SOURCING MODEL FOR A WIND TURBINE MANUFACTURING SUPPLY CHAIN

Kumar P[1] and John Rajan A[2].

[1]Research scholar, Sathyabama University, Chennai, India
[2]Mechanical and Production Engineering, Sathyabama University, Chennai, India
Email: [1]rkpkumar@gmail.com

Abstract

The objective of this paper is to explore and create a sourcing model for the wind turbine companies. To establish the model, the existing system to be studied carefully.This study was carried out in one of the wind turbine company in southern part of India. The problem statement is the company is under continuous loss..The main reasons for the loss is due to delay in execution of projects, higher inventory, government policies, etc.Out of this main reason the inventory has been taken by me for the study. The entire system supply chain system has been studied carefully and find out the root cause of the problem. Root cause of the problem is basically the changes in production schedules. Different methodology has been discussed and finally the Make to order concept/tool has been introduced. The inventory level has come down drastically.Also Pull system is introduced for the procurement of higher value components. These systems are not used in this wind turbine company earlier, so the real benefit of inventory reduction is established. This shows the methodology of make to order and pull system really benefitting such kind of industry. This system can be taken as a base for sourcing model and further improvement can be studied in the further research. The constraints of the system are all the receipt of material is considered as quality cleared, and the delivery as per the schedule .no delay in supply is considered. This research can further establish by considering these constraints.

Key words: Sourcing strategy, make to order, Pull system, Inventory, Outsourcing

I. INTRODUCTION

The Research topic is study of forecasting and inventory models in wind turbine manufacturers supply chain. The objective of the research is to optimize the inventory in wind industry. As a part of the research a study has been conducted in one of the wind turbine company at southern part of India.

I have been watching wind turbine manufacturers for more than one decade .Worldwide these companies facing serious problems in making consistent profit.

There are many reason for not making profit, Like Delay in execution of project, Loss of sales due to technological up gradation not happened, Higher inventory, government policies etc.This paper represents how a wind turbine manufacturer in India brought down the inventory level by adopting different inventory model in the system. It explains the different parameters and strategies focused to meet this target. It also suggests and recommends the supply chain design for such industry/situation so that this will become an input for such industries to get benefit in long term.

Though the wind industry started manufacturing wind turbines in India from the year 1990 onwards. But still the industry has not yet reached the matured stage. Due to this fact most of the manufacturers are not able to implement a much better system in many areas. Also the supply chain model is most complicated. Most of the critical components are imported, with long lead time. Due to volatile market in India many wind turbine manufacturers are struggling to make profit consistently. Also they are not able to implement the latest technologies like lean concept, JIT as in the auto industry. The total capacities of the installations in India are 1500 MW, 2300 MW and 2500 MW for the year 2009, 2010 and 2011 respectively. The trend looks upward. One of the organizations in India has suggested that the potential of wind power generation in India is up to 45000 MW. Many new manufacturers are setting up their manufacturing facility in India because of this high wind potential. The future of this industry looks bright.

This case study has been conducted in one of the reputed wind turbine manufacturing company in the southern part of India. The company was struggling to make profit due to many reasons. One of the major reasons is higher inventory. the objective is to bring down the inventory level to almost 'zero inventory' by year end.(Less than R5 million) The idea of this zero

inventory is impossible in reality, what I have taken an objective, is after completion of the planned production the inventory should be as minimum as possible. I also suggested the inventory design explained here, so that this will become a future model for the company to have control over inventory.

II. LITERATURE REVIEW

A supply chain is a sequence of processes and flows that take place within and between different stages of a company to fill a customer's need for a product. There are two different ways to view the processes performed in a supply chain.

(a) Cycle view

The processes in a supply chain are divided into a series of cycles, each performed at the interface between two successive stages of a supply chain.

(b) Push/Pull view

The processes in a supply chain are divided into to two categories depending on whether they are executed in response to a customer order or in anticipation of customer orders. Pull processes are initiated by a customer order, whereas push processes are initiated and performed in anticipation of customer orders.

This methodology is referred by Sunil Chopra and Peter Meindi, in their "Supply chain management–strategy planning and operation", Third Indian Reprint, 2004.

A. Cycle view of supply chain processes

Four stages of a supply chain are given below

- Customer order cycle
- Replenishment cycle
- Manufacturing cycle
- Procurement cycle

A cycle view of the supply chain is very useful when considering operational decisions because it clearly specifies the roles of each member of the supply chain. The detailed process description of a supply chain in the cycle view forces a supply chain designer to consider the infrastructure required to support these processes. The cycle view is useful, for example, when setting up information systems to support supply chain operations.

B. Push/Pull view of supply chain processes

All processes in supply chain fall into one of the two categories, push/pull, depending on the timing of their execution relative to end customer demand. With pull processes, execution is initiated in response to the customer order. With push processes, execution is initiated in anticipation of customer orders. Therefore at the time of execution of pull process, customer demand is known with certainty, whereas at the time of execution of push process, demand is not known and must be forecasted. Pull processes may also be referred as reactive processes because they react to customer demand. Push processes may also be referred to as speculative processes because they respond to speculated rather than actual demand

The author Michael H.Veatch, 2003 talks about 'Make to stock' mode. When the demand arrives to the system, it is satisfied with the on-hand inventory of the required part type. He also talks about dynamic scheduling.

The author Ronald Armstrong-Su Gao- Lei talks about zero inventory production and distribution problem with single transporter and a fixed sequence of customers.

The author Ingrid Farasyn talks about P&G's more complex supply chains implemented multi-echelon inventory optimization software to minimize inventory costs across the end to end supply chain. In 2009 this drove $1.5 billion in cash savings.

The author Herbert J.Grunwald studied about Zero inventory(ZI) and Just In Time (JIT) which are the two buzz words that introduce entirely new concepts. Also a more realistic goal is MRI, the Minimum Reasonable Inventory.

Bonney(1) mentioned in his paper that attention in manufacturing industry has to concentrate on inventory using JIT production, usually accomplished by visible pull or consumer-driven systems.

III. METHODOLOGY

The methodology adopted is given in the Fig.1 below in this section

A. Study objective

The study has been conducted in one of the wind turbine manufacturing company in India. The

organization where I carried out the case study in a 10 year old organization. The organization was struggling to make profit; the new team at top management had taken many different steps for the profitability of the organization. But they were not fruitful. I took up the area of reduction of inventory to make the organization profitable. Every year the production plan and the actual is much lower the mismatched inventory is accumulated over a period of time. This year I have taken a target of bringing down the inventory.

The inventory level was always for the past three years hovering between 1700 million INR to 2500 million INR. This year at the starting this was 1500 Million INR and the target to bring down to less than 0.5% value as fixed as 5 million INR.

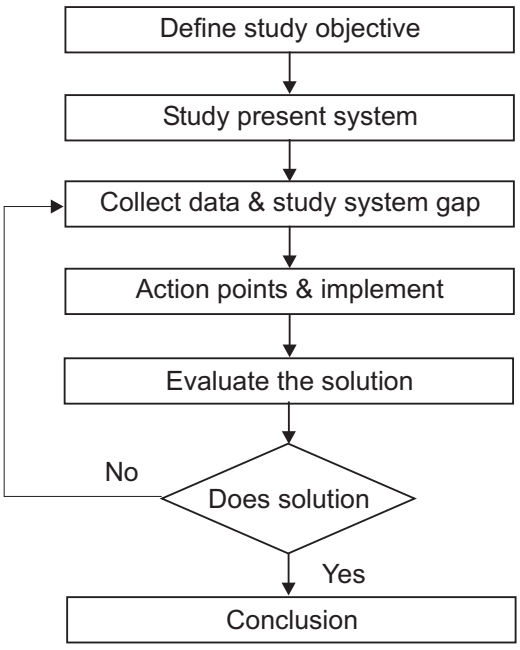

Fig. 1. Methodology

The idea was to bring the matched inventory and complete the planned production and subsequent year starting inventory can be brought in the month of January of next year. From this study to evolve a supply chain design model which will optimize the inventory level so that the organization adopts the model for their future requirement and make the organization lean.

B. Study of present system

The present system of production planning is having high fluctuation with the production plan changing frequently. As the production plan changes, the procurement of components is not aligned to the revised production plan.

Further to the above, the following points are the observation about the present system

- There is no proper system for reconciliation of sub-contractor inventory
- There is no proper system for accounting vendor rejection
- There is no system for reconciliation of supplier account
- Basically the production is based on the production plan as Push system.

C. Data Collection

The data at the start of the year was taken. It was worth Rs.1500 million INR consisting of both imported and local material inventory. Based on the production plan further inventory procurement is planned.

D. Gaps Identified and its action points

A brief business model is given in the figure.2 below. In this the procurement lead time takes 6 months from the date of placing the purchase orders. The production will happen 15 turbines per month. The excavation, foundation laying and erection of turbines takes approx.3 months period and finally the commission and the government approval takes approx.1 month time frame.

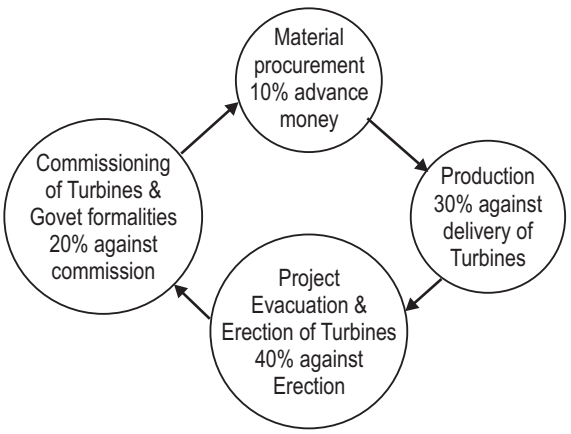

Fig. 2 A brief business model

If you look at the cash flow from the customer at the time of releasing the purchase order the customer will release only 10%, on delivery of turbines 30%, after erection 40% and finally after commissioning 20%. This is the general payment terms and may vary depending on the customer and volume of business. This gives an idea about how the cash flow requirement of wind turbine industry. The turbine cost alone 75% to 80% of the total value of the contract.

The following gaps are identified.

1. Mismatch between the actual usage and the Bill of Material.
2. Difference between Actual inventory and the system inventory.
3. The scheduling of the material is not relevant to the sales order. The scheduling is based on the production plan as a push system as shown in Table 1.

Based on the study of literature the major focus for inventory reduction is only through change in process from push to pull system. 'Make to order' pull system is suggested implementation after debating all other methodology. The present system of procurement and the pull system procurement is given below in Fig. 3.

Table 1 Action plan for a business model

No.	Issues	Action plan
1	Non BOM Materials	Identify the non BOM materials and upload in BOM through ECM
2	ECM implementation	Actual implementation of ECM will happen after BOM updation
3	Implementation of Back Flushing	Further more focus is given for PLMC activity for backflushing
4	Cycle count	Setting core data and implementation of cycle count
5	NCR Handling	Weekly NCR review mechanism
6	Subcontract items monthly stock reconcilation	Get the stock statement from supplier and verify with the system every month

AOP is nothing but annual operating plan. In this 'make to order' system, procurement order will be

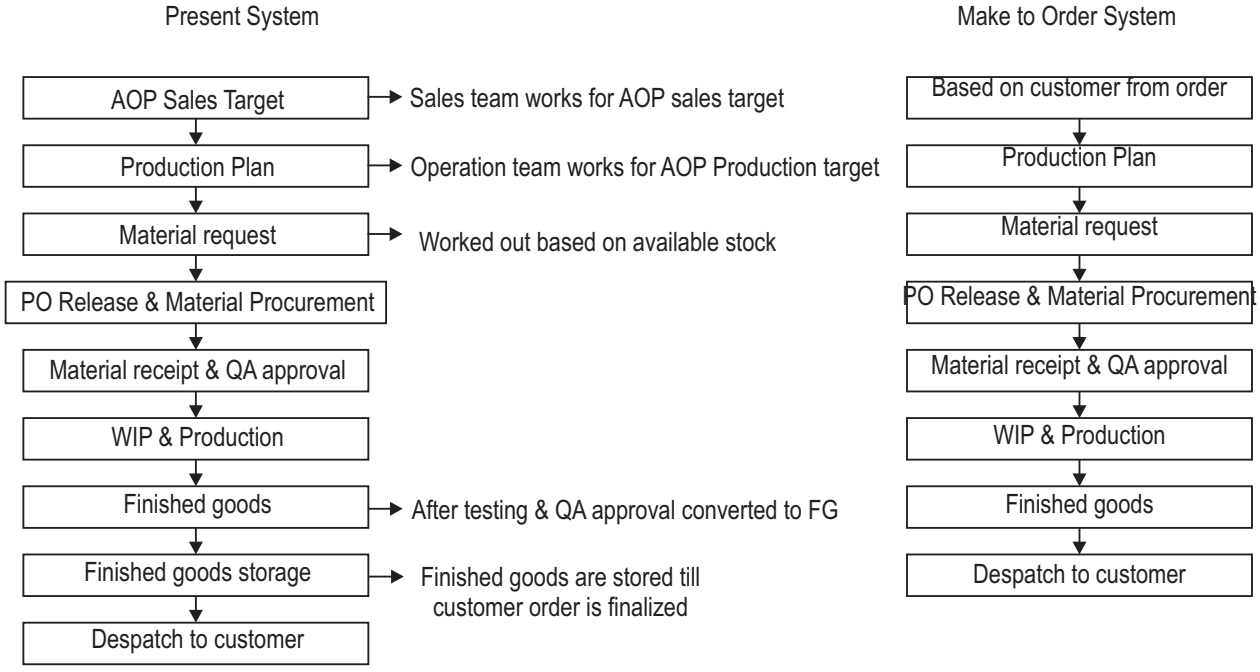

Fig. 3. Representation of present and make to order system

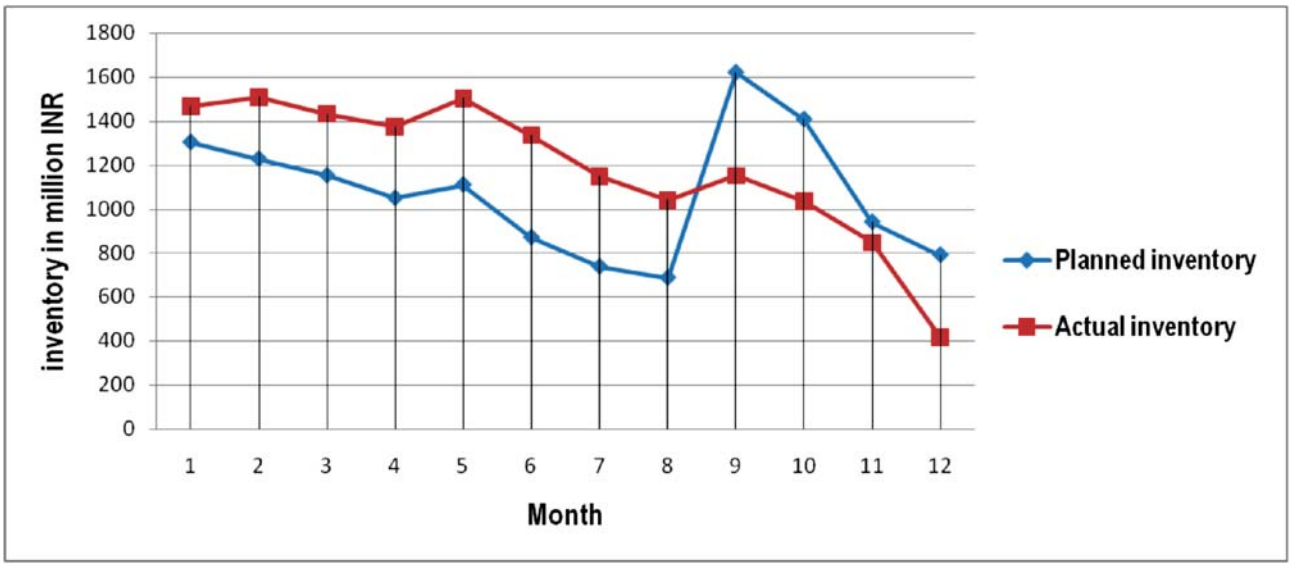

Fig. 4 Correlation between planned inventory and actual inventry

Table 2 Inventory

Inventory trend Jan-Dec 2010 Million in INR												
Month	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Plan	1303	1227	1152	1049	1109	870	737	686	1620	1407	940	790
Actual	1467	1509	1433	1373	1503	1335	1147	1040	1151	1035	847	415

released based on customer's confirmed order and hence eliminates the stocking/storage of finished goods.

IV FINDINGS

The major changes made in the system are previously the production plan is released based on the annual operating plan. This production plans keep changing frequently. Based on these changes is production plan, all procurement components cannot be changed due to contractual obligation. Due to this always mismatched inventory lying for a longer period due to this higher inventory and obsolete inventory occurred. Now the system is changed the production plan is released based on the confirmed customer order. So the material order also released based on the customer order. is as against of annual operation plan sales After implementing the Pull system of inventory and the correction of the existing system gap the inventory trend started coming down. After introduction of Pull system and Make to order most of the components procurement also postponed even though the order has been released .The materials are in warded exactly based on the production requirement. In the initial eight months the actual inventory level was higher than the planned due to implementation delay in Pull system, because of this the inventory is higher than the planed after that the inventory meet the exact planned level. The Fig.4 and Table 2 given below shows how the inventory trend started coming down against the plan. Finally the Rs170 crores inventory was reduced to less than Rs.5 Million INR. This shows that the focus given with the right strategy will reduce the inventory to optimum level.

V CONCLUSION

The study shows evident that the Make to order is the solution to the problem. By implementing this system the inventory level has come down drastically which was not possible in the earlier years. The company was struggling to find a solution for reduction of inventory for a long period after completion of this study the inventory reduction shows a drastic reduction.

This model is established under the assumption that the delivery of material from supplier is as per the schedule and the quality of components without any rejection. In practical this is not possible. Further research can be extended by take up these limitations. This model cannot be generalized for all companies.

ACKNOWLEDGEMENT

This research paper would not have been possible without the support from many people. The author wishes to express his gratitude to his guide.Dr.A.John rajan, who has been abundantly helpful and offer valuable assistance and guidance. Special thanks to Ravichandran, Thanigai velan, satishkumar, Vijay for their assistance and guidance. The author wishes to express his love and gratitude to his beloved families especially my mother for their understanding and endless love during the preparation of this paper.

REFERENCES

[1] Sunil Chopra and Peter Meindi, 2004. "Supply Chain Management – Strategy Planning and Operation, Pearson Education, Third Indian Reprint,

[2] Michael H.Veatch and Francis De Vericours, 2003, "Zero-Inventory Conditions for a Two-Part-Type Make-to –stock production system", Queueing systems 43, 251-266.

[3] Ronald Armstron-su-gao- lei, 2007, "A zero-inventory production and distribution problem with a fixed customer sequence", springer science business Media, LLC.

[4] Ingrid Farasyn, 2011, "Inventory optimization at Procter & Gamble: Achieving Real Benefits Through User Adoption of Inventory Tools", Interfaces, vol 41.

[5] Dimitris Bertsimas and Aurelie Thiele, 2006, Robust Optimization Approach to Inventory Theory, Operations research vol 54.

[6] Ritha W., Kalaiarash R., Young Bae Jun, 2011, "Optimization of fuzzy integrated vendor-buyer inventory models", Annals of Fuzzy Mathematics and Informatics Vol 2.

[7] Jayanta Kumar Dey, Manoranjan Maiti, 2005, "An Inventory Model for a Single Item with Different Types of Demand Under Different System of Management", AMO-Advanced Modelling and optimization

[8] Herbert J.Grunwald and Leonard Fortuin, "Many steps towards zero inventory", European Journal of Operational Research.

[9] Job de Haan and Masaru Yamamoto, "Zero inventory management:facts or fiction Lessons from Japan", Int.J.Production Economics 59.

[10] Benita M.Beamon, 1998, "Supply chain Design and Analysis Models and Methods", International Journal of Production Economics.

[11] Anat Kopzon, Gideon Weiss, A push-pull queueing system, Operations research Letters.

[12] Sanchez S.N., Triantaphyllou E., Webster D.B., Liao T.W., "A study of total inventory cost as a function of the reorder interval of some lot-sizing techniques used in material requirements planning systems", Computer & Industrial Engineering 40.

Kumar having rich experience in industries for more than 25 years. Presently working as Head of Operations at a wind turbine company. He is doing his Research at Sathyabama University. Wind industries are one of the green energy production sector which is the need for entire world to protect the environment for future. He have been monitoring more than a decade all the wind turbine industries which going through the tough weather. Most of the companies are making losses. The reason for such issues are identified and he have taken one of the reason higher inventory as his research topic. The objective of the research is how to optimize the inventory at wind turbine companies, also to create appropriate model for forecasting and inventory to optimize the inventory in wind turbine companies.