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Improving Efficiency of Grain Processing Industry through value Stream Mapping (VSM) – A Case Study

K. Ram Prasada[1], M. Nishala[2],Varun. V V[3]
[1,2]Assistant Professor, Sri Venkateswara College of Engineering, Pennalur, India
[3]Sri Venkateswara College of Engineering, Pennalur, India
varun.vv19@gmail.com[3]

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Abstract
Lean manufacturing technology is known widely for continuous improvement in productivity and also the quality of the product. This paper deals with lean implementation in the grain processing industry. Value Stream Mapping (VSM) is one of the primary lean tools which can be used to identify opportunities for improvement in a production flow process. All the process information related to the processing of grain is collected and a VSM for current state is developed showing the current operating status of the rice mill. Then the '5 whys' methodology issued and the root causes are determined using Fish bone diagram (Ishikawa diagram). A total of five root causes are determined which form the major problems in the rice mill. These five causes are then solved and a value stream map for future state is then developed showing the increase in overall efficiency of the process. This study will assist as a guide for the future implementation in lean activities and will help in improving the betterment of the rice mill when done on a large scale.

Keywords; *Value Stream Mapping, Fishbone diagram, Cycle time*

I. INTRODUCTION

In global market the organization are developing their manufacturing strategies to meet the important challenges that is efficiency of the system and competiveness in the market [1].

Due to the challenges and competitiveness prevailing in industries to meet for Quality and customer satisfaction, the companies are striving hard for process improvement in all areas of their operations.

Improvement in a process line can be induced through lean manufacturing, six sigma, value stream mapping [2] and flexible attitude towards change by employees. Many authors insisted the needed for applying process improvement methodologies for the benefit of manufacturing firms. For example, Bhim Singh, [3] applied lean manufacturing concepts in building sector. Results of the study indicated that of the total work, value adding activities was increased by 31% through lean activities, have reduced production errors by 44% and 58% decrease in the waiting time. Graves.R, and S.G. Li, Y.L. Rong [4,5] study pointed out the benefits obtained by a healthcare sector through application of six sigma for quality. Results show that the quality and process in health care industry can be improved exponentially. Also the patient waiting time can be decrease to certain level. This could help in designing a new model for this sector, also could be used to optimize the staff and patient experience with respect to their influencing factors.

Womack (2006)be certain of that value stream mapping is an important and essential for the people opting for continuous improvement in order to progress sustainably and go against muda. It is a

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visual tool which could document the material flow and information flow within a process to identify the areas for continuous improvement and to eliminate the wastages (Nash and Poling, 2011). In this current scenario the application of VSM is not restricted not only to manufacturing and supply chain (Forno et al., 2014).Also to process industries and service sector are adapting for implementation of VSM (Jeyaraj et al., 2013). Lai et al. (2008) proposed a framework having VSM as a base. The frame work integrates life-cycle environmental input analysis, total cost analysis, and an energy consumption analysis. Kurdve et al.(2011),made a different attempt by going E-VSM that is adoption VSM, at Volvo PentaVara and Volvo Construction Equipment Braas. Folinas et al. (2014) took food industry for application of VSM. Brown et al. (2014)did a detailed examination to demonstrate the scope of VSM. Applicability of sustainability –VSM tool was established with the help of three case studies. The fitness and limitations of VSM tool in assessing and visualizing sustainability performance in different manufacturing systems were also studied in detail. Faulkner and Badurdeen (2014) suggested a synoptic methodology for developing Sustainable Value Stream Mapping. It was developed by identifying suitable metrics of the process and presenting them visually.

For the past decade, there have been numerous reports to enhance organization's process. But, still lean manufacturing is considered as the most sought methodological approach because of its simple structure for easier application and easy monitoring. Lean manufacturing aims at non-value added activities and its continuous elimination. It focuses towards maximization of value added activities through cost reduction. In general, wastes are activities which adds only costs to the product but do not enhance its values. These activities are the ones for which the customers do not wish to pay for [14]. Several lean manufacturing tools and techniques have been currently used such as visual control, 5S, value stream mapping, and Kaizen. Of these entire tools, kaizen has been the most preferred for various firms. The word originated from Japan where "Kai" means change and "Zen" means good or for the better. Generally, Kaizen refers to continuous process improvement. It involves all employees from the top to the bottom of the process including people who are working in assembly line.

The implementation of lean in a company usually has five steps: 1) Defining from customer's perspective what value is? 2) Identifying the value streams, 3) Achieve Process flow, 4) Using Pull system to schedule production and 5) Achieving perfection through continuous improvement. Value stream takes into account both value added and non-value added activities which are needed for a development of product. Various tools and approaches such as Just-In-Time (JIT), Total Productive Maintenance (TPM) [18], Cellular Manufacturing and 5S [8] have been commonly used for lean application. Lean accounting, on the other hand, along with lean thinking as a coordinated approach provides administrators with information for decision making which are reliable and accurate. Hence it is important for strategic management approach to have implementation and control, of the lean system as new approach [14].

II. LITERATURE REVIEW

JafriMohdRohania, SeyedMojibZahraee (2015) said that Value stream mapping (VSM) was first found in Monden's 1993 "Toyota Production System"(TPS)book.TPS said about circulation kanbans with symbols that resembles VSM. Since then VSM has been finding its application in many sectors. Lean value stream mapping (LVSM) is an emerging tool which has been applied extensively in many areas. Inspite of its success VSM also have some shortcomings when it is used for analysing complex processes where there are different stakeholders and the values are largely intangible.

TeemuToivonen et al, (2016) have emphasized on the fundamental lean principles which were used for construction of VSM by identification and

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elimination of wastes. Based on the inference from future VSM, the results indicated that by implementing lean techniques, Production Lead-time (PLT) decreased from 8.5 days to 6 days, and the value added time decreased from 65 minutes to 35 minutes.

JafriMohdRohani&SeyedMojibZahraee, (2015) studied the implementation of VSM in a glass manufacturing industry. Using E-VSM method, the current facility design was studied by evaluating its performance and based on the observations; several strategies were developed for reducing cost of production and consumption of energy. A case study of cover glass manufacturing facility was also discussed which shows that environmental lean strategies helped to reduce both emission and production costs.

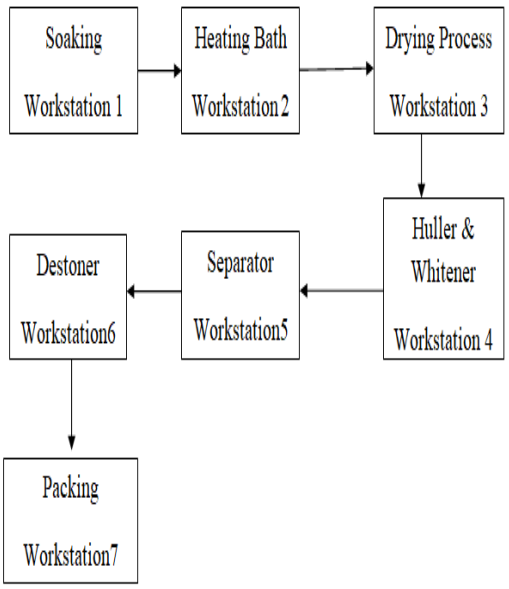
Yuchu Huang & Masayoshi Tomizuka, (2017) studied about adaption of lean principles in a large integrated steel mill. The primary tool used being VSM helped to identify opportunities for lean technique and a simulation model was created to show the "before" and "after" scenarios in detail.

FawazA.Abdulmalek et al, (2007) used VSM process symbols to discuss lean implementation process. Current state VSM prepared using VSM symbols depicted the existing status of the selected manufacturing industry and improvement areas were clearly identified. Current state map was analysed completely and the suggested improvements were incorporated in future state map prepared. Bhim Singh et al,(2010) States that VSM tool incorporates the data for each machine cycle time, utilization time, available time, transfer time and change over time. It also lets us to separate the lead time as value added and non value added which includes the inventory transfer, flow information of raw material to finished product and requirement of man power.

Bhim Singh, Suresh K. Garg et al, (2010) said that Overall Equipment Effectiveness (OEE) is a hierarchy of metrics that focuses on effectively utilizing manufacturing equipment. Results thus obtained in generic form assists in comparison against benchmarks defined for the respective industry. They also discussed about the possible comparisons that can be made in between shifts, products, machines, departments, lines and plants etc.

III. STUDY OF CURRENT PROCESS

Understanding the process- This is the initial stage in the improvement process. The basic concepts and process at each processing line should be carefully noted by visual observation for proper understanding of the process. The following observations should be made for productivity improvement- Working methods, Tools used, Process flow, Number of workstations& their purpose, Sequence of operation, Number of operations at each workstation. The basic rice milling process is shown below



Time study- The quality of the product lies in the accurate time measurement of each activity. It is important to learn how to measure and record time. Time reflects the method of action. Hence, we need to study the working condition of each process. When measuring work time to prepare standardized work, work units to be measured vary depending on

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operations. In standardized work, it is necessary to measure both manual and auto or machine time.

Value stream mapping (VSM) it works as important and prominent tool, it works in three phase system. [19].Visiting through the entire production line of a specific variety with the help of those data the first phase for creating current state mapping is done. Then, a Future State map is created for waste identification and its root causes are found through process improvements. Suggestions are put forth, which could have a greater financial impact to the process. The improvements thus suggested are then carried out, through process kaizen (continuous improvement) and pokayoke [19].

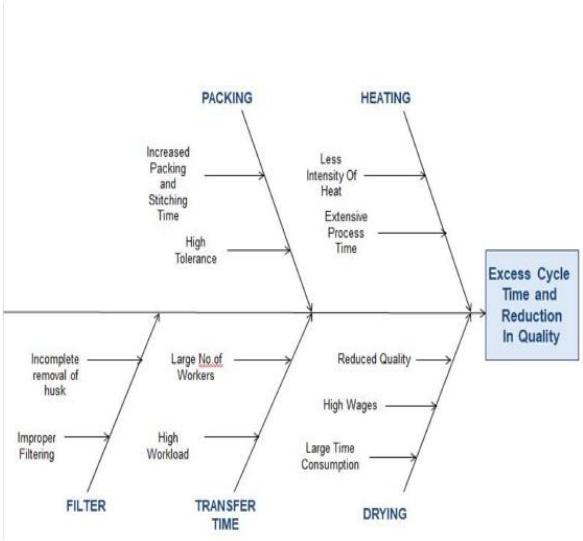
VSM Implementation and Kaizen: To optimize the production line continuous improvement tool kaizen is set in motion, detailed study has been done with the help of VSM. Thus any anomalies with the production line can be easily identified and abnormalities in any of the manufacturing cell could be identified as area for improvements. Thus the continuous improvement could be in motion to correct or improve the areas in the production line. In turn it could help us to achieve the improvements to be identified in the future VSM without any interruption and delay.

IV. OPERATION TIME FOR EACH PROCESS

S.No	Process	Workstation	Operator	Cycle time
1	Soaking	WS 1	O 1	20
2	Heating Bath	WS 2	O 1	8
3	Drying Process	WS 3	O 2	20
4	Huller &Whitener	WS 4	O 3	10
5	Separator	WS 5	O 4	5
6	Destoner	WS 6	O 5	5
7	Packing	WS 7	O 6	4

Fish Bone Diagram

Ishikawa diagram shown below states the causes and effects of each of the major problems experienced in the industry. Addressing these problems can help to minimize the cycle time and thereby increasing the efficiency to a considerable amount. This helps in increasing the production of the rice and reducing the damaged goods..



V. CURRENT STATE VSM

The current state VSM and operation table for the process carried out gives an idea about the possible areas of improvement in the process flow.

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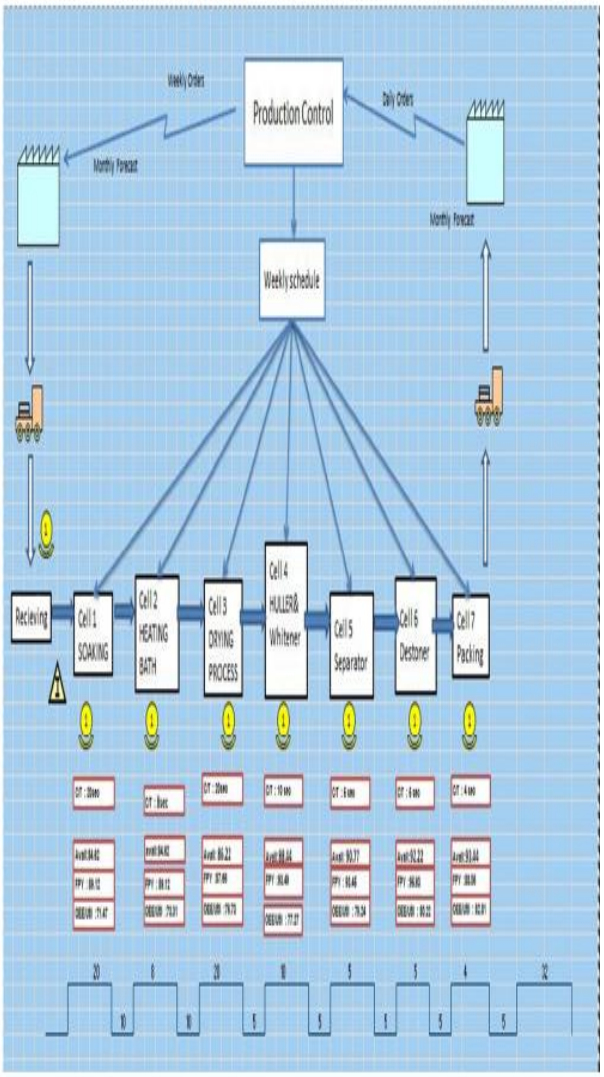

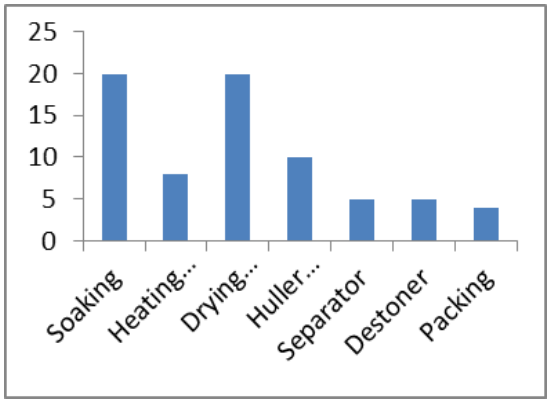

VI. AREAS OF IMPROVEMENT

From the Current state VSM, the following observations has been made for further improvements in the assembly unit

a. Soaking& Heating Bath:

In the workstation 1 & 2, the **SOAKING &HEATING BATH** are performed separately which leads to more cycle time and also motion waste occurs due to the movement of the worker from workstation 1 to workstation 2.Alsothe intensity of the heat that acts on the paddy after the soaking process is very less and hence is not effective.

b. Drying Process:

In workstation 3, the **DRYING PROCESS**, the time consumed for this process is very high as the work can be done only during sunlight. The number of workers involved in this process is also a large amount as they need to help in speeding up the drying process and this result in high wages being paid.

c. Packing:

In workstation **7 PACKING**, the main cause is increased packing and stitching time as it takes a lot of time for a person to do the job and the excess of labor will lead to unnecessary costs.

VII. PROCESS IMPROVEMENT METHODOLOGY

Kaizen is considered as an important pillar of Lean concepts, kai means change and zen means good that is continuously to adapt or search area for betterment. Kaizen is to look out for continuous change for improvement within the system with the involvement of different levels of employees in an organisation. Thus leading with different levels of employees to identify waste, analyse, eradication of waste and unnecessary work in a system. The causes identified using fishbone diagram are rectified by using Kaizen in the following workstations

Workstation 1 &2: **Soaking& Heating Bath**

Less intensity of heat after the soaking process is improved using a simple air blower. The blower is connected to a motor and it is used to speed up the heating process which reduces the cycle time to a large extent. Wastes due to transportation from one

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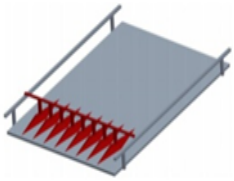
workstation to other is also reduced by implementing 5S principles and it has shown a greater improvement in OEE from an average of 70.53 to 74.23 for two workstations

Workstation 3: **Drying Process**

The main cause of higher time consumption and this is solved by fixing MS plate as shown below onto a slab and kept under direct sunlight to absorb heat. The rice is thrown onto the bed and a lever connected to a motor is used to operate the part which moves to and fro acting as the replacement for workers moving over the slab and thus heating all the rice in a quicker and less expensive manner. The cycle time is now calculated to be 16 seconds which is reduced from 20 seconds.

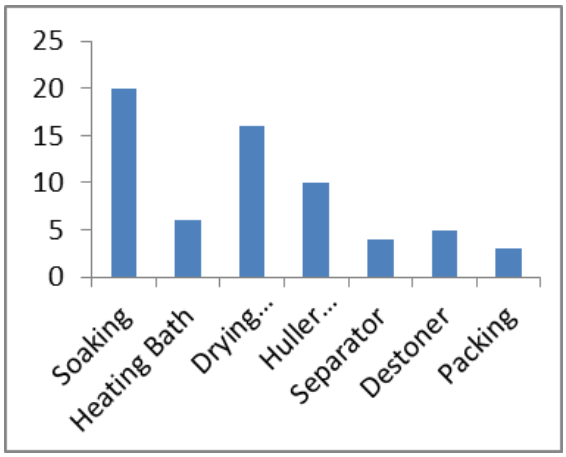


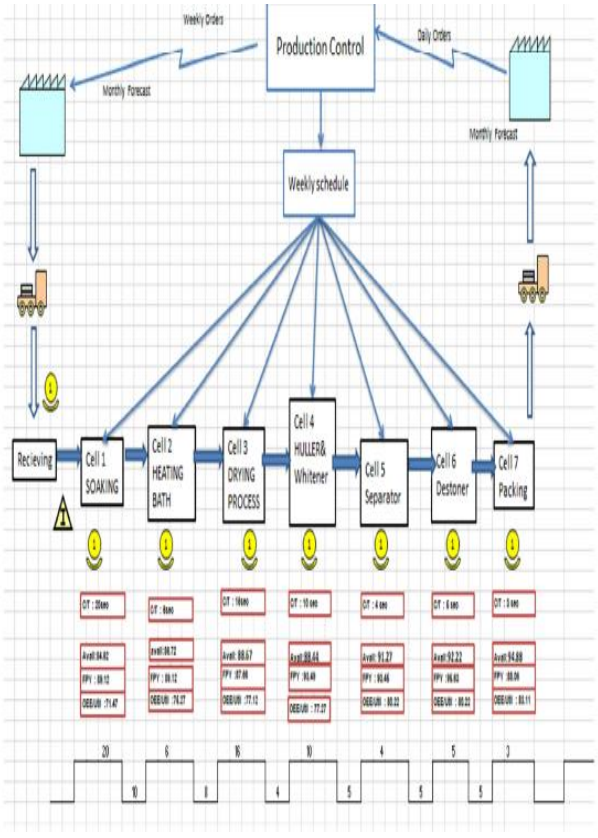
Workstation 7: **Packing**

The root cause here is the increased time consumption as the worker needs to hold and pour the rice into the bag and then tying it up with the help of a string or rope. This difficulty is reduced by means of a packing machine setup where the rice falls down from a hopper and a bag is placed in the opening. Once the bag is filled a lever is pushed to clamp the bag into place and it is held in that position which makes it easier to stitch the bag. The bag is then dropped by releasing the lever. This has resulted in reduced cycle time from 4 seconds to 3seconds and increased availability of the machine.

Future state VSM:

From the current state mapping we could identify areas for improvement which then incorporated within the mapping which could reduce the overall required time said as future state map. To develop a future value state map certain aspects to be followed, customer demand to be measured in terms of time that is called TAKT time which needs to be weighed against cycle time. Available working minutes in a day divided by number of products required per day by the customer. In general takt time is calculated monthly but this differs with respect to each product and policy of a company. Cycle time is the process time of a single process which also includes setting time, machining time, removing time, transfer time. Different machining process have different cycle time this could be shown in a bar chart, this also shows the area in which improvements can be done whether to split up a process or group them together.





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This future state value stream map consists of the changes made to the current processes which have been reflecting on the output obtained and increased efficiency. The OEE thus calculated has been used to draw the future value stream map

Revised Operation Time Table:

S no	Process	Workstation	Operator	Cycle time
1	Soaking	WS 1	O 1	20
2	Heating Bath	WS 3	O 2	4
3	Drying Process	WS 4	O 3	16
4	Huller &Whitener	WS 5	O 4	10
5	Separator	WS 6	O 5	4
6	Destoner	WS 7	O 6	5
7	Packing	WS 8	O 7	3

VIII. DISCUSSION

The results thus obtained, clearly shows that the OEE has increased for 4 workstations and the Takt time for the entire unit has also been improved.The revised Operation table for grain processingshown above indicates that using VSM, the cycle time for the following workstations has been improved

Workstation	CT before VSM	CT after VSM
WS 2	6	4
WS 3	20	16
WS 7	4	3

IX. CONCLUSION

The purpose of this research is to incorporate the study of the system using current state mapping and with the future value stream map in the grain processing organisation to identify wastages which dint contribute any set of value to the end product. This could be achieved with the reduction in cycle time and improving OEE which can increase the efficiency of the overall process. With respect to the future value stream mapping the end results shows that with the help of principles like Kaizen, JIT and OEE we can reduce the downtime and the cycle time of the process to a considerable amount. More investigation can be done by conducting more in depth research of VSM integrated with computer simulation to verify the proposed VSM method.

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