

IMPLEMENTING LEAN MANAGEMENT PRINCIPLES IN HVAC INDUSTRY USING LEAN SIX SIGMA TOOLS

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Abstract

HVAC (Heat Ventilation and Air Conditioning) is the biggest blooming industry in India next to Automobile Industry, the percentile usage of HVAC Industry is being raised day by day. There are lot of difficulties in project completion of installation of HVAC systems in high raised Building it takes more than 6-8 months for completion of installation. This Paper deals with Implementing Lean Management Principles to the project working systems to reduce the days of working and to reduce the bottle necking in the systems and to remove all the mudas in the system in order to give effective Completion rate for the Project.

On Implementation of Lean Six Sigma Principles to the Project Concepts to optimize manpower utilization and effective working system to reduce cost of the system for Ancillary scope of works.

Problem Statement

The problem faced during the HVAC installation of a High-Rise building will mostly be the number of rejections faced at the entry level process and the amount of time spent for the re-work of ducts. The root cause of the re-work is identified to be the need of reducing costs which eventually leads to rushing through a work for compromising the limited time available instead of doing a perfect job. Lack of Co-ordination and management between various departments (Construction, Electrical, HVAC installing team) may also adverse the effect and prolong the time than the actual duration.

Solution Proposed

The two problem leading extremities - Compromising Work efficiency to reduce costs and time taken, and Prolonging the installation time can both be rectified by implementing Lean Management and Six Sigma Principles. Six Sigma involves a rigorous, highly focused, effective implementation of proven techniques for a productive endeavour.

Dmaic Process



The DMAIC steps is used to identify the customer requirements and understand the business issues thereby laying a proper foundation to provide a solution and look for ways to further optimize for the best deliverable.

Define Phase

In define phase, the company collects the demands and requirements of the customers and state the problems that will be faced on the process of providing the solution by listing an organized overview considering financial, productivity improvement aspects.

Project Charter

The project charter is a document which guides the project team on understanding the purpose of their work avoiding confusion by specifying the subject boundaries. This charter lists the problem statement and the remedial measures that are proposed to be followed satisfying the objective laid down by the team.

TEAM/PROJECT CHARTER

Project Name:	Implementing Lean Management Principles in HVAC Industry using Lean Six Sigma Tools
Date (Last Revision):	25-02-2016
Prepared By:	MASTROLEE SOLUTIONS
Approved By:	NG PHARMACY

Business Case:	Opportunity Statement (High Level Problem Statement):
NG PHARMACY needs to implement Lean Management to effectively work on the HVAC systems in their plant, to reduce the installation cost, optimize labour management, increase profit eventually improving the productivity of the company.	If Lean Management is not implemented, the Company may face a significant financial impact, delay in the working time period, conglomeration in the inventory etc.
	Defect Definition: Finishing up a work in rush to reduce labour costs and Prolonging the actual completion time period owing to improper Co-ordination. Both have devastating effects on the overall Productivity.
Goal Statement:	Project Scope:
Setup an organized work flow schedule in order to achieve about 75% improvement in the total productivity of the HVAC Installation process	Process Start Point: Site Inspection.
	Process End Point: Commissioning the Product.
Expected Savings/Benefits: The company can surely anticipate a profit upto 50%	In Scope: Completing the Installation within a short span of time aided by an organized Process-Flow. Budgetary limits being clarified.
	Out of Scope: Quiescent Labours

Voice of Customers	To reduce the installation time of heat ventilation and air conditioning duct system
Critical to Satisfaction	Completing the project at a faster rate
Critical to Quality	Providing a defect free system
Voc to CTQ	Faster Installation
Voice of Design	Completion of the project in nominal time period
Voice of Process	Completion of the project in nominal time period
Defect Opportunities	Improper - Installation, Duct designing, Machine positioning, Brazing of copper tubes, Shielding of copper tubes, Gas charging.

SIPOC

SIPOC is an acronym that stands for “Suppliers, Input, Process, Output and Customers”. SIPOC is a visual tool that is used for Process Improvement, gives an overview and a roadmap for the process from the beginning till the end.

IDU=Indoor Unit			ODU=Outdoor Unit	
Suppliers	Input	Process	Output	Customers
Mastro Lee	Engineer	Site inspection	Technician, logistics	Mastro Lee
Mastro Lee	Logistics	Transportation of machines tools and equipment	Labour	Mastro Lee
Mastro Lee	Technician	Marking position for placing IDU	Driller	Mastro Lee
Mastro Lee	Technician	Marking position for placing ODU	Driller	Mastro Lee
Mastro Lee	Technician	Marking position for placing DUCT	Driller	Mastro Lee
Mastro Lee	Technician	Marking path for grooving	Driller	Mastro Lee
Mastro Lee	Driller	Drilling holes for fixing IDU	Labour	Mastro Lee
Mastro Lee	Driller	Drilling holes for fixing ODU	Labour	Mastro Lee
Mastro Lee	Driller	Drilling holes for fixing DUCT	Labour	Mastro Lee
Mastro Lee	Driller	Grooving path for copper tubes	Labour	Mastro Lee
Mastro Lee	Labour	Inserting threaded rods into holes	Labour	Mastro Lee
Mastro Lee	Labour	Providing stands for ODU	Labour	Mastro Lee
Mastro Lee	Labour	Inserting clamps for IDU	Labour	Mastro Lee
Mastro Lee	Labour	Placing ODU	Labour	Mastro Lee
Mastro Lee	Labour	Fastening ODU using bolts and nuts	Labour	Mastro Lee
Mastro Lee	Labour	Lifting IDU	Labour	Mastro Lee
Mastro Lee	Labour	Fastening IDU using bolts and nuts	Labour	Mastro Lee
Mastro Lee	Labour	Sheet metal work for DUCT	Labour	Mastro Lee
Mastro Lee	Labour	Fixing grills in ducts	Technician	Mastro Lee
Mastro Lee	Technician	Acoustic insulation of ducts	Technician	Mastro Lee
Mastro Lee	Technician	Thermal insulation of ducts	Labour	Mastro Lee
Mastro Lee	Labour	Placing DUCTs	Labour	Mastro Lee
Mastro Lee	Labour	Lifting DUCTs	Labour	Mastro Lee
Mastro Lee	Labour	Clamping DUCTS using bolts and	Labour	Mastro Lee
Mastro Lee	Labour	Fastening IDU and DUCTS	Labour	Mastro Lee
Mastro Lee	Labour	Providing drain pipes	Technician	Mastro Lee
Mastro Lee	Labour	Connecting ODU and IDU using	Welder	Mastro Lee
Mastro Lee	Welder	Brazing of copper tubes	Technician	Mastro Lee
Mastro Lee	Technician	Insulating copper tubes	Electrician	Mastro Lee
Mastro Lee	Electrician	Providing power supply	Technician	Mastro Lee
Mastro Lee	Technician	Commissioning over flow	Customer	NG Pharmacy

Measure Phase

The measure phase gives an insight on how the process is defined and on what factors are the defects measured. In this phase we tabulate input, process and output to determine the key factors such as work time and cost. The effectiveness and efficiencies are measured.

Effectiveness Measure

- Process time
- low defective process
- low error rates

Efficiency Measure

- High productivity
- high profit
- low productivity time

Following is the cost quotation given by LG Air Conditioners for the Site of NG Pharmacy, Coimbatore.

QUOTATION FOR DUCTALE SPLIT UNIT						
SCOPE OF SUPPLY AND PRICES						
Sl No	Description	Qty.	Unit	Discounted Rate	Amount	
1	Supply of factory made air cooled ductable split unit consisting of condensing unit housing scroll type					
	a. LG make 5.5 TR ductable split	1	Nos	1,10,000	1,10,000.00	
	c. LG make 8.5 TR ductable split	1	Nos	1,40,000	1,40,000.00	
	Total on equipment cost				2,50,000.00	
	ANCILLARY SCOPE OF WORK					
	Description	Qty	Unit	U. Rate		Amount
2	Installation of ductable Split			Material	Labour	Material
	a. LG make 5.5 TR ductable split	1	Nos		5,000.00	5,000
	c. LG make 8.5 TR ductable split	1	Nos		7,000.00	7,000
3	Lifting of units	2	SET		1,000.00	2000
4	Supply and laying of copper pipe 3/8 & 3/4 HD with insulation and	15	FT	450	150.00	6750
5	Supply and laying of copper pipe	15	FT	650	150.00	9750
6	Supply and laying of electric cable	40	FT	125	25.00	5000
7	Supply & laying of Drain Pipe with int	30	FT	65	25.00	1950
9	Fabrication ,Fitting of the duct 22G	20	Sqm	650	250.00	13000
5	Fabrication ,Fitting of the duct 24G	40	Sqm	850	250.00	34000
6	Supply of ODU stand for 5.5 TR	1	Nos	4000	1,000.00	4000
7	Supply of ODU stand for 8.5 TR	1	Nos	7500	2,500.00	7500
8	Canvas	2	Nos	2500	100.00	5000
9	Accoustic insulation	20	Nos	400	100.00	8000
10	Supply and Return of running grill	5	Sqm	7500	50.00	37500
11	Insulation of Thermal (nitrile)	40	Sqm	650	50.00	26000
	Sub Total					1,58,450
	Ancillary Total with Tax					2,01,650
	GRAND TOTAL for DUCTABLE AIR CONDITIONER					4,51,650.00

The above tabulation helps to determine the amount being spent for the entire installation of the HVAC system.

Analyze Phase

The analyze phase is used to find the statistical analysis of the problem under study. In this phase, using certain tools we find the cause of the things which are slowing down the process consequently helping to suggest a method to bring improved effectiveness in the process.

Cost Benefit Analysis

Cost is one of the key factor for which the installation time of the HVAC System (Heat Ventilation And Cooling) is to be reduced, so it is necessary to make an analysis on the amount being spent and picturize it to pin point the mistake of wasting the huge amount because of improper scheduling. Without a proper scheduling we could waste the man power which in turn leads to loss of money.

Profit on HVAC System

Low Side

Process	Profit
Installation of Ductal Splits	12,000
Copper pipes	12,800
Electric cables	3,000
Drain pipe	1,050
Fabrication work	6,000
Stand	5,500
Canvas	3,000
Acoustic installation	5,500
Grill fitting	12,500
Installation of a thermal nitrile	8,000
Total	69,350

Labour Charge = ₹. 31,200



High Side

Process	Profit
Machine Billing	70000

Transportation = ₹. 10,000

The company has 6 labours

- 2 for Duct working
- 1 Head Senior Technician
- 2 Fitters
- 1 Helpers

The pay scale for the technicians are as follows:

Workers Category	Labours	Pay Sale (in ₹.)	Total Pay Scale (in ₹.)
Duct Workers	2	10000	20,000
Senior Technicians	1	15000	15,000
Fitters	2	7000	14,000
Helpers	1	4000	4,000
Total	Labour pay per month in total		53,000

Usually the company takes 2 months to complete the project.

The company has a profit of ₹. 1,60,500 in his hand, where if the project is to be finished in 2 months ₹ 1,06,000 goes for labour charges and only a feeble amount of profit left behind which is about ₹. 54,500.

Followed by travel allowance and other allowance ₹ 4500 goes off.

There is only ₹. 50,000 overall profit for the company.

But on implementing lean, each and every parameters will be optimised leading to increased profitability and productivity.

Lean Parameters

Eliminating Waste

When lean is applied effectively, much waste is eliminated. You order less material and ship less to a job site. You reduce the inventory of material and tools stored on site. You also reduce redundant process steps. All of this reduces energy, fuel and materials consumed, aiding in green HVAC construction.

The most Common Types of Waste in Lean Thinking

Defects: It includes doing the wrong installation, defects in fabrication punch lists and many kind of change orders not meeting required code.

Over Production of Goods: Fabricating or ordering material too early leads to stockpiling of the materials. Office over production can include printing more job plans or making more copies report, material order or invoices than needed. This type of waste is the root cause for other wastes including inventory, transportation and motion.

Inventory: This includes raw materials, finished fabrication. Any material, not yet installed and being used by the customer, is inventory. It also includes spare parts, unused tools, consumables, forms and copies and employee stashes and personal stockpiles.

Transportation: This waste happens when material is moved around the shop, loaded on the truck or trailer or hauled to the jobsite and unloaded.

Over Processing: This includes over engineering, requiring additional signatures on a requisition, multiple handling of timesheets, duplicate entries on form, and getting double and triple estimates from suppliers. Any step in the process that is not value added is over processing.



Motion: Workers looking for materials, tools, information on where/what to work is the waste of motion which happen frequently on worksites.

By applying lean techniques, the cost is narrowly reduced and make it affordable and desirable.

Improve Phase

In improve phase, the generated ideas are used to mitigate the root causes and evaluate the solutions to pin-point the best ideas. By implementing Lean Tools in the new process, piloting the solution is made easy.

Here we use the techniques of 5S in collaboration with Lean Principles to provide the best suitable solution.

Elements of 5s:

- SEIRI
- SEITON
- SEISO
- SEIKETSU
- SHITSUKE

SEIRI

- Sorting out the inventory by labeling each items.
- Providing a common point for accessing all tools.
- Determine what is necessary in each work area.

SEITON

- Keep all record of tools and equipment in a tool box, keep tag records for the HVAC tools.
- Keep bar code generated for individual technicians to record his tools in use.
- If the technician loses any tools he is applicable for loss of pay.

SEISO

- Maintain the tools regularly and maintain proper rules and return back the fabricated parts back to the management.
- Maintain the Storage of the Procurement purchased, and have a proper check list for the items stored.

SEIKETSU

- Follow Seiri, Seiton, Seiso and make this a routine work.
- Have frequent inspections.
- Following a standard method of safety and security for workers and workplace and giving it the top priority.

SHITSUKE

- Educating the labors the importance of maintaining and organizing the workplace, safety in workplace and reducing the wastes.
- Portraying the importance of team work and workers coordination.
- It is all also necessary to get ideas from labors, as they are the one who work in and can have ideas for improvement.

Team Work and Coordination

It is necessary in our project to work with other teams in an integrated manner and manage things simultaneously. Here false ceiling process and the placement of the ducts will be co-ordinated together. Thus, as discussed above the result of completing the project in right time will be achieved.

Process Plan

From the optimised solutions that are provided, the result is depicted in the following table

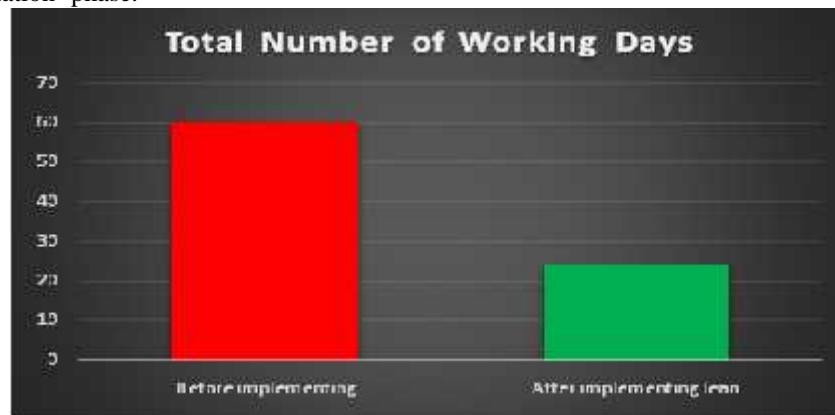
Tabulation

Process	No of Days	Start Date	End Date
Site inspection	1	day 1	day1
Transporting materials	1	day 1	day1

Marking	1	day 1	day1
Drilling	1	day 1	day1
Grooving path for copper pipes	2	day 2	day 3
Fixing clamps for IDU and ODU	1	day 3	day 3
sheet metal work for duct	4	day 4	day 7
Fixing clamps for DUCT	1	day 4	day4
Copper pipe -brazing, insulating and finishing	2	day 5	day 6
Electrical wiring	2	day 7	day 8
Fixing IDU and ODU	1	day 9	day 9
Clamping of ducts	2	day 10	day 11
waiting period for false ceiling	9	day 12	day 20
Fixing grills	3	day 21	day 23
commissioning and reporting	1	day 24	day 24

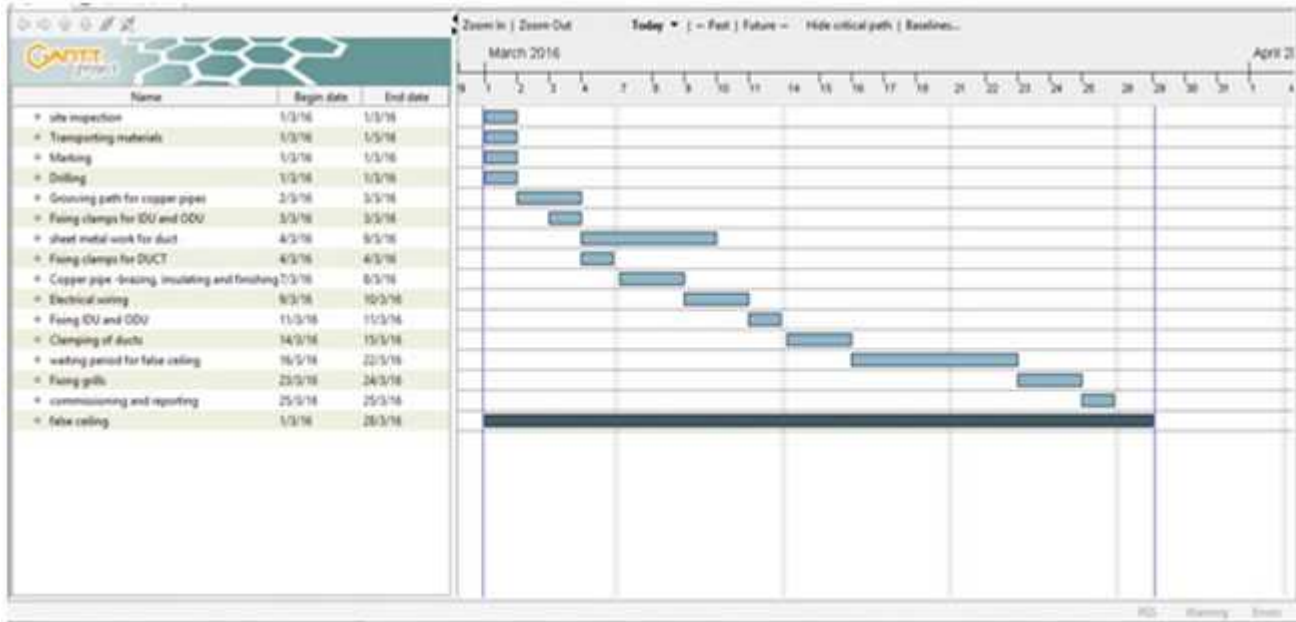
	Before Implementing	After Implementing Lean
Total Number of Working Days	60	24
Pay for Employees	106000	42400

The following bar graphs depict the improvement attained after the implementation of the lean and differentiate it from the 'before lean implementation' phase.



Thus from the graph, it is understood that an improvement of 56% in the profitability and a 60% reduction in the lead time has been attained.

Gantt Chart



Control Phase

We have controlled the total utilisation of time by implementing lean principles. The entire project were pre-planned to effectively utilise the men and resources. The ultimate aim of reducing the process time is to reduce the cost which is achieved on implementation of the lean methods. Thus by Visual management, the progress is made sustainable and progressive. Thus from calculating the improvement in the profit and work time parameters, it is clear that an 58% increase in the total productivity is achieved.