INTERNATIONAL JOURNAL OF ACADEMIC RESEARCH IN ECONOMICS & MANAGEMENT SCIENCES

OPEN ACCESS JOURNAL

Vol 3, Issue 1, (2014) E-ISSN: 2226-3624

Streamline Production Management by Econometric Methods

Teselios Delia

PhD Lecturer, "Constantin Brancoveanu" University of Pitesti, Romania

Email: delia_teselios@yahoo.com

Albici Mihaela

PhD in Mathematics, Şerban Vodă Cantacuzino Middle School, Călimăneşti, Romania

Email: mturmacu@yahoo.com

To Link this Article: http://dx.doi.org/10.6007/IJAREMS/v3-i1/644 DOI:10.6007/IJAREMS/v3-i1/644

Published Online: 02 January, 2014

Abstract

Management requires effective management of routine problems and moments of crisis in the production administration process, oriented towards perspective objectives and based on the analysis of the past. Crisis management does not differ fundamentally from the normal one. In the production process, the optimum functioning of the production equipment is an essential condition for achieving efficiency for the company. Great attention must be paid to making technical revisions in good time, thus limiting the cost for repair. However, at some point, because of some human factors, material and economic ones, production equipments are no longer valid in terms of the efficient operation, being removed from service and replaced with new equipment. This paper presents a method for selecting the optimal type of equipment to be purchased of several possible variants with the same technical performance.

Keywords: Nominal Value, Present Value, Optimum, Average Annual Cost, Production Management

JEL Classification: C10, C60

Introduction

The efficient management of production, as a component of enterprise management, is a flexible system, progressive and adaptive, responding to signs in real time and automaticcally triggers autoregulation procedures. The solutions for overcoming the crisis are hidden in production management field. The sooner people will understand the importance of the role of production management, the faster will open the perspective desired by all. Crisis manager must decide faster and more innovative on some strategig measures, to ensure the functionality of the system and follow the procedures. Assuming this role reguires a certain level of professional and general culture, competence and experience, formed skills and a

system of principles and personal values compatible to the organizational culture of the company he leads (Demi 2010).
The pace of change within a company should be coordinated within the rhythm of changes in the environment in which they evolve. In most of these organizations, the adjustment operations process, at the appropriate level to achieve the objectives, represents the primary responsibility of the operational management (7).
In order to achieve the proposed objectives, companies must operate based on their own economic strategies, robust under technical and economic report (Olaru 2005). Nevertheless, it is said that about 30% of the capital of a company is represented by the equipments. From this reason, maintaining equipment operation, at stabile parameters, constitutes a precondition for an efficient business (Burghelea and Iacob 2013).

Optimal choice of production equipment
In a long term strategy, to achieve established production, companies usually can choose between several production equipments.
The efficient functioning of an equipment of production is limited in time, because at a given moment in time physical usage of this imposes to carry out its maintenance and operation at very high costs, which determined its removal from functioning and its replacement with new equipment (Badea 2002).
We presume the following:
k = number of equipments existing on the market
n = number of years of usage for each equipment
U_i = existent equipments of production, $i=\overline{1,k}$
p_i = prices of acquisition of the equipments, $i=\overline{1,k}$
C_j = maintenance and repair expenses expected for operation of the equipment, $j=\overline{1,n}$
$\bar{y}_i$ = average annual operating cost of the equipment i
m = number of the replacements of an equipment
From the point of view of economic theory, we will choose those equipments for which the annual cost of use is minimal, more precisely, those equipments having the same technical efficiency and starting to be used throughout the period of company's production achievement.
This choice can be done in several cases (Tănăsoiu and Iacob):

- The costs of acquisition, maintenance and repair are constant through time;
- The costs of acquisition, maintenance and repair are modifying from one year to another, throughout all the running period of the equipment;
- Total operating costs of the equipment and the average annual cost of operation can be expressed in nominal values of acquisition, maintenance and repair costs of the equipment;
- Total operating costs of the equipment and the average annual cost of operation can be expressed in updated values of acquisition, maintenance and repair costs of the equipment.

In the case in which the acquisition, maintenance and repair costs are constant at the nominal value, the global costs of exploitation in n periods of time of the utilization of one equipment, is for m replacements the following:

$$Y_i=(p+C_1+C_2+...+C_n)_1+(p+C_1+C_2+...+C_n)_2+...+$$
$$+(p+C_1+C_2+...+C_n)_m$$
$$\Leftrightarrow Y_i=m(p+C_{ij}),\ j=\overline{1,n},\ l=\overline{1,m}. \quad (1)$$

Therefore, the average annual operating cost of the equipment i is:

$$\Rightarrow \bar{y}_i=\frac{Y_i}{n\cdot m}=\frac{m(p+C_{ij})}{n\cdot m}=\frac{p+C_{ij}}{n} \quad (2)$$

An optimal maintenance and repair policy of the production equipments must also resolve the problem of equipment replacement which is out of order, with a new one, which implies to choose an optimal type of equipment which will replace the old one, from many types of equipments with the same technological characteristics (Bagu, Badea and Deac 2001).

To continue with, for choosing the optimal equipment which is to be purchased, it is used the relation (2) for each equipment and it is chosen that equipment with the lowest average annual operating cost, the one to which it corresponds $\min_i \bar{y}_i$.

In the case in which the acquisition, maintenance and repair costs are constant at an updated value, using the relations (1) and (2) we obtain the average annual operating cost of the equipment i that is:

$$\bar{y}_i=\frac{1}{n}\cdot\frac{p+C_{ij}}{(1+\alpha)^{j-1}} \quad (3)$$

where α is interest rate

In the case where the acquisition, maintenance and repair costs modify to the nominal value, the global cost of exploitation becomes:

$$Y_i=(p_1+C_{11}+C_{12}+...+C_{1n})+(p_2+C_{21}+C_{22}+...+C_{2n})+...+$$
$$+(p_m+C_{m1}+C_{m2}+...+C_{mn})$$
$$Y_i=\sum_{l=1}^{m}\left(p_l+\sum_{j=1}^{n}C_{lj}\right) \quad (4)$$

Therefore, the average annual operating cost of the equipment i is:

$$\Rightarrow \bar{y}_i=\frac{1}{n\cdot m}\cdot\sum_{l=1}^{m}\left(p_l+\sum_{j=1}^{n}C_{lj}\right) \quad (5)$$

In the case in which the acquisition, maintenance and repair costs modify to updated values, using relations (4) and (5), we obtain the average annual operating cost of the equipment i that is:

$$\bar{y}_i=\frac{1}{n\cdot m}\left[\sum_{l=1}^{m}\left(p_l+\sum_{j=1}^{n}C_{lj}\right)\cdot\frac{1}{(1+\alpha)^{j-1}}\right] \quad (6)$$

For relations (1)-(6) are available only in the case in which the periods of running of the all equipments are constant and equal to n. Therefore, the average annual costs of exploitation of equipment will be calculated on the base of the longest period on running of equipment, $(\forall)\ i=\overline{1,k}$.

Economic application

To illustrate the relations presented above, we take the case of a company SC Vicprod SRL which, to achieve production proposed under a long-term strategy, can choose between production equipment U_1,U_2,U_3,U_4,U_5 all of them having the same technical performance.

(Table 1) presents the acquisition prices, maintenance and repair costs for the optimal functioning of the five equipments.
Observation: The data in (Tables 1 and 2) are for illustrative purposes only, because they are not real values of equipments.

Table No. 1 –
Acquisition, maintenance and repair prices expressed in thousand Lei

Year	**2008**	**2009**	**2010**	**2011**	**2012**
Cost / **Equipment**	C_1	C_2	C_3	C_4	C_5
U_1	450	15	-	-	-
U_2	520	20	25	-	-
U_3	570	18	36	40	-
U_4	750	14	30	35	70
U_5	830	20	35	40	80

Source: Realized by the author

We first analyze the case of choosing the most efficient equipment given the nominal values of operating costs. Then we calculate the average annual operating cost for each device and chose the equipment whose average annual operating cost is minimal.
The average annual operating cost of the equipment U_1 is:

$$\bar{y}_{U_1} = \frac{1}{2}(450 + 15) = 232{,}5 \text{ Thousands lei/year} \quad (7)$$

The average annual operating cost of the equipment U_2 is:

$$\bar{y}_{U_2} = \frac{1}{3}(520 + 20 + 25) = 188{,}8 \text{ Thousands lei/year} \quad (8)$$

The average annual operating cost of the equipment U_3 is:

$$\bar{y}_{U_3} = \frac{1}{4}(570 + 18 + 36 + 40) = 166 \text{ Thousands lei/year} \quad (9)$$

The average annual operating cost of the equipment U_4 is:

$$\bar{y}_{U_4} = \frac{1}{5}(750 + 14 + 30 + 35 + 70) = 179{,}8 \text{ Thousands lei/year} \quad (10)$$

The average annual operating cost of the equipment U_5 is:

$$\bar{y}_{U_5} = \frac{1}{5}(830 + 20 + 35 + 40 + 80) = 200 \text{ Thousands lei/year} \quad (11)$$

Based on these results, there must purchased equipment U_3.

But, taking into consideration the fact that the periods of functioning of the equipments are different (Table 2), the decision of buying U_3 is incorrect.

Table No. 2 –
Equipment Operating Period

Equipment	Operating period
U_1	$m_1=2$
U_2	$m_2=3$
U_3	$m_3=4$
U_4	$m_4=5$
U_5	$m_5=5$

Source: Realized by the author

The calculation of average annual operating costs based on lifetime maximum of m = 5 years:
The average annual operating cost of the equipment U_1 is:

$$\bar{y}_{U_1}=\frac{1}{5}(450+15+450+15+450)=270 \text{ Thousands lei/year} \quad (12)$$

The average annual operating cost of the equipment U_2 is:

$$\bar{y}_{U_2}=\frac{1}{5}(520+20+25+520+20)=220 \text{ Thousands lei/year} \quad (13)$$

The average annual operating cost of the equipment U_3 is:

$$\bar{y}_{U_3}=\frac{1}{5}(570+18+36+40+570)=246,8 \text{ Thousands lei/year} \quad (14)$$

The average annual operating cost of the equipment U_4 is:

$$\bar{y}_{U_4}=\frac{1}{5}(750+14+30+35+70)=179,8 \text{ Thousands lei/year} \quad (15)$$

The average annual operating cost of the equipment U_5 is:

$$\bar{y}_{U_5}=\frac{1}{5}(830+20+35+40+80)=200 \text{ Thousands lei/year} \quad (16)$$

According to the new results, for the period specified, U_4 equipment has the lowest annual operational cost.
Using (3) relation, analyze the case of choosing the most efficient equipment on present values of operating costs, taking into account the present values of the cost, interest rate and that of the lifetime varies from one device to another.
If the interest rate is constant and equal to 8%, we calculate the minimum annual cost of usage.
The minimum annual operating cost of the equipment U_1 is:

$$\bar{y}_{U_1}=\frac{1}{5}\cdot\left(450+\frac{15}{1,08}+\frac{450}{1,08^2}+\frac{15}{1,08^3}+\frac{450}{1,08^4}\right)=238,47 \text{ Thousands lei/year} \quad (17)$$

The minimum annual operating cost of the equipment U_2 is:

$$\bar{y}_{U_2}=\frac{1}{5}\cdot\left(520+\frac{20}{1,08}+\frac{25}{1,08^2}+\frac{520}{1,08^3}+\frac{20}{1,08^4}\right)=197,78 \text{ Thousands lei/year} \quad (18)$$

The minimum annual operating cost of the equipment U_3 is:

$$\bar{y}_{U_3} = \frac{1}{5} \cdot \left(5700 \frac{18}{1,08^1} + \frac{36}{1,08^2} + \frac{40}{1,08^3} + \frac{570}{1,08^4} \right) = 21,35 \text{ Thousands lei/year} \quad (19)$$

The minimum annual operating cost of the equipment U_4 is:

$$\bar{y}_{U_4} = \frac{1}{5} \cdot \left(7500 \frac{14}{1,08^1} + \frac{30}{1,08^2} + \frac{35}{1,08^3} + \frac{70}{1,08^4} \right) = 17,38 \text{ Thousands lei/year} \quad (20)$$

The minimum annual operating cost of the equipment U_5 is:

$$\bar{y}_{U_5} = \frac{1}{5} \cdot \left(8300 \frac{20}{1,08^1} + \frac{35}{1,08^2} + \frac{40}{1,08^3} + \frac{80}{1,08^4} \right) = 19,81 \text{ Thousands lei/year} \quad (21)$$

Therefore, the minimum annual operating cost under the conditions specified above, was obtained for equipment U_4.

Conclusions

According to the results above, we conclude that both where nominal values of the operating costs are considered and when present values of operating costs, the right decision is to purchase U_4 equipment, this one having the minimum average annual cost of operation.

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