The International Journal of
TRANSPORT & *LOGISTICS*
Medzinárodný časopis
DOPRAVA A LOGISTIKA

ISSN 1451-107X

MODELLING THE UTILIZATION OF STRUCTURAL ANALYSIS IN CALCULATION OF CONTINUOUS ESTIMATES OF TOTAL COSTS

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Abstract: *Management at operational and strategic level requires decisions of various nature and type. There are many attitudes towards decision-making; the selection of a specific approach depends on the abilities of the manager, the nature of the problem and the time available to the manager.*

The article and its conclusions suggest that the utilization of economic and mathematical methods in entrepreneurial practice is entirely justified and it makes it possible to accelerate, refine and improve the decision-making processes of managers and executives of companies.

Key words: *economic and mathematical methods, structural analysis, full total costs, continuous calculations*

1 INTRODUCTION

In modern approaches to management with regard to the development of information systems and technologies, mathematical and economic quantitative methods find more and more applications. The aim of these approaches is to apply the available databases of entrepreneurial subjects in the so-called quantitative management area, where the individual processes existing within the system of a given subject not only provide verbally descriptive characterization, but they also provide economic quantification of real existing situations and they create system oriented data for the decision-making processes of managers

2 OPERATIONAL RESEARCH AND STRUCTURAL ANALYSIS

Operational research can be characterized as a scientific discipline, or rather a set of relatively independent disciplines, aimed at analyzing various types of decision-making problems. The essence of operational research can be described quite well, if we express this term as a "research of operations". The expression adjusted this way says a lot both about the

basis of operational research and about the areas of its application as well. Operational research finds its application in all areas where the analysis and coordination of executed operations within some system is in question [1].

At this time, the methods of operational research represent a set of tools for the management of complex economic systems, both at the microeconomic level and at the macroeconomic level. Operational research provides the opportunity to improve the quality of economic decision-making, particularly in terms of speed and competency, using quantitative methods. That is why the mathematical modelling is more and more often asserting itself as an integral part of
economic theory and economic practice [8]. Every economic system (national economy, resort, branch, factory economic unit, company, etc.) consists of certain elements (fields) among which there are links in the form of supplier-consumer relationships. Any change in one element may be reflected in those elements (fields) the given element is directly or indirectly related with. The structural analysis deals with capturing and analysing these links and relationships. The basic tool is the structural model. The structural model is an instrument allowing capturing the mutual relations among the individual elements of the economic system as well as the links of these elements with the surrounding environment. It represents certain quantitative method of illustration of the manufacturing process in which the creation and use of production is captured not only in one piece, but, simultaneously, also in its structure. [6] From the mathematical means, the structural models use mostly linear algebra. The given the economic system is most commonly described by a system of linear equations. The most common representatives of the structural models are classical Leontief's static models. The possible spheres of use of the structural models and structural analysis in industrial plants are presented for example in publications written by Rutrle,P.[5],Vlček,D.a Chuchro,J. [7], Janovská, K. and Vozňáková,I. [2,3].

3 PRE-CALCULATION OF THE TOTAL COSTS

The ability to optimize costs based on the knowledge of company processes will be absolutely crucial for maintaining the competitiveness of metallurgical companies in the future. Without detailed knowledge of the costs, both the costs of individual processes and the cost of the final products of the industrial enterprise as a whole, the industrial companies will not be able to define and make the right decisions to ensure their economic growth,
sufficient profit and cash flow for their operation.

Calculation as one of the basic tools of managerial accounting displays both basic poles of the business process - naturally expressed performance and its value characteristics. For this reason, it is a very important tool that allows the managers to identify the relationships and behaviour of costs in relation to the size and structure of performances and to determine the cost of company performance as such. The structure of calculation is an enumeration of the individual cost items in such a way to allow the determination of total cost per calculation unit. In practice, the individual companies define their own calculation formulas in which the names of the items may express concrete cost types present in the given manufacturing processes. The way of cost items sequencing, details of their structure, relationship to calculation of price and other variables including the structure of subtotals is reported in variations with respect to the users and the decision-making task the solution of which the calculation should contribute.

In case of production in steps (for example in metallurgical production), gradual and continuous calculations are often used. Continuous calculation goes through the individual stages of production and it accumulates external inputs and their specific consumptions in the

final (defined) production stage. The outcome of continuous calculation is a list of all external inputs from the individual successive calculations, including their specific consumptions, prices and specific costs per unit of production of the final stage of production. Continuous calculations thus provide an overview of consumption of the basic raw material inputs, supplemented by individual specific consumptions of the final product as well as the exact definition of the fixed costs which can be used, for example, to compare the amount of wage costs, costs
of repairs and maintenance or the amount of other allocated costs per unit of production of the final product.

Continuous calculation is not often used in industrial companies because of its significant computing demandingness [4]. Today's level of computer technology in the area of basic Microsoft Office Excel software equipment allows you to easily pre-define calculations, and thus shorten the processing operation from several days to several minutes. This tool opens new possibilities for the use of continuous calculations for modelling of future cost development of the company in relation to development of prices of input raw materials and energies, and for comparing the total cost of the final production stage of the factory with other factories within the company.

4 DETERMINATION OF FULL TOTAL COSTS BY MEANS OF STRUCTURAL ANALYSIS

This article presents the utilization of structural analysis methodology for calculating the coefficients of direct consumption and complex consumption as a base for continuous calculations of the full total costs of the manufactured products.

When compiling the structural model for a concrete company, there is usually a problem in obtaining the relevant data, especially from the area of calculation of the total costs which are usually protected as a trade secret. In the procedure presented in this article we used historical model data. This is a practical case of putting together continuous calculations in the process of mining and processing of aggregate used for construction of transport infrastructure. The used data are partially adjusted.

***Tab. 1** Matice A - matice technických koeficientů*
***Tab. 1** Matrix A - matrix of technical coefficients*

Matice A Matrix A	Polotovar I. Semi-product I.	Polotovar II. Semi-product II.	Výrobek A Product A	Výrobe B Product B
Polotovar I. Semi-product I.	0	1,05	0	0
Polotovar II. Semi-product II.	0	0	1,05	1,4286
Výrobek A Product A	0	0	0	0,1799
Výrobek B Product B	0	0	0,18	0

If you want to calculate the coefficients of direct and complex consumption it is necessary to know the values of material flows which show the ties and flows between the defined processes, the input and output ties and flows to external and internal environment in the specific units. Matrix A can be compiled on the basis of knowledge of these data in the first stage. This is a matrix of technical coefficients. The technical coefficients a_{ij} are constant and they result from direct consumption (**Tab.1**).

***Tab. 2** Matice B - matice koeficientů komplexní spotřeby*
***Tab. 2** Matrix B - matrix of complex consumption coefficients*

Matice B Matrix B	Polotovar I. Semi-product I.	Polotovar II. Semi-product II.	Výrobek A Product A	Výrobek B Product B
Polotovar I. Semi-product I.	1	1,05	1,418437235	1,755206858
Polotovar II. Semi-product II.	0	1	1,350892604	1,67162558
Výrobek A Product A	0	0	1,033465686	0,185920477
Výrobek B Product B	0	0	0,186023823	1,033465686

In order to calculate the coefficients of complex consumption you must also subtract matrix A from matrix E, while matrix E is a unit matrix. For these and subsequent calculations, it is advisable to use Microsoft Excel program. Matrix B is a matrix of complex consumption coefficients. Its elements b_{ij} are the invariables of the system. This matrix in structural analysis is an important indicator of mutual links among the fields. Matrix B indicates the total consumption of production per unit of final sales (**Tab 2**).

The bellow presented initial data were used for calculation of recalculated variable costs, the knowledge of which is necessary to determine the continuous calculation of the total cost:

- the costs of mining 1 ton of Semi-product I are 5 Kč
- the costs of transfer of Semi-product I to be processed to Semi-product II are 14 Kč/t
- the costs of grinding Semi-product II into Product A and Product B are 45 Kč/t
- the cost of diesel consumption for Product B is 0.05 Kč/t
- the handling cost of Product A and Product B are 3 Kč/t
- the costs of mining permits for Semi-product I are 9 Kč/t

The bellow presented allocated data were used for calculation of recalculated fixed costs, the knowledge of which is also necessary to determine the continuous calculation of the total cost:

- depreciation costs of Product A are 3.74 Kč/t and of Product B 2.84 Kč/t
- interest costs of Product A are 2.49 Kč/t and of Product B 1.89 Kč/t
- leasing costs of Product A are 6.98 Kč/t and of Product B 5.3 Kč/t
- overhead costs of wages of Product A are 6.61 Kč/t and of Product B 5.04 Kč/t
- the cost of income taxes of Product A are 2.25 Kč/t and of Product B 1.7 Kč/t
- allocated overhead administrative and sales costs of Product A are 3.74 Kč/t and of Product B 2.84 Kč/t
- other fixed costs of Product A are 7.48 Kč/t and of Product B 5.67 Kč/t

By multiplying matrix B and the variable costs per 1 t of product, we can determine the recalculated variable costs per 1 t which represent the actual cost per 1 ton that the company spends on processing semi-products I, II, and products A, B. By multiplying matrix B and the fixed costs per 1 t of product we can determine recalculated fixed costs per 1 t of product that represent the actual fixed costs per 1 ton of semi-product I, II, and products A, B. The calculated values are presented in **Tab. 3.**

Tab.3 *Průběžná kalkulace úplných vlastních nákladů (Kč/t)*
Tab.3 *Continuous calculation of total costs to the enterprise (CZK/t)*

	Polotovar I. Semi-product I.	Polotovar II. Semi-product II.	Výrobek A Product A	Výrobek B Product B
Variabilní náklady Variable costs	t	t	t	t
Těžba Mining	5	5,25	7,05	8,75
Převoz Transportation	0	14	18,9	23,38
Drcení Grinding	0	0	46,485	8,1
Nafta Diesel	0	0	0,00954	0,054749
Manipulace Manipulation	0	0	3,639	3,639
Nákup Purchase	9	9,45	12,69	15,75
Variabilní náklady celkem Total variable costs	14,00	28,70	88,77	59,67
Fixní náklady Fixed costs	t	t	t	t
Odpisy Depreciation	0,00	0,00	4,37462	3,60692
Úroky Interests	0,00	0,00	2,91237	2,40057
Leasing Leasing	0,00	0,00	8,16434	6,7313
Zásobovací režie Acquisition overhead expense	0,00	0,00	7,73533	6,39612
Režijní mzdy Overhead wages	0,00	0,00	2,63025	2,1611
Daň z mezd Income tax	0,00	0,00	4,37462	3,60692
Správní a odbytová režie Administrative and sales overhead expense	0,00	0,00	8,74744	7,20351
Ostatní fixní náklady Other fixed costs	0,00	0,00	4,37462	3,60692
Fixní náklady celkem Total fixed costs	0	0	43,31	35,71
Úplné vlastní náklady Total costs	**14,00**	**28,70**	**132,08**	**95,38**

Interpretation of the achieved results

The outcomes of table number two for example show that:

- the cost of mining of Semi-product I are 5 Kč/t
- recalculated continuous costs of mining of Semi-product II are 5.25 Kč/t
- recalculated continuous costs of mining of Product A are 7.05 Kč/t
- recalculated continuous costs of mining of Product B are 8.75 Kč/t
- recalculated continuous costs of depreciation of Product A are 4.40 Kč/t
- recalculated continuous costs of depreciation of Product B are 3.60 Kč/t
- total costs per 1 ton of Semi-product I are 14 Kč
- total costs per 1 ton of 1 ton of Semi-product II are 28.7 Kč
- total costs per 1 ton of 1 ton of Product A are 126.84 Kč
- total costs per 1 ton of Product B are 92.86 Kč

The methodology for structural analysis was used to calculate the coefficients of direct consumption and coefficients of complex consumption and they were used as a basis for setting continuous calculations of the total costs of the individual products.

Such calculations can be efficiently used, for example, when comparing the full total costs with the achieved selling price, while the operationally reliable data related to the internal structure of these costs are immediately available. Thanks to that, the management has the possibility to effectively focus their attention on the critical cost items, because in the continuous calculation of the final product these items are presented, including the values of the previous production stages. The presented example is, for obvious
reasons, very much simplified for the purpose of this publication. In practice, we usually meet with a higher number of technological production stages, as well as with a larger product portfolio (variables). In this case, the use of structural analysis, including the corresponding software is necessary for continuous costing calculation.

5 CONCLUSIONS

The methods of mathematical modelling of economic phenomena and processes are gradually gaining permanent position in all sectors of our national economy. The importance of this tool for higher quality of management is increasing with the development of computer technology and the information technologies. The article and its conclusions suggest that the utilization of economic and mathematical methods in entrepreneurial practice is entirely justified, and it makes it possible to speed up, refine and improve the decision-making processes of managers and executives of companies

Literatúra / References

1] JABLONSKÝ, J. *Operační výzkum: kvantitativní modely pro ekonomické rozhodování*. 3.vydání. Praha: Professional Publishing, 2007.pp.323

[2] JANOVSKÁ,K.,LAMPA,M.,VOZŇÁKOVÁ,I.,Ekonomicko-matematické metody strukturální analýzy jako jeden z významných nástrojů optimalizace ekonomického řízení hutního podniku, *Hutnické Listy*, ročník LXIII, 2/2010, OCELOT s.r.o. Ostrava. pp. 83-88

[3] JANOVSKÁ,K.,VOZŇÁKOVÁ, I.,ŠVAJDOVÁ,L. The Verification of Applicability of Economical mathematics Methods of Structural Analyses as a Tool for Optimising Economic Proceedings of Metallurgical Enterprise,. *In Conference proceedings of 19th International Metallurgical and Materials Conference METAL 2010,* Ostrava: TANGER, 2010, pp. 121-125.

[4] NOVÁK, K. *Controlling v podmínkách zahraničního průmyslového podniku*. Ostrava, 2010, disertační práce na Vysoké škola báňské - Technické univerzitě Ostrava. FMMI

[5] RUTRLE, P. *Příspěvek k aplikaci ekonomicko - -matematických metod na řízení energetického hospodářství hutního podniku*. Kandidátská disertační práce,1975

[6] ŘÍMÁNEK, J.; MACUROVÁ, P.; MIKOLÁŠ, Z. *Strukturní modely v průmyslu*. 2. vydání. Ostrava: Vysoká škola báňská Ostrava, 1985. pp.195

[7] VLČEK, D.; CHUCHRO, J. Systém podnikatelských modelů (EMA.PM). *Moderní řízení*,1994, No.3, pp. 15-20

[8] ZIMOLA, B. *Operační výzkum*. 2. vydání. Brno: Vysoké učení technické v Brně, 2000. pp.168

Recenzia/Review: *doc. Ing. Gabriel Fedorko, PhD.*