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COMPLEMENTARITY OF KNOWLEDGE OF ENGINEERING ECONOMY AND INDUSTRIAL ENGINEERING IN REALISATION OF INTERNATIONAL INVESTMENT PROJECTS

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***Abstract**: In defining, and especially in elaboration of investment documentation of any kind, particularly in elaboration of such documentation which refers to broader integration relationships in the unique European region, there has always appeared the need of establishing multidisciplinary teams so that the proposed investment solution could be considered from different aspects and so that a valid decision on investment could be made. In the multitude of such knowledge, dimensions of technical-technological solutions and economic soundness of such proposals distinguish themselves from other important dimensions of definition and implementation of a project. This paper presents a certain scope of necessary knowledge in defining technical-economic solutions in the implementation of international projects of various types. Complementarity of knowledge necessary for investment decision-making is defined through the issue of technical and economic optimisation, i.e. by means of concretisation of certain knowledge of engineering economy and industrial engineering. This has unambiguously proved that knowledge in different scientific disciplines multidisciplinarily creates methodological approaches even in complex project tasks.*

***Key words:** Investment project, technical and economic effectiveness, investment, technical and economic evaluation, engineering economy, industrial engineering*

INTRODUCTION

In defining and implementation of investment projects, which differ from other projects by their significance and because they are far-reaching, researchers always, in addition to other problems, face two essential and inseparable aspects which make the essence of evaluation of the chosen solution. The first one refers to establishing elements of technical and technological optimisation, i.e. to evaluation of scientific and professional soundness of the proposed (and chosen) technical solution. In the second (and parallel) methodological procedure, the chosen technical solution in the sense of achieving technical-technological optimum must also be «tested» from the aspect of its economic profitability, i.e. it is necessary to establish its economic optimality.

The two mentioned aspects of implementation of a project imply the selection of researchers and scope of certain knowledge. Selection of researchers is not a technical issue, and the scope of knowledge is not an arbitrary selection of topics. Both issues are mutually connected and refer to engineering and economic professions, to two wide scopes of knowledge of engineering economy and industrial engineering as well as to the fact that it is impossible to treat technical-technological optimisation and economic optimisation of a projected and realised solution separately and independently.

1. CERTAIN ASPECTS OF OPTIMISATION OF PROJECTED SOLUTIONS

In every investment project, which, by definition, requires realisation and evaluation of a certain technical solution, it is necessary to define its technical and economic optimisation [1]. In the practical sense, it means selection of the investment variant which, with maximum production capabilities (capacity), «produces» the output unit at least costs. In the theoretical sense, the problem is little more complex and requires application of various investment methods in the evaluation of the chosen technical variant. And again, the chosen investment variant supposes a hypothetical process of production, which cannot be organised without production inputs. Their combination in the production process is always a selection, and the sum of their engagement refers to scarcity and rarity. Production is an economic activity exactly because scarce resources and limited time are alternatively used in achieving different goals. Production is organised on the basic economic principle – to obtain maximum results (outputs) with minimum investment (inputs). Therefore, it is not enough to determine only technical-technological optimum of such production. Certain economic evaluation of such a solution is also necessary.

But, in any production, and hence in this hypothetical solution, «cooperation» of production factors is necessary in certain combinations of inputs which are different in every production. That indisputable fact defines the technical or production coefficient, which is determined as the ratio between the quantity of engaged production factor and the product produced, or even between the quantity of consumed factor and the unit of produced goods [2]. So, technical-technological optimisation may be well defined by production function, which always shows the ratio of the maximum quantity of output realised by minimum quantity of engaged (and consumed) production inputs. In such production functions, the technical or production coefficient can be fixed or variable. Certainly, in the first case, it refers to the production in which production factors (inputs) constantly participate with unchanged quantities, and in the second case the same output can be produced with different combinations of production inputs. The first case points to the complementarity of production inputs, and the second one points to their substitution, replacement of an input with another one. Both «cases» which are observed independently point to the conclusion that it is possible to determine technical optimisation independently of economic optimisation, and if observed together – optimisation is a complex technical-technological and economic issue. Let us consider that statement more closely.

In the first case, complementary production inputs have fixed, i.e. unchangeable technical or production coefficients. The isoquants[1] of such complementary factors are given by the rectangular shape, (P1, P2, P3... Pn), and, at the same time, the increase in both inputs (in the same unchanged quantities) is given by the curve K which extends under the angle of 45 degrees in relation to the abscissa (Figure 1.1).

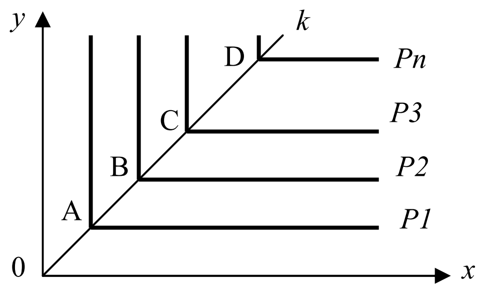

Figure 1.1. Complementary production inputs

From the graphical presentation 1.1, it can unambiguously be concluded that at points A, B, C, D, the only rational consumptions are those of inputs x and y. All other points show complementarity of these two inputs, also showing their irrational uses. On the basis of the equal product curves, another conclusion can be deduced – the farther the isoquants are from the coordinate origin, the bigger level of production they show; this is where technical-technological optimality of production is obtained.

The graphical presentation of substitutive production inputs is given in Figure 1.2. As it can be concluded, the equal product curves in substitutive production inputs have undergone specific transformation because substitution of a production input with another one is performed in order to achieve certain economic effects.

Inputs x and y can be substituted in different quantities. Therefore the rectangular isoquants (from graphical presentation 1.1) have obtained a curved, oval shape, because it is obvious that substitution is performed in order to reduce the

[1] Isoquant = curve of equal product

consumption of a (more expensive) production input with simultaneous increase in the consumption of another (cheaper) production input, where the equal product curve has not changed at all.

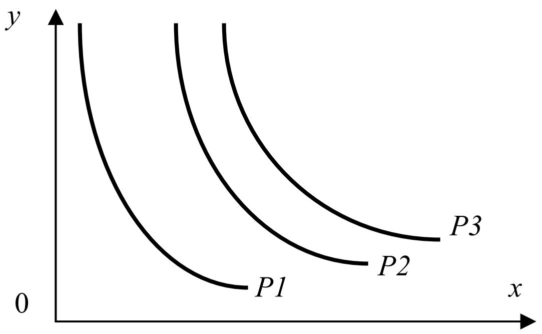

Figure 1.2 Substitutive production inputs

In other words, in substitutive production inputs, their technical or production coefficients are variable and they are given, graphically seen, by each point on the chosen isoquant, so it is impossible simply to establish technical optimality, not to speak about economic optimality of production. In such a case, complementarity of certain knowledge of economics and engineering is necessary.

2. OPTIMISATION AND CONCRETISATION OF TECHNICAL-ECONOMIC KNOWLEDGE IN PROJECTS

The degree of concretisation and application of certain technical and economic knowledge necessary for an industrial engineer, and especially to a project manager, is different in the scope of industrial engineering, engineering economics and engineering economy.

Economy as a scientific discipline on rational action of people has resulted from the fact of rarity, i.e. limited production resources and competitiveness of economic stakeholders. General economic knowledge provided by economy are very important for understanding and solving complex technical and social issues regarding rational use, selection and alternative solutions in the organisation of production. But, «generality» of this knowledge often represents a problem for their application in a realistic economic solution. This, besides other professions, particularly refers to industrial engineers who, by definition of their occupation, always search for new and more advanced methods and techniques of combining elements of the production process. Therefore, in contrast to economy, industrial engineering does not cover only economic knowledge, but it significantly extends toward sociological and psychological aspects of work and robotisation in the production process. In other words, «industrial engineering deals with creation, enhancement and implementation of integrated systems of machines, materials and people. It uses specialised knowledge of mathematical, physical and social sciences and modern principles and methods of engineering analyses and design for the purpose of determination, forecasting and evaluation of results obtained in these systems». [4].

Industrial engineering, before all, covers the engineering knowledge which refers to analysis of operations, studies of movements, handling of materials, production planning, safety at work and standardisation of procedures, measurement and economy of time, control of production, stocks, costs and budget, as well as to the system of efficient remuneration, salaries and wages, design and improvement of plants, location, replacement and procurement of new equipment, design of products and tools, etc. These are main, daily and constant activities of industrial engineering, and the knowledge is concrete and multidisciplinary.

However, the relation between industrial engineering and engineering economy is dual. It can be well presented as practice and theory, as action and understanding, as experience and knowledge. If it is known that most decisions by industrial engineers are made on the basis of solid technological and economic knowledge, then there is no special need to speak about the necessity of application of economy as a science in the realisation of projects. Industrial engineering is very concrete; it refers to concrete solving of real and practical issues in project realisation. It is also dynamic because it uses not only knowledge but the people possessing knowledge of appropriate profiles as well. Industrial engineering can approximately be defined as a skill of managing different knowledge in a company, although knowledge is considerably broader and more thorough.

In contrast to industrial engineering, engineering economy tends toward systematised theoretical and practical knowledge which is necessary for efficient solving of production tasks given to engineers in projects. Industrial engineers are a group of people which, as a rule, is at the centre of decision-making in an investment activity. And, for decision-making, as it is known, besides bravery, one needs different knowledge. In addition, every decision-making on economic courses and processes is very complex, difficult and uncertain. As responsible persons characterised by exactness and knowledge, broadness of views and innovativity, industrial engineers, more than any other profession, have to bear the risk of their proposals and decisions, which would be very irresponsible without economic knowledge.

As it may be concluded, the primary task of an engineer would be to ensure functioning of the realised projected solution [5], to design and apply new constructions and technological solutions or to improve the existing technological procedures. In addition, an industrial engineer, by definition of his profession, should constantly make improvements in the production process aiming at improving the quality of business operations and products as well as at reducing total costs of production, especially by product unit. These are all, as it can be seen, certain solutions which are out of technical-technological optimisation of the production process and they cannot be applied without certain economic evaluation. This undoubtedly refers to economic optimisation, which can be equal to technical-technological optimisation, but which very frequently differs from it. It is possible to determine economic optimisation only when production inputs and results of the production process are added by a value dimension expressed in currency units. Graphical presentation 2.1, on isoquant *P1,* shows the action of law of diminishing returns, which is a universal economic tendency in any production process.

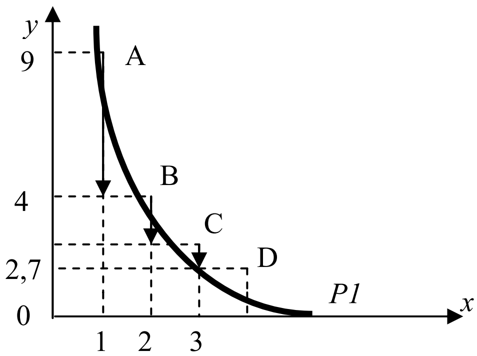

Figure 2.1 Law of diminishing returns

From graphical presentation 2.1, it can be unambiguously concluded that in treating substitution as an economic necessity, there occurs reduction of consumption of one input so that the consumption of another production input could be increased to a certain quantity. Or, quite precisely, if there is reduction of the consumption of input y from 9 to 4, the consumption of production input x will be increased from 1 to 2. Such a tendency is also continued at point C on isoquant P1, because (further) reduction of consumption of production input y from 4 to 2,7 has resulted in the increase in consumption of variable input x from 2 to 3 units, etc. It shows that the conditions of substitution are completely different at chosen points A, B, C, D, because of different quantities of consumed production inputs y and x. The mentioned conclusion undoubtedly holds in the realisation of a newly constructed technical solution.

CONCLUSION

Every investment project must have its result. But, as it could be concluded, dynamics of outputs (results, returns) is not a one-way motion. Dynamics of returns is motion of returns depending on the change of size, quality and market prices of production inputs. And it is a significantly different criterion of optimisation, which undoubtedly belongs to costs, i.e. economy and economising on production inputs. Technical-technological optimisation in combining production inputs offers a lot of acceptable answers in decision-making performed by engineering profession in the production process. But, technical optimisation cannot give answers to numerous questions, such as: financial investment, prices of production inputs, financial presentation of consumptions, i.e. costs of production inputs, etc. All mentioned categories lead to the conclusion that, besides technical-technological optimisation, it is necessary to determine economic optimisation. Moreover, without determination of economic optimisation in combining production inputs, it is not possible to make a proper conclusion on profitability of the whole selected solution.

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ДОПЪЛНИТЕЛНИ ЗНАНИЯ ПО ИНЖЕНЕРНА ИКОНОМИКА И ИНДУСТРИАЛНО ИНЖЕНЕРСТВО В РЕАЛИЗИРАНЕТО НА МЕЖДУНАРОДНИ ИНВЕСТИЦИОННИ ПРОЕКТИ

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Сърбия

Резюме*: При разработването на документация за инвестиции от всякакъв вид и в частност при разработването на документация, отнасяща се до отношенията на по-широка интеграция в единния Европейски съюз, винаги възниква необходимост от създаване на мултидисциплинарни екипи, така че предложеното решение за инвестиции да бъде обмислено от различни гледни точки и да се вземе обосновано решение. В многообразието от знания измеренията на технико-технологичните решения и икономическата обоснованост на предложенията се отличават от другите важни аспекти при определянето и осъществяването на проекта. Докладът представя обхват от необходими знания за вземане на техникоикономически решения при осъществяване на различни видове международни проекти. Допълнителните знания, необходими за решения относно предстоящо инвестиране се определят чрез техникоикономическа оптимизация, т.е. посредством конкретизацията на знанията по инженерна икономика и индустриално инженерство. Това е ясна доказателство за необходимостта чрез различните научни дисциплини да се формират мултидисциплинарни методически подходи към задачите, свързани с реализирането на сложни проекти.*

Ключови думи: *инвестиционни проекти, техническа и икономическа ефективност, инвестиции, техническа и икономическа оценка, инженерна икономика, индустриално инженерство.*