Modeling and Optimization of an Industrial Inventory Management System

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Abstract
This project describes the team’s progress at designing a robust inventory management model for a manufacturing company. The project’s main goal is to provide a management team with an adaptable inventory model that yields crucial information about the status of inventory to allow them to manage their inventory more effectively and economically. The model uses Microsoft Excel as its backbone and Microsoft Access as its front end. Through a series of queries, the model prompts the user for part number or vendor name and delivers several inventory results. The economic benefits this model can produce far outweigh the negligible cost of acquiring Microsoft Office Pro software.

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The Need for Project

Applying this project to any inventory system will yield three overarching deliverables: **First**, it will improve inventory management by providing parameters, such as optimal Safety Stock and Economic Order Quantities (EOQ), to prevent shortage and/or excess inventory. **Second**, the project will facilitate executive decision-making. It will do this by allowing the user to easily compare vendors on the basis of Lead Times, Carrying Cost, Total Annual Inventory Cost, etc. The project will also facilitate decision making by providing executives with crucial information like part specific logistical information as well as information regarding the financial burden of having inventory. **Third**, this project will provide its users with the power to negotiate with their vendors and make reasonable demands substantiated by the inventory analysis.

The Design Project Objectives and Requirements

**Information is the first step to a smart inventory model.**

**Design Objectives**

This project was designed to satisfy the typical improvement areas of a weak and infantile inventory model. The first step towards a smart inventory model is *information*. You have to know what you have (Total Inventory Cost) and what you need (Forecasts), what you will use and what you want (Current and Obsolete Inventory), whom to buy supplies from (Vendors), how long these supplies will take to arrive (Lead Time), how many parts you need to prevent shortage (Safety Stock), cost of running out of parts (Stockout Cost), etc. Providing the user with such information was this design process’ first and main objective. The second objective for this process was to provide said information in a *clear and organized* manner. To have a program that brings together all the essential information and, through the use of queries, presents it as organized figures. The third objective involved making the model as *universally adaptable* as possible. Though this model is currently being
This model can adapt to any continuous review inventory system and present its information clearly.

designed and validated with its sponsor’s inventory situation, any other users should be able to simply fill out the Excel database with their own data and be ready to begin use.

**Design Requirements**

The boundaries surrounding this design process mainly consisted on user friendliness and ease of use. This project’s target customer is either a developing company with no inventory control whatsoever or a stable company that simply hasn’t considered the economic possibilities that lie with an efficient inventory model. This customer also runs a continuous review inventory system where the inventory level is monitored frequently and an order is triggered once the amount of parts falls below a predetermined value (Ref. 2). Target customer identified, the project has to provide them with the basic information but, given the customer’s state, do so using tools they will most likely already know how to use. The selected software used to provide the customer with such information is crucial to the project’s success. The learning curve has to be minimal and the user has to feel comfortable, just by gazing through the project, at obtaining its full potential. User friendliness will come in when displaying the query’s results. These figures will be organized, uncluttered, and relevant.

**Design Concepts considered**

Initially, this project was destined to produce its results using Arena Simulation. Arena allows the user to recreate simple logistical systems in a virtual environment and, once the system has been validated, alter the basic parameters and observe the effect these alterations have on the system’s performance. Going through the design process, the team determined that in order to make the model more universally adaptable and in order to comply with the “ease of use” design requirement, the software...
remaining user friendly. Microsoft Excel is probably the most commonly used tool in the business world. Everyone knows how to use it. These reasons convinced the team to adopt Excel as the backbone of the inventory model. The Excel model the team created calculates EOQ, Safety Stock, Expected number of Stock Outs, Total Stock Out Cost (TSOC), Total Annual Inventory Cost (TAIC), amongst other figures but it lacks in user friendliness and it isn’t very presentable. It displays these values for all the possible part numbers the user will have in inventory making it hard to find information and often even overwhelming to view it. Realizing this, the team decided to incorporate Microsoft Access as a front end of the inventory model. Using various queries, the model prompts the users for part numbers or vendor names and provides them with part specific information.

**Recommended Design Concept**

The model reduces the total cost of inventory by calculating optimal economic order quantities. It then addresses uncertainties by providing the user with safety stock figures as well as incorporating vendor ratings into its calculations. As mentioned in the previous section, this model uses an Excel database as its back end and a set of Access queries as its front end.

**Design Description**

The Excel database combines data, such as part number, vendor name, current inventory level, average quarterly demand, lead-time, vendor service score, etc. from many different sources into one organized database. This data is then used to calculate the numerous components that make up the Total Inventory Cost, minimizing this cost is this model’s purpose.

**Analytical Investigations**

The inventory system this project focuses on is recognized as a Continuous Review Inventory System. The variables in this system are Demand and Order Quantity. Total cost is a function
that depends on these two variables; by finding the optimum order quantity the total cost function is minimized. Once the order quantity is established, the model proceeds to determine the reorder point to prevent inventory shortage. The reorder point depends upon lead-time. As seen in the figure below, reorder point will provide the system (constant linear demand assumed) with exactly enough parts for the length of the lead-time.

Reference 3

The supposition of stable demand is addressed with another output of this Excel model: Safety stock. Safety stock is calculated using average (historical) demand during lead-time as well as the standard deviation of said demand. Assuming that demand is normally distributed, safety stock should take care of 50% of all shortage situations. The model uses one last parameter to account for the remaining 50%: vendor on time delivery ratings. A high rating will lower safety stock while a low rating will raise it.

Key Advantages of Recommended Concept

The logic behind this model has been proved in industry for many years now. It is reliable and adaptable to any continuous review inventory system. The design of this model and its ease of use allow the user access to these parameters
that, if used correctly, will yield significant savings.

Financial Issues

Minimal financial burden; project costs about $175.00. By satisfying this design’s third goal (adaptability) this project has reduced if not completely eliminated the cost of implementation of this model. Today, most companies work with Microsoft Office Pro. If they do, then they already have the necessary tools for the job. If not, one license is worth $175.00, which compared to the savings the model will bring, is an insignificant amount. Microsoft Office Pro contains both Excel and Access.

Recommended Improvements

Adding forecasting capabilities to this project would significantly improve the accuracy of this model’s results but could also hinder the model’s adaptability. Iterations of this project could serve to make it more accurate. The primary flaw this project has is its inability to forecast. Currently it relies on the user’s attempt at forecasting to determine values such as Average Quarterly Demand amongst others. Adding a forecasting model to this project would compromise its adaptability given that forecasting practices vary significantly between different industries. This aside though, the accuracy of the results from a model with forecasting capabilities would significantly improve and ergo the user could be more confident of the model’s reliability.