1. Katarína TEPLICKÁ, 2. Katarína ČULKOVÁ

OPTIMIZATION OF PROCESSES FOR MACHINERY AND EQUIPMENT RENOVATION THROUGH MODELS OF OPERATION ANALYSIS

1-2. ÚSTAV PODNIKANIA A MANAŽMENTU, F BERG TU KOŠICE, PARK KOMENSKÉHO 19, 040 11, KOŠICE, SLOVAKIA

ABSTRACT: Securing of fluent running of production process depends from the level of fixed capital, that means machinery and equipments that are used in the firm. Permanent care for fixed capital of the firm and economical operating with fixed capital brings high service cost and therefore it is necessary to follow up state of the machinery and production equipments, their physical respectively moral depreciation, to find out ways for fixed capital renovation and to optimization interval of their real durability. Process of fixed capital renovation can be followed up from the view of management through quantitative methods that enable managers to optimization interval of fixed capital renovation.
KEYWORDS: optimization, fixed capital, reproduction, costs

❖ INTRODUCTION

Prosperity of the firms depends in present time mainly from the timely and proper decision of management about way for obtaining of financial, raw material, material, technical and human sources, decision about work efficiency achieving for individual working places and employees in the production, about efficiency of firm's fixed capital using, about optimal management of stocking and sales, about localization of clients and transport, about environment of the firm, etc.

Present management cannot run without significant using of quantitative methods during solving of economical problems of the firm. Exact accesses during decision and development of computer techniques have become decisive impulse and basis for development of quantitative accesses in management and therefore this article will be orientated mainly to the using of models for renovation during solving of optimizations of the renovation time for machinery and equipments.

❖ PROBLEM ANALYSIS

In production firm it is necessary to use production equipment that is main production tool and its service situation is necessary assumption for securing of fluent production. Due to this reason it is necessary to search time interval for renovation of production equipment. During duration of its using there is rising high cost for its service, securing of repair and maintenance, and firm must inevitably minimize such cost.

❖ METHODOLOGY OF PROBLEM SOLVING

During problem solving that is priority for the firm in area of production equipment renovation we have solved this problem according models using from operation analysis renovation. Basis of this model is to follow up process of production equipment wearing in sense of removing of negative consequences due to the physical wearing and to follow up volume of service cost, that are connected with securing of production equipment repair and maintenance.

When managing subject should to decide about time of production equipment displacing form the production process due to its obsolescence, malfunction or high service intensity, it must apply following decisions:

- To evaluate physical state of production equipment,
- To evaluate durability of equipment in relation to the technical durability,
- To evaluate level of depreciation of production equipments,
- To evaluate financial possibilities for new investment,
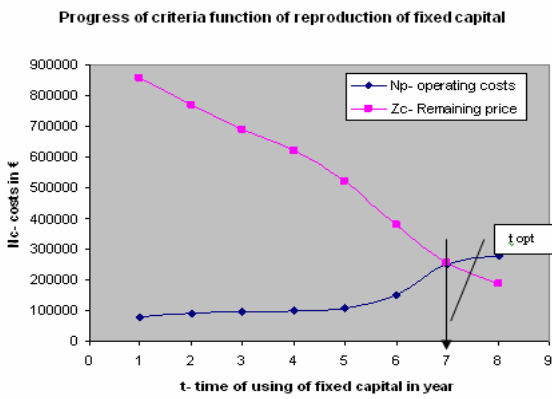- To evaluate way for new production equipments obtaining.

Figure 1: Process of criteria function of production equipment renovation

Model for renovation of production equipment will be orientated in the sense of optimization of time interval for renovation and repair performance or obtaining of new production equipment.

Such stated purpose function presents mathematical sum function of cost for service and cost that classify remaining price of production equipment. Figure 1 illustrates its process.

$$Nc\,(t)= Np\,(t) + Zc\,(t) \; \text{- minimization}$$

Through such defined purpose function there is made decision about time for production equipment displacing where there is applied cost optimum of process for its using. Basic characteristic of the process for finding of optimal time for production equipment using will result from the relationships between development of total cost connected with production equipment using and time of its using that means its durability.

Model of renovation is effective way for finding of optimal value that means stating of service year in which production equipment will be properly renewed.

Legend:
t- years of machinery using
ZC_t – Remaining price - cost of acquisition cutting about the level of depreciation (for depreciation calculation there are used various accounting methods for depreciation, firm has chosen depreciation according machinery performance)
NP_t- Service cost for maintenance and machinery repair that means assumed cost stated by statistics.
v- Interest rate, discounting factor
i- Interest tariff on the capital market
Oc- Acquisition price of production equipment

❖ **MODEL ANALYSIS**

In service of production firm there is production equipment, that has acquisition price – 300 000 € and recommended time for depreciation is given by technical assumption – 7 years, that means technical durability of production equipment. From the data of operative evidence we have find out, that service cost in every year of its using are increasing about 10 000 €, in 6th year of using cost will increase about 20 000 € (planned maintenance) and in 7th year of using about 30 000 € (planned general repair). Remaining price is stated according depreciation plan for production equipment.

Table 1: Algorithm for solving of renovation

Algorithm of solving	Index	Year of service (t)=1	Year of service (t)=2..n
Stating of service costs in (€)	$Np(t)$		
Stating of remain price in (€)	$Z_c(t)=O_c-\Sigma O_t$		
Calculation of discount factor	$v = \dfrac{1}{1+i}$		
Calculation of discount factor for period (t)	$v = (\dfrac{1}{1+i})^t$		
Calculation of discount factor for period (t-1)	$v = (\dfrac{1}{1+i})^{t-1}$		
Calculation of discounted service cost	$Np(t) = Np_t * v^{t-1}$		
Calculation of cumulative discounted service cost	$Np(t) = \sum_{t=1}^{n} Np_t * v^{t-1}$		
Calculation of discounted remain price	$Zc(t) = Zc_t * v^t$		
Calculation of purpose function	$1-v^t$		
Calculation of function f(t) for total cost of fixed capital using - Nc(t)	$f(t)=\dfrac{Oc\left(\sum_{t=1}^{n} v^{t-1}*Np\right)-\left(v^t*Zc\right)}{1-v^t}$		

Table 2: Basic parameters of cost for production equipment using.

year (t)	1	2	3	4	5	6	7
Zc_t v €	200 000	133 300	100000	75000	50000	30000	30000
NP_t v €	60000	70000	80000	90000	100000	120000	150000

During using of model for optimal renovation of production equipment with regarding to the time, that means by discounting of financial means consumed for machinery service process will be according algorithm (table 1).

We will state optimal time for production equipment renewal (t opt) according stating of minimal value of criteria function (f_t) in € – minimal.

For calculation we will need to know interest rate that is in our case 10%.

Table 3: Calculation of optimal time for renovation with time regarding.

Year of service (i)	1	2	3	4	5	6	7
NP_t	60 000	70 000	80 000	90 000	100 000	120 000	150 000
ZC_t	200 000	133 300	100 000	75 000	50 000	30 000	30 000
v^t	0,9090	0,8264	0,7513	0,683	0,6209	0,56447	0,51315
$v^{t-1} \times NP_t$	60000	63636	66115	67618	68301	74510	84671
$\sum v^{t-1} \times NP_t$	60000	123636	189751	257369	325670	400180	484851
$v^t \times ZC_t$	181818	110164	75131	51226	31046	16934	15395
f_t	1959982	1806130	1667216	1596716	1568597	1568760	1580478
f_t min					1568597		

❖ RESULTS OF THE MODEL

From the calculation it results, that optimal time for renewal of production equipment should be after 5 year of its service, since value of cost function is minimal in this year and after 5th year service cost starts to increase. Goal of the management is to decrease service cost for production equipment and therefore management must decide how to renew production equipment.
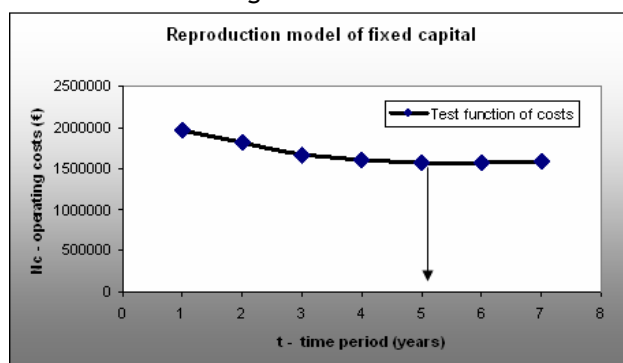

Figure 2: Reproduction model of fixed capital

Such Access of model solving for optimization is showing to the time interval of renewal, but it does not follow up way of production equipment renovation, and it is its disadvantage. For given firm it is necessary to make renovation after 5th year of production equipment service. When firm has enough financial means for extended reproduction and when firm decide to invest money for buying of new equipment, it will be one of the possibilities how to decrease cost for old equipment service, but there will be other problem in sense of financial means return on investment to new equipment.

❖ CONCLUSIONS

Quantitative methods are today most important tool of management for every firm, that must decide about risk conditions, indefinitess or definitess, it must also choose proper alternative for economical problem solving and to apply economical problem solving in practice. Modeling serves for such situations that mean illustration of reality through mathematical expressions and its economical interpretation. Renovation models enable management to decide about fixed capital renovation and to plan necessary financial means for securing of fixed capital renovation, that means machinery and production equipments that are necessary for securing of fluent production.

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