Inventory Visibility in Apparel Make-To-Order Production

By: Thu Hoang and Hebatalla Elgamal

Advisor: Dr. Shardul S. Phadnis (sphadnis@misi.edu.my)

ABSTRACT

Our research aims to provide inventory visibility for an apparel organization using a make-to-order production process. We designed a model to project inventory and correct deficiencies in the material requirements planning system in the company. Our results demonstrate the benefits of the model in projecting inventory for the Asia Operations in different time periods through the year. Moreover, it will enable the company to take corrective actions earlier to control inventory. Further improvements that are required to improve the outcome of this prototype are an assessment of the ordering policy of the company and applying this prototype tool on a larger scale.

Thu Hoang holds a Bachelor of Science in Maritime Business Management in Vietnam. Prior to joining the MSCM program, she spent 10 years working at POSCO Steel in Vietnam.

Heba Elgamal holds a Bachelor of Science in Computer and Software Engineering from Helwan University in Egypt. Prior to joining the MSCM program, she was an entrepreneur for 2 years.

KEY INSIGHTS

1. Identify deficiencies in the material planning system of a company in a make-to-order (MTO) environment.
2. We designed a model to correct the deficiencies caused by inventory invisibility in the system.
3. Demonstrate the results of inventory projection for raw materials for the Asia Operations through our model.

INTRODUCTION

In the apparel industry, which operates with a MTO system and regularly deals with complex numerical data and massive physical inventory, inventory deficiencies are often remedied by overstocking. However, this is cost inefficient as the apparel industry has a high variability in their demand.

As a part of its long-term business strategy, the company under study plans to pursue strategic acquisitions. To fund these acquisitions, the company seeks to effectively generate strong cash flow through optimizing its capital structure and managing working capital levels. Additionally, the company considers that variability in the raw materials cost has a direct relationship with fluctuating inventory and production cost. This also has an adverse material effect on results of sales and operations planning, and cash flow. As a result, the company desires to manage inventory effectively to avoid the risk of fluctuations and volatility in the price of various materials.

The company is experiencing inventory invisibility issues, which is detrimental to its service level. Excess inventory is associated with over purchasing of raw materials and accounts for 35% of their total inventory.

The over-purchasing policy is in place because the company wants to cover either uncertain lead-time or spot orders. Therefore, the company needed an inventory forecasting method that measures for the following time periods: six weeks, three months, six months, and a year; and thus provides an earlier opportunity to take appropriate actions to manage inventory effectively.

EXTANT KNOWLEDGE

The nature of the apparel industry makes inventory control even more important. Mehrjoo & Pasek (2014) cited important features of the apparel industry such as variability in demand and short life cycle, leading to the trade-off between inventory levels and holding cost.

One-third of companies use packages such as Material Requirement Planning (MRP) in inventory control management (Sower & Abshire, 2003). When MRP is implemented correctly it will improve the ability to meet product change, better capacity planning, cost estimation, inventory control, meeting the delivery process, and higher inventory rotation. It will also reduce work in progress (WIP), lead time and inventory costs. In contrast, MRP systems also have some functionality issues (Stevenson, Hendry, & Kingsman 2005) .

MRP has certain assumptions including Bill of Material (BOM) and product routing, as well as the absence of any kind of uncertainty. As a result, it is possible to forecast future demand as a basis for Master Production Schedule (MPS) (Kanet, 1988). Because of the variable nature of the design and production of a make-to-order system, the BOM will be gradually known through the project and it affects the applicability of MRP (Stevenson, Hendry, & Kingsman, 2005; Bertrand & Muntslag, 1993). As a result, MRP will not always generate feasible plans, and can lead to high WIP and long cycle times.

Our literature review found that Segerstedt's (2017) paper was the most instructive to our research. The research covered the deficiencies of the MRP system at his company, and suggested the Cover Time Planning (CTP) method as a solution. CTP is faster and can achieve exactly the same function of MRP, however the reorder system is based on time rather than quantity. The CTP method is based on a lead time error, which is not applicable in our research.

Stevenson et al. (2005) stated that it is possible to tailor the design of the MRP system to the needs of MTO companies, which is the end result of our research. We therefore designed a model to project inventory of the Asia Operations for different periods of time.

RESEARCH APPROACH

The research approach of this thesis is Design Science Research (DSR). Aken, Chandrasekaran, & Halman (2016) assert that DSR is a "research strategy for operation management" to "design and implement actions, processes, or systems" that assist in achieving desired outcomes.

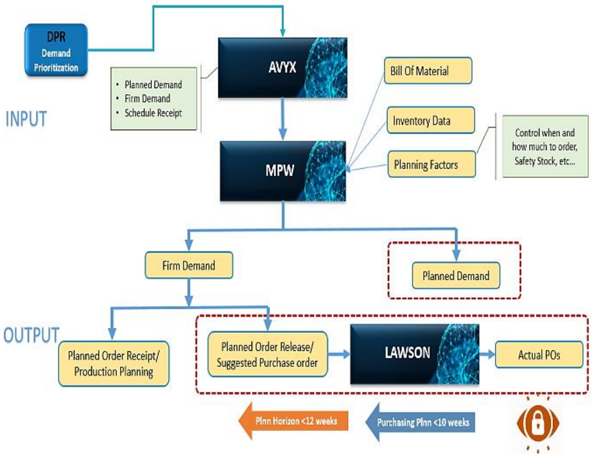
The DSR project consists of both two components: description and prescription. The description refers to the explanatory part and the prescription refers to the design and the testing part of the DSR project.

On the explanatory part, we wished to identify the reason why the company was unable to use their material requirement planning system (called MPW), and which was integrated with BOM in their inventory projection. As part of the identification process, we needed to examine the data flow from customer's orders to raw materials, which are associated with MPW, and inspect how MPW structures data to determine whether there are limitations of the system in inventory projection.
First, we deepened our understanding of the data process from demand planning to purchase planning. Next, we collected secondary data that the company used for project inventory. The purpose of collecting secondary data is to speed up the determination of the limitations of the system, which could be the information deficiency challenges that the planners have to face when estimating inventory. Based on this, we gathered primary data that was retrieved directly from the system, in order to determine whether the data matched with the described process. This, in turn, enabled demand information to transfer to raw materials information efficiently. By primary data, we also analyzed how MPW structures its data.

For the designing aspect, based on the understanding of the challenges and current practices of the company, we designed a solution-model to measure the inventory of raw materials ahead of time to the company's expectation. Next, we created a prototype, as an alpha test (tested by the designers themselves) to test the model. Finally, we tested the model with the company as beta testing (testing by third-party stakeholders) to modify the model in accordance with the company's process and practices.

RESULTS

For the explanatory part: the process of the data in the company is as follows: first, demand planning information is refined by the DPR is the input for the production planning system, AVYX, to create suggested work orders. Second, the suggested work orders in the AVYX are pulled into the MPW to generate suggested purchase orders through BOM. Last, the suggested purchase orders are pulled into the procurement system ("Lawson") to create actual purchase orders.



Demand data is prioritized before being sent to the DPR system. Then DPR evaluates this priority demand by balancing it with the inventory status, before being released to create the actual demand requirements as input to production planning. The actual demand requirements (i.e. priority and evaluated demand) are firm demand, while the non-priority are planned demand.

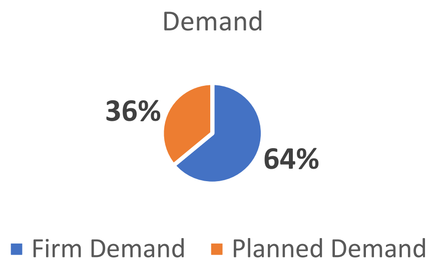


Figure 1: Percentages of Types of Demand

The analysis of primary data to map data and process, and to examine how MPW structures its data, demonstrates that information retrieved from the system matches with the process of data. It also shows the demand for end-products is transferred to demand for raw material appropriately in terms of timing and quantity.

The deficiency is that the information availability of purchasing quantity to replenish demand requirements only captures ten weeks, whereas the LAWSON system has a time fence, known as a purchase commitment point. While demand planning information is available for a longer period (almost 52 weeks) because of this limitation, MPW plans only for firm demand that represents 36 % of the total demand with limited planning horizon (12 weeks). This is because of the connection between MPW and LAWSON. Therefore, in the company's model, to get the purchasing quantity for more than ten weeks, planners replaced purchasing requirements with production planning quantity, which caused the deficiencies.
Therefore, the deficiency of the system can be fixed by designing a solution-oriented model that utilizes the company's system, which is MPW. However, this was also complemented by accessing entirely demand information (Firm + Planned) to achieve an inventory projection objective for the period of the next six weeks to one year (see figure 3).

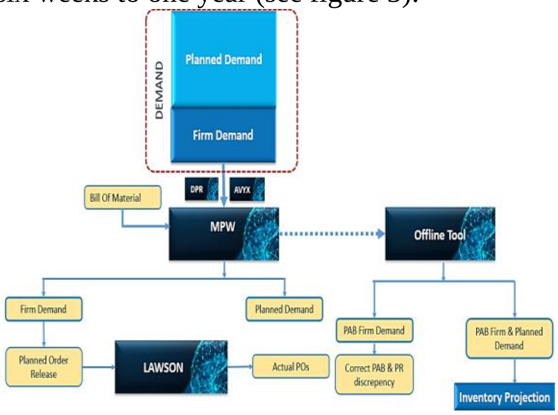


Figure 3: Offline Tool retrieve information from MPW

Lastly, we created a prototype and applied it on one product as an alpha test (testing by the designers themselves) to test the model. This prototype was designed based on a software design pattern called MVC Model-View-Controller.

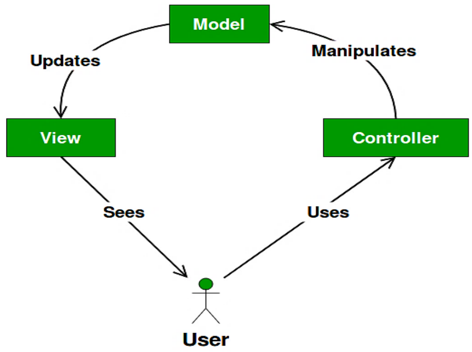


Figure 4: MCV Pattern

We utilized MySQL to design the model, Java Script to build the controller, and Postman to view the results.

For Beta testing, we applied the model to all the products of the company. It took five hours to import and run the prototype. After receiving results from the prototype, we adjusted the model to the functional requirements of the company

CONCLUSION

- We determined the data deficiencies in a short time frame with our offline tool, which functioned independently from the purchasing system via a simulation which gave better insight for data driven decision-making.
- Our model supports the company to keep lean inventory by providing visibility of purchasing planning after balance with other constraints, such as distribution and production capacity, and allows for the entire information of purchasing planning to be done accurately.
- In the MTO system, if the company did not have full visibility, it would revert to overstocking.
- We improved the availability of materials by including the supply planning of planned demand in the model.

BIBLIOGRAPHY

Aken, J. V., Chandrasekaran, A., & Halman, J. (2016). Conducting and publishing design science research: Inaugural essay of the design science department of the Journal of Operations Management. *Journal of Operations Management*, 1-8.

Kanet, J. (1988). MRP 96: Time to Rethink Manufacturing Logistics. *Production and Inventory Management Journal; Alexandria Vol. 29, Iss. 2*, 57.

Mehrjoo, M., & Pasek, Z. (2014). Impact of Product Variety on Supply Chain in Fast Fashion Apparel Industry. *Procedia CIRP 17*, 296 – 301 .

Segerstedt, A. (2017). Cover-Time Planning/Takt Planning: A technique for materials requirement and production planning. *International Journal of Production Economics*, 25-31.

Sower, E., & Abshire, R. (2003). Successful implementation of advanced manufacturing technology: a cross sectional survey. *International Journal of Computer Applications in Technology*, 1741-5047.

Stevenson, M., Hendry, L. C., & Kingsman, B. G. (2005). A review of production planning and control: the applicability of key concepts to the make-to-order industry. *International Journal of Production Research*, 869-898.