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IMPLEMENTATION OF 5S, A LEAN MANUFACTURING TOOL TO REDUCE WASTE IN SMALL SCALE INDUSTRIES- A CASE STUDY

P.M. Rojasara*1

*1Lecturer, Mechanical Engineering Department, Government Polytechnic, Rajkot, Gujarat, India.

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ABSTRACT

Small Scale Industries plays a vital role in Economy of India. It has emerged as powerful tool in providing larger employments after agriculture. It contributes more than 50% of industrial production in value addition terms and generate one third of the export revenue. Global markets are continuously changing and demanding products of high quality at low cost. Lean manufacturing, a management philosophy can help to produce a product of high quality at low cost by reducing all types of wastes at all levels of product manufacturing. 5S, a basic Lean manufacturing tool for cleaning, sorting, organizing and providing necessary ground work for workplace improvement. This paper deals with the implementation of 5S methodology in Wellmake Technocast Pvt. Ltd., Rajkot, Gujarat. Out of the available various lean manufacturing techniques, 5S offers good potential for required improvement. Eight week study is carried out in the case company. The results after the 5S implementations states that production system efficiencies improved from 61.64% to 89.28% in the successive week.

Keywords: Lean Manufacturing, 5S, Analytic Hierarchy Process (AHP).

I. INTRODUCTION

To remain in business arena it is of upmost important to win hearts of customer though quality and cost of the product or service. It is also crucial to have sustainable production with continuous improvement. The present need of the organization is to deliver high quality product through continuous improvement at lower cost. [1].However, manufacturing organization throughout the world is under great pressure to reduce the cost and meet the challenge of maintaining global quality standards [2]. Lean Manufacturing is the hymn of survival and success of any organization through minimizing the wastage of resources. Moving towards implementation of lean manufacturing has become one of the key strategies to achieve cutting of cost. The goal of lean manufacturing is to minimize all types of non-value added activity (waste) through incorporating less human effort, less inventory, less time product development time and less space to become highly responsive to customer demand, while at the same time producing good quality products in the most efficient and economical manner.

The aim of this paper is to implement 5S methodology and measure the performance improvement in Wellmake Technocast Pvt. Ltd., Rajkot, Gujarat. 5S is Lean manufacturing tool for cleaning, sorting, organizing and providing necessary ground work for work place improvement. 5S is already selected using Analytic Hierarchy Process (AHP), a Multi Criteria Decision Making (MCDM) tool by considering different criteria for case company. AHP is a problem solving framework based on the innate human ability to make sound judgment about small problem. It is a quantitative technique use to facilitate decision that involves multiple competing criteria (Saaty T.L., 1990). Poor workplace conditions may lead to rising of wastes such as time spent in searching for needed items or motion to avoid obstacles. It may also lead to raising an accident. Implementation can be started by establishing good workplace and housekeeping conditions. 5S is lean manufacturing tool for work place organization and it is fundamental to the implementation of lean strategies. 5S is a reference to five Japanese works which described standardized clean up. The 5S are: (ReVelle 2002). In this paper I focused on 5S system, which make us able to understand the improvement criteria for particular S of 5S system.

II. LITERATURE REVIEW

Chakraborty et al. (2011) studied the critical problems facing by small scale industries while selling their product. SSE (Small Scale Enterprise) is not having huge financial backup and therefore they are depending upon the revenue eared after selling their product. The product sales can only be increased by reducing the cost of the product.

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Upadhye et al. (2010) studied the importance of small and medium scale industries in Indian context. Medium size manufacturing industry plays an important role in Indian economy. Their contribution to the economic development of the nation is indeed significant. But the productivity level of these industries is quite low as compared to other country.

Palaniappan (2010) described the performance and benefits of small scale manufacturing industry in India. Small scale industries form an important sector constituting 40% of the total output to the privet sector and much more significant is the employment generation capacity of small scale sector.

Chauhan et al. (2010) shows the problem to sustain in global market for an organization. Lean manufacturing is hymn of survival and success of any organization. The goal of lean manufacturing is to minimize all types of waste so cost of the product can be reduced.

Hudli and Inamdar (2010) described the development of key areas which could be used to assess the adoption and implementation of lean manufacturing practice also presented some of the key areas developed to evaluate and reduce the most optimal project so as to enhance their production efficiency.

Lucas et al. (2010) focused on implementation of lean on small manufacturer of all 4-wheel drive vehicles, through implementation of basic lean tool, the small manufacture rapidly increase output and reduce quality defects by 80%.

Dalgobind and Anjani (2009) presented methodology for determining the real problem associated with industries in implementation of lean. They also presented selection of required lean tools in the light of company's long term vision.

Kumar and Kumar (2010) described the steps undertaken for the implementation of 5S emphasizing on the benefit of an organization. Also described the initiation and benefit of implementing the 5S.

Gheorghe (2008) presents a continuous improvement strategy aiming to improve manufacturing at Auto car Exhaust. The implementation of 5S has immediate and significant effect on the sequence of activities in the work post, thus influencing the performance of process in the analyzed company.

Khedkar et al. (2012) worked on implementation of 5S on plastic moulding industry. 5S is used in small industry and also showed the advantages and benefits of 5S implementation.

Prashant koli (2012) presented the methodology for calculation of each S in 5S system.

A study was conducted at Sunmill industry Pvt. Ltd. MIDC by R.A.Pasale et. al. (2013) to improve the organization standard in terms of manufacturing. The major problem was the time taken to setup the machine was more than actual machining cycle time. This occurred due to misplaced tools, fixtures and improper material. To decrease the finding time of the tool, author introduced the sorting concept of 5S. In this, they differentiate various tools according to the machining sequence processes. They introduced numerous "bins" to solve the lost material issues. They set the order of material of operation and jig fixtures according to the operation held. After the implementation, they observed the time taken for setting up the fixtures was shockingly differed from the initial one. The average time taken to set up the fixtures was 98 minutes before implementation. However, after implementation the time was drastically declined to 76 minutes.

P. M. Rojasra et al (2013) described the development of key areas, which could be used to adopt and implement the lean manufacturing practice and also presented some of the techniques to evaluate and reduce the resources needed on projects resulting in enhanced production efficiency [8]. The prime aim of this study was to implement 5S methodology and measure the performance improvement in Krishna Plastic Company, which is a small-scale industry situated at Amreli, Gujarat. It shows that a small manufacture can rapidly increase output and reduce quality threats by 80%. Also, it presents methodology for determining the real problem connected with industries in implementation of lean. Author also presented selection of required lean tools in the light of company's long-term vision.

III. RESEARCH METHODOLOGY

Poor workplace conditions may lead to rising of wastes such as time spent in searching for needed items or motion to avoid obstacles. It may also lead to raising an accident. Implementation can be started by establishing good workplace and housekeeping conditions. 5S is lean manufacturing tool for work place organization and it is fundamental to the implementation of lean strategies. 5S is a reference to five Japanese works which

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described standardized clean up. The 5S are: (ReVelle 2002).

In this paper I focused on 5S rating system, which make us able to understand the improvement criteria for particular S of 5S system. Here we give total rating of 25 score, which is divided in five equal parts for each S of 5S system. We give highest 5 marks to each S. After that we will make a graph which will make us able to understand the efficiency and make able to do better improvement. The detail and calculation of each S is given bellow.

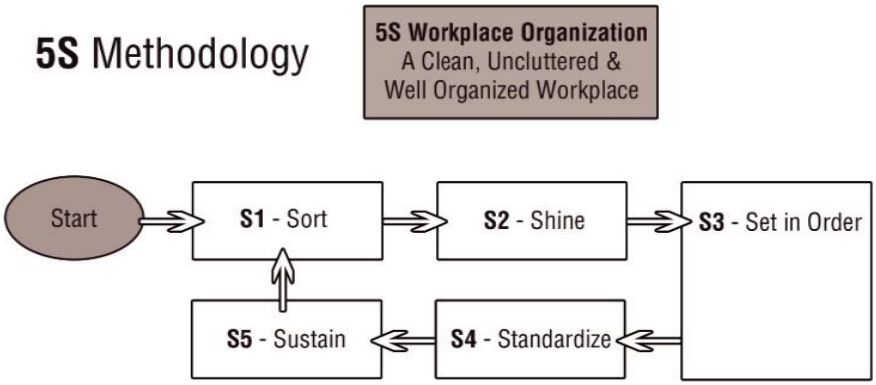

Figure 1: The 5S system

S1 Seiri (Sort)

Seiri is the first S in 5S system, which is basically deal with the availability of materials and process of product manufacturing. For calculation of Seiri rating, we allot 5 criterion regions for seiri arrangement, and decide that the sub system should achieve minimum 3 marks out of 5 because it tends us to define that the system will be in issue when it is above 50% active. Following are the Seiri rating criterion.

(1)Material availability

Give 1 mark if material is fully available or give 0 marks if material is not fully available.

(2)Defective goods

If there are X items which contains Y items as defective Then the marks will be

Fraction of fine goods = [1- {Y/X}]

(3)Operating condition

Operating condition is an important aspect for the arrangement of material and tools, because without the comfort of operator the best process arrangement also has zero value. Give 1 mark if operating condition is under control and give 0 marks if operating condition is not under control.

(4)Relative information

Relative information about working condition, process guidelines, tools information, material information etc., is also important for Seiri rating. Give 1 mark for full information and give 0 marks for partial information.

(5)Elimination of waste

Elimination of waste is also an important aspect for Seiri rating. Let total N no of wast are listed but only M were eliminated the marks of elimination process will be

Fraction of waste elimination = [1- {M/N}]

Now add all five marks and get total rating of Seiri out of 5. If the Seiri system will get less than 3 marks then do the arrangement again because if it is got below 3 marks it means it has very poor condition of analysis.

S2 Seiton (Set in order)

Seiton is second S of 5S system which deals with the proper arrangement of equipment and tools on the shop floor. The main objectives of Seiton are forming a regular workplace, avoiding time loss while searching the material and mistake proofing work. Following are the Seiton rating criterion.

(1)Sequence rating

Let there are A no. of tools are in proper sequence and B no of tools are not in proper sequence. Then sequence rating will be

Fraction of proper sequence = [1- {B/A}]

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(2)Material arrangement rating

This criterion basically deals with the providing of raw material and accessories for the particular operation. Let D be the lack of material and C be the total material required, then

Fraction of material available = [1-{D/C}]

(3)Tool arrangement rating: This criteria shows the consistency if the system about providing service for proper fulfilment of tooling requirement. Let P be the no. of irregular process and Q be the total no. of process.

Fraction of consistency to tool arrangement: [1-{P/Q}]

(4)Material arrangement consistency: The aim of this consistency is "every time perfect arrangement". Let U be the fail arrangement and V be the total no. of arrangement.

Fraction of consistency: [1-{U/V}]

(5)Working efficiency of Seiton system:

Working efficiency = working time for process / Total time allotted for process

Now do sum of all the above five criteria and note it as the rate of the Seiton system. This rate should have minimum value of 3 points, if not then system will set again or need analysis again.

S3 Seiso (Shine / Clean)

In order to realize effective tasks, it is essential to create a clean and regular working and living environment. This is because dust, dirt and wastes are the source of untidiness, indiscipline, inefficiency, faulty production and work accidents. We can handle cleaning practices by two approaches: "general cleaning of workplace" and "machine, hardware and tool cleanliness". Seiso process indicates the "Renovation of the work place".

Seiso system contents the following criteria:

(1)Is the machine clean or not : If the machine is clean then give 1 point and if not then give 0 point

(2)Process path clean: If the path of process is clean then allot 1 point and if not give 0 point.

(3)Proper environment for working condition:

Working environment include the ergonomics of the worker like proper souse of light and air, which makes the worker continuously fresh and energetic and make him stay away from errors during operation. Working condition rating will be Let J will be total aspect for favourable condition and I be the no. of fail arrangement.

Fraction of environment: [1-{I/J}].

(4)Cleaning consistency:

Let E be the total no. of cleaning required and F be the cleaning not done say inconsistency. So consistency rate will be Fraction of consistency = [1-{F/E}].

(5)Safety from accident:

Let K be the total no. of accident chances and L be the total no for accidents occurs. Then safety rate will be Fraction of safety: [1-{L/K}].

After adding all the above five criteria the rate of Seiso system can be recorded. This rate should have minimum value of 3 points, if not then system will set again or need analysis again.

S4 Seiketsu (Standardize)

Seiketsu is generally means for make a peak standard which should be achieve by the manufacturing process practice. Standard should be communicative and easy to understand. Seiketsu rating will be found by calculating the average of previous three S, because standard of any system will rise and fall by mean rate depending factors.

$$\text{Seiketsu(Standardize) rating} = \frac{\text{S1 rating} + \text{S2 rating} + \text{S3 rating}}{3}$$

S5 Shitsuke (Sustain)

Shitsuke (Sustain) is the last S of the 5S system which is deal with the regularity of maintaining the standard of the organization for the particular process, which is only done by regular practices and by following the proper instruction of machine operating. By doing regular following of accurate of instruction we can maintain the machine condition at its peak level, which may help for better production and stay away from breakdown.

(1)Removing small faults through the aid of cleaning.

(2)Providing the execution of visual control.

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(3)Providing the performance of protective activities.

(4)Granting the responsibility of the machine to the operator.

(5)Formation of a disciplined company.

Shitsuke rating will be depending on the previous four S because without that the regularity will not maintain.

Therefore Shitsuke rate will be the average of previous four S ratings.

$$\text{Shitsuke(Sustain) rating} = \frac{\text{S1 rating} + \text{S2 rating} + \text{S3 rating} + \text{S4 rating}}{4}$$

After the calculation of this rating of 5S, efficiency is calculated at the end of every week and will so the performance improvement at the end of four week. The overall efficiency of the 5S system for the permitted or approved period will be average of the particular efficiencies for required week. Also we will make a graph which will show the real condition of the system and can find the improvement required regi After the calculation of this rating of 5S, efficiency is calculated at the end of every week and will so the performance improvement at the end of four week. The overall efficiency of the 5S system for the permitted or approved period will be average of the particular efficiencies for required week. Also we will make a graph which will show the real condition of the system and can find the improvement required region.

IV. CASE STUDY

Investment casting is a manufacturing process in which a wax pattern is coated with a refractory ceramic material. Once the ceramic coating material is dry and hardened, the wax is melted out and leaves an internal cavity the shape of the final product's geometry. Molten metal is poured into the cavity where the wax pattern was. The metal solidifies within the ceramic cavity, cools, and the ceramic is removed from the metal casting. The result of this process is a net to near-net precision metal component which can be used for a broad range of applications in industries. . The industry considered for case study is Wellmake Technocast Pvt. Ltd., a small scale Investment casting industry. Summary of case organization is given bellow.

Table 1. Case Organization's summery

Industry characteristics	Detail about case organization
Industry type	Discrete
Industry sector	Manufacturing
Product	Industrial valve body, Defense components, Cryogenic components, Automotive components, Orthopedic implants etc.
Product type	Both critical components and Non critical components
Product volume & variety	High volume High variety
Company vision	Live up to expectation of customer through focus on research, technology up gradation and innovation
Company mission	To be amongst the topmost precision investment casting manufacturing company in the country through Quality, Price, Precision and Perfection

Table 2. S1 Seiri Rating

Week No.	Duration	Material Availability Rating	Defective goods Rating	Operating Condition Rating	Relative Information Rating	Elimination of Waste Rating	Total Rating
		0 or 1	[1-{Y/X}]	0 or 1	0 or 1	[1-{M/N}]	
1	06-04-2023 to 11-04-2023	1	0.20	1	1	0.2	3.4
2	13-04-2023 to 18-04-2023	1	0.40	1	1	0.2	3.6
3	20-04-2023 to 25-04-2023	1	0.40	1	1	0.4	3.8
4	27-04-2023 to 02-05-2023	1	0.60	1	1	0.4	4.0
5	04-05-2023 to 09-05-2023	1	060	1	1	0.6	4.2

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6	11-05-2023 to 16-05-2023	1	0..80	1	1	0.6	4.4
7	18-05-2023 to 23-05-2023	1	0.80	1	1	0.8	4.6
8	25-05-2023 to 30-05-2023	1	0.80	1	1	0.8	4.6

Table 3. S2 Seiton Rating

Week No.	Duration	Sequence Rating	Material Arrangement Rating	Tool Arrangement Rating	Material Arrangement Consistency Rating	Working Efficiency Rating	Total Rating
		[1-{B/A}]	[1-{D/C}]	[1-{P/Q}]	[1-{U/V}]	w.t./t.a.t.	
1	06-04-2023 to 11-04-2023	0.2	0.4	0.6	0.4	1.25	2.85
2	13-04-2023 to 18-04-2023	0.4	0.6	0.6	0.6	1.23	3.43
3	20-04-2023 to 25-04-2023	0.6	0.6	0.6	0.6	1.21	3.61
4	27-04-2023 to 02-05-2023	0.6	0.6	0.8	0.6	1.18	3.78
5	04-05-2023 to 09-05-2023	0.6	0.6	0.8	0.8	1.12	3.92
6	11-05-2023 to 16-05-2023	0.8	0.6	0.8	0.8	1.08	4.08
7	18-05-2023 to 23-05-2023	0.8	0.8	0.8	0.8	1.06	4.26
8	25-05-2023 to 30-05-2023	1	0.8	0.8	0.8	1	4.40

Table 4. S3 Seiso Rating

Week No.	Duration	Machine Cleanliness Rating	Process Path Cleanliness Rating	Working Environment Rating	Cleaning Consistency Rating	Safety Rating	Total Rating
		0 or 1	0 or 1	[1-{I/J}]	[1-{F/E}]	[1-{L/K}]	
1	06-04-2023 to 11-04-2023	1	1	0.2	0.4	0.4	3.0
2	13-04-2023 to 18-04-2023	1	1	0.4	0.4	0.6	3.4
3	20-04-2023 to 25-04-2023	1	1	0.4	0.6	0.6	3.6
4	27-04-2023 to 02-05-2023	1	1	0.6	0.6	0.6	3.8
5	04-05-2023 to 09-05-2023	1	1	0.6	0.6	0.6	3.8
6	11-05-2023 to 16-05-2023	1	1	0.8	0.6	0.6	4
7	18-05-2023 to 23-05-2023	1	1	0.8	0.8	0.6	4.2
8	25-05-2023 to 30-05-2023	1	1	0.8	0.8	0.8	4.4

Table 5. S4 Seiketsu Rating

Week No.	Duration	Total Rating (S1+S2+S3) /3
1	06-04-2023 to 11-04-2023	3.08
2	13-04-2023 to 18-04-2023	3.47
3	20-04-2023 to 25-04-2023	3.67
4	27-04-2023 to 02-05-2023	3.86
5	04-05-2023 to 09-05-2023	3.97
6	11-05-2023 to 16-05-2023	4.16
7	18-05-2023 to 23-05-2023	4.35

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8	25-05-2023 to 30-05-2023	4.46

Table 6. S5 Shitsuke Rating

Week No.	Duration	Total Rating (S1+S2+S3+S4) /4
1	06-04-2023 to 11-04-2023	3.08
2	13-04-2023 to 18-04-2023	3.47
3	20-04-2023 to 25-04-2023	3.67
4	27-04-2023 to 02-05-2023	3.86
5	04-05-2023 to 09-05-2023	3.97
6	11-05-2023 to 16-05-2023	4.16
7	18-05-2023 to 23-05-2023	4.35
8	25-05-2023 to 30-05-2023	4.46

Table 7. Efficiency of 5S system

Week No.	Duration	(S1+S2+S3+S4)*100 / 25	Efficiency
1	06-04-2023 to 11-04-2023	(3.4+2.85+3.0+3.08+3.08)*100 / 25	61.64%
2	13-04-2023 to 18-04-2023	(3.6+3.43+3.4+3.47+3.47)*100 / 25	69.48%
3	20-04-2023 to 25-04-2023	(3.8+3.61+3.6+3.67+3.67)*100 / 24	73.40%
4	27-04-2023 to 02-05-2023	(4.0+3.78+3.8+3.86+3.86)*100 /25	77.20%
5	04-05-2023 to 09-05-2023	(4.2+3.92+3.8+3.97+3.97)*100 / 25	79.44%
6	11-05-2023 to 16-05-2023	(4.4+4.08+4.0+4.16+4.16)*100 / 25	83.2%
7	18-05-2023 to 23-05-2023	(4.6+4.26+4.2+4.35+4.35)*100 / 25	87.04%
8	25-05-2023 to 30-05-2023	(4.60+4.40+4.40+4.46+4.46)* / 25	89.28%

V. CONCLUSION

The present paper demonstrates the implementation of 5S a lean manufacturing techniques in small scale investment casting industry. Lean manufacturing is one of the options to reduce non value-added activity (wastes) and improve operational efficiency of the organization. The efficient implementation of 5S technique leads to subsequent improvement in productivity of the industry. The 5S improves environmental performance and thus relate primarily in reduction of wastes in manufacturing. It promotes neatness in storage of raw material and finished products. The 5S implementation leads to the improvement of the case company organization in many ways for instance. (1) Better usage of working area, (2) Work environment improvement (3) Prevention of tools losing. (4) Reduction in accidents. (5) Reduction in accidents. (6) Reduction in pollution. (7) Discipline in the employee. (8) Increasing of awareness and moral of employee. (9) Improvement in the internal communication. (10) Improvement in the internal human relation. (11) Decreasing of mistakes through error proofing. Table no. 7 shows efficiency improvement from 67.64% to 89.2.8% through successive week.

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