Production Performance Increase through Five S Technique on Manufacturing Equipment Tools

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Abstract *— Pharma LLC, a company dedicated to solid drug product manufacturing, performed an assessment and determined they were experiencing overtime cost increases, lower productivity and personnel discomfort with tools and resources available for them to work. To address these issues, the Five S technique was used to minimize equipment downtime, reduce overtime costs, and increase productivity in three manufacturing lines. Several cross functional interviews and feedback sections were held to align on developing and implementing the solution. A shadow board box was implemented on each manufacturing line. This not only allowed to easily find tools within the different areas, but also to identify missing tools and trigger a process to replace if needed. For the process to be maintained, a checklist was added to the daily activities for operations supervisors. The implementation of shadow boards resulted in a reduction of 56.75 hours in equipment downtime over a period of 10 days, overtime cost avoidance of $184K annually and average increase of 15% on productivity for the three manufacturing lines.*

Key Terms *— Equipment Downtime, Five S, Lean Manufacturing, Process Improvements, Waste Reduction.*

INTRODUCTION

Companies across the world are facing day-to-day challenges due to changes in customer behaviors, competitors, and cost increases. To overcome these obstacles, they need to become more efficient in the way they operate, while maintaining high quality and meeting regulatory requirements.

Pharma LLC, a company dedicated to solid drug product manufacturing with many years of presence in the pharmaceutical industry, has also faced these challenges. As part of company goals and objectives, a series of capacity increases, and cost reduction initiatives were necessary across their different manufacturing sites.

During the assessment, it was observed that over the years, overtime cost increased, productivity declined, and personnel has expressed discomfort with the tools and resources available for them to successfully execute their activities. Specifically, for the solid drug product manufacturing lines there was a need to increase production performance through Five S technique implementation to manufacturing equipment tools.

The specific facility where these activities were performed has three manufacturing rooms within the scope of the project, which are supported by manufacturing operators and maintenance technicians responsible of running and troubleshooting equipment as needed. As part of the initiative, it was expected to eliminate waste associated to movement, downtime, and poor capacity due to lack of standardization and availability of critical tools to manage equipment utilized for manufacturing activities. To measure the success of this implementation, a series of project objectives were agreed upon as follows:

- Minimize solid drug products manufacturing equipment downtime by Q2 2022.
- Reduce overtime costs in solid drug products manufacturing lines by Q2 2022.
- Increase productivity by 20% in solid drug products manufacturing lines by Q2 2022.

LITERATURE REVIEW

Companies and all types of organizations strive for high quality and efficiency while lowering cost and providing an appropriate work environment. There are many ways to achieve efficiencies and

increase competitiveness, including the Five S (5S) methodology.

The Five S methodology is widely used around the world and across different businesses [1]. The structure provided focus on the use of the following concepts as a framework in the work area to assess solutions:

- Sort: elimination of unnecessary tools or instructions from unwanted materials.
- Set in Order: organization of anything that remains by arranging parts by ease of use.
- Shine: execution of cleanup activities.
- Standardize: establishing periodic maintenance by conducting the above 3S.
- Sustain: making the changes and the 5S implementation a habit by always following the steps above.

When following this or similar methodologies, it is suggested to use elements of planning, designing and management of the production process in combination with technical information to determine the next steps and approaches to be taken [2]. Learning from other organizations' experiences and leveraging their success is also important to better implement changes and process improvements. Lean, Six Sigma and Change Management should be used in conjunction to achieve processes with zero defects [3].

An important step to make process changes is to assess facility design and ensure it is aligned with the expected outcome. Exploring technologies, while understanding the relationship among them. Facility management can have a variety of meanings according to the audience and therefore it needs to be analyzed in those terms, considering elements like the type of organization, building and even management [4].

During application of 5S and Lean Methodologies interviews should be completed throughout the process, as they allow to gather feedback on the changes being implemented and how people would react to them. Performing this exercise post implementation allows one to gain valuable insight on how the results have improved according to the desired outcome [5].

Six Sigma should be seen as a journey for organizations and its professionals. Even though it is not considered an active, the results coming from it can be considered active. Using statistically Six Sigma measures to analyze process capabilities, correlate characteristics of defects and determine probabilities of success or failure is a tool to be used when assessing processes to identify opportunities for improvement, but also to measure results post-implementation [6].

METHODOLOGY

The methodology followed for this project encompassed the following:

- Identification of non-value-added activities (waste).
- Reduction and elimination of non-value-added activities to increase productivity in solid drug products manufacturing lines.
- Identification of sources of overtime costs associated to drug product manufacturing lines.
- Reduction or elimination of sources of overtime cost.
- Identification of sources of equipment downtime for drug product manufacturing lines.
- Reduction or elimination of sources of equipment downtime through implementation of 5S technique to manufacturing equipment tools.

Along with these activities, data was collected through cross-functional meetings, personnel interviews, and process observations prior and post process changes. Solutions were developed, including the development of 5S shadow boards and procurement of new process tools for associates and technicians.

RESULTS

In order to measure changes, implementation results and their impact in the manufacturing line

performance data on equipment downtime, overtime and productivity was collected over a period of ten-days period before and after implementation activities were completed. Table 1 shows a summary on equipment downtime, showing that the three manufacturing lines experienced a total of 33.75 hours of downtime prior improvements. Post-implementation a total of 2.0 hours were observed, with a total reduction of 31.75 hours, successfully meeting established objective.

Similarly, Table 2 shows a summary of overtime for the same period of time with a total reduction of 56.75 hours. These overtime hours were assessed in terms of cost according to a rate of $125 per hour leading to a projected annual cost of $207K prior implementation and $23K post implementation, with a projected cost avoidance of $184K annually, successfully achieving the second objective.

In terms of productivity, scheduled and worked hours were assessed for the same period of time and summarized on Table 3 which shows an average productivity increase of up to 15% for the three lines and up to 20% by individual lines per day. Average productivity prior to changes was 84% increasing up to 99% over the period assessed, demonstrating completion of the third objective.

To achieve these results, implementation of Five S methodology was required. From assessment with cross functional teams and operations and maintenance associates, it was determined that the main cause of equipment downtime and cost associated with it was due to the lack of the proper tools to support production activities and equipment maintenance and utilization in the different manufacturing rooms. Missing and broken tools were the most common cause of extended periods of downtime. Required tools for each room were identified and procured. To ensure easy access and sustainable solution a shadow board box, a place to store the tools with specific locations was created for each room. This shadow board uses the tool image, identifying its specific location within the board allowing easy identification of missing tools.

To ensure the tools are always in place, a daily check was added to operations area walks for each manufacturing shift. This process required each supervisor or lead to confirm that all tools were in place or available in each manufacturing room at the beginning of each shift activities. In the case of missing tools, the process would trigger associates to look for tools and replace in case of being needed. Due to criticality of the tools, these were included in the spare part list, ensuring they are always available on the facility. The Five S methodology was embedded in the process of buying new tools, creating a place to store them and a system to monitor ensuring all five elements of the methodology are in place: Sort, Set in order, Shine, Standardize, and Sustain.

Table 1
Equipment Downtime Summary

Area	**Before (Hrs)**	**After (Hrs)**	**Difference (Hrs)**
Manufacturing Room 1	10.00	0.50	9.50
Manufacturing Room 2	10.75	0.50	10.25
Manufacturing Room 3	13.00	1.50	11.50
Total Hours	33.75	2.00	31.75

Table 2
Overtime Summary

Area	**Before (Hrs)**	**After (Hrs)**	**Difference (Hrs)**
Manufacturing Room 1	20.00	1.50	18.50
Manufacturing Room 2	20.75	1.00	19.75
Manufacturing Room 3	23.00	5.50	17.50
Total Hours	63.75	7.00	56.75

Table 3
Productivity Summary

Area	Before (Hrs)	After (Hrs)	Difference (Hrs)
Manufacturing Room 1	60.00	69.50	9.50
Manufacturing Room 2	59.25	69.50	10.25
Manufacturing Room 3	57.00	68.50	11.50
Scheduled Work Hours	210.00	210.00	N/A
Worked Hours	176.25	207.50	31.25
Productivity*	84%	99%	15%

*Average Value.

Achievements were a result of cross-functional collaborations, team engagement and on-site resources utilization. Tools were procured using established vendors and the construction of the shadow board was completed by personnel from engineering and facilities within the company, minimizing the cost associated with the project implementation and increasing its benefits. No additional budget was required since all activities were completed with the utilization and current personnel and allocated resources for the different teams participating.

Active engagement with personnel from the impacted areas assisted with change management and faster changes adoption. Personnel owned the changes, participated in brainstorming ideas, and took ownership of the expected results, therefore working as a team to achieve a successful implementation of activities, according to plans and with high interest in ensuring its results are sustained. The excitement along with the benefits and results observed post implementation, were confirmed through interviews with the personnel at each area which provided feedback on the overall project from idea to implementation and identified opportunities to leverage the results and further improve facility performance.

CONCLUSIONS

To achieve production performance increase through Five S on manufacturing equipment several objectives were established. The first of these objectives included minimizing equipment downtime in solid drug product manufacturing lines which its achievement was demonstrated in the results section of the report by showing a reduction of 56.75 hours in equipment downtime over a period of ten-days. Similarly, the second objective of reducing overtime costs for the same manufacturing lines was achieved resulting in cost avoidances of up to $184K annually according to the observations from the ten-days period assessed. Finally, the third objective of increasing productivity was achieved through an increase of up to 20% by individual manufacturing lines and an average of 15% for the three manufacturing lines.

The changes resulting in the results describes where achieved through the implementation of Five S technique and shadow board utilization. The shadow board consisted of specific boxes for the three manufacturing lines that included dedicated and marked locations (in the form of a shadow) for each tool. These boxes allowed to easily find tools within the different areas, but also to identify missing tools and trigger a process to replace if needed. For this process to be maintained, a checklist was added to the daily activities for operations supervisors and leads for them to confirm tools availability on a daily basis and replace them as needed.

For this project to be successful it was essential to maintain an open communication with all the cross-functional groups impacted by the changes in all stages of the activities. There was active engagement through several interviews and feedback sections with the associates' responsibilities of executing, collecting data, and using the tool developed to identify root causes, but also to develop the right tool for their areas. This active collaboration allowed for the changes to be widely and easily accepted by different functions. Throughout the process it was also identified additional opportunities to leverage the learning from this project and enhance other areas of the facility. Within these there is potential to enhance the two packaging lines for solid drug products and by implementing similar shadow boards. A similar idea was also identified for the maintenance carts for maintenance technicians. In this case instead of shadow boards, carts with drawers using the shadow concept for the tools could be created.

Implemented and proposed ideas can be fully delivered using resources and budgets already established which add high value with minimal resources, time, and cost. Active participation from the different functions impacted by changes in all stages of the project is highly encouraged.

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