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Reducing Costs in a real company by application of an inventory model

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The authors of this paper are undergraduate full time students. Yosselín Silva, Omar Bernal and Rodrigo Nieto study Industrial and Systems Engineering in the Tecnológico de Monterrey Campus Estado de México. Gloria Voglozin studies Industrial Systems Engineering at the University de Technologies de Troyes in France; she is currently an exchange student of the ITESM-CEM.

Reducing costs in a real company by application of an inventory model

ABSTRACT

The role of inventory in the organizations represents the major part of the activities of manufacturing, service, distribution and sales, and of course it exists an associated cost to holding it. Here is presented the current situation of a real company and a proposal to improve the actual system.

OBJECTIVES

1. It will be analyzed and evaluated the inventory system, basing the studio in the actual situation of a real organization.
2. In order to guarantee the requirements and expectations about the project, the team will work according to the professional administration of projects; so the main stages can be accomplished: start, planning, execution, control and project closure. In this way, it'll be easier to achieve the nodular objectives.
3. Also, the team will work under the teamwork modality in which it is expected that every member contribute in an active manner. In this context, according to this model, there would be different activities assigned to each one managing a situational leadership over project development. At the end, team members expect that each one's aspiration is satisfied creating a positive interdependence.
4. Likewise, theory learned will be applied in such a manner that an improvement to the actual system could be proposed based on the idea of increasing organization's profitability by planning and

controlling the levels of inventory. If doing so, as a consequence, the costs associated with carrying inventory and putting orders will be reduced.

LITERATURE REVIEW

The role of inventory in the organizations represents the major part of the activities of manufacturing, service, distribution and sales. Of course, there is a cost associated with the management, control and supply of stocks. Therefore company's reliability and competitiveness are strongly influenced by this factor; reason for which it is widely studied in the manufacturing sector. It is important to take this into consideration in order to meet the demand in terms of the right product, in the right place, at the time required and in the right quantity.

What does inventory mean? It could be defined as an amount of assets under the control of a company stocked for a certain time to meet future demand. For the manufacturing sector, those goods are mainly materials: raw materials, purchased units, products in process, finished products, spare parts and consumables. Planning and control becomes even more sophisticated as the planning horizon and the variety of products increase. There are two main decisions when studying inventories: first, the quantity that would be ordered and second, and the time that might occur between each order.

The inventory can be also understood as a "buffer" between the supply and demand processes. In this context, it is necessary because of the differences between the rates and times among those processes. That difference may be due to internal[1] or external[2] factors. For matters of planning, there can be two kinds of demand: deterministic or stochastic and independent or dependent. Also, three main types of inventory can be identified: raw materials inventory, product-in-process inventory and finished products inventory.

[1]Refers to endogenous factors, including policy issues such as economies of scale, operations smoothing and customer service.

[2] The exogenous factors are incontrollable, the most important is uncertainty.

The principal factor that affects the inventory is the demand; certainly, the stock level is affected by the output and input rates. In this sense, there are some revision politics that might help a company to maintain certain desired level: periodic revision and continuous revision. First, it consists of verifying the level every "fixed period" and only the ordered quantity (Q) varies; in the second one, the level is reviewed continuously and the Q remains constant. Once that a demand behavior is identified and a politic implemented, a mathematical model should be selected in order to calculate the quantity to order which could be the optimal or not[3].

BACKGROUND

As it was written before, the objective of the present work is to analyze the inventory system of a company, to evaluate its economy and strategy in order to propose improvement for a part or the totality of the system. To reach this goal we will apply concepts, models or theories of inventory management. But first, in this section we present a brief history of the selected enterprise and the description of current inventory system.

The company that the team selected is HRC, it has been in the market of construction and architectural details for 20 years. In the last 10 years the company has contributed to the growth of the Mexican industry of construction. HRC is the principal supplier of prebuilt systems in Mexico, integrating products and services such as drywall, modular ceilings, W panels and carpets. It is the principal representative and distributor of USG, which is leading manufacturer of building materials for the construction and remodeling industries in Mexico and it is also a member of the Global Growth Companies of the World Economic Forum.

[3] Some mathematical models that assure the optimal decision are: Economic Order Quantity (EOQ), Economic Production Quantity (EPQ), dynamic programming, among others. Some models that calculate a Q, that is not necessarily the optimal, are the heuristic methods such as Silver & Meal, minimum unit cost and swing by period.

DESCRIPTION OF CURRENT INVENTORY SYSTEM

HRC does not have a sophisticated inventory system, so some data is missing because it is not available from the historical data of the enterprise; so team decided to propose them and in other cases we use averages as they have defined all the variables needed for analysis the inventories.

The enterprise has three classifications: A, B and C. Products A, have a inventory turnover of 1 day. It consists of selling a product that presents a deterministic demand and distribution centers need to be supplying local branches almost daily. An example of the materials managed in HRC is the drywall.

Product B has a slow and varied turnover of inventory but the product is sold with great regularity. One example is the metal for structures and platforms. The C ranking refers to the products that are only dispatched when an order is placed.

In order to distribute all its products, the company owns 3 distribution centers, located in Monterrey, Guanajuato and Mexico State. To manage those distribution centers, HRC uses specialized software which quantifies the average of the outputs of the warehouse and forecasts the requirements of each retailer replenishment.

Its inventory level varies according to the demand submitted by the distribution centers. If the product is released from a closed distribution center, it will arrive to its destination 2 days later. If the destination is farther it will take 5 days to reach its final place. For one trip, the company can send trucks of 36, 30 or 15 tons. Usually de departures from Monterrey and Guanajuato weight 36 tons and those from Puebla weight 30 and 15 tons.

The analysis of inventory presented will be of a particular kind of product: drywall; team chose this one because it is representative of HRC's sales and presents a similar behavior – in terms of costs

and space occupied by each unit in stock- to other materials managed in the company. The drywall is in a group of the company's own classification as type A in which the demand is known historically and which is used to supply a regular number of orders. That is, that retailer always ask the same amount as when giving out their inventory by sending goods from the distribution center to different points of sale over certain planning horizon. For this reason, demand forecast is not necessary.

Additionally, they use a special ERP system developed exclusively for HRC's application in which the inventory level can be monitored, but only in its maximum and minimum points. However, as it will be explained in the section "Support and Resources" software does not help to calculate the reorder point. Also, for the distribution center of the company analyzed (locate in the Mexico State), they do no not manage levels of safety stock.

On average, there are about 27 or 28 million pesos invested in inventory per year considering three main costs: ordering costs, carrying costs and cost of materials.

OPPORTUNITIES APPROACH

1. One area where we identified an opportunity for improvement is to calculate the optimal Q suggested to be ordered. The proposal estimates and assumptions used are available at the point of "proposals or strategies for improvement."
2. Another opportunity for improvement we identified was driving a safety stock (currently, they do not maintain levels for this kind of inventory) to be prepared for any contingency that might occur as a delay of suppliers and avoid late deliveries to the diverse sales points, even when it is supposed that they know the exact demand.
3. Finally, they run a constant demand for these products because, as explained above, the drywall has a deterministic demand and the product is sent every two days. One alternative could be to

forecast demand so it can be useful to plan the optimal quantities (Q*) to order. In a parallel way, for the proposed model of EOQ when the Q* is placed, an equilibrium between the carrying and ordering costs is reached.

4. The ERP software is only able to control the minimum and maximum storage capacity, without some development in the area of inventory so it does not consider the application or the reorder point of the articles. In this sense, it can result practical to monitor the inventory levels in a real state and even, an automatized system for ordering can be programmed in order to replace certain number of products took off from the stock.

PROPOSALS OR STRATEGIES FOR IMPROVEMENT

- Attending the first point of last section "Opportunities Approach" team decided to use the Economic Order Quantity model to estimate the size of the order issued to stock company's inventory. Additionally, there have not been considered backlogs since for this product (drywall) there are no backorders due to inventory turnover is five times a week (the number of articles handled daily, oscillates between 800 and 1000 units). So it is not register of an exact number of items that are handled every day, the team members have considered a daily average demand of 900; that represents an annual demand of 328,500 units.
- The interest rate used for calculations is the composition of taxes and insurance as a fraction of the value of the investment on the average inventory. For this specific data, company does not manage an exact rate so the team decided to use the interest that corresponds to the credit card that HRC summed with the rate at which the money invested in inventory represents a loss of opportunity in other investment areas is of 32.6%.
- Additionally, when analyzing the inventory system at the distribution center does not interest their production time nor the capacity connected with it, for this reason what the team

considered appropriate is to use the **EOQ model.** As the company's element analyzed is a distribution center, the items managed there are finished products so their stock is mainly of this type.

- It is also important to point out that the maximum capacity of inventory is equal to the quantity to order (even when it is not the optimal one) and the minimum level represents the reorder point that is also calculated considering safety stock so it is not convenient to let the units in stock fall to its lowest level.

Let be,

D = Demand = 800-1000 units /day

D_A = Average Demand= 900 units /day

Considering a year = 365 days

DAy = Average annual demand = 900 (365) = 328,500 units / year

A = ordering cost = $71.03 / order

c = unit cost = $66.09

i = interest rate = 32.6% annual

Also, define

Costs associated to inventory = K(Q) = CD + $\frac{AD}{Q} + \frac{hQ}{2}$

Optimal Quantity to order = Q =* $\sqrt{\frac{2AD}{h}}$

Time that must elapse at a constant demand rate when ordering Q = T =* $\frac{Q}{D}$

Substituting the data identified,

Q =* $\sqrt{\frac{2(71.03)(328{,}500)}{.326(66.09)}}$ *= 4849 units*

$$K(Q) = (66.09)(328{,}500) + \frac{71.03(328{,}500)}{4849} + \frac{.326(66.09)(4849)}{2} = \$\ 21{,}767{,}613.67$$

$$T = \frac{4849}{328{,}500} = .01476 \text{years} \Rightarrow 5.4 \text{ days}$$

Therefore,

Cost of materials = $ 21,710,565

Ordering cost = $ 4,811.99

Inventory carrying cost = $ 52,236.68

- For the second issue enlisted in last section, it is also important to point out that the maximum capacity of inventory is equal to the quantity to order (even when it is not the optimal one) and the minimum level represents the reorder point that is also calculated considering safety stock so it is not convenient to let the units in stock fall to zero.
- As written before, HRC manages historical data to determine the deterministic demand but in order to attend any unexpected increase in customer demand there could result convenient to forecast demand or maintain levels of safety stock. Forecasts are usually incorrect so demand is dependent on so many variables that is impossible to capture the impact of all; so in order to make forecasts more accurate there are two main possibilities: first, to make them for families or groups of products and second, for time periods closer to present. If forecast remains incorrect, it is convenient to maintain a safety stock; it can be calculated with the following equation:

Let define,

Lead Time = L_D = 2 days[4]

RP = reorder point

[4] This is a numerical data proportioned by the company, was not calculated or modified and is considered as the maximum lead time.

SS = safety stock

D_{max} *= maximum demand*

$$SS = L_D * (D_{max} - D_A)$$

Substituting the values,

SS = (2 days) * (1000 – 900) = 200 units

For this case L_D is less than *T*, therefore, the *RP* is calculated with this equation:

$RP = D(L_D) - SS$

RP = 900(2) -200 = 1600 units

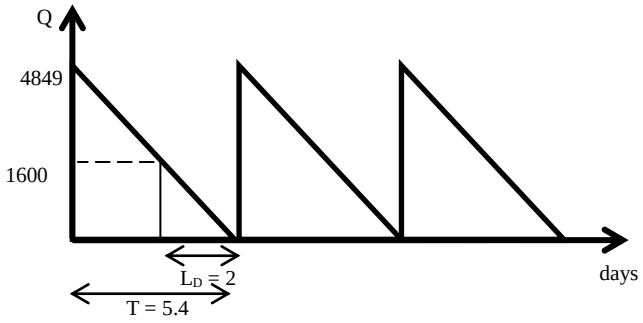

Figure 1. Quantity vs time expressed in days for the EOQ model proposed

The proposal on the last point (4) has to do with the development of software capable of considering the forecasted demand of the product and from that, calculate the optimal order quantity and reorder point so that they can minimize costs, improve productivity and efficiency, and achieve a constant verification of the inventory level for the selected product. In this sense, another recommendation is to systematize the process so the order would be placed automatically by the development of a special ERP. Of course, this would imply an additional cost of implementing the new system and many another variables must be considered as budget permission by inversion justification and so on, that is not within the slope of this project.

SUPPORTS AND RESOURCES

Rosa Maria Ferradas is the contact that is supporting us with information about the company. She belongs to the area of “Continuous Improvement”.

The person giving her the necessary data is Leticia Godínez Guerra, Purchasing Manager in HRC. The software used to manage inventory is an ERP system developed especially for HRC called "IMAS”. With this software, the inventory can be monitored but the safety stock, reorder point the inventory level are not considered.

ANALYSIS OF RESULTS

It does not exists historical data in the company about the total costs associated with holding inventories subdivided into ordering costs, cost of materials and inventory carrying costs; so it is not possible to compare each entry with the calculated one. Also, the ordered quantity that actually HRC planner places vary according to the retailer’s demand and for reasons of company’s internal policies they could not share that information; but the total costs oscillate around 27 and 28 million pesos per year (for practical issues, the team considers the pessimist scenario: the most expensive) and the calculated cost with the model proposed is $21,767,613.67. This represents a difference of $6,232,386.33 that in percentage terms represents savings of 22.26%.

That saving quantity does not consider the implementation of a new ERP system because its cost is very expensive and the initial investment might reach very high levels. For the reasons exposed before in the present document, this decision must need the approval of the company’s board and is not within the slope of this project. Supposing that the initial investment is done, the annual savings must

contribute to return the investment in a reasonable period of time according to board requirements so the costs associated can be justified in economic terms.

In conclusion, one of the main benefits of implementing a new system is that the ordering cost would be almost eliminated so everything in that process would be automatized. Even if they do not opt to contract the system described, the total cost of the model of EOQ proposed results cheaper.

IMPLEMENTATION OF PROPOSAL and CONCLUSIONS

By presenting the results of the proposal, it might result very probable that the board accept the initiative so it represents saving for22.26% and maybe the most attractive issue is that does not requires an initial investment. The improvement in the current inventory system is interpreted in terms of the direct impact that the reduction in costs has in the company's profitability. By adjusting the quantity to order to demand, this reduction can be possible and also, with the implementation of a system that considers a safety stock there can be a buffer between the demand and unexpected events.

With this implementation, in addition to the economic impact, the competitiveness in the global market is also. Only would have to focus on the customers so they can offer a better service according to clients requirements; but this is not part of the slope of the project.

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