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LEAN MANUFACTURING IMPLEMENTATION USING VSM:

CASE OF JUNCTION BOX POST-PROCESSING PHASE

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ABSTRACT –
In today's world, competition is very intense in business. Customers are keen towards the quality of the product with timely receipt of products.
The aim of this study is to develop a value stream map for a discrete manufacturing company in India which is manufacturer of Junction Box. The goal is to identify & eliminate waste which is any activity that does not add value to the final product, in the production process which leads to reduction of lead time. In order to collect the information needed to complete the project, we had visited first company where the production taken place to be familiar with the activities being performed at the shop floor. It helped us in getting an idea of the production flow. Based on all the information gathered, we had started with Current State Mapping (CSM) & looking for opportunities to eliminate wastes & to improve the process flow from CSM, the company would utilized these results as a plan to map the Future State Mapping & like wise implemented VSM technique for lead time reduction.

Keywords: VSM, Current state map, Future state map, Lead Time, Takt Time.

INTRODUCTION

Value Steam Mapping is a powerful tool used in Lean Manufacturing study. VSM is the simple process of directly observing the "flow of information & material" as they occur & summarizing them visually. It is a tool to analyze process flows from a systems perspective & to document the performance of the process. A Value Stream involves all of the steps, both value added & non-value added, required to bring a product or service through the process steps. VSM is a visual tool used to help see the hidden waste – & sources of waste – in the value stream. A Current State Map (CSM) is drawn by a cross-functional, multi-disciplined team to document how things actually operate. Then a Future State Map (FSM) is developed to design a lean process flow through the elimination of the root causes of wastes & non-value added activities & through process improvements. As with the theories of waste identification & elimination, Lean Manufacturing principles, VSM has its roots in Toyota Production System (TPS).
In industry where implementation of VSM techniques is yet to be implemented is discrete manufacturing environment. One such discrete manufacturing environment is the post-processing of Junction Box, where the absence of any VSM increases lead time, & thereby delaying the supply to target customers. The current study focuses on applying VSM to the Junction Box Industry & reduction in lead time.

LITERATURE REVIEW

J. Dinesh et. al [1] introduced VSM is a useful tool for process analysis & improvement by identifying & eliminating time spenton non-value-added activities. By using VSM the process time & value added & nonvalue added activities are identified. Lead time is reduced by improvement made in the pump industry. VSM have been proven to be a greatly useful tool to eliminate some waste in a cycle & find there are more waste for you to eliminate in next cycle, during which lean becomes a habit or culture.
G Saranya,S.B. Nithyananth [2] have implemented VSM. In This paper they compares the current state & future state of a manufacturing firm & witnessed 20 % reduction in TAKT time, 22.5 % reduction in processing time, 4.8 % reduction in lead time, 20 % improvement in production,9 %

improvement in machine utilization,7% improvement in man power utilization, objective improvement in workers skill level,& no change in the product & semi finished product inventory level.

R.M. Belokar [3] reported the application of VSM in an automobile industry where they achieved nearly 67% improvement in cycle time by improvement in value adding activities.

Ramnath B.V. et al [4] described using VSM as a main tool. The focus of the lean manufacturing approach is on cost reduction by eliminating Non- Value added activities; identify sources of waste & to identify lean tools for reducing the waste. To eliminate the wastes found from the current state map, Kanban system was suggested for pre machining section & single piece flow concept is suggested for Machining section.

Maria Elena Nenni1, et. al. [5] (2014), demonstrated the positive effect of a Lean Management (LM) approach, in a pharmaceutical company, subject to critical market issues, by using VSM tool outcomes, with decrease in non value added activities, Total cycle time reduction, Work force reduction, Work in process reduction, Reduction of shop floor area & floor space.

According to Taho Yang Yiyo Kag [6] suggested & implemented lean production system for fishing net manufacturing, using the various lean tools & simulation method & make to order process are apply for the regular shipment. VSM tool was used to predict future state map & increase service level & reduce lead time, also provided guide lines for the implementation of VSM in any manufacturing industry successfully & cost reduction by elimination of waste.

According to Jafri Mohd et. al. [7] used production line analysis through VSM for color industry, thereby identified & eliminated waste by using team formation, product selection, conceptual design, & time frame formulation through TAKT time calculation. Some lean techniques were used to reduce change over time by 5s, decreased lead time from 8.5 days to 6 days & value aided time decreased from 68 minutes to 37 minutes.

Rajenthirakumar & R.G. Shankar [8] reported a noticeable reduction in cycle time increase in cycle efficiency with an application of VSM. The production flow was optimized, thus minimizing several non-value added activities/times such as bottleneck time, waiting time, material h&ling time, etc.

K. P. Paranitharan [9] provided a useful platform for research in implementation of lean tools in any mfg unit.Their results showed a significant improvement in productivity,reduction of production lead time &reduction in inventory.These were achieved by layout modification & balance to TAKT time.

Praveen Saraswat et al. [10] applied VSM on bearing industry for reducing the work in process & inventory & lead time This research study described how the value mapping graphically visualized the flow of material & flow of information from customer order to finish product. With this approach (VSM) wastes in the company can be reduced. Reduced work in process inventory & lead time.

Rumbidzayi Muvunzi et. al [11] Inroduced Using the VSM, Productivity increased from 20,220 tiles per month to 28,350 tiles per month, In the tile manufacturing industry. There was reduction of defects from 245 defective tiles per day to 10 defects thus saving the company up to $4419.9 per month. Raw materials were saved which contributed to 168 tiles per day which translates to $2993.76 per month. Lead time reduction from 8467 seconds to 5657 seconds, that is by 46.8 minutes, which contribute up to 12% of production time.

RESEARCH METHODOLOGY

Fig. 1 Research Methodology

STUDY OF ALUMINIUM JUNCTION BOX & ITS PROCESSES.

A Junction box is an enclosure housing electrical connections, to protect the connections & provide a safety barrier. Also it is a cabinet for electrical or electronic equipment to mount switches, knobs & displays & to prevent electrical shock to equipment users & protect the contents from the environment, also to be pleasing to the eye. Regulations may dictate the features & performance of enclosures for electrical equipment in hazardous areas, such as petrochemical plants or coal mines. Electronic packaging may place many dem&s on an enclosure for heat dissipation, radio frequency interference & electrostatic discharge protection, as well as functional, esthetic & commercial constraints. Also there are so many application of Junction box like in Lokomotives, Mining, Process control, Automation, Crane hoisting, Solar Panels.etc.Aluminium Junction made up by die casting process. Following are the basis post production processes,

Linishing_ Linishing is a type of finishing technique used to smooth or flatten metal objects.
In Junction Box, Linishing is done with the help of abrasive linishing belt there are different sizes of belts they are use according to the type of finsh required.

Vibro_This is also finishing process used to deburr, radius, descale, burnish, clean, & brighten the object, The machine has a steel bowl lined with rubber or polyurethane which is filled up with required media (either ceramic, plastic, maize etc. depending upon the finish required) & components. Eccentric weights are mounted on an extended shaft attached to a heavy duty motor to cause vibrations & create a spiral of the media & the components. Variations in vibration, achieved by varying weights & angles, & suitable combination of media enable machine to be used for different components. In Junction Box Ceramic media is used for finishing.

Machining (Drilling & Tapping) _Drilling is a cutting process that uses a drill bit to cut a hole of circular cross-section in this case of JB drilling done on Lid & Base. After drilling Tapping is done on the same hole to do threading inside a hole so that a cap screw can be fit properly at time of assembly.

Powder Coating_ Powder Coating is a type of coating that is applied as a free-flowing, dry powder. In Junction Powder coating fisrt the aluminium pretreatment process is often done as RoHS-compatible chromate conversion coating or Phosphating of Aluminium. The process involves dgreasing, rinsing, etching, deoxidation & chromatising or phospating.this varies based on th composition of the metal to be power coated & end customer specification. Already pretreated Junction boxes are dry cleaned & power is spread electrostatically on to them in an enclosed dust free chamber. There are various types of powder like pure epoxy, epoxy polyster, pure polyster. etc. used according to customer requirement also there are different colours requirement from customers like Black, Blue, Grey Junction Boxes.The coated boxes then move to oven for curing at the required temperature as specified by the powder manufacturer or as required for the component to be cured well & to bond with the base metal so as to achive the desired finish.

In XYZ Company dem& of Junction boxes is 15000 no. per month, effective number of working days for all processes are 26 per month, number of shift per day is 11 working hours for all process is 11hrs. Takt time comes out are 68.64secs. Details regarding cycle time, effective cycle time, inventory time, lead time, up-time, no. of operators shown in Appedix-1 for current state map & Appedix-1for future state map.

1. CURRENT STATE MAP- APPENDIX attached.

Acting upon the gap areas identified by the VSM of the current state, it is seen that except two processes all processes are under the takt time, hence capacity of process is not a constraint for the Lead Time, so following Kaizen projects is identified from the CSM.

5.1 KAIZEN-1 Reduce Measurement System Variation between Casting Supplier & XYZ Company.

PROMINENT PUBLICATION HOUSE

We have seen in CSM since cycle time of incoming inspection at XYZ is more than the takt time leads to higher lead time. Therefore Casting Incoming inspection at XYZ needs to eliminate. Methodologies used for the same is explain as below,

Incoming Rejection Percentage Trend –

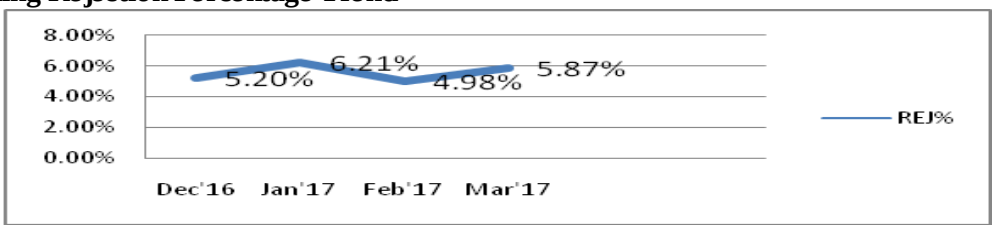

Fig. 2 Incoming Rejection %

Considering last 4months rej % found that Avg rej % is 5.57%. Rej% is high due to major difference between XYZ Company & Supplier inspection capability. So we have work on measurement system.

MSA by Agreement Attribute Analysis.

Since Process Output is attribute parameter, we have selected Agreement Attribute Analysis. Measurement system analysis (MSA) is an experimental & mathematical method of determining how much the variation within the measurement process contributes to overall process variability. Attribute data is based on upon counting how many units fall into discrete distinctions such as: pass/fail or percentage defective. Attribute Agreement Analysis is the Measurement System Analysis method used to analyze measurement systems for attribute data.

MSA Study Design :

Inspection method : Visual.
No. Of operators: 3 from supplier, 3 from XYZ.
No of parts : 50
No of trials : 3

We have started with the evaluation of rejection trend of incoming inspection. Considering last 4months data of incoming castings rejection, we have seen that average monthly rejection is around 5.57%. This is due to major difference between XYZ Company & Supplier inspection capabilities. Since Process Output is attribute parameter, we have selected MSA Agreement Attribute Analysis, for the analysis we have taken 50parts & 3 inspectors from XYZ Company as well from the Casting supplier & taken three trials of inspection & compared with reference of quality. From the analysis it is found that at supplier end Kappa coefficient is less 0.75 which means that measurement system at supplier end is not in line with requirement of quality st&ard since as per thumb rule for excellent agreement kappa value > 0.75.

Hence to improve the performance of measurement system Training is conducted at supplier end & again at XYZ also, after training again MSA done at both level & result observed from MSA is that measurement system kappa coefficient is greater than 0.75. Effectiveness of MSA monitor for the nest lot of inspection & result observed was there is reduction in casting rejection percentage from 5.31% to 2.01%.

Effectiveness monitoring after reduce variation of Measurement System

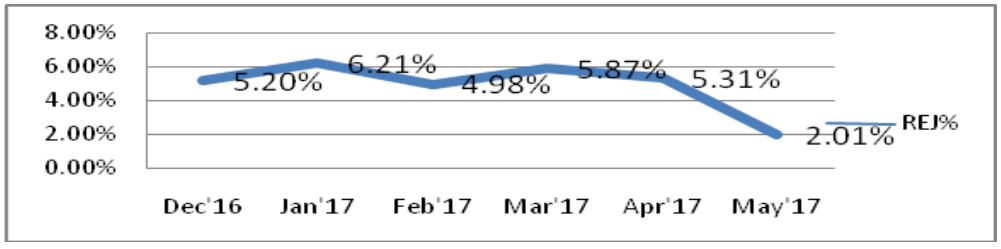

Fig. 3 Incoming Casting Rejection %

PROMINENT PUBLICATION HOUSE

KAIZEN 2- Eliminate Touch up rework for Powder Coating

Touch up rejection trend :-

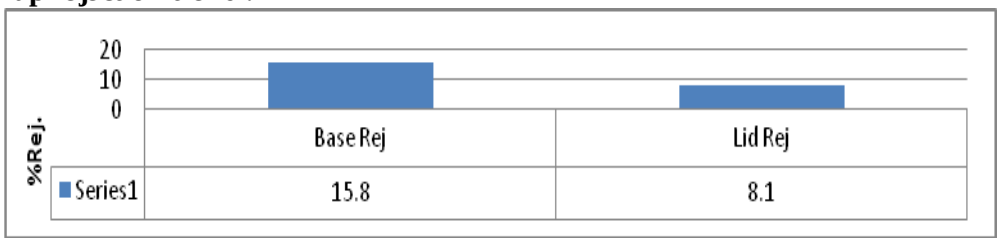

Fig. 4 Touch up rejection trend

We have studied the rejection trend as above for two months data separately for the lid & base it is found that average rejection for the base is 15.8% & Lid is 8.1%, based on the visual inspection it is analyze that, type of damages found was packing dameges & h&ling damages.

Among the various quality tools we have studied Defect Concentration diagram is used show the location of errors or defects. When either capturing or displaying defects data that can be segregated by location.

Defect Description

Based on visual inspection it is analyze that, type of damages found was packing dameges & h&ling damages as shown in fig. below,

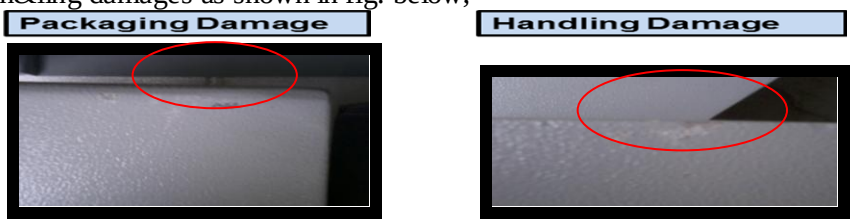

Fig. 5 Defect Description

Tool description – Defect Concentration diagram

We have studied different Quality tools/techniques from the study it is found that individual tools have their importance to identify different types of causes.

What is it used for: To show the location of errors or defects

Why use it: To determine where the faults are occurring on the production part.

When to use it: For either capturing or displaying defects data that can be segregated by location.

First we have started with identification possible zone. After that Concentration Check List for Base & Lid is done, where causes for defect are segregated zone wise.

Concentration diagram – for Touch up location

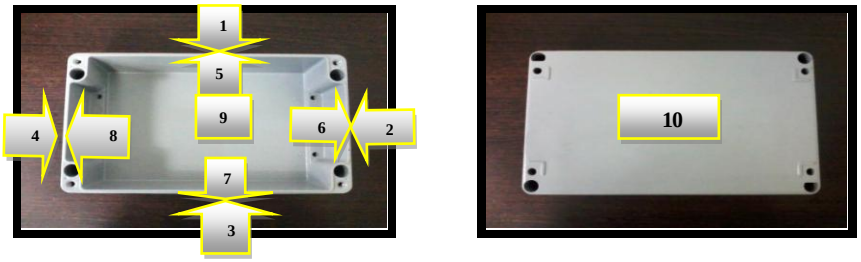

Fig. 6 Concentration diagram

Concentration diagram – Zone wise trend

JB Zone	Base	Rej %	JB Zone	Lid	Rej %
Zone 3	57	21	Zone 3	27	26
Zone 4	52	19	Zone 2	21	20
Zone 2	45	17	Zone 4	16	16
Zone 1	40	15	Zone 1	15	15

Zone 10	34	13	Zone 10	6	6
Zone 9	16	6	Zone 6	4	4
Zone 6	12	4	Zone 8	4	4
Zone 7	7	3	Zone 9	4	4
Zone 8	5	2	Zone 5	3	3
Zone 5	3	1	Zone 7	3	3

Table 1 CD –Zone wise trend

After analysis we have found 84% damages on outside area ie. max on zone 1,2,3,4 & 10. Again the concentration diagram is drawn with the major contributor of the damaged problem. as bellow,

Concentration diagram – Major touch up location

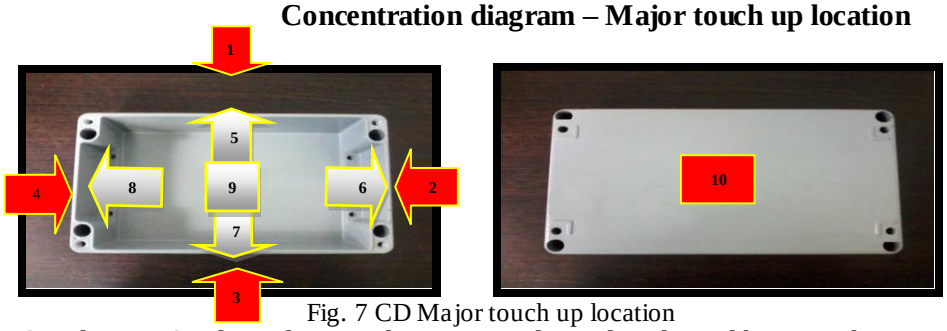

Fig. 7 CD Major touch up location

Conclusion: Analysis denotes that zones indicated in the red box are the major contributor of the damaged problem. So now we have to find the causes for damages.

Cause & Effect diagram (CE) Diagram: Powder coating touch-up.

A cause & effect diagram, often called a "fishbone" diagram, can help in brainstorming to identify possible causes of a problem & in sorting ideas into useful categories. A fishbone diagram is a visual way to look at cause & effect.

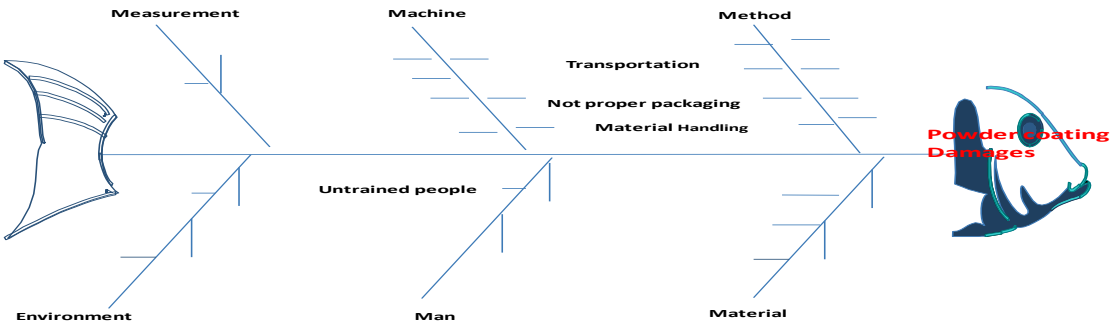

Fig. 8 CE Diagram for PC

Training program for packaging improvement in XYZ & Coating supplier

Fig.9 Traning at XYZ &PC Supplier

Before Improvement Photograph
Previously we were sending the powder Coated material in bin & corrugated boxes.

After Improvement Photograph
We are started the powder coated parts Packaging with polybag to avoid the damages.

Fig.10 Before Improvement

Fig.11 After Improvement

Rejection Improvement monitoring
It is observed that after analysis rejection trend reduce from 15% to 6%.

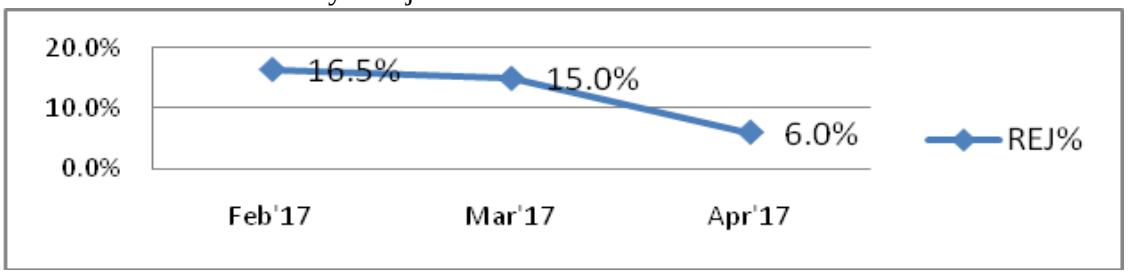

Fig.12 After analysis rejection trend

2. FUTURE STATE VALUE STREAM MAP Appendix attached

3. CONCLUSION:

Research conclusion

Lean Manufacturing is applicable for all the type of the organization irrespective of their size, lot of work has been carried out in manufacturing sector that to in different functional areas, the level of implementation varies across the sectors & their size.
Conclusion of this study reveals that the successful Lean Manufacturing System implementation needs integration & simultaneous implementation of Lean elements along with proper sequence. Thus the proposed implementation structure reduces the implementation duration & reduces manufacturing system divergence. As a result it is proposed that the Lean Manufacturing System can be sustained in competitive business environment.

Case study conclusion

Conclusion of the study is that after detailed analysis, VSM & Kaizen technique is successfully implemented in post production processes of Junction Box manufacturing with the reduction in lead time from 30.33days to 21.14days.

8. REFERENCES

- J. Dinesh, A. Prabhukarthi, “Reduction Of Lead Time Using VSM In Pump Manufacturing Industry”, Proceedings Of The National Conference On Manufacturing Innovation Strategies & Appealing Advancements, April 19, 2013.

- G.Saranya1, Mr. S.B. Nithyananth, " Improvement Of Crankshaft Assembly Supply Chain Using Lean Techniques-A Case Study", IJMER , Vol.2, Issue.2, Mar-Apr 2012 Pp-403-406.
- R.M. Belokar & Vikas Kumar, " An Application of VSM In Automotive Industry: A Case Study," 2012. IJITEE, July-2012, pp 152-157.
- Ramnath B.V., Elanchezhian C. & Kesavan R.(2010), Application of Kanban system for implementing lean manufacturing (a case study),JERS/Vol.I/Issue I/July-Sept. 2010/138-151.
- Maria Elena Nenni1,Luca Giustiniano2 & Luca Pirolo2. Improvement of Manufacturing Operations through a Lean Management Approach: A Case Study in the Pharmaceutical Industry. Int J Eng Bus Manag, 2014, 6:24 | doi: 10.5772/59027 PP1-6.
- Taho Yanga, Yiyo Kuob, Chao-Ton Suc, Chia-Lin Houa. JFMS 34 (2015) 66–73
- Jafri Mohd Rohani,Seyed Mojib Zahraee Procedia Mfg Production line analysisvia VSM:alean Mfg.process of color industry.2nd,MIMEC2015,4-6 Feb'15,Bali Indonesia,PP-6-10.
- D. Rajendrakumar & R. Gowtham Shankar, "Analyzing the Benefits of Lean Tools: A Consumar Durables Manufacturing Company Case study," IJ of Engineering, 2011.
- K. P. Paranitharan, "Redesinging an Automotive Assembly Line Through Lean Strategy,"
- International Journal of Lean thinking, 2011.
- Praveen Saraswat, Deepak Kumar & Manoj Kumar Sain, Reduction of work in process
- Inventory & production lead time in a bearing industry using VSM tool (IJMVSC) vol. 6, no. 2, june 2015, PP27-35.
- Rumbidzayi Muvunzi, Catherine Maware, Simon Chinguwa, Mwodzacaspah, "Application Of Lean VSM To Reduce Waste & Improve Productivity: A Case Of Tile Manufacturing Company In Zimbabwe", IJOAI in Engineering & Management, Volume 2, Issue 7, July 2013.