

Data Mart Approach for Stock Management Model With a Calendar Under Budgetary Constraint

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Abstract

In all economic sectors, the control of stock management is a crucial problem that enterprises undergo in fields such as industry, commerce, agriculture or army.

To maintain an abundant stock beyond the required stock is without any importance because it makes increase the risk of loss by unsold, damage, obsolescence, etc. The good stock management of goods lies on ordering the exactly required quantity at a precise moment. Hence comes our preoccupation is to try to answer, according to circumstances, to the question of knowing ‘When should we order’. How Much should we have to order to minimize the cost at the Storage Center.

With the historization of data, there is a possibility to determine the resupply calendar for each product. That is why one should arrive to display a data cube in doing multidimensional analyses.

Key words: Data Mart, stocks, budget, calendar, historization

1. Introduction

The stocks management based on determinist models implies that the process associated to the order is characterized by very weak variations: Quantity to order to resupply Date (HADLEY and WHITIN, 1996) so much so that this request is supposed, in the mathematics model, to be known certainly. This consideration is also done on the delivery time which is considered as a constant. The objective of the stocks management theory is to supply scientific elements helping decisions allowing deciders to minimize the management cost and rationally determine *the resupply date and the resupply quantity*.

Several stocks management models have been elaborated, each of them having its particularities and *characteristics* based on its *hypotheses*. Thus, in this article we focus ourselves on the stock management model with a calendar under budgetary constraint using Data Mart approach by historization of data that will allow us to determine the calendar for the resupply of each product.

It is a matter of reconciling contradictory requirements:

- Should we order by small quantities in order to limit capitals immobilizations knowing that we multiply the risk of shortage?
- Or, order by strong quantities in order to reduce the order cost placement, the transport, handling and even stock shortage?
- Which service rates should we assure to customers as far as the security stock level will depend on it?
- How should we set the calendar from historized data in stocks management model with budgetary constraint?

2. Data Warehouse

2.1. The OLAP system

OLAP tools (On Line Analytical Process) are based on a multidimensional data base intended to exploit quickly the dimensions of a data population.

Most of OLAP solutions are based on a same principle: to restructure and stock in a multidimensional format data derived from flat files or relational bases. This multidimensional format, also known under the name of **hypercube**, organizes data along the dimensions [D. LAROSE, 2000]. Thus, the users analyze data according to particular axes to their professions.

In this architecture, there is a Data Warehouse [INMON and J. WILEY 1996]. Data warehouse centralizes stemmed from several sources (enterprise production base, texts files, web document [html sgml etc.]). These data are merged in the data warehouse which is generally a big data base (SQL Server, Oracle etc.).

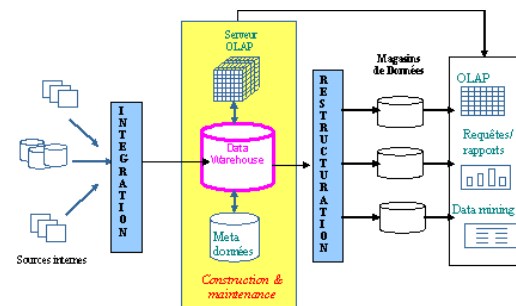


Fig.1: OLAP system

Next, once the data warehouse built, data are extracted in analysis servers or OLAP servers in data cubes from in order to be analyzed.

2.2. Multidimensional analysis

OLAP servers have been conceived to integrate themselves into customer/server environment in order to make profit of the given possibilities.

The users of computers access to a multidimensional data base server. This one contains a predefined hypercube in which the entirety of data should be stocked. What requires relying on pre-stored and strongly structured information? thus it allows analyzing the distribution of an indicator according to axes or dimensions.

Furthermore, hierarchies will be defined for each analysis axes (for example, the year, next season, the month and the week, for the time axes).

Dimensions can be refined, split up in hierarchies, in order to allow the user to examine his indicators at different detail levels, “come down” in data, from the global level to the thinnest one. For example, a date will be split up into <year, month, week, and day>. Then we will have a pyramidal view of data, the basis of the pyramid representing the most detailed level and the most global one. We

may have a pyramidal representation as below:

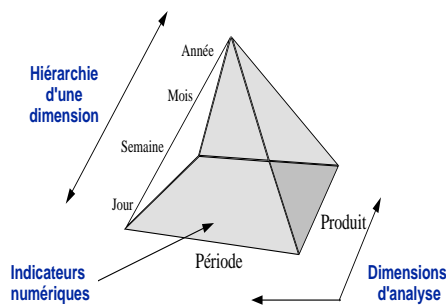


Fig.2. : pyramid

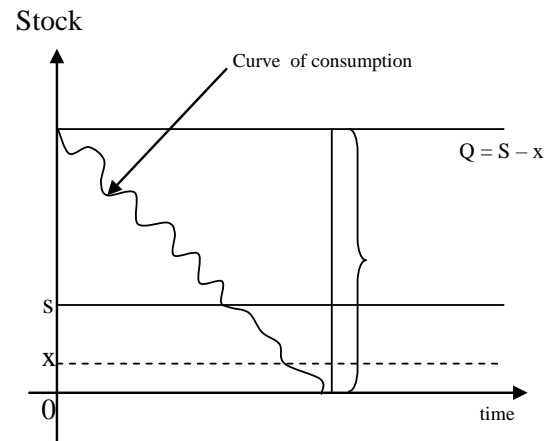


Fig. 3: Continuous inventory management policy.

3. Stocks management policy and models

3.1. Types of policy

a. Management policy with continuous inventory

This system functions under the following hypotheses:

-The stocking center (Center-I) is with continuous inventory (s, S), where S is a positive whole which designates the *maximum level of the potential stock* and s is its *critical level*. ($s, S \in \mathbb{N}, s < S$).

-The continuous inventory management policy (s, S) means: the Center-I manager constantly follows (or regularly controls) the level of the potential stock; if the level of the potential stock falls at $x \leq s$ after a request, it sooner place a quantity order $Q = S - X$ in a way to re-establish the level of the potential stock at the S value; but as the potential stock exceeds the level s , no order is placed. Potential stock is understood as available stock plus stock on order minus number of postponed sales (or reported).

b. Calendar management policy (cyclic management)

In this case, the manager fixes in advance the periods of the order placement, the stock may be empty or full, the order is only placed at the foreseen date. In this work, we maintain the calendar management policy.

3.2. Budgetary constraint calendar model

3.2.1. Introduction

Stocks problems always exist since ages; even in our traditional societies, stocks were constituted for miscellaneous reasons, mainly surviving. Thus, these stocks aimed remedying certain deficiencies or shortage that can crop up during the year. In these stocks, a part was kept for the next seeds. One could also make recourse to these stocks at exceptional occasions such as when welcoming important visitors or during great demonstrations.

As for businessmen, stocks measured the degree of wealth. The more one had goods in stock is declared as a rich. But, nowadays, to have abundant stocks may constitute a risk. The risk of losing never recuperate the capital invested in case of damage, theft or obsolescence. The excessive

storage may also represent a loss of efforts or money spent. That is way it's better to invest in under activities which can produce the benefits for the company instead of using that money for storage the same goods or activities.

As far as we are concerned, our analysis will be focused on the budgetary constraints calendar model.

3.2.2. Hypotheses

We consider n different items stocked in a store and there exists a bound superior to the sum invested in stock at any time.

We suppose (cfr Wilson I) that all the orders must be satisfied from the ordered stock, there is no shortage and reported sales (ALCOUFFE, 1987) in optimal policy. In Wilson I, the time delivery is null (MANYA, 2012).

Let D_j be the annual request known with certainty of the item j, ($j=1,2, 3...n$).

Let us note by :

Q_j : The gust to the iteme j ($j=1, 2, 3,....n$):

L_j : the fixed cost of the order placement of the item j ;

P_j : the cost price or fixed unitary price cost of the item j ;

I_j : The maintenance charges or (updating factor) relative to the item j ($j=1,2,3,...n$);

$K = K(Q_1, Q_2, Q_3, ..., Q_j, ..., Q_n)$: the economic function of the costs at the storage center. $Q_1, Q_2, Q_3, ..., Q_j, ..., Q_n$

are controllable variables (or decision variables).

$$Q_j = \sqrt{\frac{2 * D_j * L_j}{C_s * 2B}} \quad (1), \text{ if the constraint}$$

does not act.

T^* : Supply cycle

$$T^* = \frac{Q}{D}$$

3.2.3. Problem and solution

It is a matter of finding the economic gusts $\varphi_1, \varphi_2, \varphi_3 \dots \varphi_j \dots \varphi_n$ which minimize the economic function $K = K(\varphi_1, \varphi_2, \varphi_3 \dots \varphi_j \dots \varphi_n)$ under budgetary constraint.

a. The investment constraint is written:

$$\sum_{j=1}^n P_j \cdot \varphi_j \leq B \quad (2)$$

b. The economic function expression is

$$K = K(\varphi_1, \varphi_2, \varphi_3 \dots \varphi_j \dots \varphi_n) = \sum_{j=1}^n \left[L_j \frac{D_j}{\varphi_j} + I_j \cdot P_j \cdot \frac{\varphi_j}{2} \right] \quad (3)$$

To resolve the above mentioned problem, the method to be used is as follows:

1) We start resolving the mentioned problem without taking into account the constraint. This means that we minimize separately according to each of the $\overline{\varphi}_j'$; it gives:

$$\overline{\varphi}_j = \sqrt{\frac{2 * D_j * L_j}{I_j * P_j}} \quad (4)$$

$j = 1, 2, 3 \dots n$; in accordance with Wilson I

2) Test : - if the $\bar{\varphi}$ verify the constraint

$$\sum_{j=1}^n P_j \cdot \bar{\varphi}_j \leq B \dots \dots \dots (5)$$

Then these $\bar{\varphi}_j$ are gust optimal values

- Otherwise, the constraint plays and the values of $\bar{\varphi}_j$ calculated are not optimal, go at (3).

3) To obtain economic gusts verifying the budgetary constraint, we use the *Lagrange multiplier* method: let J be the Lagrange auxiliary

$$\text{function : } J = \sum_{j=1}^n \left[L_j \frac{D_j}{\varphi_j} + I_j \cdot P_j \cdot \frac{\varphi_j}{2} \right] +$$

$$\mathcal{G} \left(\sum P_j \varphi_j - B \right) \quad (6)$$

where \mathcal{G} is the Lagrange multiplier

We suppose that the auxiliary function J is a convex function. From then on *the necessary conditions of local extremum are also sufficient for a global minimum.*

$$\begin{cases} \frac{\partial J}{\partial Q_j} = 0 \\ \frac{\partial J}{\partial \theta} = 0 \end{cases} \Leftrightarrow \begin{cases} \frac{-D_j \cdot L_j}{\varphi_j^2} + \frac{L_j \cdot P_j}{2} + \mathcal{G} \cdot P_j = 0 \\ \sum_{j=1}^n P_j \cdot \varphi_j - B = 0 \end{cases}$$

This system has the following unique solution:

$$\varphi_j^* = \sqrt{\frac{2 * D_j * L_j}{I_j * P_j + \vartheta^* * P_j}} \quad (7)$$

($j = 1, 2, 3 \dots n$) or by substitutions.

$$\mathcal{G}^* = \left(\sum_{j=1}^n \left(P_j \sqrt{D_j \cdot L_j / \sqrt{P_j}} \right) \right)^2 - \frac{1}{2} \quad (8);$$

where. I is the actualization factor common to n items

Algorithm of the model (ALGO AMCCB)

Beginning

Step1

*/*Declaration of variables*/*

Variables D(J), P(j), n, l(j), teta, Kopt, Q(j),

Qopt(j), TabQ(j) : Table of the real

B, Som, Soml, Kt, Kopt, teta : reals

n, j : whole

Step 2

*/*Data Reading*/*

Display « enter n »

keyboard n

Display « enter B »

Keyboard B

Step 3

*/*Initialization*/*

J=1

Som = 0

Kt=0

Soml = 0

Step 4

WHILE j<=n

*/*REad :*/*

Display enter le D(j)

Keyboard D(j)

Display « enter le l(j) »

Keyboard l(j)

Display « enter P(j)

Keyboard P(j)

$$Q(j) = \text{racinecrrée}(2 * D(j) * l(j) / I * P(j))$$

$$TabQ(j) = Q(j)$$

$$Som += Q(j) * P(j)$$

$Kt += D(j) * l(j) / Q(j) + P(j) * Q(j) / 2$

$J = J + 1$

FTQ

Step 5

*/*Test of som*/*

If Som ≤ B

Then

$Q_{opt}(j) = TabQ(j)$

$K_{opt} = Kt$

Step 6

*/*display*/*

Display « la quantité optimale Q_{opt} est : » $Q_{opt}(j)$

Display « la fonction économique K_{opt} est : » K_{opt}

Go to 20

Otherwise

$J = 1$

Step 7

WHILE $j \leq n$

$Som1 += P(j) * racinecarrée(D(j) * l(j) / P(j))$ DimP(), Kopt, som, som1, som2, som3, I, L(), teta,

$J = J + 1$

FTQ

Step 8

$teta = (Som1/B) * (Som1/B) - I/2$

$J = 1$

WHILE $J \leq n$

$Q(j) = racinecarrée(2 * D(j) * l(j) / (I * P(j) +$ ReDim $Q(n): P(j))$

$TabQ(j) = Q(j)$

$Kt += D(j) * l(j) / Q(j) + I * P(j) * Q(j) / 2$

$J = J + 1$

FTQ

Step 9

$Q_{opt}(j) = TabQ(j)$

*/*display*/*

Display « the optimal quantity $optQ$ is: »

$optQ(j)$

Display « the economic function K_{opt}

is : » K_{opt}

20 :End

The presented algorithm has an order complexity $O(n)$; this means linear which is one of the best complexities.

3.2.4. Budgetary Constraints Model

Implémentation

Public Class budgetary model

DimD(), n, Qopt(), Q(), TabQ() AsDouble

DimP(), Kopt, som, som1, som2, som3, I, L(), teta,

B AsDouble

Dim j AsInteger

PrivateSub Button1_Click(senderAsObject, e

AsEventArgs) Handles Button1.Click

I = Cdbl(TextBox1.Text)

n = Cdbl(TextBox2.Text)

ReDim D(n)

ReDim Qopt(n)

ReDim Q(n): P(j))

ReDim TabQ(n)

ReDim P(n)

ReDim L(n)

som = 0

som1 = 0

som2 = 0

```
som3 = 0
B = CInt(TextBox3.Text)
ForMe.j = 1 To n
    D(j) = (InputBox("Enter the request of the
item "& j & "", "Keyboarding the request of the
items ", 0, 150, 120))
    L(j) = (InputBox("Enter the cost of the
placement per order of the item "& j & "",
"Keyboarding of the cost of the placement of the
item", 0, 150, 120))
    P(j) = (InputBox("Enter the sale price of the
item "& j & "", "Keyboarding of the sale price of
items", 0, 150, 120))
    som += Q(j) * P(j)
Next
ForMe.j = 1 To n
    Q(j) = Math.Round(Math.Sqrt((2 * D(j) *
L(j)) / (I * P(j))), 0)
    TabQ(j) = Q(j)
    som1 += (((D(j) * L(j)) / (Q(j))) + (I * P(j) *
Q(j)) / (2))
Next
GroupBox2.Visible = True

If (CInt(som) <= CInt(B)) Then
ForMe.j = 1 To n
    Qopt(j) = TabQ(j)
ListBox1.Items.Add("Q"& j & "="&Qopt(j) & " ")

Next
Kopt = Math.Round(som1, 2)
Else
ForMe.j = 1 To n
    som2 += (P(j) * (Math.Sqrt(D(j) * L(j))))
/ (Math.Sqrt(P(j)))
Next
teta = (som2 / B) ^ (2) - (I / (2))
Label5.Text = "Teta = "&teta
Label5.Visible = True
```

```
ForMe.j = 1 To n
    Q(j) = Math.Round(Math.Sqrt((2 * D(j) *
L(j)) / (I * P(j) + 2 * teta * P(j))), 0)
    TabQ(j) = Q(j)
    som3 += (((D(j) * L(j)) / (Q(j))) + (I *
P(j) * Q(j)) / (2))
    Qopt(j) = TabQ(j)
ListBox1.Items.Add("Q"& j & "="&Qopt(j) & " ")
Next
Kopt = Math.Round(som3, 2)
EndIf
Label10.Text = "Kopt="&Kopt
EndSub
Private Submodel
budgetary_Load(senderAsObject, e AsEventArgs)
Handles MyBase.Load
    GroupBox2.Visible = False
EndSub
PrivateSub Button3_Click(senderAsObject, e
AsEventArgs) Handles Button3.Click
Me.Hide()
EndSub
PrivateSub Button2_Click(senderAsObject, e
AsEventArgs) Handles Button2.Click
    TextBox1.Text = ""
    TextBox2.Text = ""
    TextBox3.Text = ""
    GroupBox2.Visible = False
    TextBox1.Focus()
EndSub
EndClass
```

4. Application:

4.1. Data presentation

The data are from a survey conducted in the BELTEXCO store concerning 30 products over a period of 2016-2017 on the basis of quantities ordered and according to supply dates. Our application will use data in the inventory management of the various products. And the logging of the data led us to the determination of

the calendar for each product passing by the average.

4.2. Data processing

The modelling and implementation of a decision-support tool has been implemented for this template. We used SQL-server to generate the data cube.

We have deployed the cube that abounds in its bottom four dimensions tables (Dim_Client, Dim_Produit, Dim_Localisation and Dim-Temps) and a fact table. Command

4.3. Results

The result below gives us the different supply times for each product through the five communes of the town of Kananga in Central Kasai , the provincial headquarters of the BELTEXCO.

4.3.1. Product Replenishment Period

These durations were calculated from the average replenishment times for each product:

P001=63.3, P002=69.7, P003=46.2, P004=55.5, P005= 60.5, P006=57.8, P007= 79.6, P008=51.5, P009= 47.8, P0010= 60.4, P0011= 39.3, P0012= 54.9, P0013= 38.3, P0014=38.1, P0015= 34.7, P0016=38.5, P0017= 31.4, P0018=36.3, P0019= 34.8, P0019= 34.8, P0020= 34.4, P0021= 31.8, P0022= 41.4, P0023= 44,3, P0024= 43.5, P0025=64, P0026= 118.1, P0027= 102.1, P0028= 111.8, P0029= 101.6, P0030=152.5.

4.3.2. Calculating the confidence interval

The confidence interval was calculated with the thresholds $\alpha = 0.01$ and we obtained the following results: $T1 = 46.63$ and $t2 = 73.30$ in terms of number of days.

Considering the constant replenishment time, you can place the order for the product set between 1 month and 2 months.

5. Conclusion

This approach (Data Mart) has allowed us to determine the confidence interval for the supplies of the product set in order to set the average duration considered as a constant in the calendar model with budget constraint.

Deterministic models for the management of constrained stocks formalized in this work represent only one case among the many systems of stocks that can be encountered actually.

It starts from the principle of minimization of management costs, by determining an optimal quantity of fixed order that will make a compromise between the costs of possession of the stock and the costs of supply.

Optimal management is an effective way of managing in terms of the complexity of the calculations generated by some of the cases we have dealt with; This is the case of simultaneous management of multiple items under constraints.

The procedure consisted, first to deploy the cube, second to conduct the study on the axes time and third by producing the confidence interval for the replenishment time and finally we wrote an algorithm to determine the Minimum quantities to be ordered and the minimum cost before implementing the algorithm.

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