

A METHOD OF THE MINIMIZING OF THE TOTAL ACQUISITIONS COST WITH THE DECREASING VARIABLE DEMAND

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Abstract

By companies evolution and because of the competition development, the management has been tried various ways to streamline the activities and thus profit attraction. One of the most efficient ways to obtain these results is to reduce the costs of any kind. Either that are the supply costs, storage costs, or expenses of maintenance and repair of equipment, either that are expenditures on human resources or advertising expenditures, all this leads to decreasing income and profit at the same time. The more work is done at the reduction of expenses of an entity, the better benefits, will not cease to appear.

There were carried out a lot of studies for costs reduction, but it is still not found the most efficient way to solve this problem. This study has a new approach for solving this, trying to make known a new way of minimizing the total cost of supply, by presenting some hypothesis about the decreasing variable demand, their demonstration and the development of formulas for reducing the costs. The hypothesizes presented in the model described below, can be maximally exploited for obtaining new models of reducing the total cost, depending on the ways the entities are supplied.

Key words: inventories, stock management, variable demand decreasing, total acquisition cost, minimizing costs

JEL Clasification: B41, C02

1. Introduction

The basic financial aim of a company is maximization of its value.[1] By companies evolution and because of the competition development, the management has been tried various ways to streamline the activities and thus profit attraction. One of the most efficient ways to obtain these results is to reduce the costs of any kind. The better the entity is managed, the higher market value can get. If the competition is more bitter, the satisfaction of the customers increases. If the requirements of the customers are more rigorous, the goods and the services on the market will be more qualitative. If the company minimizes at maximum the costs, it can register more performance. The problem with the costs decreasing is known from the oldest time until today, this becoming more acute in the moment in which the entities have evolved. The countless studies, conducted both the theorists and the practitioners, have helped develop this area.

With all these researches, the details of this field are still not discovered, each company applying the methods considered appropriate in their field.

The main objective of this article is to minimize the total cost of supply. To achieve this goal are considered five hypotheses which will be demonstrated and on which will be developed a new model to reduce the cost of supply.

2. The presentation of the method of minimizing the total acquisition cost

The model management approach in this article is Willson model, which aims at minimizing the total cost of supply (C_T). The elaborate of this model took as an example by Professor Eugen Țigănescu, together with the lecturer Dorin Mitrut, in their study „Operational research foundation”.[2] In order to achieve this objective, are known five hypotheses, which will be demonstrated subsequent:

1. The first hypothesis of the model is decreasing variable demand in time, ie unequally demand on the equal interval of time. From this hypothesis, results the following relation:

$$\frac{n}{\tau} > \frac{N}{T} \quad (1) = \text{demand per unit of time} \Rightarrow s(t) = \text{decrease variable,}$$

where: n = quantity ordered and brought on each supply

τ = interval between two successive supplies

N = total demand on the period T

T = total period of time which the storage is studied

$s(t)$ = stock levels from the warehouse at time t

$$\frac{n}{\tau} > \frac{N}{T} \Leftrightarrow \frac{N}{T} < \frac{n}{\tau} \Leftrightarrow N \times \tau < n \times T \div n \Leftrightarrow \frac{N \times \tau}{n} < T \div \tau \Leftrightarrow \frac{N}{n} < \frac{T}{\tau} \quad (2)$$

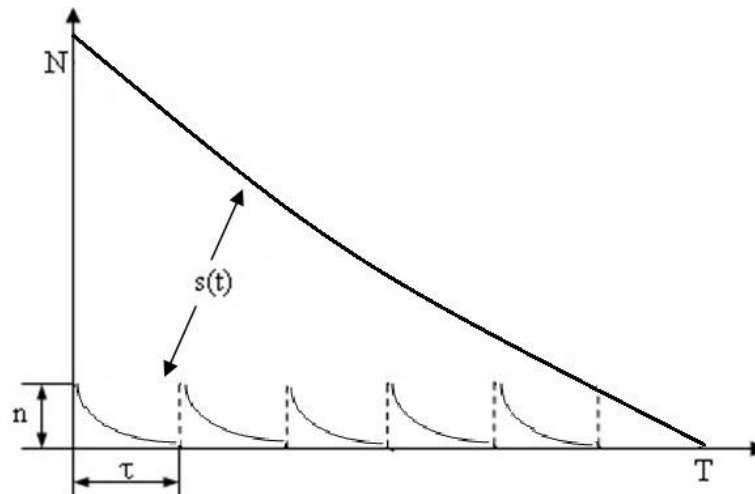
2. The second hypothesis assumes a fixed period of supply, ie the supply at equal intervals of time. Therefore, the manufacturer buys raw materials on the same time each month, which means that the interval between two successive supplies (τ) is the same between any two commands.

3. The third hypothesis assumes equal amounts of supply. This means that the entity purchase the same amount of raw materials, at every supply, ie n is the same for all orders.

4. The fourth hypothesis implies that the purchase is made in the moment when the stock becomes 0, there are not accepted time intervals having the stock 0. If the manufacturer grants the supplier of raw materials full trust, this can provide when the stock is 0, but no matter how much trust he has, there is a risk of blocking the production, because the goods will not be delivered in time. However, considering the idealistic case, the relationship results from this hypothesis $\Rightarrow s(t) \geq 0$ for anyone would be t .

5. The fifth and final hypothesis of the model indicates that the purchase is made instantaneously, the duration between the moment of placing the order and the entry of goods into the warehouse being 0. From here, it results the fact that, at the end of the interval between two successive supplies, $s(t)$ will have a jump from 0 to n .

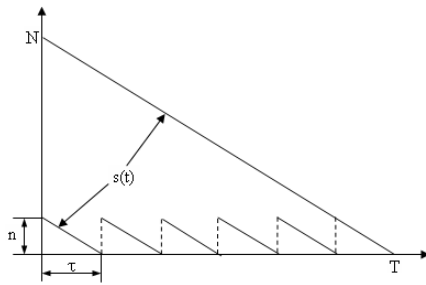
The situations resulted from this model, will be better analyzed on the basis of the graphic representation of the evolution of the stocks, as follows:



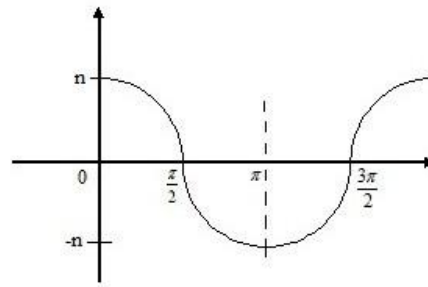
Graphic no.1 - The evolution of the stock over time intervals, in the case of a decreasing variable demand

From the graphic no. 1, shown above, results are the following: The first graphic representation (the one above) assume the fact that all the necessary quantity will have brought at the beginning of period, and the second graphic representation (the bottom one) assume the fact that would bring n units in the interval between two successive purchase in τ units of time (will be brought n units of the interval τ in the same τ units of time).

Starting from the graphic representation of the constant demand in the time (the graphic no. 2), elaborated by authors Eugen Țigănescu and Dorin Mitruț, in the study „Operational research foundation” (mentioned above) and combined with graphic representation of the cosinus function (graphic no. 3), will be analyzed the following issues:



Graphic no. 2 – The evolution of the stock over time intervals, in case of a constant demand [2]



Graphic no. 3 – the graphic $n \times \cos u$ [3] – [5]

The interval $[\frac{\pi}{2}; \pi]$, from the graphic $n \times \sin u$ (graphic no. 3), may be associated with the time interval „ τ ”

from the graphic no. 2, and the curve from $\frac{\pi}{2}$ to π from the graphic $n \times \sin u$, it may be associated the curves in the stocks evolution chart, on the time intervals in case of increasing variable demand (graphic no. 1). Considering the fact that the evolution is periodical, by τ period, will be calculated the total acquisition cost considering the fact that during a time period there is one single launch, ie a cost (c_1) and the storage expenditure during a period τ , and by the fact that the stock varies cosinusoidally from n at 0, the cost of storage (c_s) is calculated:

$$c_s \times (-\cos u) \times \tau \quad (3), \quad u \in (0; \frac{\pi}{2}], \text{ where } u = \text{a some constant.}$$

It is worth mentioning that generally determination the cost of storage is conducted by the formula:

$$c_s \times \int_0^\tau [-\cos(u)]s(t)dt = c_s \times (-\cos u) \int_0^\tau s(t)dt \quad (4)$$

- the number of periods will be determined thereby: $\frac{N}{n} < \frac{T}{\tau} \quad (5)$

- the total acquisition cost will be determined: $C_T = (c_1 + c_s \times (-\cos u) \times \tau) \times \frac{N}{n} \quad (6)$

With the relations outlined above, the minimum of the function will be determined:

$$C_T(n, \tau) = (c_1 + c_s \times (-\cos u) \times \tau) \times \frac{N}{n} \quad (7), \text{ where } n \text{ and } \tau \text{ are strictly positive, } n \in (0; N], \tau \in (0; T] \text{ and } u \in (\frac{\pi}{2}; \pi],$$

together verifying the relationship $\frac{N}{n} < \frac{T}{\tau}$.

From the relationship $\frac{N}{n} < \frac{T}{\tau} \Rightarrow \tau \times N = n \times T \Rightarrow \tau = n \times \frac{T}{N} \quad (8)$, then:

$$C_T(n) = (c_1 + c_s \times (-\cos u) \times n \times \frac{T}{N}) \times \frac{N}{n} = \frac{c_1 \times N}{n} + c_s \times (-\cos u) \times n \times \frac{T}{N} \times \frac{N}{n} = \frac{c_1 \times N}{n} + c_s \times n \times (-\cos u) \times T \quad (9)$$

From the above formulas, the total cost (C_T) was separated in the total expenditure with the launches and total expenditure with the storage, where it can be seen that the first are decreasing in n and the other are increasing sinusoidally. This means that if the whole amount will be brought in one installment, the storage costs will be very high and if it is brought very often a little quantity, launch costs will be very high. A solution for this problem would be to determine the total cost derived according to n placed in the interval $(0, N]$, thereby:

$$C'_T = \frac{c_l \times N}{n} + c_s \times n \times (-\cos u) \times T \quad (10)$$

$\frac{c_l \times N}{n} + c_s \times n \times (-\cos u) \times T = 0$ (11); according derivative rules:

$\left(\frac{1}{n}\right)' = -\frac{1}{n^2}$; $(n^2)' = 2n$; $n' = 1$; $(3n)' = 3$ (12), obtain:

$$-\frac{c_l \times N}{n^2} + c_s \times T \times (-\cos u) = 0 \Rightarrow -\frac{c_l \times N}{n^2} + \frac{c_s \times T \times (-\cos u)}{1} = 0 \Rightarrow \frac{c_s \times T \times (-\cos u)}{1} = \frac{c_l \times N}{n^2} \Rightarrow$$

$$c_s \times T \times (-\cos u) \times n^2 = c_l \times N \times 1 \Rightarrow n^2 = -\frac{c_l \times N}{c_s \times T \times \cos u} \Rightarrow n = \pm \sqrt{-\frac{c_l \times N}{c_s \times T \times \cos u}}$$

(13) which has zeros:

$$n_{1,2} = \pm \sqrt{-\frac{c_l \times N}{c_s \times T \times \cos u}} \Rightarrow n_1 = -\sqrt{-\frac{c_l \times N}{c_s \times T \times \cos u}} \notin (0, N]; \quad (14)$$

$$n_2 = \sqrt{-\frac{c_l \times N}{c_s \times T \times \cos u}} \in (0, N] \Leftrightarrow \sqrt{-\frac{c_l \times N}{c_s \times T \times \cos u}} \leq N \quad (15) \quad /^2 \Rightarrow$$

$$-\frac{c_l \times N}{c_s \times T \times \cos u} \leq N^2 \quad / \div N \neq 0 \Rightarrow$$

$$-\frac{c_l}{c_s \times T \times \cos u} \leq N \quad / \times T \times (-\cos u) \Rightarrow$$

$$\frac{c_l}{c_s} \leq -N \times T \times \cos u \quad (16)$$

As a conclusion of this model there are we have two situations:

- If $\frac{c_l}{c_s} \geq -N \times T \times \cos u$ (17), ie if the cost of launch is more than times higher than the cost of storage, the variation formula will be:

$$C_T(n) = \frac{c_l \times N}{n} + c_s \times n \times (-\cos u) \times T \Rightarrow$$

$$C_T(N) = \frac{c_l \times N}{N} + c_s \times N \times (-\cos u) \times T \Rightarrow$$

$$C_T(N) = c_l + c_s \times N \times T \times (-\cos u) \quad (18)$$

Table no. 1 The variation of n from 0 to N (case 1)

n	0	N
$C_T'(n)$	-	-
$C_T(n)$		$c_l + c_s \times N \times T \times (-\cos u)$

and so will be a single purchase at beginning of period T in that will bring the entire quantity N, total cost being $c_l + c_s \times N \times T \times (-\cos u)$. (19)

- If $\frac{c_l}{c_s} < -N \times T \times (-\cos u)$ (20) obtain:

$$C_T(n) = \frac{c_l \times N}{n} + c_s \times n \times (-\cos u) \times T \Rightarrow$$

$$C_T(n) = \frac{c_1 \times N}{\sqrt{\frac{c_1 \times N}{c_s \times T \times (-\cos u)}}} + c_s \times T \times (-\cos u) \times \sqrt{\frac{c_1 \times N}{c_s \times T \times (-\cos u)}} \Rightarrow$$

$$C_T(n) = \sqrt{\frac{(c_1 \times N)^2}{c_1 \times N}} + \sqrt{[c_s \times T \times (-\cos u)]^2 \times \frac{c_1 \times N}{c_s \times T \times (-\cos u)}} \Rightarrow$$

$$C_T(n) = \sqrt{\frac{(c_1 \times N)^2}{1} \times \frac{c_s \times T \times (-\cos u)}{c_1 \times N}} + \sqrt{(c_s \times T \times (-\cos u))^2 \times \frac{c_1 \times N}{c_s \times T \times (-\cos u)}} \Rightarrow$$

$$C_T(n) = \sqrt{c_1 \times N \times c_s \times T \times (-\cos u)} + \sqrt{c_s \times T \times (-\cos u) \times c_1 \times N} \Rightarrow$$

$$C_T(n) = 2\sqrt{c_1 \times N \times c_s \times T \times (-\cos u)} \quad (21)$$

Table no. 2 The variation of n from 0 to N (case 2)

n	0	$\sqrt{-\frac{c_1 \times N}{c_s \times T \times \cos u}}$										N
$C_T'(n)$	-	-	-	-	-	-	0	+	+	+	+	+
$C_T(n)$	$2\sqrt{c_1 \times N \times c_s \times T \times (-\cos u)}$											

From the table above, results the fact that the total costs are strictly decreasing from 0 to the square root of n and strictly increasing the square root of n up to N.

3. Conclusions

In conclusion will be made: $\frac{N}{n}$ purchasings at intervals of $t_{opt} = \sqrt{-\frac{c_l \times T}{c_s \times N \times \cos u}}$ that will be brought

in a quantity $n_{opt} = \sqrt{-\frac{c_l \times N}{c_s \times T \times \cos u}}$, variant which will purchase with the lowest possible total cost:

$C_T = 2\sqrt{c_1 \times N \times c_s \times T \times (-\cos u)}$, where:

$$\frac{N}{n} = \frac{N}{\sqrt{\frac{c_1 \times N}{c_s \times T \times (-\cos u)}}} = \sqrt{\frac{N^2}{c_1 \times N}} = \sqrt{\frac{N^2}{1} \times \frac{c_s \times T \times (-\cos u)}{c_1 \times N}} = \sqrt{\frac{N \times c_s \times T \times (-\cos u)}{c_l}}$$

When the only accepted solution for this situation are n and t integers, computed like this:

$$n_1 = \left\lceil \sqrt{-\frac{c_l \times N}{c_s \times T \times \cos u}} \right\rceil \text{ și } n_2 = \left\lceil \sqrt{-\frac{c_l \times N}{c_s \times T \times \cos u}} \right\rceil + 1$$

$$t_1 = \left\lceil \sqrt{-\frac{c_l \times T}{c_s \times N \times \cos u}} \right\rceil \text{ și } t_2 = \left\lceil \sqrt{-\frac{c_l \times T}{c_s \times N \times \cos u}} \right\rceil + 1$$

whichever is the cheapest solution. ($\lceil x \rceil$ = the whole of x).

4. References

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