ASSESSMENT BASED IMPLEMENTATION OF ‘5S’ TECHNIQUE IN TRANSFORMER MANUFACTURING FACTORY

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ABSTRACT

This paper presents implementation of 5S methodology in a transformer manufacturing factory. 5S is a step by step methodology to minimize waste and improve productivity at workplace. Providing place to everything and keeping everything in proper place is the main objective of 5S. Efficiency of equipment can be increased by implementing lean techniques such as Kaizen, 5S and TPM. Successful implementation of 5S increases the overall performance of production lines, warehouses, stores and offices. The main objective of 5S methodology in this factory was to overcome the problems arising from huge inventory, long searching time of tools, greasy workplace, unavailability of walkways and dirty environment in production as well as store area. To achieve the best working conditions in the factory area, 5S was implemented systematically. An assessment was carried out to check the performance of continuous implementation of 5S and results were plotted on time series using Minitab software. The implementation of 5S resulted in improved performance of operations, better utilization of workplace and a safe work environment.

Keywords: Implementation, 5S, Assessment, Performance, Efficiency, Inventory.

I. INTRODUCTION

In 21st century, industries are known by how agile and lean they are in their operations to survive in race of excellence. Organizations now need to recognize that they ought to increase their aggressive competencies in an effort to succeed within the markets nowadays [1]. The survival of both manufacturing and service industries may depend upon their ability to respond rapidly to the changes which may impact the product value. There is a broad variety of lean tools and philosophies available for every size of industry to get the opportunity to minimize the non-value added activities in order to improve the overall performance and business [2]. Lean is reduction of wastes in manufacturing, continuous improvement, process improvement and providing satisfaction to the customer by reducing lead time.

Grit Private Limited Lahore, a sub company of Albario Engineering Private Limited (AEPL), is producing distribution transformers for power supply companies in public and private sectors. Grit Manufacturing facilities are capable of producing distribution transformers of various types including oil immersed, coil type, dry type, power and auto transformers.

1.1 5S TECHNIQUE

The term 5S was originated from Japan and was initially introduced in early 1980s, while the actual 5S implementation was first carried out in 1991 [3]. Through effective 5S implementation, organizations can achieve best working conditions and optimized use of resources. Implementation of 5S in an organization helps meeting the requirements of clauses 7.1.3 and 7.1.4 of ISO 9001:2015. 5S tool introduced by Toyota production system and it is one of the most used management philosophy in automobile sector [4].
SORT

The first S of 5S Methodology stands for "Seiri" which is known as sorting. Saving and recovering space within the workplace is the main objective of Seiri. For this purpose, the company is divided into different small zones and each zone has its coordinator separately [3]. Unnecessary items and equipment are eliminated from the workplace, and red tagging is applied on selected items in Seiri. Red tagging contains all the information of item/equipment including name, specification, purchase date, material safety data sheet, etc.

SET IN ORDER

Seiton is the second S in 5S methodology which is known as set in ordering. In this step, each item is arranged and ordered according to their frequency of use. There are two main phases for the implementation of Seiton: first one is 'choosing appropriate place' and second one is 'identifying place'. Color coding, painting, and outlining strategies are used in Seiton [5].

SHINE

The third S in 5S methodology is 'Seiso' which means cleaning and sweeping of everything at workplace. The renovation of workplace is the starting phase for the 3rd rule of 5S. The shining and cleaning of tools and equipment in the workplace is not an easy task; it requires shining methods and right tools to avoid wastage of time.

STANDARDIZE

Standardizing the cleanup done in 'Seiso' is the fourth step in 5S methodology, which is 'Seiketsu'. Procedures and instructions-based standards are implemented at workplace in this step.

SUSTAIN

The fifth S of 5S methodology is 'Shitsuke' which means sustain, making it habit to properly maintain right procedures is the main objective of this step [3, 6]. Questions based assessments carried out to check the sustainability of performance.

II. LITERATURE REVIEW

Applying all steps of 5S in an organization is not a simple task; it is very tough and time-taking duty. Companies know that the main barrier to lean implementation is lack of knowledge and know-how. The non-lean companies do not follow the practices of lean because they cannot understand the gains and profit obtained by following the lean practices. This lack of understanding can be minimized through training sessions and visual management in workplaces [7]. Continuous improvements in an organizations not only depends upon lean tools but their effective implementation with committed management and team [8].

Methodology for the implementation of 5S within the various industries was discussed. It was noted that 5S implementation is very simple and easy to understand for all staff of company. To make our production system safe from environmental attacks, 5S is very useful [3]. A case study was conducted by researchers in MNC Samsonite Pvt Ltd, Maharashtra which is one of the leading manufacturers of luggage bags in India. All the 5S activities carried out and successfully increased the overall productivity. Different zones were compared before and after implementation of 5S. Time wasted by searching for tools and equipment from store was reduced after 5S technique. Inventory holding cost was also reduced by removing unwanted items from the workplace [9].

A framework was developed by researchers to implement 5S in the Food and Beverage industry. This company exports different types of products to 90 countries. Lean tools like 5S were implemented in this industry to keep up with the ongoing national and international competitors. A five steps methodology to implement 5S was determined starting from observation, questionnaire preparation, data collection, implementation, and
auditing. Four sections were identified and step by step 5S activities carried out all sections. Space and cost saving for all section was identified separately. Productivity comparison in results showed tremendous increase in production after successful 5S implementation [10].

Plant performance and economy of water circulation and are directly affected by lean practices. Water circularity system was improved by researchers without affecting the performance through 5S practices. Obtained results after 5S implementation showed that the lean circular economy (CE) leads to 45% less water usage with 20% increase in labor productivity at the same time [11]. 5S is very less expensive tool that will help an organization to develop a culture in which organizations grow progressively. A plastic water tank manufacturing industry in India was facing problems regarding rapid market change, less investment and competing with large scale industries. They pointed out that cost reduction and innovation in production can be achieved by lean tools implementation. An effective and step by step methodology for 5s implementation was prepared. Results were summarized by 10 weeks audit which based on assessment. The before and after condition at workplace was also summarized in table as comparison [12].

Agile companies not only focus on ISO series 9000:2000 standards but also comprise the tools and techniques of Total Quality Management (TQM). 5S technique is one of very common TQM concept. A case study was conducted by researchers in Asia commercial Bank Vietnam to check the importance of 5S methodology for the perspective of occupational safety and health. An effective and step by step framework for the implementation of 5S was implied by the researchers to achieve well-organize, healthy and safe workplace [5]. Classification and sorting of necessary and unnecessary materials at workplace is very important task for implementation of 5S methodology. Authors evaluated the performance after implementing 5S through assessment criteria. A graph had been drawn to visualize the evaluation of 28 weeks [13].

The applications of Environmental management system and 5S implementation are affected by commitment of leadership, participation of employee, trainings and regulations. In EMS, environmental aspects within organization are managed with obligatory compliance. The ISO 14001:1500 provides the codes for effective environment management through PDCA cycle [14].

5S implementation has great influence on occupational safety and health for any type or size of organization. All activities of 5S was applied in excavator manufacturing company to reduce wastes and optimize the production line. Results after implementation were assessed and modeled using structural equation modeling using AMOS 24 software. Researchers suggested that level of awareness among employees must be enhanced through daily and weekly training sessions [15].

A research was conducted in Transformer Manufacturing Company in North Carolina and they pointed out that the desired production rate was unable to achieve due to several reasons including work method, constraints, rework, uncontrolled scrap and poor storage arrangement. Value stream mapping was the tool used to identify wastes and various tools like 5S, Poke Yoke and Kanban system were used to eliminate these wastes [16]. Current state map and future state map was compared and the processing time of production line reduced from 78.31 minutes to 60.83 minutes. They successfully achieved reduction in lead time from 31.1 days to 19.3 days [17].

The evolution of 6S from 5S technique has occurred to achieve the compliance in additional safety awareness step. In this paper the advantages of 6S methodology in ink manufacturing industry were explored as a lean tool to mitigate the chances of accidents due to hazards. Researchers introduced two types of data collection methods for effective 6S implementation. During the implementation of 6S methodology, an audit for 8 weeks was carried out to ensure the safety, productivity and process improvement [18]. Organizations have followed the modern lean practices of 7S by focusing on safety and support from top to bottom management [19]. 5S technique focuses on the visual management to control the non-conformities process. Industries use many lean tools like 5S, Poke-Yoke, Kaizen to make manufacturing accident free and lean. In this research, the impact of accident was notified even after 5S implementation. It was concluded after reviewing literature that the internal audit is required time to time for assurance of performance [20].
Researchers developed a framework for implementation of 5S in manufacturing industry. This Malaysian manufacturing industry has a number of foreign workers who put their effort to develop the methodology for 5S implementation in said industry. The barriers to implementation were also discussed in this research and trainings were conducted to overcome these barriers. Researchers concluded that employee motivation directly depends upon organization culture, management role, employee involvement and trainings. After successful implementation, data analysis was performed to check the accuracy of results [21].

A crankshaft manufacturing company experienced all 5S activities. Company was not fulfilling the customer demand because of traditional layout and poor workplace management. The main objective of 5S implementation in inspection department was to improve the process flow, working environment and item searching time. They successfully reduced the non-value added activities and saved time up to 39.60% [22]. To increase the productivity of scientific equipment manufacturing company, 5S practices are applied in shop floor. First they developed a team and then data was collected through three different ways. They performed regression analysis for audit and quality assurance purposes. Bottleneck activities were removed after efficient implementation and improvement score reached to 72 from 6 in 24 weeks [23].

5S methodology was implemented in wire manufacturing company because company was not following the standardized workplace management and cleaning methods as a result heat treatment problems in process and vibration issues occurred in machines. The manufacturing plant was divided by three floors which include all the departments in it. The current state was observed and bottlenecks were isolated with the help of sort, set in order and shine process. Self-explaining visual management system improved the working conditions of system [24].

### III. METHODOLOGY

5S Practices require the support and commitment of top to bottom management for all through the organization. For successful implementation of 5S it is necessary to benchmark with companies having high productivity and success rate. 5S implementation requires the involvement of all the departments of company. All employees must be familiar with the advantages of 5S [25].

In first step, two zones were created. Zone 1 has the area of production line of transformer and zone 2 has store area. Leaders and teams of committed employees were created for both zones. A lean champion invited from 3rd party who had already implemented 5S successfully in many companies. Activities of IS was implemented in both zones and after successful implementation an audit was performed to discuss queries. Leader of each zone presented “before-after” photos to all team members. Remaining 4S activities implemented and audited as IS. After implementation of all activities of 5S, an assessment was performed by both leaders, and results were plotted on time series for ten weeks. 5S assessment has many questions and each question falls in very bad, bad, average, good and very good categories. 5S control list and scoring section have been shown in Table 1 and Table 2 respectively.

#### 3.1 ‘5S’ ACTUAL IMPLEMENTATION

First of all, sorting was carried out in both zones. Raw material, WIP and finished goods list was made in factory area. Tools & equipment are separated that were not in use or expired in store area. These separated and unwanted items were collected in red tag area and red tag card is attached with unwanted tool & equipment. The format of red tag cars is shown in Figure 1. The visual condition of workplace before implementation of 5S and results of sorting and set in order (first two 5Ss) are demonstrated in Figure 2.
Figure 1: Format of Red tag card

(a) Before  
(b) After

Figure 2: Unwanted items moved from machine shop area

Racks were introduced in store area and items were placed top to bottom depending upon the frequency of use as shown in Figure 3 and Figure 4. Each rack has its location number and each tool or equipment in that rack has its tool card as shown in Figure 5. Deep stocks must be avoided where FIFO is using.

(a) Before  
(b) After

Figure 3: Tools and equipment placed on racks
All the tools, equipment and machines in store as well as production area were cleaned by standard methods of cleaning. Also special walk ways were drawn in production area. All the machines including welding plants, lathe machine, punching machine, bending machine, testing ovens and core winding machines were cleaned by team members. Cleaning schedule of all the machines were developed by leaders according to the up-time of machine. Walkways were drawn on floor according to layout of production area. Figure 6 and 7 clearly show the cleaning and walkways drawn on floor.
5S awareness posters placed on different places of factory area and notice boards. To avoid accidents, mistakes and rework, standard operating procedures (SOP’s) were made for all electrical and mechanical processes involved in production line. Quality policies, safety awareness and risk assessments were placed on notice boards which were not used before as shown in Figure 8.

3.2 5S ASSESSMENT

5S assessment was carried out by team leaders of both zones to check and graphically represent the performance of execution on weekly bases. This assessment was started just after one week of implementation of all activities of 5S and continued for 10 weeks. This assessment-based audit helps an organization to get 5S certifications. 5S assessment scoring sheet format is shown below in table 1 and variation of recorded data for 10 weeks is shown in table 2. The data recorded in table 2 was collected by team leaders by ensuring the quality of implementation.
<table>
<thead>
<tr>
<th>SS No.</th>
<th>Control Point</th>
<th>Criteria of Assessment</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Material, Parts</td>
<td>Make sure there is no unnecessary material in stock.</td>
<td>0</td>
</tr>
<tr>
<td>2</td>
<td>Equipment’s, Machines</td>
<td>Machines and equipment’s are operated in regular daily bases.</td>
<td>1</td>
</tr>
<tr>
<td>3</td>
<td>Visual Management</td>
<td>Unnecessary items can be easily find and visualized. Red tags are used.</td>
<td>2</td>
</tr>
<tr>
<td>4</td>
<td>Disposal Standard</td>
<td>Standards are available to dispose unnecessary items.</td>
<td>3</td>
</tr>
<tr>
<td>5</td>
<td>Labeling</td>
<td>Labeling to determine regions and places.</td>
<td>4</td>
</tr>
<tr>
<td>6</td>
<td>Shelves with labeling</td>
<td>There must be labeling of racks and parts on it.</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Separation Lines</td>
<td>There must be clear and certain separation lines.</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Quantity</td>
<td>There must be marks on material in stock which shows the quantity.</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Grounds</td>
<td>Grounds at workplaces must be clear and shine.</td>
<td>0</td>
</tr>
<tr>
<td>10</td>
<td>Machines</td>
<td>Machines must be clean and well painted.</td>
<td>1</td>
</tr>
<tr>
<td>11</td>
<td>Control of Cleaning</td>
<td>Must be controlling of cleaning.</td>
<td>2</td>
</tr>
<tr>
<td>12</td>
<td>Habit of Cleaning</td>
<td>There must be a habit of cleaning among all employees.</td>
<td>3</td>
</tr>
<tr>
<td>13</td>
<td>Ventilation</td>
<td>Make sure air within the workplace is fresh and odorless.</td>
<td>4</td>
</tr>
<tr>
<td>14</td>
<td>Lightening</td>
<td>There is proper lighting.</td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>Clothes</td>
<td>Clothes of everyone must be clean from dust and any kind of lubricant.</td>
<td>0</td>
</tr>
<tr>
<td>16</td>
<td>Dirt Protection</td>
<td>Protection from dirtiness must ensure.</td>
<td>1</td>
</tr>
<tr>
<td>17</td>
<td>Rules</td>
<td>Rules and must be followed according to the given standards for all employees.</td>
<td>2</td>
</tr>
<tr>
<td>18</td>
<td>People Interaction</td>
<td>Training, meetings, practical exercises for sustainability. All department tours.</td>
<td>3</td>
</tr>
<tr>
<td>19</td>
<td>SOP, SOC</td>
<td>All SOP’s and SOC’s are known and applied.</td>
<td>4</td>
</tr>
<tr>
<td>20</td>
<td>Observation</td>
<td>Observation to check adaptation and application.</td>
<td></td>
</tr>
</tbody>
</table>

0 = Very Bad, 1 = Bad, 2 = Average, 3 = Good, 4 = Very Good.
<table>
<thead>
<tr>
<th>No. of weeks</th>
<th>Sort</th>
<th>Set in Order</th>
<th>Shine</th>
<th>Standardize</th>
<th>Sustain</th>
<th>Total score</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>3</td>
<td>4</td>
<td>7</td>
</tr>
<tr>
<td>2</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>6</td>
<td>9</td>
</tr>
<tr>
<td>3</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>7</td>
<td>15</td>
</tr>
<tr>
<td>4</td>
<td>4</td>
<td>2</td>
<td>6</td>
<td>7</td>
<td>9</td>
<td>28</td>
</tr>
<tr>
<td>5</td>
<td>6</td>
<td>2</td>
<td>7</td>
<td>7</td>
<td>10</td>
<td>32</td>
</tr>
<tr>
<td>6</td>
<td>7</td>
<td>4</td>
<td>7</td>
<td>8</td>
<td>10</td>
<td>36</td>
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<tr>
<td>7</td>
<td>11</td>
<td>11</td>
<td>6</td>
<td>9</td>
<td>10</td>
<td>47</td>
</tr>
<tr>
<td>8</td>
<td>12</td>
<td>10</td>
<td>7</td>
<td>8</td>
<td>11</td>
<td>48</td>
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<tr>
<td>9</td>
<td>11</td>
<td>10</td>
<td>8</td>
<td>9</td>
<td>11</td>
<td>49</td>
</tr>
<tr>
<td>10</td>
<td>12</td>
<td>11</td>
<td>8</td>
<td>9</td>
<td>11</td>
<td>51</td>
</tr>
</tbody>
</table>

### IV. RESULTS AND DISCUSSION

The overall productivity of transformer manufacturing and inventory management increased after the successful implementation of all steps of 5S methodology.

#### 4.1. Sorting:
Sorting enhanced the space in store as the scrap and unwanted items moved to red tag area as shown in Figure 2. Fixed asset and inventory lists were made that was nonexistent before. It resulted in identification of necessary tools. The performance of execution of sorting in factory from week 1 to week 10 can be seen in figure 9.

![Figure 9: Variation graph of 10 weeks of sorting](image)

#### 4.2. Set in Order:
Tools, equipment and consumables were not well arranged specially in store. Racks were installed in store and all the tools, equipment, consumables and related items were arranged in these rack depending upon the frequency of use as shown in figure 3, 4 & 5. Each rack and item in it labelled from A-1 to K-10. This caused to reduce the searching time of item from store and quick response to production requirements. Furthermore, the unnecessary tools were removed from the immediate vicinity of operations resulting in availability of more space. The availability of more space results in much safer working conditions with decreased chance of getting bumped into accumulated items around the workplace. From...
week 1 to week 10, setting in order activity was assessed every week and performance improvements can be seen in Figure 10.

**Figure 10:** Variation graph of 10 weeks of set in ordering

4.3. **Shining:** Cleaning workplace, machines, tools and floor from water, dust and lubricant will increase the effectiveness of process. Leakage of water or lubricant may cause slip accident and cleaning minimized chances of such accidents resulting in much safer and performance conducive conditions. It also extended the operating life of equipment and helped reduce emergency downtime arising due to dirt-clogged machines and equipment. Compliance for daily shining and cleaning process can be seen in Figure 11 throughout the 10 weeks.

**Figure 11:** Variation graph of 10 weeks of shining

4.4. **Standardization:** The continuity of all the activities of first 3S in daily bases was achieved by strict standard operating procedures (SOP’s). The fourth S brings process improvement and provides standard methods of execution depending upon the machines and layout of production line. The improvements with
standardizing can be seen in Figure 12. Rejection rate in final product was also reduced by developing SOP’s for material and inventory handling. This paved the way for long-term improvement.

![Variation graph of 10 weeks of standardizing](image1)

**Figure 12:** Variation graph of 10 weeks of standardizing

4.5. **Sustainability:** Expected results and targets were achieved by educating employees about adopting all 5S activities on daily bases. For sustainability of implementation, skip level meetings and tool box talks were conducted by managers and leaders directly with employees. The repeated cycle of first four steps of 5S resulted in more and more problems getting exposed and removed resulting in continuous and study improvement. The trend of sustaining for 10 weeks can be seen in Figure 13 which shows performance is increasing week by week.

![Variation graph of 10 weeks of sustaining](image2)

**Figure 13:** Variation graph of 10 weeks of sustaining

4.6. **Collective:** Collectively 5S weekly assessment score can be seen in Figure 14. From the figure it can be seen that outputs are started coming just after first week. The continuous improvements sustained
through 5S awareness and strictly following SOP’s. The main objective of plotting assessment score is to check and measure performance statistically.

![5S Score Variation Graph](image)

**Figure 14:** 10 weeks assessment score variation graph of 5S

### V. CONCLUSIONS

5S approach can be implemented in any size and in any kind of organization through simple trainings. In this study, 5S Methodology was implemented in a distribution transfer manufacturing facility and the following conclusions are drawn from this study:

- Sorting enhanced the space in store as the scrap and unwanted items were moved away from the workplace.
- Set in order caused to reduce the searching time of items from store significantly, resulting in quick response to production requirements.
- Shining resulted in reduction of potential accidents and improved the overall handling and effectiveness of tools and equipment. It further improved the process.
- Standardization prompted the SOP development. Rejection rate in final product was reduced by developing SOP’s (standardization) for material and inventory handling.
- Sustainability caused study and continuous improvement and utilization of workplace and tools/equipment.
- Development of a 5S Assessment scoring sheet provides a reliable way to assess performance improved achieved through implementation of 5S.
- Assessment based implementation of 5S is very helpful to check and compare progress of current state with initial state.
- 5S technique makes the material handling smooth by providing systematic arrangement of raw material, WIP and finished goods.
- In overall, 5S improved the process performance and equipment efficiency due to establishment of clean, neat and orderly workplace with better visual management.

### VI. REFERENCES


[8] Dhanashree, E., IMPLEMENTATION OF “5S METHODOLOGY” IN AN ORGANIZATION.


