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Implementation of inventory levels for raw material at herramientas Stanley

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Abstract

Inventory management is a vital task within the supply chain. Most companies seek high inventory turnover as this could indicate effectively pulling in product sales. This project is focused on establishing efficient inventory levels and main-taining the company's competitiveness within the market. Herramientas Stanley (HS) manufactures demolition tools. Due to fluctuation in customer demand and lack of knowledge regarding inventory management, HS's inventory levels for raw material are $2.5M USD monthly when target is $1.85M USD, generating excess and obsolete inventory and losing the opportunity of working capital. In addition, the company does not currently have a standardized procurement pro-cess. For this project, 245 finished goods were classified, selecting 31 finished goods from a stratified sample. Finished goods were further broken down into 255 components to apply forecasts, Material Requirements Planning (MRP) and an Inventory Management System. After this analysis, logistics costs were re-duced by $ 1 M USD annually and forecasts were improved by 21%.

ABC Classification, Forecast, Inventory Management System, Liquidation Rate, MRP

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Introduction

HS is part of a multinational corporation that is one of the largest global manufac-turers of tools and storage (T&S), commercial electronic security, and engineered fastening systems with powerful growth platforms in the oil, gas, and infrastructure industries. HS Puebla is a wholly owned subsidiary of this corporation forming part of the T&S division in Mexico. HS is focused on satisfying customer demand and does not follow a standardized process or mathematical method to calculate accurate inventory policies (Mendoza, 2013). In contrast, when companies are capable of controlling their own inventory, they can reduce waste and increase working capital within the business (Rao, 2009).

According to Mendoza, some organizations base their demand and replenishment policies on qualitative approaches (Mendoza, 2013). Being a multinational compa-ny, HS should use qualitative approaches, however they do not follow an inventory system to procure the correct quantities of material for the production area. Nowa-days several methods for the planning and control of purchases exist to manage the correct material required for companies, such as re-order points, MRP, Kanban, or any other planning method supported by an ERP to control inventory (Jonsson, 2006). Small Business Administration or World Class companies should use invento-ry management systems and a standardized process to procure material; Supply Systems and inventory polices have been proven to improve management in the supply chain, optimizing the inventory supply to satisfy customer demand (Rojas, 2016).

This paper is focused on controlling inventory through an Inventory Management System and an improvement in forecasts.

Although there are several ways to resolve this problem, this paper analyzes current forecast reliability, improvement to the forecast, and inventory control through a systematic Inventory Management System that HS could use on a daily basis. Marin R. states the importance of the Supply Chain and using methods that help to achieve efficient production plans and satisfy customers; the right quantity of how much material to stock and a correct inventory classification are important ways to improve fill rates (Rusanescu, 2014). HS is cur-rently focused on Fill Rates, but they are not using the correct means to comply with internal and external customers. They are dealing with shortages, excess and obsolete inventory while using their current sourcing process. When HS standardizes their pro-curement process, they will receive benefits by reducing their total logistics costs as well.

Problem Description

There are certain key performance indicators (KPI´s) of upmost importance for the company such as Fill Rates (FR), inventory levels, inventory turnover, and work-ing capital. The company is facing nowadays a trade-off when trying to fulfill cus-tomer demand; HS is increasing inventory levels and not monitoring other KPIs. Cur-rent inventory levels and inventory turnover are 26% above target causing excess and obsolete inventory in the raw materials. Even though the inventory is meant to fulfill customer orders, there are unbalanced purchases that are not in accordance with the liquidation. Liquidation is an important KPI that refers to the transformation cost during production.

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HS supplies their customers through Distribution Centers (DC). Each DC is respon-sible for supplying information to the corporate offices to forecast future require-ments; HS downloads this information through the JDA forecast system. The mate-rials department at HS is responsible for the Material Requirements Planning (MRP) for raw materials, and is the decision maker for the manufactured components of the finished goods or SKUs. During the first observation of the MRP, it was noted that HS does not classify their components by importance nor is there an inventory manage-ment system in place. Therefore, the process is overall general without applying any analytical methods.

Problem Root Cause

An Ishikawa analysis was performed to determine what might be causing these unbalanced inventory levels. In the following diagram, it can be observed that one of the causes of having an unbalanced inventory level is an incorrect sourcing process, especially in the MRP. This project will focus on the material requirements process, from the forecast calculation to the purchase order to fulfilling customer demand. Although quality and effective human resources are important, this project concen-trates on processes and methods.

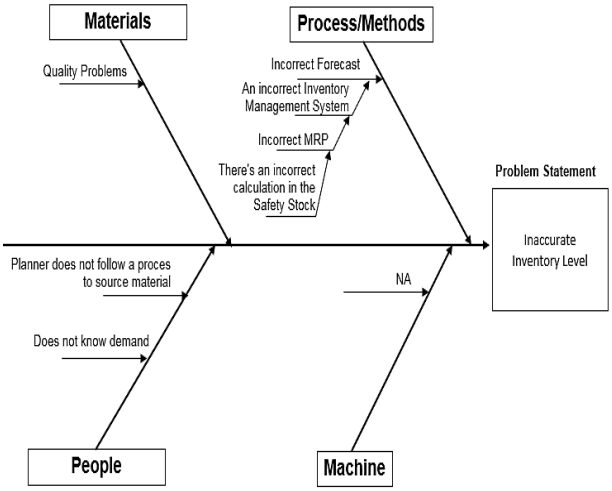

Figure 1 Ishikawa Inaccurate Inventory Level

Methodology

The initial study will begin by analyzing the fact pack of all the SKUs HS currently produces. The below methodology was analyzed within the company following a systematic, logical and mathematical method to plan and control activities. Steven C. proposes to maximize values and constraints of the current information and situation, starting from the beginning of the process and until the end; if there is a purpose in one direction, the rest of the process will embrace the changes (Cavaleri, 2012). The purchasing process was analyzed according to the current ISO 9001 certification. The following steps were taken to carry out the analysis.

Initiate an ABC analysis with all the finished goods considering two variables: liquidation and volume.

Verify the relation between these two variables with equation (1). These two variables are measured as KPIs by HS's corporate offices.

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$$\varrho = \frac{\sum_{i=1}^{n}(X_i - \overline{X})(Y_i - \overline{Y})}{\sqrt{\sum_{i=1}^{n}(X_i - \overline{X})^2 \sum_{i=1}^{n}(Y_i - \overline{Y})^2}} \quad (1)$$

Utilize 80% of the SKUs resulting from the ABC analysis. The Pareto principle was used to generate a large output from a small input. Mohamed S. stated that Pareto is a powerful tool in the fields of purchasing and operational management within the Supply Chain (Ab Talib, 2015).

Validate the accuracy of the forecast, comparing the corporate forecast vs. the forecast calculated in this project.

Validate some SKUs using a stratified sample from the ABC analysis. Myoung L. proposes to use a stratified sample if strata does not depend on the response (Lee, 2011). This project focuses on validating the forecast regardless of the number of SKUs selected. Equations (2) (3).

$$n = \frac{N * z^2 * p * (1-p)}{z^2 p * (1-p) + e^2(N-1)} \quad (2)$$

$$\binom{N}{n} = \frac{N!}{n!\,(N-n)!} \quad (3)$$

Analyze the demand of the SKUs: Coefficient of Variation for a time period of 12 months. Equation (4).

$$VC = \frac{\sigma}{|\bar{X}|} * 100 \quad (4)$$

Determine the dependent demand considering the scrap for each component.

Calculate the MRP considering current on-hand inventory and any open purchase orders (PO) with suppliers.

Obtain information for the Inventory Management: product, carrying, ordering and transportation costs.

In the Inventory management implementation, separate the items as direct purchase, consignment, and internal production; each type of item requires a different strategy for inventory management purposes.

Proposed systems are: Lot per Lot (L4L), average inventory, Economic Order Quantity (EOQ), and reordering point (ROP), equations (5) (6) (7) and (8) shown below.

L4L = Current_Period_Demand (5)

Average Inventory = Average_Demand_per period (6)

$$Q = \sqrt{\frac{2kd}{h}} \quad (7)$$

OP = Average_demand*Lead_Time (8)

Results

Correlation Variables

During the analysis process, there was an agreement with HS to use volume and liquidation as variables. Volume was selected as the first variable since it is important to determine which SKUs have a high rotation, and Liquidation was selected as the second variable since the efficiency of the company is measured based on this fac-tor. A correlation study was performed using equation (1) to review if these two variables have dependency. The correlation obtained was high, 93%. It is accurate to use these two variables for the ABC analysis.

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ABC Analysis

Class	% Vol	% Liq	Total SKUs
AA	50%	65%	33
AB	14%	1%	5
AC	16%	0%	9
BA	6%	14%	16
BB	7%	10%	35
BC	2%	1%	14
CA	0%	1%	1
CB	1%	4%	16
CC	3%	3%	116
Grand Total	**100%**	**100%**	**245**

Table 1 Number of classes, ABC analysis, liquidation and volume

Having obtained nine classes, selecting 80% of the highest volume, a stratified sample was applied to each class to obtain the number of SKUs required for this pro-ject. After obtaining the number of SKUs, each SKU was selected by a random sam-ple so that each one had the same probability of being selected. The sample size stratified sample, formula (2). It is important to mention that all of the SKUs have the same probability of being selected since the goal is to select a representative quantity of SKUs to validate the current forecast. The significance level used to calculate the sample size in each group was 95%, where z = 1.96 and the probability of acceptance was p = 1%. This probability was used since all of the SKUs have the same importance and homogeneity; when the data is uncertain, p = 50% is typically used. Finally, the margin error used for this sample was 10%. The total number of combinations obtained for each class was determined from the formula (3).for each class was calculated with the

The following table shows the sample size and number of combinations per class.

Class	n	Combinations	Class	n	Combinations	Class	n	Combinations
AA	4	40,920	BA	4	1,820	CA	1	1
AB	3	10	BB	4	52,360	CB	4	1,820
AC	3	84	BC	4	1,001	CC	4	7,160,245

Table 2 Sample size and combinations per class

For the 31 SKUs, a random sample was also performed for each class; the total combination per class in the random sample was 7,258,261. Having selected the 31 SKUs for the analysis demand, the Coefficient of Variation (CV) was calculated for each SKU using formula (4). This formula was used to understand the data dispersion and variability. The coefficient of variation helps to understand the percentage variability of the standard deviation; if the percentage is high, data tend to be heterogeneous, while if the percentage is low, data tend to be homogeneous.

The results obtained for the CV were positive. From the 31 SKUs, only 3 had a CV superior to 30%; the other SKUs had a stable CV of less than 30%, meaning there is an ordinary fluctuation in the demand.

Forecast and Comparison Strategy

HS provided the historical sales data from 2014 until the end of 2015. This data was used to forecast the first semester of 2016. Richard H. states that the difficulty to forecast demand is found in the variability of market volatility, competitive pressures and product life cycle. It is important to use an accurate forecast method and an Enterprise Resource Planning system to run a successful Master Production Schedul-ing and hence, a correct MRP using the minimum working capital (Herrin, 2010).

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As it is important to supply accurate forecast data using the different types of forecasting methods existing in the literature, R Studio® was selected as the forecast software to use for this project. R Studio® is a set of integrated tools designed with two forecast algorithms: exponential smoothing methods and a forecast algorithm with ARIMA applicable for seasonal and non-seasonal data (Hyndman, 2007). The work of Rob Hyndman allowed us to calculate an automatic forecast optimizing the parameters of the best model that fits the demand. At the end it was agreed with the company to add 10 more SKUs to use the majority of raw material in this project; the forecast results obtained with R Studio® were outstanding.

The summary in Table 3 details that the data forecasted with R Studio® was more accurate than the forecast used by HS. The methods used were various, but Multipli-cative and Additive without trend nor seasonal component were detected the most accurate. There was an improvement of approximately 21% in the Mean Average Deviation and in the Total Absolute Error. Both forecasts were on average below the real demand, however the forecast from R Studio® was closer to the actual demand than HS's forecast. Due to the forecast calculated with R Studio® providing im-proved results, this forecast was used with the 41 SKUs throughout the next steps of this project.

	R Studio	Current	R Studio	Current	R Studio	Current	R Studio	Current
	|Tot|	|Tot|	MAD (avg)	MAD (avg)	Err	Err	TS (avg)	TS (avg)
41 part # forecasted	448702	568145	1824	2310	-120832	-432047	-1	-5
Improvement	21%		21%		72%		76%	

Table 3 Forecast Improvement Summary

Below, the strategy to be followed to implement an inventory management system at HS is described.

– With the forecast calculated using R Studio®, perform a BOM explosion and execute a proper MRP to propose an inventory management system. Time period used, 6 months (January to June 2016)

– Calculate real operational costs during this 6 month period (January to June 2016), using actual HS purchases.

– Compare the total logistics costs incurred by HS vs the proposed methodology in this project.

– Estimate improvements in fill rates and operational costs.

BOM Explosion

The engineering team at HS supplied the complete BOM for all 41 SKUs. The BOM was exploded and the dependent demand was obtained. In this demand, HS was already considering the scrap for each raw material. After calculating the de-pendent demand, a total of 255 items that have to be acquired for the production of these 41 SKUs were obtained; Table 4 presents a summary below.

Tot Raw Mat	Description	Action
135	Direct Purchase	Implement an Inventory Management System
34	Internal Production	Will not be studied
86	Consignation	Recommend Safety Stock

Table 4 Dependent Demand

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The breakdown of the total 255 items is as follows: 135 items are direct purchases, so implementing an inventory management system to lower the total logistics costs is recommended. 34 items are produced internally and there is already a Kanban sys-tem in place to assure material availability, these parts will not be studied. The rest of the items are managed through consignment, and although the supplier is responsible for maintaining proper inventory levels, there is no policy or knowledge of what effi-cient inventory levels are.

Raw Material in Consignment

Every year, the buyer negotiates with most of the suppliers to start working under consignment; this is a good opportunity for the company to raise working capital when suppliers decide to work through this scheme. Only suppliers whose spend is higher than $30,000 USD are eligible for consignment.

The current consignment process at HS is to send a forecast to the supplier every 3 to 4 weeks, and the supplier will decide the inventory levels to be maintained at the HS facility. There is no policy with suppliers stating correct inventory levels, so the following process was suggested for the items handled under consignment:

- Take the real demand for the last 12 or 24 months for the items under con-signment.

- Maintain 4 weeks of inventory on average.

- Cycle inventory replenishment every 3.5 weeks.

- Calculate a safety stock with 98% confidence level considering a normal distribution.

Below the top five items in consignment at HS with the supplier's cycle replenish-ment and safety stock are extracted.

Part #	U/M	SS	Cycle Inv	Tot Inv
4643300	PZ	19,749	132,220	151,969
4643306	PZ	26,967	122,964	149,931
74207810	PZ	39,564	182,558	222,123
74207820	PZ	42,130	215,493	257,623
81800000	KG	59,799	314,898	374,697

Table 5 Safety stock and delivery quantity every 3.5 weeks

Raw Material Direct Purchase, Inventory Management System

For the remaining 135 items, the MRP was used to select the best inventory man-agement system for HS. To accomplish this task, the materials department provided: production and transit lead times for each item, current inventory in January 2016, Material cost, Ordering cost, Carrying cost and Transportation/Customs cost. Having collected the information above, the MRP was run for both cases, for the forecast calculated with R Studio® and for the real purchases from January to June 2016. Four different types of inventory acquisition were used: Lot per Lot (L4L), Economic Order Quantity (EOQ), average inventory, and Reorder Point (ROP). These systems were used as it has been proven that frequent order releases lower inventory and re-duce the need for continuous forecast adjustments (D'Avino, 2013), plus the compa-ny is aligned to not place large orders as the space in the warehouse is limited. The best result was the reordering point, which should be considered the new method for the MRP with suppliers.

Benefits

The benefits obtained in this project were exceptional.

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First, the forecast was im-proved by 21%, which does not only imply that purchases will be more accurate, but closer to the real demand. When analyzing the tracking signal in the forecast calcu-lated by R Studio®, on average it is closer to the real demand, while HS's forecast is inaccurate. Using this data would ultimately increase customer FR. Table 6 shows that both forecasts were calculated below real demand, but the forecasts from R Studio® were significantly better.

	Tot Items	% Err
Real Demand	1,495,533	-
HS Forecast	-432,047	-29%
R Studio Forecast	-120,832	-8%

Table 6 Forecast total error below real demand

On the other hand, the total logistics costs obtained with each of the inventory management systems in the 6 month period was $244,507USD. The opportunity to improve the current sourcing process at HS is feasible, and it is important to restructure their current procedure as soon as possible.

L4L Cost	EOQ Cost	Avg Inv Cost	ROP Cost	HS Cost
1,542,731	2,845,588	1,451,308	1,273,594	1,518,101

Table 7 Logistics Costs Inventory Management vs Current HS Operation

Conclusions and Limitations

Multinational companies usually have people responsible for forecasting customer requirements and smoothing the information according to customer needs. HS never validated its forecasts in the past and do not have a standardized process to procure material to satisfy customer requirements. This project detected some weaknesses in the material requirements planning process and it was able to improve the forecast and standardize the procurement process by implementing an inventory manage-ment system. Logistics costs were reduced by $0.5M USD and forecast reliability was improved by 21% focusing on SKUs extracted from a stratified sample. However, it is important to implement a standardized procurement process for all of the raw ma-terials currently used in HS. Although this project was successful in its approach, there are two points to review further: (1) the forecast needs to be readjusted for all of the corporate manufacturing plants before doing any changes to HS, and (2) a further analysis of the inventory suggested for consignment, and the order suggestions are not a limitation regarding the space in the warehouse, some suppliers under consign-ment might have to deliver more frequently due to the volume of their products.

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