

CHARACTERISTICS OF INVESTMENT FACILITIES AND EQUIPMENT SELECTION AND INVESTMENT COSTS ANALYSIS

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Drago Soldat, Rada Plavšić

Beogradska banka, a.d. – Institute for Investment Economics, Belgrade

Abstract. *This paper presents the method for selection of investment facilities and equipment as well as the analysis of costs in the investment process. In order to select one of the alternatives, the analytical approach is applied. This approach is based on the study of technical and technological aspects of investment. In this way, a model applicable to all branches of business activity, regardless of the category, size, complexity and type of the project is obtained.*

INTRODUCTION

The selection of investment facilities and equipment is performed today according to the methodology for evaluation of social and economic justification of investments and investment efficiency [1,2], in such a way that it is not systematic, comprehensive or argued enough. This is especially true in case of selection and classification of investment costs according to engineering logic.

Characteristics of investment facilities and equipment relate to their selection and to the analysis of investments. They are based on a detailed study of technical and technological aspects of the investment. Out of numerous technological investment aspects (technological production process, production capacity, scope of production, material inputs, fuel, etc.), technological process, production capacity and scope of production are the most important when selection of equipment is concerned.

Selection of investment facilities and equipment as well as investment costs analysis is extremely important concerning the fact that the expected results are related to development and directed towards the future.

Selection of investment facilities and equipment depends on the type of production, sort and complexity of activity and it is directly related to the work post and space required for equipment disposition and uninterrupted flow of planned production activities.

It should be mentioned that technical and technological aspects of investment process together form a set of mutually related problems concerning engineering analyses. These analyses provide significant and necessary input data for further study of investment activities, especially for calculations, projections and estimations as elements of the financial analysis of the investment study [3].

The key idea of the authors is to introduce systematic and comprehensive methodological solutions related to the field of basic characteristics of the process for selection of necessary investment facilities and equipment accompanied by the corresponding money investment analysis, regardless of the kind, size, complexity or type of the project.

2. TECHNICAL ASPECTS OF INVESTMENTS

Having in mind that construction costs of investment facilities are usually high, it is necessary to perform a comprehensive examination of the alternative projects and variant solutions in order to choose the most convenient one. Basic approach to the analysis of problems of this kind consists of variant solutions – research, valorization and selection of the optimal solution. The investment study should also provide a short review of the performed analyses as well as all considerations that preceded the final selection.

According to the current methodology, the investor and the designers take into consideration variant solutions and make their selection based on comparative advantages. The optimal solution shall be further elaborated in the investment technical documentation. According to recommendations proposed by the World Bank experts, at least two, but no more than five alternatives should be considered – this approach has proven to be effective [1].

The dominant question related to investment facilities is the selection of construction system and building material. In case that all problems concerning dimensions and functional characteristics of facilities have been previously resolved, the analysis of variant solutions shall consist of evaluation of cost-effectiveness and rationality of planned method of construction.

An investment study must provide a short overview of the pre – investment analysis of variant solutions, characteristics (advantages and disadvantages) of each solution taken into consideration and reasons that influenced the final decision. Finally, quality evaluation of technical solutions means analysis of selected solution's advantages in comparison with other proposed solutions. Chosen solution should satisfy all required criteria and all aspects of the analyses. Beside the evaluation of the construction system, building technology and used materials, the investment study must also contain the evaluation of the following aspects [4]:

- functionality, size and purpose structure of the facilities – Table 1.,
- infrastructure and exterior surfaces – Table 2.

Table 1. Purpose structure and size of the facilities

Purpose	Surface	Structure(%)
Production buildings		
Warehouses		
Administrative buildings		
Auxiliary buildings		
Power production buildings		
Environment protection objects		
Shelters		
Social standard objects		
Other objects		

Table 2. Overview of infrastructure facilities and external works

Type of objects and works	Unit of measure	Total	Remark
Internal roads and parking lots			
Waste disposal areas			
Green areas			
Surface rebuilding			
Other			

When there is a choice to be made between two or more alternative locations, the infrastructure and dependent costs in exploitation can be decisive factors. The optimal solution should result in the lowest location furnishing costs as well as dependent costs that arise during the exploitation of the project [5]. When more complex projects, such as industrial, tourist, agricultural and other complexes are concerned, it is necessary to show the external connections to the existing infrastructure – Table 3.

Table 3. Overview of the external connections to the existing infrastructure

Type of connection and works	Unit of measure	Total	Remark
Water supply			
Plumbing			
Power supply (electricity, gas...)			
Telecommunications			
Traffic infrastructure			
Ecological connections			
Other			

All values in the above tables are expressed in natural units, using numerical values followed by standard measures (for diameter, power, width, etc.).

3. TECHNOLOGICAL ASPECTS OF INVESTMENTS

In the equipment selection process, regardless of the type of the project¹, attention has to be paid to a detailed study of the technological process, production capacities and scope. These three elements represent criteria of great influence arising from the technological aspects of the investment process during exploitation of the project.

Since technological work process forms the basis for the selection and acquisition of necessary equipment, it is essential to study it and describe in detail. While studying the technological work process, it is necessary to present its detailed description as well as [6]:

- graphic presentation of described technological work process,
- graphic presentation of equipment disposition,
- graphic presentation of the disposition of workers on their respective work posts,
- descriptive and graphic presentation of the disposition of raw materials, semi-finished and finished articles in their respective warehouses; it is obligatory to keep record of the day these elements entered the warehouse,
- description of quality control methods,
- descriptive and graphic presentation of storage method and internal transport.

Production capacity can be defined as [7, 8]:

- peak (installed, theoretical capacity) – (C_{\max}),
- technological or work capacity – (C_{teh}),
- minimal capacity (C_{\min})

A general tendency exists to perform a certain technological process by using the equipment in such a way to achieve optimal capacity (C_{opt}); it is characterized by lowest cost per production unit and ranges from (C_{\max}) to (C_{\min}), depending on various production factors for each type of production equipment [8].

Considering the equipment production capacity, the scope of production by product or by assortment groups is determined for the economic lifetime of the project. Scope of production is defined according to the available working time and compared to the optimal scope and to the scope of possible sales determined by means of market analysis [3].

From the economic point of view, if planned scope of production exceeds the optimal capacity, economic results drop – the decrease is proportional to the increase of total costs per unit of product. Optimal production capacity depends on type and sort of production activity and ranges from 75 – 90%.

Reaching the optimal and approaching the peak capacity is the basic aim of good management.

The analysis of capacity utilization for the existing production activity provides a good indication of the necessity to invest, especially in reconstruction, modernization or expansion-type projects

In order to assess the selected equipment (having in mind the requirement to achieve planned scope of production and capacity utilization) it is necessary to perform the analysis of maintainability as well as the analysis of staff training capabilities. These two important factors are not covered by the existing methodological manuals [1, 3]. When

¹ In the investment process, type of the project refers to reconstruction, modernization or expansion of the existing activity or to investing into a new activity.

planning to realize certain scope of production it is necessary to make a decision, i.e. to choose the optimal equipment supplier. The investor has to consider at least three offers by different producers, their references, costs, delivery and payment terms which have crucial influence on the selection of a certain alternative [3].

Basic information on the equipment² required for technological production process can be obtained from technological and commercial documentation. Commercial documentation refers to preliminary or final offers made by equipment suppliers [2].

Special analysis has to be performed in case when equipment is purchased at foreign markets.

Purchasing equipment from the foreign market asks for special expert arguments. These arguments should primarily include comparative advantages of purchasing such equipment abroad instead at the domestic market.

In any case, in the process of selection of equipment required for the realization of planned production scope according to the specified technological process, it is necessary to classify it. This classification directly depends on production type, sort of activity and its complexity and it should be adapted to the specifics of each particular investment project. It is important to mention that the equipment should be grouped in such a way to include all of it, which means that the inventory should contain all the equipment necessary for the uninterrupted flow of planned production:

- production equipment,
- necessary tools and devices,
- measuring equipment for quality control,
- equipment for maintenance of production equipment,
- transportation equipment (predominantly for internal transport),
- energy production equipment,
- storage equipment,
- infrastructural equipment,
- fire prevention equipment,
- personal work protection equipment...

When choosing the equipment, besides from studying already adopted technological criteria (technological process, production capacity and scope), in order to get a more comprehensive overview of the problem, it is necessary to consider other criteria such as material inputs, fuel, environmental protection and work protection, etc. It is also important to determine whether it is optimal to choose equipment with higher or lower level of automation (even though automation is not a subject of this paper).

4. ANALYSIS OF INVESTMENT COSTS

Investment costs can be defined as all costs for the realization of selected investment facilities and equipment, which have been determined necessary for the planned investment project in the process of analytical study. According to their importance and influ-

² Equipment is the set of machines, devices and tools necessary for the realization of certain products intended for the market and it is object of investment processes.

ence they have on the efficiency of the investment process, investment costs represent one of the key elements that determine the success of the product as a whole. At the same time, optimization of investment costs directly influences the increase of the efficiency of the project during the realization period.

Often used methodological cliché for standard specification of scope, structure and dynamics of costs related to investment facilities and equipment should be shaped into an easy-to-understand "preliminary estimate" to be used by practicing engineers who must be able to present investments in a form that is directly applicable to further economic calculations.

Table. proposes one methodological cliché of technical cost structure. Investment specification refers to all cost-related activities that have to do with investments in capital goods (investment facilities and equipment and permanent capital goods).

Evaluation of investment costs is performed according to current prices determined during the investment facilities and equipment selection process; after that, a projection of the increase of costs during the investment is made on the basis of the anticipated difference in price.

The actual price value of investment facilities and equipment is given in the offers used for alternative selection and it is called "permanent prices in the project" for the base month. These are, in fact, values that would be necessary for completion of the project at the moment in which preliminary calculations for the investment are made.

Since the values of the investment effects change during the time period between start and finish of the realization, they need to be reduced to the same time basis. However, since part of financial spendings refers to the future, present value has to be recalculated to the value at the moment when financial funds are engaged.

So called "current prices" are obtained by the technique for projection of real values of anticipated financial spendings - investment costs for the future. Current prices can be defined as future value of the costs at the moment when financial funds anticipated for the purpose of investment realization are spent [3].

It is important to mention that the calculation of money investments in current prices, i.e. amounts determined by the dynamic – term plan of the financial realization of the project, results in funds needed to close the financial construction. The increase in planned costs caused by values of current prices at the moment in which investment is being completed is referred to as exceeded expenses, which are not subject of this paper.

According to current regulations, the investor is obliged to determine the value of works related to investment facilities and equipment after he has obtained and considered at least three offers. The offers are analyzed from the aspect of technical and technological criteria. Speaking in academic terms, legally regulated method for determination of investment costs in the process of project evaluation is the method of comparative analysis of offers. Practically, it is a control of reliability and value of all elements of the offer, including quality assessment of bidders offering to perform works on investment facilities and delivery and assembly of the equipment.

The costs of investment facilities and equipment represent a necessary parameter of financial and economic analysis of the project, as well as an element for evaluation of economic justification of the planned investment.

4.1. Investment facilities and their costs

Basic investment costs given in Table 4. refer to land, infrastructure and buildings (production workshops, administrative buildings, etc.). Construction of investment facilities is preceded by compilation of technical documentation and investment program - which should be realized at least at the idea or general project level.

Table 4. Methodological cliché of investment costs technical structure

	Description of purpose investment	Investment period	Investment costs	Structure (%)
1.0.	<i>Investment facilities</i>			
1.1.	Land purchase and preparation			
1.2.	Infrastructure			
1.3.	Buildings with utilities			
2.0.	<i>E q u i p m e n t</i>			
2.1.	Domestic			
2.2.	Imported			
2.2.1.	Expenses in foreign currency			
2.2.2.	Expenses in domestic currency			
3.0.	Other payments in dom. currency			
3.1.	Physical reserves for inv. facilities			
3.2.	Physical reserves for equipment			
3.3.	Licenses and patents for equipm.			
4.0.	Other foreign currency expenses			
5.0.	<i>Founding capital</i>			
5.1.	Technical documentation			
5.2.	Engineering			
5.3.	Supervision during invest. realiz.			
5.4.	Staff training			
6.0.	<i>Legally regulated investments</i>			
7.0.	<i>Invest. In perm. capital goods</i>			
	<i>Total money invest. – costs</i>			
	I	Domestic currency costs		
	II	Foreign currency costs		

According to current methodology which defines ways to quantify construction costs of investment facilities (based on designed solutions, preliminary estimate, planned prices and terms for project completion), it is required to submit three offers or the valid contract for performance of planned works as proof of accuracy of the highest level.

Authors of greater and more complex projects favor classification of future costs into the following items [4]:

- external installations and lot arrangement
- secondary infrastructure
- primary infrastructure.

As far as investments in infrastructure are concerned, costs should include all elements related to arrangement of free surfaces. Costs of arrangement of free surfaces in projects for activities such as sports and recreation, tourism, city public functions, clean industry (production of food, pharmaceuticals, cosmetics, etc.), for others in which esthetics plays

an important role because of their function or if it is an aspect of marketing as well as for objects on important locations (downtowns, public parks, seacoasts, etc.) can be considered economically justified costs.

Even with all these cost analyses available, it is not always possible to eliminate completely the risk of bad cost estimate. This is why so called physical reserves and other costs have to be added to the cost plan. These additional funds serve to cover unpredicted works.

4.2. Equipment purchase value costs

Analysis of investment into selected equipment includes its type and characteristics, as well as required suitability and functionality; it also examines the possibility of integrating the equipment into existing production when modernization and reconstruction – type projects are concerned. Analytical recapitulation of investment costs grouped into functional categories is given in Table 5.

Table 5. Recapitulation of investment costs of planned equipment

No	Type of equipment	Unit of meas.	Currency	Unit price	Purchase value	Total
1.	TECHNOLOGICAL					
2.	ENERGY SUPPLY					
3.	CONTROL					
4.	TRANSPORTATION					
5.	MAINTENANCE					
6.	STORAGE					
7.	AUXILIARY					
8.	OTHER					
<hr/>						
<i>DOMESTIC EQUIPMENT</i>						
<i>IMPORTED EQUIPMENT</i>						
<hr/>						
TOTAL VALUE						
<hr/>						

When compiling the list of necessary equipment, it should be classified and grouped according to origin (domestic vs. imported). Specifications including all relevant data should be made.

Equipment invoice value can be calculated on the basis of determined number of pieces of equipment, their individual price and exchange rate (for imported equipment). By adding dependent costs (import duties, transport, assembly, insurance), purchase value of the equipment is obtained. It represents investment costs of the equipment [10].

Import duties are determined according to legal regulations. Other dependent costs are estimated according to the purpose and complexity of equipment and they range from 2 to 5%. In order to cover the unpredicted costs it is necessary to anticipate physical reserves for additional and unpredicted works that amount to 5% of total investments into capital goods which also include equipment – Table 4.

Purchase value of the equipment is obtained by summation of individual values corresponding to each equipment group. Detailed specification defining the amount to be invested expressed in domestic and foreign currency is a prerequisite for this.

In cases when it is not possible to obtain offers from equipment suppliers, its value has to be estimated. Inventory of existing equipment and estimation of its value is performed by certified assessors for reconstruction, modernization or expansion – type projects. Estimated value of the equipment is categorized as personal participation of the investor in the realization of planned investment.

An emphasis should be made on the fact that investments in equipment are expressed as "fixed prices" – usually at the time when the investment program is being completed. Costs expressed in this way represent indispensable data for financial calculations.

4.3. Accompanying investment costs related to investment facilities and equipment

Money investments in material rights, founding and other investments are considered accompanying investment costs [2, 3]. Investments in material rights are investments in purchase of patents, licenses, models, samples, technical and technological documentation, etc. Other investments include purchase of books, periodicals, paintings, sculptures, etc.

Founding investments include expenses related to studies and research, purchases and indemnities, staff training, compilation of investment technical documentation, etc. Founding investments also include intercalary interest rates and other credit costs and they are defined by the financial project analysis because of the fact that their source becomes known only after the source of financing is defined.

Accompanying costs are usually assessed using the *ad valorem* method, which means that they represent a certain percent of the investment value of relevant cost items. Applied rates correspond to real prices and they amount to [6]:

- compilation of investment and technical documentation – up to 3%,
- investment program preparation – 0.6 – 2.5%,
- supervision – up to 1%,
- engineering – 6 – 8%,
- investor's expenses (consultants, taxes, permits, etc.) – up to 0.5%,
- marketing expenses – up to 2% of yearly production value.

Realistic perception and anticipation of all future accompanying expenses makes the investment process less uncertain. Having this in mind, it is necessary to draw up a realistic assessment of all future expenses related to the completion of planned investment. These expenses can be relatively high, especially for projects with higher degree of uncertainty.

5. CONCLUSION

Detailed analysis of technical and technological aspects of investments aimed at recognizing the characteristics of selection and assessment of investment facilities and equipment complemented with detailed analysis of investment expenses represent important planning elements which are decisive for successful realization and performance of the project during its economic lifetime.

Realistic assessment of the above mentioned investment aspects and investment analysis are a prerequisite for completion of planned investment without exceeding anticipated expenses and it is required for obtaining respectable indices of economic and financial

success of the project. The basic purpose of accurate prediction of future investments is to avoid exceeding of planned expenses.

Analysis of investment facilities and equipment selection and assessment combined with investment expense analysis in a way presented in this study is more systematic, argued and comprehensive, and since it includes classification of expenses according to engineering logic, represent standardized form.

Analyzed aspects of investments represent methodological and theoretical conceptual basis for selection of investment facilities and equipment. These aspects are based on the ability to predict optimal solutions for preparation, planning, evaluation and realization of planned undertaking and as such they are applicable to all projects regardless of their size, complexity or type.

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KARAKTERISTIKE IZBORA INVESTICIONIH OBJEKATA I OPREME SA ANALIZOM TROŠKOVA ULAGANJA

Drago Soldat, Rada Plavšić

U radu su prezentovani postupak izbora investicionih objekata i opreme kao i analiza troškova ulaganja u procesu investiranja. Analitički pristup problematici ove vrste u postupku alternativnog izbora investicionih objekata i opreme baziran je na proučavanju tehničkih i tehnoloških aspekata investiranja. Na ovaj način dolazi se do modela primenljivog u bilo kojoj grani delatnosti bez obzira na njenu vrstu, veličinu, složenost i tip projekta.