A framework for decision support system in inventory management area

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ABSTRACT

The Enterprise Resource Planning's (ERP´s) are computer systems that help companies to standardize operations integrating business information. For inventory management these packages have some models for control and management purposes that require the definition of several parameters, which in many cases are set arbitrarily by the inventory managers ignoring the impact that these have over the inventories, costs and service levels. In order to help inventory managers to define, in a more technical way the parameters of inventory control policies, this paper presents a framework for decision support system for inventory management area. The model's outline includes the underlying inputs, a general description of the morel and the expected outputs, which allow companies to define more technically all the information that an inventory control model requires to improve the effectiveness of the system.

Key words: Decision support systems, inventory management, inventory control parameters.

1. INTRODUCTION

The decision making in inventory management must resolve mainly three basic issues: How often the inventory status should be determined? When a replenishment order should be placed? and How large the replenishment order should be? (Silver & Pyke, 1998).

Some companies, to solve the first question acquire enterprise information systems in order to know the inventory status in real time, and with this information make the processes of purchasing, manufacturing and distribution.

To solve the second and third issues, companies implement inventory control policies that require the definition of some parameter such us: reorder points, order quantities, inventory levels, security stocks, and service levels.

Enterprise information systems include some inventories models but the inventory manager has the responsibility of determine, in most cases empirically, the parameters that these need to process the information; but these systems do not have tools that support the decision making (Gutierrez, 2009) and help managers to identify if the parameters that they had define are correct and what improvements they should make.

2. STATE OF ART

The inventory administration can be divided in two main activities: inventory control and inventory management. Inventory control is usually support by enterprise information systems such as SAP, Oracle, QAD o Dynamics, which have transactional operations. For a complete review see (Moon, 2007; Shehab, et al, 2004).

In 2009 was made a research about inventory management and control software that Colombian companies use for this purpose and it concluded that most of them are transactional tools that not include decision support systems (Gutierrez, 2009).

In an inventory management process must be defined policies, models and parameters for a huge quantity of stock keeping units (SKU). Decision support systems are tools that can help managers to evaluate how these policies, models and parameters affect the inventory levels according with the supply chain strategy that the company had established, mainly in terms of service level and/or costs.

The decision support systems for inventory management and control and their relevance have been studied by (Arnott, 2005; Achabal, 2000 and Behesthi, 2009). Arnott (2005) analyses the nature and state of decision support systems (DSS) research. The analysis found that DSS publication has been falling steadily since its peak in 1994 and the current publication rate is at early 1990s levels. Other findings include that personal DSS and group support systems dominate research activity and data warehousing is the least published type of DSS. Around two-thirds of DSS research is empirical, a much higher proportion than general Information System research. Design science is a major DSS research category. Almost half of DSS papers did not use judgment and decision-making reference research in the design and analysis of their projects and most cited reference works are relatively old. Achabal (2000) describes the market forecasting and inventory management components of a Vendor Managed Inventory (VMI) decision support system and how this system was implemented by a major apparel manufacturer and over 30 of its retail partners. The DSS implemented helped the vendor and retailers arrive at jointly agreed upon customer service level and inventory turnover targets. Benesthi (2009) demonstrates the usefulness of a decision support model in analyzing and developing a cooperative environment among supply chain members in order to reduce the cost of inventory as well as the cost of goods sold. The effects of utilizing such tools as just-in-time and electronic business systems are illustrated and discussed.

Additionally, there are also some researches that document tailor made decision support systems for inventory management (Spyridakos, 2008; Achaval, 2000; Shang, 2008), but they are the result of expensive consultant work.

This paper presents the first part of an important research that is trying to develop a decision support system for inventory management that can be accessible to the small and mediums companies in Colombia.

In 2008 was made a study in Colombian companies of all kind of business that concluded that only the 50% of companies use transactional systems, 35% of the companies use DSS tools, and only 8% of the companies have the trained personnel for inventory management (Rey, 2008). This numbers show that it is essential that Colombian companies can acquire accessible and simplified decision support systems that can interact with their enterprise information systems, and allow companies to improve their effectiveness on inventory management.

3. MODEL OUTLINE FOR INVENTORY MANAGEMENT DSS

Decision support systems are tools that improve decision making process by transforming some inputs in outputs required to make a decision. The inputs and outputs for an inventory management DSS are shown in Figure 1 and explained in more detail later. Outputs are explained first because they represent the information we need to make an inventory management decision. Then, we explained the overview and the inputs required to obtain the outputs presented.

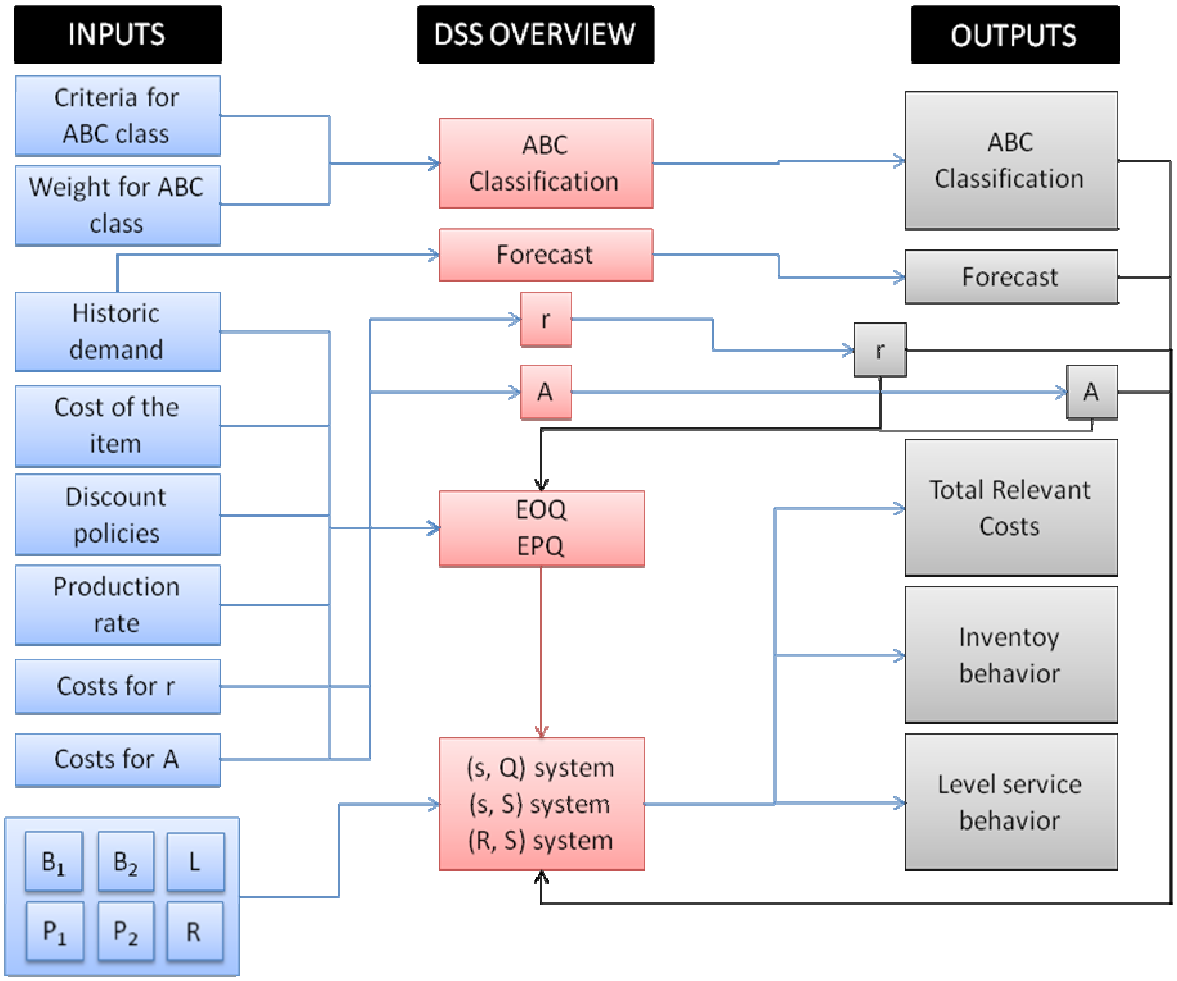

Figure 1: Model outline for proposed DSS

3.1 OUTPUTS

Companies try to maintain a balance between holding inventory, backlog and loss of good will but this balance is hard to find and manage. When a company uses an ERP for inventory management purposes, inventory managers have the responsibility to define models, parameters and information that are relevant for the process. Unfortunately, companies have a huge quantities of SKU's that must be monitored and controlled, so is virtually impossible to know if everything is working at the minimum levels of inventory or if they are going to achieve the service level the company needs, unless there are information tools that facilitate and simplify these procedures.

Therefore, managers should have the following information to define the models and the parameters for the inventory management process:

- ABC Classification: This classification allows managers to assigned priorities on management time and financial resources. The inventory control models should be according this classification.
- Forecast: It is a common practice that inventory control models are set up based on average demand and his standard deviation, instead of forecast demand and standard deviation of forecast errors. This practice in many cases had led companies to have excessive inventory or backlogs. A decision support system for inventory management should include different forecasting models that allow obtain information defined above.

- Carrying costs (r) in $/$-year: It includes the opportunity cost of the money invested, the expenses incurred in running a warehousing and counting costs, the costs of special storage requirements, deterioration of stock, damage, theft, obsolescence, and taxes.
- Ordering or setup costs (A) in $/order: There are fixed costs that are independent of the replenishment quantity and includes all costs that are generated once an order is set up.
- Total Relevant Cost: For inventory management is important to know how (for decision making purposes) approximately how much will cost the selected inventory strategies, divided in the three main categories of inventory cost: replenishment, holding and shortage costs.
- Inventory and Service level behavior: Finally, the decision support system for inventory management should provide a graphical behavior of the levels of inventory and the service level that could be achieve according to the models selected and the parameters defined.

3.2 DSS OVERVIEW

This is the most important part of the decision support system because is where the system answers the decision making in inventory management main questions:

- ABC classification: This tool defines how to assign priorities according with some criteria. The traditional ABC classification only classifies taking into account the percent of total annual dollar usage. Some other criteria like lead times, volume, etc. could be useful.
- Forecast: Forecasting is going to be made using time series models. These models need the definition of some parameters and they will show the most common performance measures so the user can define which one of them should pick.
    - Time series models:
        - Simple moving average
        - Simple mean
        - Exponential smoothing
        - Exponential smoothing with trend
        - Double exponential smoothing
        - Simple seasonal model
        - Holt Winters for multiplicative seasonal model
    - Performance measures:
        - Mean absolute deviation (MAD)
        - Mean square error (MSE)
        - Tracking signal range (TSR)
- Economic Order Quantity (EOQ) and Economic Production Quantity (EPQ): These tools are going to define how large the replenishment order should be, by using the traditional economic order quantity and the economic order quantity with discounts for the gross materials, and the economic production quantity for finished goods.
- Inventory control systems: These tools answer the question how often the inventory status should be determined and when a replenishment order should be placed. The models that the DSS is going to evaluate are:
    - Order Point, Order Quantity (s, Q) system
    - Order Point, Order up to level (s, S) system
    - Periodic Review, Order up to level (R, S) system

These models provide numbers to calculate Total relevant costs and to simulate inventory behavior and level service behavior.

3.3 INPUTS

Finally, if inputs are not reliable, outputs are not reliable either, so the quality of this information is vital for the success of the inventory management decision support system. The key inputs in a DSS inventory management are:

- Costs for r: The DSS needs carrying costs (r) in $/$-year in order to calculate total relevant costs. These are some of the issues that are important to consider:
    - Value of the inventory
    - Depreciation of the building
    - Mortgage of the building
    - Operating cost per year for the warehouse: Municipal taxes, insurance on building and contents, electricity and water, labor, pilferage, obsolescence
    - Opportunity cost
- Costs for A: The DSS needs Ordering or setup costs (A) in $/order in order to calculate total relevant costs. These are some of the issues that are important to consider:
    - For a merchant: Cost for order forms, postage, telephone calls, authorization, typing of orders, receiving and inspection, following up on unexpected situations, handling of vendor invoices
    - For a production setup: Many of the previous issues and costs related to interrupted production, such as: wages of a skilled mechanic, lower quality production, slower speed production and opportunity costs.
- Historic demand: At least 12 months of historic demand are needed but if there is a probability of seasonal behavior, 36 months are required.
- Approach to define safety stocks: all these values are defined according to the company logistics strategy
    - Safety stocks based on minimizing costs:
        - Cost per stockout occasion (B_1) in $/event
        - Fractional change per unit short (B_2) in %/$
    - Safety stocks based on customer service:
        - Specified probability (P_1) of no stockout per replenishment cycle (cycle service level)
        - Specified faction (P_2) of demand to be satisfied routinely from the shelf (fill rate)
- Lead time (L): This is one of the most important values used in the models. Most of the times, companies define this value as a constant parameters, but it is important to evaluate if a variable lead time would be a more appropriate approach.
    - Constant lead time
    - Variable lead time: at least 10 historic lead time periods
- Units of time of a replenishment order (R):
    - If it is defined by the company, you must enter this value
    - If it is calculated using relation Q/D, the process will calculate it
- Replenishment quantity order (Q): This quantity can be determined in several ways and the inputs required depend on which you use:
    - Economic order quantity (EOQ)
        - If it is a value defined by the company, you must enter this value
        - If it is calculated using EOQ standard formula you need: Annual demand, r, A, cost of the item

        - If it is calculated using EOQ quantity discounts formula: Additionally you need the discount rate and the amounts when you can have it
    - Production order quantity (EPQ)
        - If it is a value defined by the company, you must enter this value
        - If it is calculated using EPQ formula you need Annual demand, r, A, cost of the item and the production rate
- Classification criteria and Criteria weight: you can use the traditional criteria or you can use multiple criteria for it with specified weights, such as: Annual usage rate, volume per unit, lead time, annual inventory costs

4. SUMMARY

This paper presents the framework required to develop a decision support system for inventory management. Inputs are described in detail so inventory managers can build the information required; this is not an easy job but is not impossible either. This DSS does not optimize the results but presents the behavior that inventory and costs will have with the information defined.

This is the first result of the research "Development of a decision support system for inventory management". The main objective of this research is to develop a Decision Support System (DSS) of inventory management by using time series models, ABC classification and inventory management models including a full definition of its parameters. The main objective of this research is to develop a Spreadsheet that is going to be tested in a company.

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