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Prediction Analysis on Inventory Management

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Abstract: *Inventory management, the management of the flow of stocks or services from materials stage to the end user, is a complex process because of the level of uncertainty at each stage of the inventory management. The Inventory management analytic, was developed in an effort to provide supply chain solutions using forecasting as the foundation. In this paper, the goal will be to show how prediction analysis is used to analyze Inventory management processes.*

In this paper we have present a visual analytics system to provide predictive event patterns. Since the volume of the data is enormous and the data analysis requires large amount of time and effort. It is more problematic when predictive analytics is necessary for futuristic decision making. In order for predictive analysis there are many studies to forecast future trends. The goal is to identify what particular items need to have more stocks and determine when they will need it and to predict the request pattern of items of every warehouses. Appropriate demand forecasts make quality which greatly contributes to overall corporate management. In addition, proper stock can be maintained to save the costs of maintaining different warehouses.

Keywords: Inventory Management, Supply Chain Management, Material Management, Prediction Analysis.

1. Introduction

This paper proposes Tableau-BI, a tool to support the capacity planning process of maintaining inventories of complex product systems from a predictive analytics (PA) perspective. The motivation for the development of the proposed tool is the inability of current approaches in accurately forecasting the workload of future stocks and in planning an adequate capacity to face that expected workload. To address this challenge, Inventory management was developed and implemented in the particular case of aerospace parts. Mathematical programming model is developed considering multiple types of raw material and finished good. To estimate the inventories, several forecasting methods have been proposed in the literature

Tableau-BI improves the forecasting capabilities of maintenance organizations by providing more accurate workload forecasts, while dealing more effectively with the uncertainty of the capacity planning process. In the real-world companies have to paid attention for the inventory management since the management of a huge number of inventories have a difficult task. The inventory management is considered as a classical Operational Research problem. A flawed inventory management may cause financial loss and customer dissatisfaction. To avoid these drawbacks, any company should well manage its inventories through inventory items classification. The most effective Inventory management systems are designed to deliver raw material and finished good promptly and reliably at the least cost. To accomplish this goal, all the Inventory management processes must be effectively coordinated. One major obstacle in creating a seamless Inventory Management is uncertainty. In order to deal with this issue, managers must identify and understand the causes of uncertainty and determine how it affects other activities up and down the Inventory management.

An Inventory management is a connected series of activities concerned with planning, coordinating, and controlling materials, parts, and finished goods from suppliers to customers, linked together via information and material flows. In this work, we present a predictive visual analytics system using some mathematics calculation, especially for raw material, to forecast how stock quantity for certain event evolve over time in the future. This study will help to identify what particular items need to have more stocks and determine when they will need it. Hence, they could also know how much budget will be allocated for the next purchases. Moreover, it will predict the request pattern of items for particular warehouse that they will know how much supplies they are consuming. Predictive analysis determines the possibility of future result of an event or even the probability of a condition that can occur.

1.1 Models Optimizing Only for The Inventory Classification

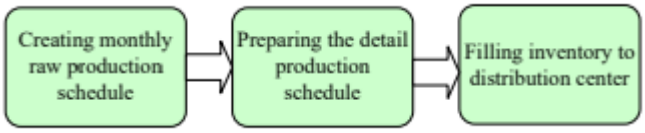
In this stream, there are several methods from different fields such as: Mathematical programming, Artificial Intelligence and Multi Criteria Decision Making that have been proposed to solve the Inventory problem. Some typical models based on Mathematical Programming are addressed to classify the raw material items.

A mathematician proposes the linear weighted optimization model (R-model) in this, criteria weights are generated. The output of this model is a weighted score obtained by a weighted additive function. The R-model is a maximization MP to be solved for each inventory item.

2. The Materials Flow

Due to the large demand fluctuations, the Inventory management system often experiences out-of-stock problems, which has a serious impact on the performance of both the customer and the supplier. Therefore, the inventory management has the objective to maintain the raw material at a desired level in spite of demand fluctuations taking into account, it has various types of information and different factors. The factory plays an important role in the raw material flow.

The factory must forecast demand and create a monthly raw material production plan called a Forecast master. As there is always a gap between actual and forecasted demand, the production quantity will be modified to fill in the gap in the detail production schedule. After that, production will be transferred to the distribution centers based on the company's inventory filling strategy.



Factory's operational flow

3. Research

3.1 Analytics & Reporting Requirement:

Final overall inventory status on the basis of stock coverage and availability for next 24 months should be displayed on a calendar chart as shown below.
Dashboard will have the format Raw Material (RM) and linked Finished goods (FGs) side by side and not in the following format (As per the Coverage model shared- snapshot below)

Planning location / Project - (From Master file)	Product (RM on top below the linked Fgs)	Customer part number (from Forecast file, For RM codes add up customer parts of respectivie FGs))	Specifications (FG code EXT spec from Master, For RM codes add up Specs of respectivie FGs)
CIMA330	PA134A44/012_700	10001078-C,10001077-C,10001076-C,10001075-C,	ABS5117C+CIMA330
CIMA330	10001078	10001078-C,	ABS5117C+CIMA330
CIMA330	10001077	10001077-C,	ABS5117C+CIMA330
CIMA330	10001076	10001076-C,	ABS5117C+CIMA330
CIMA330	10001075	10001075-C,	ABS5117C+CIMA330

RM & FG being listed one below other in the same column

Customer Part numbers to be aggregated as above

EXT spec being aggregated of linked FGs against RM

Stock and incoming quantity of linked FGs to be summed to the RM level from Stock file and PO history file for the coverage model i.e. Customer Part Code and tkAI FG codes will be displayed in a single cell respective to their column, in a comma separated format as highlighted in the figure above. Also, their respective Quantities should be aggregated and shown at planning location+ RM+ Ext Spec level. Ultimately, Forecast Report, Coverage Report and availability report should have linked tkAI FG codes and customer part codes separated by comma in a single row corresponding to Planning Location+ RM+ Ext Spec Combination.

					Inventory in hand (From stock file)		
Planning location / Project - (From Master file)	Product (RM on top below the linked Fgs)	Customer part number (from Forecast file, For RM codes add up customer parts of respectivie FGs))	Specifications (FG code EXT spec from Master, For RM codes add up Specs of respectivie FGs)	Thickness (from Master)	Inventory on hand Finished goods (To be summed up to RM level)	Inventory on hand - Raw material	Total inventory (Finished goods + RM)
TSAAH64	PA127A37/088_900	10002201	HMS1-1270+TSAAH64	88.9	93.16	380.23	473.39
TSAAH64	10001314	10002201	HMS1-1270+TSAAH64	88.9	93.16		
					FG Inventory being summed up to the RM level		Total Inventory adding Stock of Linked FGs & RM

3.2 Business Logic to Calculate Coverage and Availability

We solve the Inventory problem, and use the buffer logic for prediction analysis.
Buffer logic to be followed as shown in the table snapshot below [need to consider Test Buffer columns]

	PA134A44/012_700,	D0	D1	Current	Test	Current buffer % in file	Test buffer %	Current Buffer factor	Test Buffer factor with simple average	Test Buffer factor with weighted average
Example Part	10001078	0	11	1.2	1.20	20	20	12.78	13.711875	12.78
	10001077	0	18	1.2	1.30	20	30	21.888	23.484	23.712
	10001076	0	77	1.2	1.45	20	45	92.88	99.6525	112.23
	10001075	0	50	1.2	1.20	20	20	60.192	64.581	60.192
				1.20	1.2875					
		0.00	156.45					187.74	201.429375	208.914
								1.2	1.2875	1.335340364

Calculation to be used	Sum of (D1*BF1)+(D2*BF2)+(D3*BF3)+(D4*BF4)/Sum of (D1+D2+D3+D4) = X
Buffer factor	1+X
Remarks	If the demand is "0", then buffer factor to be taken as 1

Test column= (100+Test buffer%)/100
Test Buffer factor with weighted avg column**(X)**= SUM (Fg level Forecast demand*Test column) / SUM (Fg level Forecast demand)
Buffer factor=1+X (if demand is 0, then buffer factor to taken as 1)
Note: Always Final Buffer factor value will be considered at RM level and multiplied with forecast value at RM level in coverage calculations.

1. Coverage Formula for current month = (Inventory on Hand All + CF_tkA_Alternative SOH + Incoming stock for the month + Alternate Incoming for the month) – (Forecast for the month * (**Buffer factor**)
2. Coverage Formula for next month = (Previous month coverage + Incoming stock for the month+ Alternate Incoming for the month) – (Forecast for the month* **Buffer factor**)
3. Availability Formula for current month= (Inventory On Hand All + CF_tkA_Alternative SOH) – (Forecast for the month* **Buffer factor**)
4. Availability Formula for next month=Previous month Availability– (Forecast for the month* (**Buffer factor**)

3.3 Colour Coding

The above colour coding is done on the basis of conditions given in the table below:

Cover-age	Availa-bility		Condition	Sub-condition	Colour code	Significance
>=0	>=0				Green	Indicates Material in stock @ tkAI / no demand -no supply issue
>=0	<0				Amber	Material incoming to tkAI in the same month of requirement or before in full. Need to ensure on time incoming or option of expediting
<0	<0	3A	COV of month + demand of the month(X) <=0, then red	COV of month + demand of the month(X) <=0, then red	Red	If Coverage of the month when added to Demand of the month is less than "0" this indicates No stock/ incoming to supply that specific month
		3B	COV of month + demand of the month(X)>=(demnd/2) then yellow, else blue	COV of month + demand of the month(X)>0 & more than 50 % of demand of that month yellow	Yellow	Indicates 50 % or more of requirement can be supported either from stock/ incoming - but not in full, need to explore option of Expedite and sourcing in full
		3C		COV of month + demand of the month(X)if (X)>0 & less than 50 % of demand of that month Red	Blue	Indicates less than 50 % of requirement can be supported either from stock/ incoming - need to explore option of Expedite and sourcing in full

Colour code chart

3.4 Forecast report

This sheet shows, how much forecast demand can be served based on available stock.

Forecast Report

PLANNING LOCATION	MBOM Component	Ext Specs	tKAI_FG_Codes	Cust_Part_Codes_Li	Month of FORECAST_MONTH					
					Nov-18	Dec-18	Jan-19	Feb-19	Mar-19	Apr-19
AEQ	BS1154/152_..	AMS5659+..	10000914	RMMOOG0018	3,201.25	3,073.20	3,073.20	3,073.20	2,048.80	1,024.40
	FS1031/050_8..	AMS5659+F..	10000001	RMGRCH0111A	0.00	0.00	0.00	0.00	0.00	0.00
	FS1170/050_8..	AMS5659+F..	10000002	RMGRCH0165	894.08	894.08	391.16	0.00	0.00	0.00
	Not Available	ABS5044D+..	10001526,10001527	U1NONBULK00138,U1..	100.50	0.00	0.00	100.50	0.00	0.00
		ABS5077A+..	10000773	RMSHAL10320	0.00	0.00	0.00	0.00	0.00	0.00
		AIMS03-04-..	10001796	RMSHAL10320-SUB	200.00	0.00	0.00	500.00	0.00	0.00
		AMS4027+..	10001254	RMHW0029	44.40	0.00	0.00	0.00	44.40	0.00
		BSL164+LA..	10001285	RMSHAL10319	0.00	0.00	0.00	0.00	0.00	0.00
	PA103A15/01..	ABS5032A+..	10001795	U2NONBULK00135	7.20	7.20	28.80	7.20	0.00	0.00
	PA121A29/12..	AMS4027+..	10001235	RMHW0027	2,170.70	1,063.20	1,063.20	0.00	1,063.20	1,063.20
	PA121A29/13..	AMS4027+..	10001236	RMHW0028	2,501.45	1,225.20	1,225.20	0.00	1,276.25	1,276.25

4. Conclusions

In this paper, we deal with the problem of stock outage. We conduct predictive analysis to find out whether a stock can fulfill for next 24 month. An Inventory analytic tool for forecasting and capacity planning of complex product systems is proposed in this work. The solution, developed and implemented in the particular case of aerospace parts manufacturing company.

The forecasting module, used to predict the total quantity in future for raw material, It is combined with the BI module, developed to update prior forecasts into predictive forecasts as observations on raw material being predicted and become available. Inventory systems help the organization for making decisions. It may be buying too much or not buying enough for the supplies used by different warehouses.

5. References

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