a broader meaning, but is necessarily carried out by performing a set of activities. Another aspect of the project is the non-routine nature of the activities. Each project is unique, in the sense that the activities of a project are unique and non-routine. The implementation of a project necessarily involves the use of certain resources, such as people, materials, money, and time. Therefore, we can define the project as an organized schedule for implementation of a certain number of activities that are not routine in nature and that must be completed using the allocated resources within the specified period.

Newman et. al. (1995) define the project as a clearly stated mission that must be achieved within a clearly defined deadline.

According to Gillinger (Shaghil & Mushtaque, 1997), *project* is the whole set of activities associated with the use of resources to achieve results (outcomes). The USA Project Management Institute defines *project* as a "system for coordination of various units and departments of an organization for completion of certain tasks within certain time limits and resource constraints."

In his Encyclopedia of Management Theory, Kessler (2013) states that "a project is an organized unit dedicated to the achievement of a specific goal, brought to a successful and timely completion within a certain budget and in accordance with a pre-set implementation schedule."

The basic characteristics of a project are: (1) Objective: A project usually has a set of objectives or a mission statement. The project effectively terminates when these have been achieved; (2) Life cycle: Projects tend to pass through five clear stages of development: concept, definition, design and planning, implementation, and commissioning; (3) Unique characteristics: Each project is unique and no two projects ever have identical characteristics; (4) Teamwork: Projects often draw together members from different specialisations. The coordination of these members requires teamwork and successful cooperation; (5) Complexity: Projects include multidisciplinary activities; (6) Risk and uncertainty: Projects tend to be characterised by a high degree of uncertainty and risk. A project always involves certain risks, whether they are obvious or not or predictable or unpredictable; (7) Customer-specific: projects are always customer-specific; (8) Change: Changes occur during the life cycle of the project as a natural result of many environmental factors. Changes can range from minor, having little impact on the project, to significant changes that can have a big impact or even change the very nature of the project; (9) Optimality: Projects always aim at optimal use of resources for the overall development of the company; (10) Subcontractors: The large volume of work in a project implies the need to use subcontractors. The greater the complexity of a project, the higher the degree of the so-called. external assignment; (11) Unity in diversity: Projects are complex sets of thousands of elements in terms of technology, equipment and materials, machinery and people, work, culture, etc. Their unity and skilful (successful) combination is a prerequisite for the successful implementation of the project.

The above definitions lead to the conclusion that the specific characterristics of a project are defined as: activities (defined, allocated, and coordinated), start and end (time constraint), schedule, resources (time, labour, financial), result (financial or not). From investment point of view, these characteristics of a project can be used to define the concepts of investment and investment project.

An essential element of any project and a prerequisite for its successful implementation is the need to invest a certain resource, which is expected to lead to a positive result or, in other words, the need to make specific investments. Investment is defined as the current commitment of money to derive future payments at a required rate of return. If the resource is invested correctly, the return will correspond to the risk assumed by the investor (Fisher & Jordan, 1975).

The basic definition for a capital investment is the investment in a real asset that is expected to result in a future return (Brealey et al., 2011). For a company, this can be, for example, an investment intended to increase its capacity, improve its product quality, or contribute to more efficient use of its resources.

In his book Fundamentals of Investment, Ivan Georgiev (2013) gives a comprehensive definition of investments, which lists their essential characterristics and the way they are used in business organizations. He defines investments as “cash to acquire (or construct) assets that are likely to provide income, capital gains, and other long-term benefits.”

The importance of capital investment is further emphasized by Lumijärvi (1991, p. 171), who states that: "investment affects the operations and cash flows of companies over a long period of time, which makes investment success extremely important". Capital investment decisions are also considered an important tool for implementing strategies (Grundy & Johnson, 1993) and ensuring corporate performance (Emmanuel et al., 2010). Investment decision-making is a matter of resource allocation (most often, but not only financial) (Bower, 1986), and research shows that firms that have "more room for financial manoeuvring", i.e. more disposable resources, have a less formal investment decision-making process (Van Cauwenbergh et al., 1996, p. 175). However, since firms usually have limited resources available, allocation decisions on the various investment decisions are essential (Lumijärvi, 1991).

Therefore, the question is “How do companies make these important investment decisions?”

Of course, the specifics of investments, combined with the characterristics of projects and their overall process organization, suggest that to some extent there are both general and specific features of investment projects in comparison with the projects in a business organization. In other words, every investment project is a project, but not every project is an investment project. Thus, the logical question is “What is the definition of an investment project?

According to Ivan Georgiev (2013), investment projects are one-off investments of funds in some assets to ensure financial gains and/or other positive results over a period of time. He also points out that projects differ in too many aspects, such as their scale (large, small); assets (real, financial); field (market, production, etc.); goals (minimizing costs, increasing revenue, increasing capacity); risk (high risk, low risk); design (internal, or by external entities) and variability (complementary, mutually exclusive), etc.

In her dissertation research, Vanya Pandakova (2015) defines that “investment project” should be understood as a unique set of interconnected activities aimed at achieving a clearly defined goal related to the construction of new or renovation of existing buildings and facilities through construction, expansion, reconstruction, modernization and overhaul, the main feature of which is the performance of construction and installation works within a defined period of time, at a given cost and quality requirements and at predetermined permissible levels of risk.

Investment projects are a long-term allocation of funds (with or without recourse to external financing of the project) in order to implement an investment idea to the stage of generating a stable income. A viable investment project aims to achieve a profitable return that guarantees (1) timely payment of interest and principal on external sources of its financing, (2) a satisfactory return on invested capital and (3) positive and consistent cash flows.

Businesses have many investment opportunities, each one associated with different trade-offs in risk and return. Each investment project is different in terms of its characteristics, which makes the investment decision a challenging process. Thus, the investor must carefully analyse each of the characteristics and compile a portfolio of projects for investment in real assets, which corresponds to his risk profile and is in line with the company's goals and objectives, strategy, etc.

The process of investment decision-making was described first by Cyert and March (1963). However, capital investment decision-making studies usually focus on the financial evaluation of investments such as the use of capital budgeting tools and practices (e.g. Bennouna et al., 2010; Graham & Harvey, 2001; Lefley, 1996; Sandahl & Sjögren, 2003; Qiu et al., 2015).

Although financial evaluation plays an important role in investment decision-making (Van Cauwenbergh et al., 1996), it is only one step in the process (King, 1975) and “corporate investment behaviour is significantly more complex than it can be described by the basic NPV concept as an investment model” (De Canio & Watkins, 1998).

All this enables us to develop a methodology adapted on the basis of various investment concepts and concepts for portfolio management of investment projects, on the basis of which to seek and achieve optimization and reasonable selection of individual projects included in an investment portfolio of the business organization by key characteristics. It is based on Markowitz's (1959) portfolio management concept, which was adjusted and interpreted in terms of corporate management of portfolios of projects for investment in real assets.

### Portfolio theory applied to business organizations’ investments in real assets

When compiling a portfolio of projects, one of the main factors to consider is the project selection procedure. In theory and practice, there are many procedures to decide which projects are worth investing in. It is important to note that in order for project selection to be successful, it must meet two important conditions. First, before the process is carried out, it is necessary to clarify the criteria by which the projects will be selected. They must be clearly defined and applied to all projects. Second, regardless of which selection method is chosen, it must be clearly described and allow the use of the underlying selection criteria.

The methods for selection of securities for investment portfolios of financial assets cannot be used directly to select portfolios of projects for investment in real assets due to differences between investments in real and in financial assets. Therefore, we should consider the method and procedure used for selection of stocks and their feasibility for selection of investment projects.

Financial theory and practice offer a wide variety of stock selection methods. For the purposes of this study, we will consider only the optimization models and in particular the mean-variance model. It was originally proposed by H. Markowitz and developed further by other authors, among which Grinblatt and Titman (2001); Sharpe, Alexander, and Bailey (1999); Elton, Gruber, Brown, and Goetzmann (2003); Huang and Litzenberger (1988) and Merton (1972). It uses non-linear programming and the necessary input parameters for the analysis are: expected return, variance, covariance between all cash flows and desired return or desired risk. The model has two variants:

minimum risk exposure at a certain return rate and maximum return at a certain level of risk.

In the case of the minimum risk at a certain rate of return, the weights of the assets in the portfolio are determined on the basis of optimization by the method of quadratic programming using the following mathematical and statistical equations:

$$Z = \sum_{i=1}^{n} \sum_{j=1}^{n} w_i \, w_j cov_{ij} \rightarrow min \tag{1}$$

$$\sum_{i=1}^{n} r_i w_i = R \tag{2}$$

$$\sum_{i=1}^{n} w_i = 1 \tag{3}$$

(4) $w_1 \geq 0$ , i =1,....., N,

where:

ri – is the expected rate of return of the i[th] asset;

wi – is the weight of the i[th] assey in the portfolio – unknown variable;

covij – is the covariance between the rates of return of the i[th] and the j[th] assets;

R – is the rate of return required by the investor;

N – is the number of assets in the portfolio.

The method for selection of a basket of stocks through mean-variance optimization has two main advantages: flexibility and adaptability of the model to the requirements of investors and perfect accuracy in determining a portfolio that meets the requirements of the investor. However, this advantage is closely related to the biggest disadvantage of the method. Nawrocki (2009) uses the popular name "butterfly effect" to describe this shortcoming of the model. It means that even a minimal deviation in the input data will lead to significant differences in portfolio selection. This is because the solution of the optimization problem is done through multiple mathematical iterations and even a small deviation in the input data would have a multiplier effect.

The optimization method for selection of shares is characterized by the fact that the only characteristics by which projects are selected are the financial indicators of risk and return. When investing in financial assets, investors are rarely interested in other features. When investing in real assets, the investing business organizations are interested in a wide range of indicators. In addition to project risk and return, they also consider strategic, environmental, technological and other features. This is due to the fact that with their investment projects business organizations pursue goals that are may not be related to the investment policy of the company. These goals may be related to other company goals and the specific activities of the company. This is why we have to add other criteria to a possible model for selection of real-asset investment projects.

Another problem with stock selection models is the application of stock-specific indicators, which are often irrelevant in terms of real assets. The use of concepts such as beta coefficients, systematic and non-systematic risk, return on risk-free assets and market risk would impair the accuracy of the method when it is applied to real-asset investment projects. The need to calculate the beta coefficient of such an investment project would deter most businesses from using the method.

It is for these reasons that the method of mean-variance optimization is considered, taking into account its requirements for input data - return, risk (variance and standard deviation) and asset covariance. The return on an investment project can be measured using many indicators, but it is necessary to take into account the preference for dynamic indicators that reflect the time value of money. We can use the net present value to account for the return on an investment project. The indicator is dynamic and covers the entire project period. The variance and standard deviation used in risk measurement may not be the indicators preferred by some business organizations but these methods for assessing the risk of an investment project are well-known and can be used in a project selection method. The covariance between two projects is probably a weak indicator, but it is easy to calculate.

To calculate the return and risk of a portfolio of investment projects, we can use the inputs used for calculating these values for a stock portfolio of shares, i.e. the net present value of a portfolio of investment projects will be a weighted average of the net present value of all individual projects in the portfolio, and the risk will not be a weighted average of the individual risks of these projects.

(5) $NPV_p = \sum_{i=1}^{n} x_i NPV_i$,

where:

NPVp is the net present value of the portfolio;

NPVi is the net present value of the $i^{th}$ project in the portfolio;

Xi is the relative share of the $i^{th}$ project in the portfolio. $0 \leq Xi \leq 1$.

### Methodology for selection of real-asset investment projects

The developed methodology is used for compilation and management of portfolios of real-asset investment projects of business organizations. The resulting portfolio must meet the optimality criteria according to Markowitz's portfolio management theory. This means that the portfolio must be on the efficient frontier, i.e. that there is no portfolio with better risk and return characteristics. The proposed methodology uses the net present value as an indicator of return and standard deviation as an indicator of the level of risk.

The statistical indicator coefficient of variation will be used to select the best option from the effective portfolios. It expresses dispersion as a percentage, i.e. shows the ratio of the standard deviation of the net present value to the average net present value. Thus we can compare different portfolios to select the portfolio with the lowest value of the coefficient of variation.

The portfolio of a business organization must meet the objectives of its investment strategy which in turn must support its main business strategy. Investment pursues goals related to various aspects of company's business - production, human resources, marketing, R&D, etc. When investing in financial assets, in most cases we are only interested in the financial indicators of the portfolio - return and risk. Although all business organizations invariably pursue profit as their main goal, their long-term growth should not be neglected in order to achieve maximum profitability in the short term.

### Stage 1 Financing the portfolio

The first stage of the methodology is to estimate the financial resource to be allocated to the portfolio. The steps are shown in the figure below.

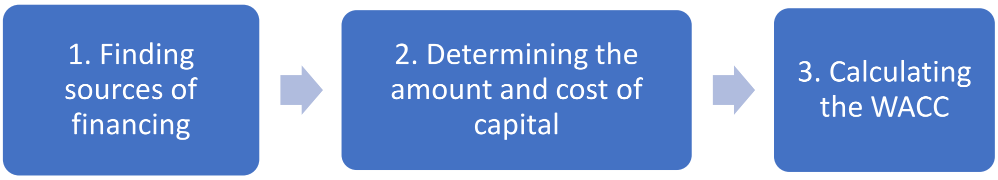


*Figure1. **Stage 1 steps: Financing the portfolio***

Companies have access to two main groups of sources of financing: internal and external. They are characterized by various indicators such as cost of capital, risk and size. At this stage it is required to find the possible and appropriate sources of financing and for each of them to calculate the cost of capital, the amount of financing and its relative share in the total investment.

The next step is to determine the weighted average cost of capital (WACC) as a weighted average of the cost of capital of all possible sources of financing. The WACC will be the discount rate applied to evaluate the individual projects. In most cases, the investment budget will not be spent in full. The sources of financing as well as the exact amounts that will actually be used will be determined at a later stage depending on the projects in the portfolio and their interrelation, i.e. the cost estimated at this stage will differ from the actual cost. It will be used to update project cash flows, select projects and design draft portfolios. Then a new value of the weighted average cost of capital will be calculated for each draft portfolio based on investment budget optimization.

The second stage to develop the individual projects to be included in the investment portfolio.

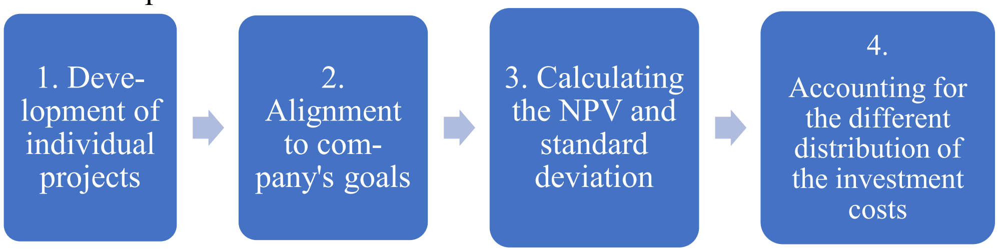


*Figure 2.* ***Stage 2 steps: Development of individual projects***

Individual projects must be developed taking into account the foals of the company because its investment portfolio must be in line with its strategic goals.

Alternatively, each individual project and the portfolio as a whole may be subjected to strategic evaluation to ensure their coherence with the company's goals. The investor may consider the strategic profile of the investment to determine the strategic profile of the portfolio by setting minimum values for each strategic goal and ranking them according to the degree of their importance for the business organization.

If additional assessments (technological, environmental, etc.) are required, they may be set as portfolio criteria and estimated at this stage. In the presence of many criteria, it would be appropriate to introduce a weighted average assessment of the set additional criteria (in addition to risk and return, which we consider to be the main ones).

At this stage, the individual indicators of each project needed for the follow-up are calculated. We will use the net present value to assess the return on the portfolio and projects, and the standard deviation to assess the risk. These indicators can be changed depending on the preferences of each business organization. In the current methodology we have focused on them due to their good theoretical and practical value and the ability to be used for the purposes of the methodology.

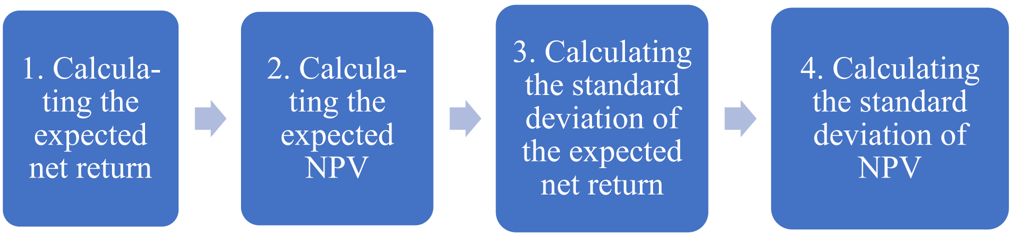


*Figure 3.* ***Stage 3 steps: Calculating the individual project indicators***

The average value of the expected net return can be calculated in two ways depending on the method used to determine the possible values of the net return.

(6) $$\overline{U_t} = \sum_{t=1}^{N} U_i P_i,$$

where:

Ut is the expected net return in year t;

Ui is the $i^{th}$ variance of return in year t;

Pi is the probability for $i^{th}$ variance of return.

Assuming a beta distribution of the net return, the expected value is calculated as:

(7) $$\overline{U_t} = \frac{1}{6}[D(U_t) + 4M(U_t) + O(U_t)],$$

where:

D(Ut) is the pessimistic net return scenario for year t;

M(Ut) is the most probable scenario for the net return in year t;

O(Ut) is the optimistic net return scenario for year t.

The expected net returns calculated for each year are used to calculate the net present value.

(8) $$\overline{NPV} = \sum_{t=1}^{n} \frac{\overline{U_t}}{(1+k)^t} - I,$$

where:

NPV is the expected NPV;

I is the initial investment cost;

k is the capital cost.

The next step is to calculate the standard deviation of NPV based on the expected net return for each year as:

(9) $\sigma_t = \sqrt{\sum_{i=1}^{N}(U_i - U_t)^2 P_i}$,

where:

σt is the standard deviation of the expected return for year t.

Assuming a beta distribution, the standard deviation is calculated as:

(10) $\sigma_t = \frac{1}{6}[O(U_t) - D(U_t)]$

Then we calculate the standard deviation of NPV as:

(11) $\sigma_{NPV} = \sqrt{\sum_{t=1}^{n}\frac{\sigma_t^2}{(1+k)^{2t}}}$ ,

where:

σNPV is the standard deviation of NPV.

Given the fluctuating time value of money, different allocations of investments would change the net present value of the project. This is one of the factors that affect the final result - the portfolio, so it is appropriate to take into account its impact in the development of various project options and to be included in the optimization. This can be done by developing each variant of allocation of investment costs as a separate project assuming that these projects are mutually exclusive. In this way, the impact of the different distribution of investment costs on the selection of projects and, accordingly, on the portfolio will be taken into account.

At this stage, the selection of projects and the compilation of possible investment portfolios is performed. The selection itself will be done through nonlinear optimization, and the coefficient of variation will be used to select the optimal portfolio. At the next stage, only the portfolio with the lowest coefficient value will be accepted. If two or more portfolios have similar values, then all portfolios with similar coefficients of variation will continue in the next stage. Schematically, the stage is presented in the figure below.

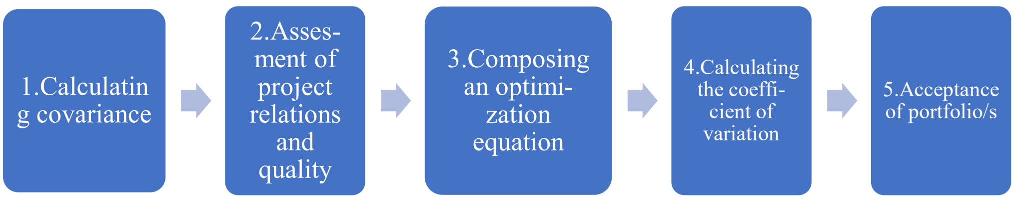


*Figure 4.* ***Investment project selection diagram***

First, we have to calculate the covariance of each pair of projects. The value of this indicator shows the extent to which the profitability of two projects changes simultaneously. To calculate the covariance we use the following formula:

$$(12) \quad \mathrm{cov}_{12} = \sum_{i=1}^{n} \left(\frac{U_i - \bar{U}_t}{(1+k)^t}\right) \times \left(\frac{C_i - \bar{C}_t}{(1+k)^t}\right) \times P_i,$$

where:

$\mathrm{cov}_{12}$ is the covariance of cash flows from projects 1 and 2;

$U_i$, $C_i$ is the $i^{th}$ variation of return in year t;

$\overline{U_t}$, $\bar{C_t}$ is the expected net return in year t;

k is the cost of capital, part of unit;

$P_i$ is the probability for the $i^{th}$ return variation.

Once we find the covariance of each pair of projects, they are compared using the covariance matrix shown in Table 1 below.

*Table 1*

***Covariance matrix***

| | Project 1 | Project 2 | Project 3 | Project n |
|---|---|---|---|---|
| Project 1 | $\sigma_1^2$ | $Cov_{12}$ | $Cov_{13}$ | $Cov_{1n}$ |
| Project 2 | $Cov_{21}$ | $\sigma_2^2$ | $Cov_{23}$ | $Cov_{2n}$ |
| Project 3 | $Cov_{31}$ | $Cov_{32}$ | $\sigma_3^2$ | $Cov_{3n}$ |
| Project n | $Cov_{n1}$ | $Cov_{n2}$ | $Cov_{n3}$ | $\sigma_n^2$ |

The correlation coefficient of the cash flows of each project will be equal to 1 and is expressed as:

$$(13) \quad Cov_{11} = 1 * \sigma * \sigma = \sigma^2 .$$

The other cells contain the covariance coefficients for each pair of projects (e.g. $\mathrm{cov}_{12} = \mathrm{cov}_{21}$, $\mathrm{cov}_{13} = \mathrm{cov}_{31}$ , etc., because we use the same cash flows to calculate $\mathrm{cov}_{12}$ and $\mathrm{cov}_{21}$, and therefore the value is the same.)

According to modern portfolio theory, the covariance between two projects has a stronger impact on the risk of the portfolio than the risks of the individual projects. The covariance of two projects can take values from -1 to +1. In case of covariance between two projects, equal to +1, the addition of the second project will not reduce the risk and it will be a weighted average of the risks of both projects. With a lower value of the covariance, the addition of the second project will reduce the risk of the combination of two projects. In this case, the risk of the two projects will not be a weighted average of their individual risks. It should be noted that in practice there are no assets with a covariance equal to -1, which would achieve the most significant risk reduction.

When compiling the optimization equation, we must take into account the relationship between the various projects, regardless of whether the projects are mutually acceptable, exclusive or interdependent. In the first stage, through covariance, we established the relationship between the profitability of each pair of projects. After establishing the connection on the basis of their implementation, restrictions arising from its specifics are introduced.

*Table 2*

***Project relationship constraints***

| | |
|---|---|
| Mutually exclusive | $x_i + x_j = (0,1)$ |
| Mutually acceptable | $x_i = x_j$ |
| Inclusion of existing projects/portfolios | $x_i = 1$ |

The next step is to optimize the portfolio using an optimization equation based on mean-variance optimization with the assumption of minimum risk at a certain return. It is based on well-known indicators such as: the covariance between different projects; the profitability of each project in terms of its net present value; the risk exposure of each project expressed through the variance and desired return of the portfolio in terms of its NPV in the following equation:

(14) $Z = \sum_{i=1}^{n} \sum_{j=1}^{n} w_i \, w_j cov_{ij} \rightarrow min,$

(15) $NPV_p = \sum_{i=1}^{n} x_i NPV_i,$

where:

$NPV_i$ is the expected net present value of project i;

$w_i$ is the relative share of project I in the portfolio – unknown variable;

$cov_{ij}$ is the covariance between the rates of return of projects i and j;

$NPV_p$ is the net present value of the portfolio;

$NPV_i$ is the net present value of project I in the portfolio;

$X_i$ is the relative share of project i in the portfolio; $0 \leq X_i \leq 1$.

The optimization equation is repeated with a different required net present value of the portfolio until all possible portfolios from the existing individual investment projects are compiled.

Portfolio risk is calculated as:

(16) $\sigma_p^2 = \sum_{i=1}^{n} w_i^2 \sigma_i^2 + 2 \sum_{i=1}^{n} \sum_{\substack{j=1 \\ j \neq i}}^{n} w_i w_j cov_{ij},$

where:

$\sigma_p^2$ is portfolio dispersion;

$w_i$ is the relative share of project i, i = 1, 2, 3…n;

$\sigma_i^2$ is the individual risk exposure of project i measured through dispersion;

$cov_{ij}$ is covariance between projects i and j ($i \neq j = 1, 2, 3….n$)

The relative shares (w) of the projects are calculated as ratios of the present value of the investment in the project to the total present value of the investment in the portfolio.

(17) $$w_i = \frac{PVI_i}{PVI_p},$$

where:

$w_i$ is the relative share of project i;

$PVI_i$ is the present value of the investment in project i;

$PVI_p$ is the present value of the investment in the portfolio (the total updated cost of all projects included in the portfolio).

When an already completed project is added to the portfolio, its cost is assumed as zero. In such case, its relative share is calculated using the present value cost of the investment made in this project. It must be added to $PVI_p$ as well.

(18) $$w = \frac{\begin{array}{c}\text{project investment costs}\\ \text{incurred in the past}\end{array}}{\begin{array}{c}\text{present value of future and past costs}\\ \text{of investment in the portfoliio}\end{array}}$$

The relative shares determined on the basis of investment costs (w) will be used to calculate the portfolio risk, and the project acceptance shares (x) will be used to determine the NPV. The sum of all relative shares, calculated on the basis of investment costs, will be equal to 1, which does not necessarily mean that the whole investment project of the company will be spent, as only the investment costs are taken into account, not the investment budget of the company.

The optimization is carried out using the following functions of Excel Solver:

- For the net present value of the portfolio:

=SUMPRODUCT (project acceptance shares; projects' NPV);

- For the portfolio risk measured through its dispersion:

=MMULT(MMULT(TRANSPOSE (the relative shares of the projects); covariance matrix);

- For the portfolio risk measured through its standard deviation:

=SQRT (portfolio dispersion).

Depending on the specific constraints, the optimization may result in more than one possible portfolio. They (the portfolios) will differ in terms of risk and return. It should be noted that all these portfolios will be efficient according to the modern portfolio theory, i.e. they will be on the efficient frontier. However, the investor can choose only one of the possible portfolios. This choice can depend on the coefficient of variation of each portfolio. thus the investor will determine the best option in terms of how the risk relates to the profitability of the portfolio, i.e. the lower this ratio, the better the portfolio. The coefficient of variation is calculated as:

(16) $V = \frac{\sigma_p}{NPV_p}$,

where:

V is the coefficient of variation;

$\sigma_p$ is the standard deviation of portfolio's NPV;

$NPV_p$ is the net present value of the portfolio.

The last stage is budget optimization. As inputs we must have one or more compiled portfolios. The output of this stage will be the best investment portfolio based on the input and its optimal financing. We will use nonlinear optimization to calculate the investment budget. Schematically, the model is shown in the figure below.

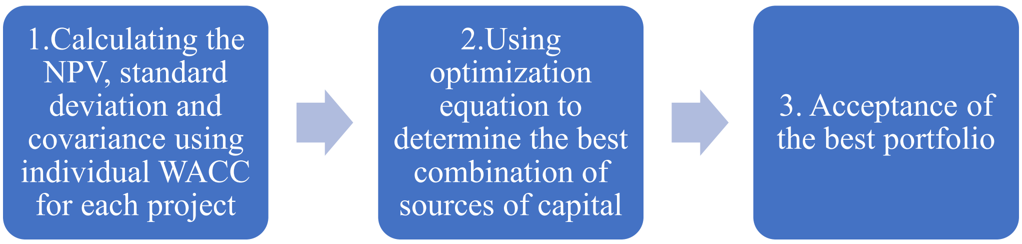


*Figure 5.* ***Budget optimization procedure***

The goal of budget optimization is to find the weighted average cost of capital at which the coefficient of variation of a given portfolio will be the lowest. This value is accepted as the lowest feasible WACC.

The main function will be to minimize the coefficient of variation.

(17) $Z = V \rightarrow min$,

where:

V is the coefficient of variation of the portfolio.

The optimization aims to determine the relative share of financing for each project from each available source of funding. The relative share is expressed by the variable Y (e.g. $Y_{11}$ is the share of financing project 1 from source 1, $Y_{12}$ - the relative share for the financing project 1 from the second source of financing, etc.)

The value of this variable may vary between 0 and 1, i.e.

$$0 \leq Y \leq 1$$

If Y=0, then this project will not be financed from this particular source and vice versa, if Y=1, then the whole investment for this project will come from this particular source of financing. The exact amount of financing from the given source for the given project is found by multiplying the share by the entire possible amount from the source.

Another constraint is that the sum of all relative shares for all projects financed from one source cannot be greater than 1, i.e.

$$(18) \quad \sum_{i=1}^{n} Y_i \leq 1,$$

where:

$Y_i$ is the relative share of financing of project i,

Another constraint is the requirement that all projects be fully financed, which is assumed at the previous stage of the methodology. In the previous stage a selection of projects has been made, one or more potential portfolios of investment projects have been identified and at this stage only their optimal financing is sought, as no change in the choice of investment projects is allowed. Each of the projects in the portfolio should be financed in full.

Several optional constraints can be set depending on the policy of the business organization. Such constraints may be a required ratio (or absolute amount) of internal to external financing; a requirement for mandatory use of only one type of financing, etc.

The investor shall accept the portfolio with the lowest coefficient of variation.

## Conclusion

In practice, more and more business organizations are adopting project-oriented management, which shows their growing role and the need for effecttive management. A similar trend is observed in terms of investment projects. Capital investment decisions are the main drives of corporate growth, achievement of the strategic goals of the company, and increasing its profitability.

The traditional approach to discounted cash flows does not cover the overall complexity of investment decisions in business organizations. Although contemporary corporations, implement more than one investment project at any time in the course of their operations, very few of them consider these projects as a portfolio. The impact that the combination of different investment projects will have on their return, risk exposure, or other goals pursued by the company is not taken into account.

The proposed conceptual model (methodological framework) aims to present the possibility of using portfolio theory when investing in real assets and in particular in the selection of a portfolio of real-asset investment projects. The main goal is to achieve a better ratio between risk and return by taking into account the impact of covariance between the cash flows of different investment projects. On this basis, formulas are presented for deriving the return on the portfolio, measured by the net present value, and the risk, measured by the standard deviation of its return.

At the same time, we believe that the model is flexible enough and allows the use of additional criteria, the most important of which is strategic, viz. the achievement of a more accurate match between the goals of the portfolio and the company's goals. Options have been proposed for the implementation of this task and for the possibility of strategic assessment of the portfolio or its strategic profile.

**References**

*** Introduction to Investments, A study on investment pattern amongst academicians in Bangalore, online on: http://shodhganga.inflibnet.ac.in/bitstream/10603/92732/7/10.chapter%201%20(introduction%20to%20investments).pdf посетено на: 19.12.2019

*** Project Management Institute (2017). A Guide to the Project Management Body of Knowledge (PMBOK® Guide)–Sixth Edition, Published by Project Management Institute, Chicago, USA.

Bennouna, K., Meredith, G. & Marchant, T. (2010). Improved capital budgeting decision making: evidence from Canada. Management Decision 48(2): 225-247.

Bower, J. (1986). Managing the Resource Allocation Process. Harvard Business School Press Books.

Brealey, R., Myers, S. & Allen, F. (2011). Principles of Corporate Finance. 10th ed. McGraw-Hill.

Cater, T. (2008). A Guide to Project Management (An introduction to principals and practice), Second edition, Publ. Business Performance Pty Ltd., Victoria, Australia, pp. 5.

Chandra, Pr. (1989). Projects. Preparation, Appraisal, Budgeting and Implementation, Third ed., New Delhi, Tata McGraw-Hill.

Chandra, Pr. (1995). Projects-Planning Analysis, Selection, Implementation & Review, Tata McGraw Hill, New Delhi.

Choudhury, C. (1995). Project Management, Tata McGraw Hill, New Delhi.
Cyert, R. & March, J. (1963). A behavioral theory of the firm. Prentice-Hall Inc, Englewood Cliffs New Jersey.
DeCanio, S. & Watkins, W. (1998). Investments in energy efficiency: do the characteristics of firms matters? Review of Economics and Statistics 80(1): 95-107.
Elton, E., Gruber, M., Brown, S. & Goetzmann, W. (2003). Modern Portfolio Theory and Investment Analysis, New York: John Wiley & Sons, 6th edn.
Emmanuel, C., Harris, E. & Komakech, S. (2010). Towards a better understanding of capital investment decisions. Journal of Accounting and Organizational Change 6(4): 477-504.
Fischer, D. & Jordan, R. (1975). Security Analysis and Portfolio Management (Sixth Edition). Prentice Hall International Inc.
Graham, J. & Harvey, C. (2001). The theory and practice of corporate finance: evidence from the field. Journal of Financial Economics 60: 187-243.
Grinblatt, M., & Titman, S. (2001). Financial Markets and Corporate Strategy, New York: McGraw-Hill, 2nd edn.
Grundy, T. & Johnson, G. (1993). Managers' Perspectives on Making Major Investment Decisions: the Problem of Linking Strategic and Financial Appraisal. British Journal of Management 4: 253-267.
Huang, C. & Litzenberger, R. (1988). Foundations for Financial Economics, Englewood Cliffs NJ: Prentice Hall.
Kessler, E. (2013). Encyclopedia of Management Theory, Volume one, SAGE Publications, Inc., Pace University, USA, p.376.
King, P. (1975). Is the Emphasis of Capital Budgeting Theory Misplaced? Journal of Business Finance & Accounting 2(1): 69-82.
Lefley, F. (1996). The payback method for investment appraisal: A review and synthesis. International Journal of Production Economics 44: 207-224.
Lumijärvi, O. (1991). Selling of capital investments to top management. Management Accounting Research 2: 171-188.
Markowitz, H. (1959). Portfolio Selection: efficient diversification of investments, John Wiley & Sons, New York, USA.
Markowitz, H. (1987). Mean-Variance Analysis in Portfolio Choice and Capital Markets. Basil Blackwell, Cambridge, MA.
Merton, R. (1972), An analytic derivation of the efficient portfolio frontier, Journal of Financial and Quantitative Analysis, 7(4), pp. 1851–72.
Nawrocki, D. (2009). Portfolio Optimization, Heuristics, and the "Butterfly Effect", Villanova University. достъпно на https://www.researchgate.net/publication/250606548_Portfolio_Optimization_Heuristics_and_the_Butterfly_Effect/download, посетено на 19.12.2019.

Qiu, Y., Wang, Y., & Wang, J. (2015). Implied discount rate and payback threshold of energy efficiency investment in the industrial sector. Applied Economics 47(21): 2218-2233.

Sandahl, G. & Sjögren, S. (2003). Capital budgeting methods among Sweden's largest groups of companies. The state of the art and a comparison with earlier studies. International Journal of Production Economics 84: 51-69.

Shaghil, M. & Mushtaque, M. (1997). Project Planning and Management Vol. 1.

Sharpe, W., Alexander, G. & Bailey, J. (1999), Investments, Englewood Cliffs, NJ: Prentice Hall International, 6th edn.

Van Cauwenbergh, A., Durinck, E., Martens, R., Laveren, E., Bogaert, I. (1996). On the role and function of formal analysis in strategic investment decision processes: results from an empirical study in Belgium. Management Accounting Research 7: 169-184.

Wallace, W. (2014). Project Management, Edinburgh Business School, Heriot-Watt University, Edinburgh, United Kingdom, Module 1, p.16.

Георгиев, Ив. (2013). Основи на инвестирането. Издателски комплекс УНСС, София, с. 7.

Георгиев, Ив., Цветков, Цв. & Благоев, Д. (2013). Мениджмънт на фирмените иновации и инвестиции,. Издателски комплекс-УНСС, София.

Пандъкова, В. (2015). Усъвършенстване управлението на инвестиционни проекти при изграждане на търговски центрове, Дисертационен труд за придобиване на ОНС „Доктор", Стопански факултет, ИУ-Варна (автореферат), с. 15.

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