

Standard Product Based Manufacturing: A Case Study of Engineering Equipment Manufacturer

Nilesh Pendharkar

PhD Scholar, School of Management,
Pandit Deendayal Energy University, India
nilesh.pphd19@spm.pdpu.ac.in

Sudhir Yadav, PhD,

Professor, School of Management,
Pandit Deendayal Energy University, India
sudhir.yadav@spm.pdpu.ac.in

Abstract

This paper is a case study of an engineering and manufacturing company which designs, manufactures, and services equipment used in the extraction of petroleum and natural gas. The company faced the challenge of long lead time for its products. A study was undertaken for one of the products to reduce the lead time. Study involved mapping all processes from order receipt till dispatch that includes identification of Value Added and Non-Value-added processes /activities with recommendation for better utilization of available resources. Study included Process Mapping for Design, Procurement, Assembly, Painting and dispatch, Value Added and Non Value Added activities were identified, process Analysis was undertaken and Suggestions for improvements were made. It was observed that the company followed “Project Based Manufacturing” which made the critical path longer. There are only minor changes in design of most of the products. The analysis suggested the company to move from Project based manufacturing to Standard Product based manufacturing for the studied product which will improve the information flow and throughput time. Changing to “Standard Product” thus helped in eliminating some non-value-added processes. In order to keep the benefits for longer period and get sustained improvements, few more suggestions were given.

Key Words:

Process Analysis, Lead Time, Project Management, Critical Path

1. Introduction:

The studied company is into manufacturing of engineering machinery and equipment having headquarter in United States of America (USA). The company designs, manufactures, and services equipment used in the extraction of petroleum and natural gas. The products of the company includes turbo and reciprocating air compressors, steam turbines, industrial and aero-derivative gas turbines, high-speed engines, and modular power substations. The company has a presence in over 150 countries, including the United States, France, Spain, Germany, Norway, Brazil, India, Russia, Poland, Saudi Arabia, China, and the Netherlands.

Orders received for various products by the company were treated as a Project by the company as each order requires some customisation. The company was facing a challenge of longer lead time its products. This study is for one of the products i.e. Air Compressors offered by the company. The management of the company planned to implement lean philosophy for an overall improvements in the working of the company and reduce the lead time of Air Compressors from an average of 11 months to 6-7 months. With the help of industry experts a process mapping study using lean philosophy was undertaken to reduce the lead time.

This study focuses on all the processes from order receipt till dispatch for the product Air Compressor. The process analysis includes identification of Value Added (VA) and Non-Value-added (NVA) processes / activities. The study includes Process Mapping for Design, Procurement, Assembly, Painting and dispatch. Further recommendation for overall improvement in working and for better utilization of available resources were also made.

1.1 Objectives of the Study:

(1) To Study the current processes followed for Air Compressor Manufacturing (2) To reduce lead time from receiving Letter of Intent (LOI) / Purchase Order (PO) from customer to Air Compressor dispatch from 11 Months to 6-7 Months by (i) Identifying bottlenecks and de-bottlenecking (ii) Identifying Series and probable parallel activities (iii) Re-scheduling Processes (iv) Identifying critical path along with suggestions for reducing lead time for critical activity.

2 Methodology:

Methodology followed to address the problem of long lead time is as below.

(i) Data collection through discussion with concerned departments. Brain storming sessions were planned with various concerned departments to understand the processes and collect the data (ii) Develop Process diagram and map of the processes (iii) Time Assessment for the activities wherever possible (iv) Developing Current state Process Map (v) Identify VA / NVA (vi) Develop Process Map suggesting the improved lead time from 330 days to 221 days.

All processes from order receipt till dispatch were discussed for current actions followed along with approximate time and responsible department. Total time required from order to delivery was worked out using project management tools i.e. networking techniques. To develop the current process map activities undertaken were (i) mapping of material flow processes and quantities (ii) study of work sampling sheets (iii) Study of Elemental Time analysis sheet.

3. Findings and Analysis:

3.1 Findings:

The brainstorming session with company executive identified the major processes and sub processes followed by the studied organization from order receipt to dispatch which can be classified as below.

- (i) Project Management Processes
- (ii) Engineering Processes
- (iii) SCM (Supply Chain Management) Processes
- (iv) Order Management Processes
- (v) Quality Processes
- (vi) Assembly Processes
- (vii) Packaging Processes
- (viii) Testing Processes
- (ix) Shipping Processes
- (x) Commercial Project Management Processes

Sub processes identified for each of the above processes are as below.

(i) Project Management Processes: The sub processes are IKOM (Design Knowledge Department- Technical and Commercial) - EKOM (Technical Design Department) - Project Schedule – Procurement Guidelines – Customer DCI (Design Confirmation Intimation) – Communication from Company – Documents Submission Process – Packing List – Pre-shipment Letter- Project review – CRC (Customer Relations and Contract) Management – Release of PR (Purchase Requisition)

(ii) Engineering Processes: The sub processes are Internal DCI (Design Confirmation Intimation) with Schedule - Basic Engineering - Detailed Engineering – BOM (Bill of Material) for PR – Engineering Completion – Salient Features – PEM (Production Engineering and Management) – Imaging – Pre-Shipment Check List – As Built Document – O & M (Operations & Maintenance) Manual – Engineering Change Notification

(iii) SCM Processes: The sub processes are Quotation – Purchase Order (PO) placement – Vendor follow up – Vendor Schedule – Transportation to and from Suppliers

(iv) Order Management Processes: The sub processes are Material Receipt – Production Order – Material Issuance to shop floor – Tracking for shortage – Manufacturing Planning - Store

(v) Quality Processes: The sub processes are QAP (Quality Assurance Plan) – Procedures – Quality Dossiers

(vi) Assembly Processes: The sub processes are assembly of various parts and components

(vii) Packaging Processes: Packaging the Final Product along with instruction manual etc.

(viii) Testing Processes: Testing of final products

(ix) Shipping Processes: The sub processes are Packing – Dispatch – Packing List

(x) Commercial Project Management Processes: The sub processes are PO (Purchase Order) Acknowledgement and Booking – Bank Guarantees (BGs) – Invoicing – Business Unit – Project Review

Some of the observations while the studying the processes are (i) Duplication/Triplication of work in many activities, different departments doing same process (ii) Excessive check /control (iii) Use of ERP and parallel use of Spreadsheet (iv) Project Management practices were followed. These observations will help improve the overall workings in the organization.

3.2 Data Analysis:

Current Process Map

With the help of data collected for understanding the processes from order receipt to dispatch, Current Process Map was prepared to understand & map the process along with assessment of time required for each activity within process. Most time consuming activity i.e. critical activity (bottleneck activity) being “Getting material from supplier” required almost 180 Days, it can be squeezed to 162 Days through some standardisation in the product. Appendix – 1 (Network Diagram) shows the current process map with critical path along with process duration. Activity times mentioned in above network diagram (appendix -1) are the times given by process owners. It is assumed that the time assessment given is generally on a higher side.

4. Suggested Improvements:

The expert’s team observed that the organization follows Project “Based Manufacturing” for each customised order received from different buyers. The team suggested changing the concept of “Project Based Manufacturing” to “Standard Machine Manufacturing”. The change will make most processes prior to “Getting material from supplier” either parallel, or redundant and reduce the lead time for supplying (throughput Time), resulting in approx. 7.5 month delivery time from current 11 months of lead time. It will also improve the information flow.

Following are the other suggested improvements for processes in each department

4.1 Engineering

Standardise the product design and develop Standard Package General Arrangement Drawing (GAD). Standardize Lube Oil and Cooler Systems, Base Frame and associated piping’s and fittings, couplings, guards. Also Standardizing ancillary service design and General Arrangement Drawings. The components which will require standardization are Suction Expansion Joint, Core Compressor, Process Gas Piping, Process Gas Cooler (Inter Cooler and After Cooler), Lube Oil System, Coupling, Coupling Guard, Base Frame (integrated with oil tank), Discharge Expansion Joint, Inter connecting Oil Piping, Cooling Water Piping, Discharge Non-Return Valve, Anti-Surge Valve, Instrumentation - as defined in Packaging & Identification (P&ID).

4.2 Marketing

With standard Designs from Engineering, Market Standard products with some customization and delivery time commitment of 7.5 months initially.

4.3 SCM

Negotiate with suppliers to (i) Start manufacturing process at supplier end on based on LOI (Letter of Intent) (ii) Reduce lead time for manufacturing at supplier end

Manufacturing

Realign the manufacturing activities to (i) Reduce manufacturing / assembly lead time (ii) To work on pull manufacturing and create flow in manufacturing

4.5 Quality Assurance and Inspection

Provide general QAP (Quality Assurance Plan) and ensure adherence to standards. Eliminate inspection of material at the time of material receipt i.e. remove quality gate for materials inspected at supplier end by the company

5. Recommendations:

The expert's team strongly recommended the following actions for further implementation.

It is observed that "Project Based Manufacturing" makes the critical path longer and there are minor changes in design of product. Changing to "Standard Product" will help in eliminating some non-value added processes as they will become redundant. Following recommendations will help in developing a culture included in the philosophy of Lean. In order to keep the benefits for longer period and get sustained improvements, few more suggestions were given.

Agreed Actions:

(i) Standardization of Product (Design) (ii) Documentation for Standard Compressors – Frozen documents for 6-7 months delivery – agreement with customer during sales phase along with order finalization. Frozen documents are Package GAD, P&ID – only change in tag numbers are acceptable, Foundation Plan – without motor data, Foundation Load Data – without motor data, Approved Vendor List, Scope matrix, QAP, DCI, BG Format (iii) No review of design at any stage after customer PO for Standardized products (iv) Minimum customization (that too in Non-critical items) (v) To Issue LOI to vendors on receipt of customer LOI & Vendor to start processing on Receipt of LOI (vi) Rate Contract Finalization with Vendors for main items (vii) Delivery time of Products from vendor includes Inspection & Transportation (viii) Testing may be excluded as purchase of Electric Motor is at the Customer end (ix) Manufacturing activity of Gear Box items are to be completed within 135 days of issue of LOI as it is one of the critical activity within material supply and receipt.

5.1 Immediate Remedies and Actions

(i) Standardize the product GAD package and other items. Minor changes in design may be the requirement of standardization of work. (ii) Market the standard product with initial 7.5 months delivery for at least 3 orders (iii) List and Monitor each activity in every process, identify and eliminate the waste (NVA) (iv) Start recording activity time in Hours / Minutes (v) Minimize / reduce approval process (vi) Inculcate Continuous Improvement Culture (vii) Encourage Innovation

5.2 Other Recommendations

(i) We need to define all the activities in a Process and then evaluate the activity for "Value Addition". The activities that add Value (when either there is a physical change in product or information, or it is requested by the customer, or It is legal or policy requirement), then actual time required for the activity should be recorded.

(ii) Material receipt monitoring practices in the plant need to be further considered in totality

(iii) Methods / processes Standardization is needed after implemented improvements are assimilated and sufficient learning experience is achieved.

(iv) Post standardization, Work with Vendors to reduce their Lead Time by following actions.

(a) Engineering to work on design of Product for changing RM specifications to suit better availability of RM

(b) SCM to help vendor to identify better RM Source

(c) PM team to help Vendor to reduce their manufacturing lead time by training them on World Class Manufacturing

(d) Assembly activities to be scheduled by Production Planning & Control (PPC) to facilitate minimum hold time for material received.

(e) Working on Software to support single time entry and seamless transmission from one department to other.

(f) Recording the learnings to create and maintain Knowledge Management System

(g) Change management and Team building to facilitate smooth flow of information and coordination

6. Conclusion:

The results of complete analysis have been tabulated in table below for ready reference. The table shows activity number, activity/sub processes, preceding activity, parallel activity, responsible department, current duration, proposed duration and remarks/reasons for reduced duration. Further we have proposed process map with critical path which is shown as annexure – 2, this shows the reduced lead time of 221 days for delivery of air compressor. To further reduce the delivery time it was suggested to look at assembly process and analyse it through process analysis and process mapping.

Biographies:

Nilesh Pendharkar has around Thirty years of experience in Industry in Improvement Drives, Team Building, undertaking Productivity Improvement assignments including serving at leading Organizations like STI, JCT Electronics, Jord Engineers India Ltd, Indore Composite etc at Vadodara, Indore and Dewas. He is currently working at Vrunda Consultancy Services, Ahmedabad as Principal Consultant since March 2001 and actively involved in the Lean Implementation, Productivity Improvement and Operations Management areas. In Consulting Career, he has worked with over 450 clients in India and across the globe. His areas of expertise is in manufacturing operations involving Lean, Team Building, Industrial Engineering, TPM, Operational Excellence, 6 Sigma and process improvement.

Sudhir Yadav has more than 32 years of experience including about 7 years in industry and 24 years into academics. He has been with School of Petroleum Management, Pandit Deendayal Petroleum University, Gandhinagar-Gujarat, India Since 2006. As an industry professional he has worked in marketing and international business divisions of various companies. Dr. Yadav has developed and delivered academic & training modules in the area of Operations Management, Project Management and Supply Chain Management. His Case Studies & Publications in Oil & Gas Management have been acclaimed by learners. He has conducted in-company and executive management programmes for corporate executives. In the past he has contributed to the Natural Gas Technical Skill Development initiatives of Petroleum & Natural Gas Regulatory Board (PNGRB). He has visited USA, Europe, Middle East and South East Asia for his academic and professional assignments. Dr. Yadav has published more than 25 research papers in refereed international journals and two books (published by international publishers).

Proposed Processes							
Activity No.	Activity / Sub-Processes	Preceding	Parallel / Eliminated	Responsible Department	Current Duration	Proposed Duration	Remark / Reason for Time Reduction
A001	Customer PO/LOI	0			7	1	Package GAD and other Docs available - STD.
A002	Handover From Sales	A001			7	1	Data Standard, Available
A003	LOI to Critical Items Supplier based on Rate Agreement	A002		SCM		1	PO within 15 days
B001	PO Booking in SL	A002	Parallel		2	0	
B002	IKOM	B001	Parallel		15	1	
B003	EN. Release	XXXX	Parallel		30	0	Process eliminated due to standardization
C001	Schedule	XXXX	Parallel			0	Process eliminated due to standardization
C002	Advance from Customer	B002	Parallel		23	23	
B004	PO to DR	B002	Parallel		30	0	
B005	Offer From Supplier & Evaluation	YYYY	Eliminated			0	Process Eliminated, due to Rate Contract
C005	Offer Review & Approval	XXXX	Eliminated	EN	60	0	Process eliminated due to standardization
C006	Customer KOM	XXXX	Eliminated		7	0	Process eliminated due to standardization
B006	WBS Creation in DR	B004	Parallel			0	Same day process due to standardization
B007	SO Creation in DR	B006	Parallel		7	0	Same day process due to standardization
B008	PR Creation	B007	Parallel		10-30	0	Same day process due to standardization
C007	PO to Supplier	B008	Parallel		30-60	3	PO for Rate Contract. Other POs Parallel
C008	EN Review/ Clearance	C007	Parallel			30	Parallel Process
A004	Material Receipt at DR	A003			150-180	162	
B009	Internal Production Order Release by DR & Planning for S	A004	Parallel		12	12	Parallel Process
B010	Quality Review	B009	Parallel			0	
A005	Material Issue to Shop Floor	A004			7-21	3	
A006	Core Com. Assembly	A005			28	19	
A007	Packaging	A006			21	24	
B011	Testing	XXXX	Eliminated		14	0	Process eliminated due to Standardization
C009	Customer Inspection	B011	Parallel		7	0	
A008	Pre Shipment Audit	A007			2	2	
A009	Packing	A008			14	5	
A010	Dispatch Clearance	A009				1	
B012	Final Invoice	A010				1	
A011	Dispatch	A010				2	
A012	Post Delivery Documentation	A011	Parallel				

