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THE MANAGEMENT AND DETERMINATION OF THE BEST PERIOD TO RECONDITION THE PRODUCTIVE EQUIPMENT IN ROMANIA

Case study

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Abstract

This paper shows the importance and actuality of the approached problem. Romania, adhering to the European Union, created opportunities for developing socio-economically, but also problems emerged. The economy of the country became open for all the countries belonging to EU, countries where the productivity of work is about 5 times greater than productivity of work in Romania. In these conditions, merchandises originating in Romania will hardly compete with those from the other countries in EU; Romania will have to face the situation (if the level of productivity of work is still reduced) of exporting raw materials, work resources, to accept a negative net export, to transform itself in a colony of EU. In this context of "fears", the theme of "managing and determining the best periods to recondition the productive equipment in Romania" becomes actual. Considering the general character of reconditioning, we can distinguish two great types: financial-organizational and technological (6, page 52). For the second type, the main successes of the enterprise depend not only on the volume of the investments made to introduce the technique and modern technology, but also on the level of efficiency of using these funds.

Enterprises, depending on their specific, face unclear methodological problems regarding the correct judgment of the efficiency of the elaborated versions of the project caused by the implementation of the new technique. Among these problems, we mention: when, where, and why this necessity of the complex analysis of the efficiency of technique projects emerges, modern technologies; which are the conditions that imposed the introduction and use of the new technique. In our vision, the complex analysis of the economic efficiency in enterprises in Romania must be a continuous process. Enterprises must be part of this continuity due to competition with other countries from EU, to technical and technological progress, to the wish of every enterprise to become a leader in the respective economic activities. In the context of the main economic aims concerning the introduction of the modern technique, it is necessary to determine the costs of the preparation and execution of technical measures. The economic efficiency of introducing the technique, of the new technologies is a report between the costs of introducing the respective technical measure, regarding the partial or total modernization of manufacturing processes or the means of work and the effects obtained or those which are expected to be obtained as a result of the application of these managerial measures. The effects of introducing the technique, new technologies can be: material effects, like the physical volume of the production obtained by the enterprise; value effects, expressed through the economies of the enterprise as a consequence of the reduction of work costs, of the price of the final product; social effects, the ease of working conditions and the rise of level of work security and protection; ecologic effects, reducing the use of toxic resources by the enterprise in the productive processes. The recondition of the productive equipment, having a low degree of repeatability, many times being unique, raises many problems. The modernization of the enterprise is a complex problem, following the limitation to minimum of the risk of emerging flaws, in the conditions as small as possible work costs. The most important effects of modernizing the enterprise are the growing quality of the final product and the growing duration of the equipment. The solution of this problem is connected with the organization based on the theory of management; decreasing the work costs, materialized. Growing the functioning duration of the machines and equipment of the enterprise is a direct consequence of improving the methods of selecting the options. From a technical point of view, there is this possibility of extending the life duration of the equipment for ever; from economical reasons, the equipment has to be inoperable after a certain period of time, and the determination of the functioning durations has to be the object of

optimization calculations. We can distinguish between the calendar duration and the effective duration of functioning. The first one has to be as small as possible in order to avoid the action of the moral attrition; the second one-the efficient functioning. The best duration of the running equipment of the enterprise is connected with the avoidance of the moral attrition, with the recovery of the value of the equipment by inclusion in the cost price in the fabricated production; it is determined by the speed of renovation in other countries of EU. The determination of the moment of replacement of the old equipment with the modern one can be realized through comparison with the remained value of the old equipment with the estimated accumulations of the new and old machines, multiplied by the approximate number of years needed for the old machine to be recovered. When a new machine offers, in a certain unity of time (due to technology and, consequently, to a higher yield, due to the simplification and, consequently, to the cheapening of the maintenance, and also the growing level of safety in functioning), greater accumulations than the old one and a plus of accumulations, able to recover the main value, keeping the old machines (the equipment) working means, for the enterprise, loss of work and financial resources. Effectuating, at certain intervals of time, the comparison described above, allows the establishment of the best moment for replacing the equipment. In order for these operations of reconditioning the equipment to be effectuated, the manager of the enterprise has to have access to the data concerning the working and maintenance characteristics of the modern equipment from the investigated area. The study could be effectuated in those compartments of the enterprise, where the system of record of the working process of the respective equipment is richer. The enterprises in Romania are the most diverse ones, concerning the branch belonging, the technological specificity, the destination of the final product (used as a means of production or good intended for unproductive consumption). Through aggregation, the enterprises can be grouped: electric and thermic energy; fuel (coal, cocso-chemical, petroleum, extraction of the marsh gas); ferrous metallurgy, including the extraction of metal ores, non-ferrous metallurgy, including the extraction of non-ferrous ores; building machines and metalworking; the extraction of non-metallic ores and products from abrasive substances; construction materials, exploitation and processing of wood; cellulose and paper, including the exploitation of reed; glass, porcelain and tile; textiles; leather clothing; fur and footwear; food industry; soaps and cosmetics; polygraphy; other branches of industry. We can add to these agricultural enterprises, from the unproductive spheres that beneficiate from fixed funds with

unproductive destinations. However different would be the enterprises, they share a common feature: the methodology of determining the best period of reconditioning the productive equipment.

The economic indicators of a company are greatly determined by the age of the productive equipment. The dynamic of the indicators is connected with the income (Total Revenue), with the costs of exploitation of the equipment in every period. If the productive equipment is reconditioned too often, then the company misses the possibility of realizing extra profits; if the equipment works, being very old, then the company has bigger costs for exploiting the equipment, and consequently, reduced profits. In order to formulate a methodology, useful for every company, we will examine an example. At the company A, at the beginning of the period $t=1$, there have been put into operation productive equipment at the price of 300.000 lei with exploitation costs of 10.000 lei and a total income (Total Revenue) of 360.000. In the next periods,

$t=2,3,\dots,8$, the income (raw produce) is reduced from 355 to 220.000 lei, and the total cost of exploitation grows from 70 to 225.000 lei; the profit in the period $t=1$ is $360-300-10=50$, in the periods $t=2,3,\dots,8$ is reduced from 285 in the period $t=2$ to -5.000 lei in the period $t=8$. (see table 1).

The problem is: determining the best period when the productive equipment has to be replaced with the new equipment, of the same productivity. The criteria of optimization: the maximum profit, realized by the enterprise, in the period of functioning of the productive equipment. The enterprise is considered a system. (Table 1). The condition of the system is characterized by the "age" of the equipment. The management of the system is reduced to the determination of the period (parameter) t of renovation or not of the productive equipment. The decision of keep running the equipment is represented by U_1 ; of renovation (replacement) by U_2 . We elaborate the functional equation Bellman [5, p. 126]:

$$\Pi_k(t^{(k)}, U_k) = \begin{cases} TR(t^{(k)}) - TC(t^{(k)}), & \text{for the decision } U_1 \\ TR(1) - TC(1) - K, & \text{for the decision } U_2 \end{cases} \quad (1)$$

Where $K=300.000$ lei-the costs of the new equipment
 $t(k)$ -the age of the equipment at the beginning of the period k , $k=1,2,\dots,8$.

In these conditions, the Bellman equation has the form:

$$\Pi_k(t^{(k)}) = \max_t \begin{cases} (t^{(k)}) - C(t^{(k)}) + \Pi_{k+1}(t^{(k+1)}) \\ (1) - C(1) - K + \Pi_{k+1}(t^{(1)}) \end{cases} \quad (2)$$

Based on this equation and initial data from table 1, we elaborate table 2. In the period $t=8$, the company supports loss because the total cost of exploiting the equipment (225.000 lei) overcomes the total income (220.000 lei) with 5.000 lei.

It is correct to admit that the company A will take the decision i of reconditioning the equipment in the period $t=8$. (Table 2)

In the option 8 (the last line from table 2), the decision 1, the company A has reconditioned the equipment in the period $t=1$; during the periods (1-8), the realizable profit is 955.000 lei. In the option 1 (the first line from table 2), the company A, through the decision 8, has reconditioned the equipment in the period $t=8$; during the periods (1-

8), the realizable profit is 1010.000 lei. The variables 8, 7, 6, ..., 1 represent the decisions of the company A of reconditioning the equipment, respectively in the period 8; 7; 6; ...; 1. The total maximum profit in the options 1, 2, ..., 8 represent $\max(1010; 1260; 1410; 1460; 1410; 1260; 1010; 955)=1460$ (mii lei).

Problem 1 may be generalized (Table 3).

Based on the information from table 3, we elaborate the possible options for reconditioning the productive equipment, starting with their recondition in the period $t=T$ (decision τ_T); in the period $t=(T-1)$ (decision τ_{T-1}) etc. The period t , when the company has to recondition its equipment may be determined by the relation:

$$\Pi_{t^*} = \max \left\{ \left(\sum_{i=1}^{T-1} \Pi_{1i} + \sum_{t=1}^1 \Pi_{1t} \right); \left(\sum_{i=1}^{T-2} \Pi_{1i} + \sum_{t=1}^2 \Pi_{1t} \right); \dots; \left(\sum_{i=1}^1 \Pi_{1i} + \sum_{t=1}^{T-1} \Pi_{1t} \right); \left(\sum_{i=1}^T \Pi_{1i} \right) \right\} \quad (3)$$

The algorithm for determining the best period for reconditioning the productive equipment for the considered problem: the company has to recondition its productive equipment in the period $t=5$; for the general case, the reconditioning period is determined by the intersection of the line t^* with the diagonal "from right to left". And, because the number of lines and columns coincide, the best period is t^* -the order number of the line, where the profit is maximum. In order to solve problems similar to the examined one, it is necessary to elaborate the algorithm-table: line 1 is made of the initial data of the problem, excluding the last period, where there are submitted the data of the period 1; line 2 is made up of is the initial data of the problem, excepting the last two periods, where there are submitted the data from the periods 1 and 2 etc; for each line we determine the total profit, realized in the examined period; we determine the maximum profit from the elements of the last column; the order number of the option with maximum profit is the period when the company has to recondition its equipment. (Table 4)

The algorithm cannot stand essential modifications in the processes of effectuation of calculations even in the cases where there are conditions and extra restrictions in the problem. For instance, the equipment removed and replaced with a new one are not depreciated, but are commercialized. Or the company replaces the running equipment with machines already used one, two or more periods of time by another companies. We will examine this sort of cases for a problem, for which the initial data is to be found on table 5. Based in the data from table 4, we complete the first line (profit) from table 5.

In this case, the equipment is working, without being replaced, 9 periods (years). The profit of the company is reduced from 10, made by the new equipment, to 0 lei in the period 9. The total profit is 56.000 lei. In the period 9, the profit was 9.000 lei. It is logic for the company to recondition the equipment from the previous period, from the period 8. In this case (line 2 from table 5), the total profit will be 73.000 lei. The rest of the lines from table 6 are completed in a similar manner. The best option is determined by the relation:

$$\max (56; 73; 7; 80; 80; 80; 77; 73; 66; 56)=80 \text{ (mii lei)}.$$

The intersection of the lines 3;4;5 with the second diagonal determines three periods, when the company has to recondition the running equipment with new equipment, of the same productivity. This is the beginning of the periods 4; 5 or 6. The

decisions of reconditioning the equipment in table 6 are expressed through $6, 5, 4$. In the examined case, the price of the new equipment was 10.000 lei; the removed equipment has the price 0. But the equipment, already used for t ani, can be commercialized at the price of $K_{t, \text{mii lei}}$ (Table 6).

In the case when the removed equipment can be commercialized at the prices indicated in table 7, the dynamics of the economic indicators of the company will be another one (Table 5). Unlike the first case, the equipment of 1;2;3;4;5;6;7 years contribute to growing the income of the company in the reconditioning year of the equipment with the quantum of the cost of the old equipment (Table 7). The best period for reconditioning is determined by the relation

$$\max (56; 73; 78; 82; 83; 84; 82; 79; 75; 56)=84.000 \text{ lei}.$$

Another case may be the one when the company decides to recondition the running equipment with old equipment, for instance, with 1 year old equipment. Based on the data from Table 4, the company, with this equipment, will have in the first year an income of 24000 lei; the cost of exploitation will be 15.000 lei; the price will be 7.000 lei. Consequently, in the year of reconditioning, the company will have a profit of $24-15-7=2.000$ lei. In the next years, the dynamics of the indicators will coincide with the data from Table 8.

The decision 4 is the best, the equipment has to be reconditioned at the beginning of the period 4.

The data from table 9 represent the base for making the decision of reconditioning the equipment. From the relation $\max (37; 41; 49; 54; 56; 58; 56; 54; 49; 41)=58.000$ lei, the company takes the decision 5 – the equipment has to be reconditioned at the beginning of the period 5.

The determination of the best period to recondition the productive equipment is a multi iterational problem; in the process of taking the best decisions, separately for each step, the manager takes many decisions. Each one is the best for the given iteration; all the decisions are directed towards the realization of the final aim-the maximum income, profit or minimum costs and expenses; at each step in solving the problem, usually, the one and the same criteria of optimization is used by the manager; the problem of the determination of the best period of reconditioning the equipment can be solved only for separate intervals of time; the problem must be decomposed in a multitude of sub-problems of optimization for each period; the multitude of solutions for optimization problems is

presented by a consecutiveness of values of the function-aim; solving the problems of optimization for each period is made through algorithms, elaborated for each problem depending on its specific, starting with the last period; the best solution for each period examined separately is the best within the periods. In the process of reconditioning the productive equipment, it is necessary to keep in mind the experience of other countries in these activities. More local scientists think that one of the determinants of the economic raise is the efficient use of direct foreign investments (ISD) [1, page 185]. Nevertheless, we notice that none of the enterprises from the powerful industrially developed countries do not recondition their equipment, machines, technologies with the ones already used in another countries. In this way, they manage to maintain themselves as leaders, to produce original products, without homolog, precedent, in space and time, to establish discriminatory prices for its products and services on the international market. This sort of possibilities for the industrially developed countries are created by the growing countries, including Romania, which imports morally overcome equipment for the exporting countries, but provisionally useful for the poor countries. In this way, the developing countries are transformed into the industrial dustbin of the industrially developed countries. In this process, the poor countries, partially, provisionally, create opportunities for economic raises, reducing unemployment, improving the life quality of the population. But, a certain economic policy of the enterprises in the poor countries is the disadvantage of society. So, old equipment in Romania must be replaced with modern equipment, mainly new, efficient, without homolog in space and time.

Conclusions

Regarding the specialization, small and middle enterprises in Romania are mainly oriented towards the area of services, with a percentage of 76,5 % and in the area of commerce and restoration of autovehicles.

The determination of the best period for reconditioning the productive equipment is a multi iterational problem; in the process of taking the best decisions, separately for each step, the manager takes a consecutiveness of decisions. Each decision is the best for the given iteration; all the decisions are directioned towards the realization of the final aim: maximum income, profit or minimum costs, expenses; at each step of solving the problem, the manager usually uses the same criteria of optimization; the problem of determining the best period of reconditioning the equipment can be solved only for separate intervals of time; the problem must be decomposed in a multitude of subproblems of optimization for every period; the multitude of the solutions of optimization problems

is presented by a consecutiveness of values of the aim-function; solving optimization problems for each period is made through algorithms, elaborated for each problem depending on its specificity, starting with the last period; the best solution for each period examined separately is the best in the ensemble of the periods.

The problem of determining the best assortment, the technologies used for making the finite products may be solved only after examining all the possible options; the best solution for the problem may be the base of the system of taking the decisions for other services of the company as well. The optimization criteria does not depend on the principle, can be modified depending on the specificity of the problem, may be replaced with minimum costs or maximum profit.

In the conditions after the adherence to EU, the company faces new main problems: the price of the products of the company are not established by the company, but by the market. The reduced prices of the products of the company may worsen its economic status. In this context, the company is forced to reduce to the minimum the productive efforts. This thing can be realized only through the analitic potential of the mathematic planning. The manager of the company must know the potential of the analitic methods; to form groups of experts for solving the problems related to the strategic development.

The enterprises from Romania function in an open economic environment, and they are engaged in an economic competition with the countries from EU, and the material, financial, work resources are limited, including skilled labor. The productive potential of enterprises is determined by a string of exo factors, endogenous: technological progress, inovational level, the availability of fixed capital and its efficiency; the specific consumes (at a unity of product) of resources; the supply and demand on the market from Romania, from EU; the economic policies of the enterprise, of the country, of EU. The enterprise can not function efficiently anymore based on some programs elaborated intuitively; the situation demands the maximum use of all possibilities for becoming an enterprise of the future.

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Tables

Table 1: The dynamics of economic indicators of the commercial enterprise A: initial data

Periods, years Indicators	1	2	3	4	5	6	7	8
Total Revenue (TR), mii lei	360	355	345	330	310	285	255	220
Total Cost (TC), mii lei	310	70	120	160	190	210	220	225
Profitul , =TR-TC, mii lei	50	285	225	170	120	75	35	-5

Source: elaborated by the author

Table 2: Options of reconditioning the equipment of the commercial company

Periods, years Decisional options	1	2	3	4	5	6	7	8	The total profit in the version t, mii lei
1	50	285	225	170	120	75	35	50 ₈	1010
2	285	225	170	120	75	35	50 ₇	285	1260
3	225	170	120	75	35	50 ₆	285	225	1410
4	170	120	75	35	50 ₅	285	225	170	1460 _{max}
5	120	75	35	50 ₄	285	225	170	120	1410
6	75	35	50 ₃	285	225	170	120	75	1260
7	35	50 ₂	285	225	170	120	75	35	1010
8	50 ₁	285	225	170	120	75	35	-5	955

Source: elaborated by the author

Table 3. The dynamics of the economic indicators of the company: initial data (general case)

Periods, Years, Indicators	1	2	...	t	...	T
Total Revenue (TR), mii lei	R ₁	R ₂	...	R _t	...	R _T
Total Cost (TC), mii lei	C ₁	C ₂	...	C _t	...	C _T
Profit (), =TR-TC, mii lei	P ₁	P ₂	...	P _t	...	P _T

Source: elaborated by the author

Table 4: The dynamics of the economic indicators of the company A: old equipment

Periods, Years Indicators	0	1	2	3	4	5	6	7	8	9
Total Revenue (TR), mii lei	25	24	24	23	23	23	22	22	21	20
Total Cost (TC), mii lei	15	15	16	16	17	17	18	18	19	20
Profitul (), =TR-TC, mii lei	10	9	8	7	6	6	4	4	2	0

Source: calculations based on the data take from [157, page 311]

Table 5. The best option

Periods, Years	0	1	2	3	4	5	6	7	8	9	Total profit, mii lei	Profit max, mii lei	Decision t
Profit, mii lei Variants	10	9	8	7	6	6	4	4	2	0	56		
1	10	9	8	7	6	6	4	4	10	9	73		
2	10	9	8	7	6	6	4	10	9	8	77		
3	10	9	8	7	6	6	10	9	8	7	80	80	6
4	10	9	8	7	6	10	9	8	7	6	80	80	5
5	10	9	8	7	10	9	8	7	6	6	80	80	4
6	10	9	8	10	9	8	7	6	6	4	77		
7	10	9	10	9	8	7	6	6	4	4	73		
8	10	10	9	8	7	6	6	4	4	2	66		
9	10	9	8	7	6	6	4	4	2	0	56		

Source: elaborated by the author

Table 6: the price of the equipment already used for t years

t years	0	1	2	3	4	5	6	7
K_t , thousands lei	10	7	6	5	4	3	2	1

Source: elaborated by the author

Table 8: Options for reconditioning the productive equipment

Periods, Years	0	1	2	3	4	5	6	7	8	9	Total profit, thousands lei	Profit max, mii lei	Decision t
Profit, thousands lei Variants	10	9	8	7	6	6	4	4	2	0	56		
1	10	9	8	7	6	6	4	4	10	9	73		
2	10	9	8	7	6	6	4	11	9	8	78		
3	10	9	8	7	6	6	12	9	8	7	82		
4	10	9	8	7	6	13	9	8	7	6	83		
5	10	9	8	7	14	9	8	7	6	6	84	84	4
6	10	9	8	15	9	8	7	6	6	4	82		
7	10	9	16	9	8	7	6	6	4	4	79		
8	10	17	9	8	7	6	6	4	4	2	75		
9	10	9	8	7	6	6	4	4	2	0	56		

Source: elaborated by the author

Table 9: Options for reconditioning the fixed capital with 1 year old equipment

Periods, Years	0	1	2	3	4	<u>5</u>	6	7	8	9	Total profit, mii lei	Profit max, mii lei	Decizia
Profit, years Variants	2	8	7	6	6	4	4	2	0	-2	37		
1	2	8	7	6	6	4	4	2	0	2	41		
2	2	8	7	6	6	4	4	2	2	8	49		
3	2	8	7	6	6	4	4	2	8	7	54		
4	2	8	7	6	6	4	2	8	7	6	56		
5	2	8	7	6	6	<u>2</u>	8	7	6	6	<u>58</u>	58	5
6	2	8	7	6	2	8	7	6	6	4	56		
7	2	8	7	2	8	7	6	6	4	4	54		
8	2	8	2	8	7	6	6	4	4	2	49		
9	2	2	8	7	6	6	4	4	2	0	41		

Source: elaborated by the author