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Implementation of 5s Methodology for Operational Efficiency Improvement

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Abstract: *The use of the 5S technique in improving operational efficiency in the small scale manufacturing sector in Durgapur, West Bengal will be the focal point of this research. The use of the 5S technique—also referred to as Sort, Set in Order, Shine, Standardize, and Sustain—in a mechanical workshop environment to address issues such as hazards, time spent looking for tools, improper workplace arrangement, and machine idling will be carefully carried out in solving the problems mentioned. The implementation process, which will take four weeks, will be preceded by a pre-implementation evaluation to determine baseline measures. Some of the improvements observed include increased efficiency of around 30-50%, reduced machine breakdown by 40%, and a saving of 70% of time spent on tool searching. Besides this, organized, cleaned, and standardized work environment led to great improvement in workplace safety and order. This shows that 5S can be considered as an inexpensive and effective way of increasing production, safety, and discipline in a factory setting. In addition to that, it provides a sound platform for implementing innovative lean manufacturing approaches such as JIT, Kaizen, and TPM..*

Keywords: 5S methodology, lean manufacturing, operational efficiency, productivity improvement, workplace organization

I. INTRODUCTION

Industrial firms continuously endeavor to maximize their productivity, reduce their cost of operations, and ensure high-quality products while adhering to safety regulations in the modern highly competitive manufacturing industry. Major production inefficiencies include messy workstations, unnecessary movement, excessive handling of materials, and lack of proper operating systems. Lean manufacturing practices are regularly applied to solve such problems and are known to include techniques like 5S, which is considered among the simplest ways to enhance efficiency. The lean manufacturing principles follow the 5S approach, which was developed in Japan as a part of the Toyota Production System (TPS). Sort, Set in Order, Shine, Standardize, and Sustain make up its five methodological processes. The guidelines, which eventually lead to higher productivity and less waste, focus on organizational, cleanliness, visual, and discipline factors [1]. The development of a clean, organized, and standardized workplace that encourages effective workflow and minimizes any unnecessary activities is the key objective of the 5S approach. With the purpose of minimizing cluttering and making more room available, the first step in the process is the sorting of unneeded items (Seiri). To ensure easy access to tools and materials, the second process, Setting in order, ensures a systematic process of organizing, reducing the time taken for searching and unnecessary movement significantly. The third step of 5S, which focuses on ensuring a safe and flawless workspace, emphasizes regular cleaning and inspection of equipment (Shine). The process of Standardization aims to create standard operating procedures and visual controls for consistency in the operations (Seiketsu). Finally, Sustain employs the elements of training, discipline, and monitoring of the whole process [2]. In the case of small- and medium-size companies, in which poor housekeeping, disorderly practices, and improper layout abound, operational inefficiencies are easily observable. In particular, workers have been observed to spend considerable time dealing

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with additional articles or locating tools. The inefficiencies mentioned earlier increase the risk of accidents and machine breakdowns, aside from reduced productivity levels. With improved discipline, enhanced visibility, and increased organization, 5S effectively addresses these issues by its very nature [3].Affordability and simplicity constitute among the biggest advantages of 5S. The implementation of 5S is not expensive, unlike the development of advanced technology, which requires huge amounts of money. On the contrary, 5S only requires proper management, behavioral changes, and participation of employees. It has been found through studies that successful adoption of 5S improves employee satisfaction, teamwork, and pride in the work environment [4]. In addition, 5S forms the foundation of other lean methods, which assist organizations to reach continuous improvement, such as Kaizen, JIT, and TPM [5]. Moreover, 5S plays a crucial role in enhancing safety and quality management. There will be fewer defects and contaminants in an organized and clean environment. Although regular cleaning and inspection help detect any abnormalities and machine issues, standardization ensures that all processes are consistent. Hence, there will be no need for rework, customers will be more satisfied, and quality products will be produced [6].However, despite its advantages, many organizations find it difficult to sustain 5S due to inadequate management commitment, insufficient training, and lack of regular assessment. Thus, the key to success lies in a well-planned implementation process, auditing, and employee participation. In an effort to gauge the impact that the 5S model may have on efficiency within operations, the current study will consider its effective implementation through the lens of a mechanical workshop. Evaluating the levels of productivity, safety, waste minimization, and organization within the operation before and after the introduction of the 5S model is the primary objective.

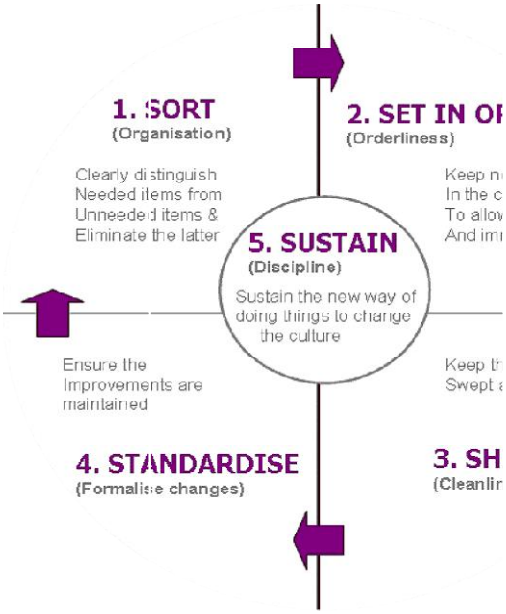

Fig. 1.1 5S Quadrant

II. MATERIALS & METHODOLOGY

To evaluate the effectiveness of the 5S method in improving efficiency in operations, the present study was performed in a mechanical workshop. This workshop contained traditional equipment like lathes, drills, and grinders, together with spaces for storing tools, benches for doing work, and rooms for handling materials. At the onset of the experiment, the workplace had problems related to lack of proper arrangement, inappropriate placement of tools, untidiness in the working area, and inadequate practices, causing more time spent on searching, inefficiency, and possible risks to safety[7]. In solving the problem, the 5S method was employed systematically. The required materials for implementing the method were readily available and affordable; they primarily focused

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on workplace arrangement and visualization.These included cleaning materials such as brushes and rags, storage shelves, tool boards, floor strips, marking pens, and color coding for visual management, red tags for labeling unnecessary tools, tool labels and stickers, and checklists for monitoring activities. The application of these technologies facilitated the performance of each stage of the 5S process systematically without any substantial capital expenditure at the beginning.The complete pre-implementation assessment of the workshop provided a basis for the application of the technique[8]. Data was collected through direct observation, personal interaction with workers, and time study analysis. In order to establish a benchmark against which improvement could be measured, key elements such as tool search time, machine downtime, space utilization, cleanliness, and safety were recorded[9]. The inefficiencies discovered in this preliminary analysis are the amount of time spent looking for tools, unnecessary accumulation of things, and the absence of consistent maintenance activities.Sorting (Seiri) was the first step implemented in this process which involved the identification and removal of unnecessary items from the place of work[10]. Anything that is not required to be kept within the workplace was tagged red and either thrown out or relocated to an appropriate place. This helped free up space as well as significantly reduce the number of cluttered areas in the work area. The second stage known as Set in Order (Seiton) involved the proper arrangement of the required equipment and tools. The entire working area was cleaned and examined under the Shine (Seiso) stage. Machines, the floor, and other parts of the factory were free from dust, oil, and any form of waste[11]. It was ensured that hygiene was kept to maintain a high level of cleanliness and detect any wear or leakage or any problem with the machinery in the early stages of production. This helped improve the overall efficiency of equipment and safety measures. After which the Standardize (Seiketsu) stage was introduced to ensure continuity of the first three steps. To ensure sustainability of adherence to 5S concepts, there came up the need for developing what is known as the Sustain or Shitsuke stage. It entailed continuous training, audit cycles, and continuous monitoring of workplace conditions[12]. Employee participation was encouraged as a way of instilling discipline. Workplace performance was measured through a standardized auditing process encompassing organization, standards, cleanliness, and overall effectiveness. The implementation was executed throughout four weeks, with every step being executed in sequence and monitored. Data collection was performed after the implementation based on the exact criterion as used during the initial evaluation. A proper analysis of improvements in efficiencies, reduced time wastage, improved safety, and overall productivity could easily be conducted based on pre-implementation and post-implementation data collection[13]. This systematic process ensured that the impacts of the 5S methodology were quantifiable and sustainable within the workshop environment.

Table2.1: Before and After Implementation (West Bengal Industry Case)

Parameter	Before 5S Implementation	After 5S Implementation	Improvement
Tool Searching Time	12–15 minutes	3–5 minutes	Reduced significantly
Machine Downtime	High	Moderate	Improved
Workspace Condition	Cluttered	Organized	Highly improved
Safety Level	Unsafe	Safer	Improved
Productivity	Low	High	Increased

Table 2.2: Key Performance Indicators (KPIs)

Parameter	Unit	Measurement Method
Tool Searching Time	Minutes	Time study
Machine Downtime	Hours/day	Maintenance records
Workspace Utilization	%	Area analysis
Safety Level	Rating	Inspection checklist
Productivity	Output/hr	Production data

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Table 2.3: Before and After Implementation (Case Study Data)

Parameter	Before 5S	After 5S	Improvement
Tool Searching Time	12–15 min	3–5 min	Reduced significantly
Machine Downtime	High	Moderate	Improved
Workspace Condition	Cluttered	Organized	Highly improved
Safety Level	Poor	Good	Improved
Productivity	Low	High	Increased

III. EXPERIMENTAL DETAILS

In order to gauge the impact of 5S technique on the efficiency of operations within the selected small scale industry located in Durgapur, West Bengal, an extensive empirical study was conducted. The employment of the 5S approach was the only factor that varied in the study; other parameters remained constant throughout the process, thus making comparison possible. Before applying the 5S technique, initial data was collected regarding the existing situation in the plant. Several variables such as tool searching time, machine down time, space utilization, safety conditions, and levels of productivity became part of evaluation[14]. For measuring those factors, methods of time study were employed as well as direct observation. It was found that operators used too much time for tool search, there was disorganization of the workshop, and tools were not systematically organized. Within four weeks, the 5S process was successfully completed. The first step was sorting (Seiri), which occurred in the first week. This was accomplished by identifying unnecessary objects and marking them for disposal, including scrap metal, broken tools, and unused machinery. The next stage was organizing (Seiton), done in the second week, where tools and supplies were systematically arranged in their rightful places[15]. Shadow boards, labeling shelves, and floor markings ensured that the place was organized and easy to locate.

Shine (Seiso) was achieved in the third week. This involved thoroughly cleaning floors, workstations, and machines. In addition, cleaning schedules were established and machine inspections combined with cleaning activities were done in order to detect any irregularities such as wear, misalignments, and oil leaks. To maintain consistency in work operations, SOPs, visual tools, and checklists were developed simultaneously with the implementation of the Standardize (Seiketsu) stage.To ensure continuous compliance with the 5S methodology, the Sustain (Shitsuke) stage was introduced at the final week of the implementation period. Monitoring, training, and auditing were conducted regularly. The workers actively participated in promoting discipline and ownership of their work environment.The same set of metrics was re-measured under identical work conditions after the implementation process ended. Data collected from pre and post 5S implementation were analyzed for comparison.

Table 3.1: Experimental Plan

Days	5S Stage Implemented	Key Activities
Day 1	Sort (Seiri)	Removal of unnecessary items using red-tagging
Day 2	Set in Order (Seiton)	Tool arrangement, labeling, shadow boards
Day 3	Shine (Seiso) + Standardize (Seiketsu)	Cleaning, inspection, SOP development
Day 4	Sustain (Shitsuke)	Training, audits, monitoring

Table 3.2: Observations Before and After 5S Implementation

Parameter	Before Implementation	After Implementation
Tool Searching Time	12–15 minutes	3–5 minutes
Machine Downtime	High	Reduced
Workspace Utilization	Poor	Efficient
Safety Conditions	Unsafe	Improved
Productivity	Low	High

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Table 3.3: Improvement Analysis

Parameter	Percentage Improvement
Tool Searching Time	~70% reduction
Machine Downtime	~40% reduction
Workspace Efficiency	~60% improvement
Safety Level	Significant improvement
Productivity	~30–50% increase

IV. RESULTS & DISCUSSION

The operational efficiency, organizational structure of work, and safety at the factory greatly enhanced after the implementation of the 5S system in the selected factory located in Durgapur, West Bengal. Pre- and post-implementation results of the experiment were analyzed for a comparison of the outcome. The following discussion highlights all enhancements that have been made after the implementation of the 5S system.Search time for tools has reduced drastically from 12-15 minutes to 3-5 minutes and hence, one of the major improvements. This reduction has been possible due to efficient placement of tools under Set in Order. Worker efficiency and reduction in idle time have been affected by the reduction in search time for tools. It thus becomes glaringly clear that the need for an effective work structure cannot be overemphasized if one wants to eliminate such activities that do not add any value to the business.One more important discovery was the reduced time for machine downtime. This happened because machines needed maintenance, cleaning, and inspection before being installed. With the help of Shine (Seiso), the process of inspecting and cleaning became easy. It led to the reduction of machine downtime by 40%. After the completion of the Sort (Seiri) step, there was an observed improvement in the workspace arrangement and organization. Items that were not necessary were removed to free up space, and the ability to locate things became easier because of the systematic organization. The workspace became organized and no longer cluttered.

The introduction of the 5S methodology drastically reduced hazards in the work environment due to safety conditions. Prior to implementing the 5S technique, unsafe working conditions existed because of slippery floors due to oil spills, loose items lying around, and poor housekeeping. After implementing 5S, the safety standard was improved through regular cleaning and proper storing of items. The productivity of the workshop has also witnessed marked growth, with figures varying between 30 percent and 50 percent. Time wastage is minimized, and better coordination, increased machine availability, and higher levels of discipline have contributed toward this success. As the workers participated in maintaining the 5S principles, they became more responsible and productive.

Table 4.1: Summary of Results

Parameter	Before 5S	After 5S	Improvement
Tool Searching Time	12–15 min	3–5 min	~70% reduction
Machine Downtime	High	Reduced	~40% reduction
Workspace Condition	Cluttered	Organized	Highly improved
Safety Level	Poor	Good	Significant improvement
Productivity	Low	High	30–50% increase

These clearly demonstrate that the use of the 5S approach enhances operational efficiency in concrete terms. Apart from increasing production capacity, the process itself helps to enhance safety and discipline at the place of work. The results match the findings of past studies on lean manufacturing that emphasize 5S as a tool for continuous improvement.In summary, it can be seen that adopting 5S does not necessarily need massive investment and could produce great returns even in small companies. Moreover, the achievements gained can become sustainable and form the basis for embracing more advanced lean manufacturing concepts.

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V. CONCLUSION

The current research is a clear demonstration of how 5S can be utilized to maximize efficiency in small scale manufacturing industries in Durgapur in the state of West Bengal. Efficiency, productivity and workplace safety were clearly enhanced by the application of the five stages of sorting, setting in order, shining, standardizing and sustaining in a systematic way.The outcomes clearly demonstrate that the sorting stage led to increased space by getting rid of excess items in the workplace. Setting in order helped in systematically organizing tools and equipment thereby enhancing effective operations. There was less downtime thanks to the Shine stage that helped keep things clean and helped identify machine malfunctions. In other words, although the Sustain stage aided in the creation of long-term discipline through audits and employee participation, the Standardization stage helped in ensuring consistent performance through the use of visual controls and standardized practices.Through a quantitative analysis, it was found that there were increases in total productivity of 30 to 50 percent, reductions in machine downtime of about 40 percent, and a reduction in tool search time by about 70 percent. Also, there was much more cleaning and improved work habits, which resulted in a significant boost to workplace safety. This clearly indicates that 5S can be a good technique for ensuring safety and efficiency in the workplace.The major advantage highlighted in the above study is that, since 5S requires behavioral changes, employee participation, and better organizational systems, it requires minimal capital investment to implement. It suits small and medium-sized enterprises quite well, particularly those operating in developing countries where there is a scarcity of resources.However, the report notes that sustaining the 5S methodology poses some challenges. Sustaining the progress achieved through implementation involves close observation, regular auditing, commitment from management and training for employees. There is a risk of reverting to previous inefficiencies if follow-ups are not done.Finally, the 5S method is an excellent foundation for improvement and lean production. This methodology can greatly improve organizational performance when properly implemented as seen in this case study. Furthermore, it provides an excellent platform that would help facilitate the introduction of advanced lean techniques such as JIT (Just-In-Time), Kaizen, and TPM (Total Productive Maintenance).

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