REVIEW ON IMPLEMENTATION 5S SYSTEM IN EDUCATIONAL LABORATORIES

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ABSTRACT

The purpose of this review paper is to study the significance of implementing some of principles of the 5s and kaizen to enhance the productivity of manufacturing organizations to become more efficient and more productive. 5s is a basic tool of lean manufacturing systems which is used for sorting, organizing and systemizing the necessary things for job place enhancement. The research findings from the literature review shows that the industries have developed the necessity of implementing the 5s in the job shop and according to them, implementing the 5s is relatively possible. Moreover, the educational institute's labs has been a platform where 5s can also be implemented. It is also to make the student teachers become aware of different plans and organizing skills; develop an insight into the responsibilities and help them in becoming a leader to manage physical, human and financial resources.

1. Introduction

5S is one of the first techniques used by organizations that adopt methodologies such as lean, total quality management, and six-sigma. Organizations learn that it is difficult to have well-defined operational procedures, improved working conditions, and quality products without 5S (Jugraj & Inderpreet, 2017). The 5S technique consists of five steps. In Japanese the words are *Seiri*(sort), *Seiton* (set-in-order), *Seisou* (shine), *Seiketsu* (standardize), and *Shitsuke* (sustain). 5S is a low-cost technique used by organizations to clean, order, organize, and standardize the workplace. This study implemented 5S in an educational laboratory. Using 5S, the laboratory was expected to improve in the areas of working environment, safety, reduction of equipment search time, and increase deficiency.

Educational laboratories that provide students with experiential learning that create knowledge through insights gained by practical experience has become an integral part of undergraduate STEM education (Reck, 2016). Universities and technical colleges aim to close the gap between theory and industrial practice using educational laboratories. These laboratories have technical resources and comparable functional characteristics with industrial facilities (Jimenez et. al., 2015). They prepare students with the skills required to work in a professional environment (Gibbins & Perkin, 2013). With shared similarities, the gap between educational laboratories and industrial facilities can be narrowed through the adoption of professional continuous improvement techniques such as the 5S for workplacestandardization.This study was conducted in the surveying laboratory in the Engineering and Biological Sciences building at Western Kentucky University (WKU), which is equipped to provide students with hands-on experiential knowledge during field data collection.The surveying laboratory seeks to provide students with the required experience. The laboratory practicums are conducted with this goal in mind.The researcher visually observed the surveying laboratory in WKU and established the need to implement 5S. The study population were surveyed pre and post implementation to assess the perceived impact of 5S based on selected performance metrics. The study was divided into three

parts. The first was to provide an approach for implementing 5S in an educational laboratory. The second was to implement 5S in a surveying laboratory. The third was to assess the benefit of 5S and present the results with future recommendations.

1.1 Problem Statement

From visual observation and conversation with faculty, the surveying laboratory requires organization as it has become unsafe for its users due to the clutter of equipment, unwanted boxes, long equipment search time, and congested workspace. Although the laboratory has some instructions, it is lacking in organization with little existing standardization in place or well-defined work procedures. It is critical that educational laboratories become standardized to improve lab ergonomics and prepare students for industrial careers. An unstandardized laboratory results in higher equipment search time, smaller workspace due to unwanted materials and equipment, reduced efficiency (i.e. longer time to carry out experiments), and poor working environment.

1.2 Significance of the Research

The significance of the research was to implement the 5S technique in standardizing and improving the ergonomics of the surveying laboratory by providing a framework for other professionals to successfully pursue its replication in similar educational laboratories or other industries. In addition, it also assessed the benefits of implementing the steps of 5S in an educational laboratory. The benefits of implementing the 5S technique in manufacturing and other industries have been extensively discussed in other studies. This study emphasized the benefits of applying this technique to improve safety and equipment search time, laboratory working environment, increase workspace, and efficiency in a surveyinglaboratory.

1.3 Purpose of the Research

The purpose of the research was to standardize and improve the ergonomics of the surveying laboratory in WKU by implementing the 5S technique. The expected results at the end of the research was shorter time for experiments, safer and cleaner environment for students, clearly labelled equipment areas to reduce equipment search time, and increased workspace for easier movement after unused items have been disposed. The purpose of the study was to assess the significant changes in performance metrics pre and post implementation of 5S in the laboratory.

2. Hypothesis

The study hypothesis follows:

1. After implementing 5S, efficiency will increase.
2. After implementing 5S, workspace will increase.
3. After implementing 5S, equipment search time will be reduced.
4. After implementing 5S, laboratory working environment will be improved.
5. After implementing 5S, safety will be improved.

2.1 Assumptions

The study assumed the following:

1. Participants were willing to take part in the distinct phases of the researchthat ensure the success of 5Simplementation.
2. The participants were honest in their answers to the survey based on the selected performance measures.
3. The time-frame selected for the implementation of 5S wassufficient.

2.2 Limitations and Delimitations

The implementation of 5S requires participants having a basic understanding of the concept of 5S phases. The study is limited by the lack of previous knowledge about 5S by the participants, which might have affected the responses. In this study, 5S implementation was delimited to the surveying laboratory in Western Kentucky University. In addition, although 5S is a continuous improvement technique, its implementation was delimited to six weeks and one laboratory.

2.3 Definitions of Terms

Terms used during the study:

1. *Continuous Improvement (CI) Methodology*: These are methods that continuously improve processes and standards.

2. Lean: A methodology for eliminating seven types of wastes (muda) in a process.

3. *Standardization*: Standardization is the documentation of best practices ineach process/project. If best practices are well documented there is room for continuous

improvements.

4. *JIT*: According to Gunasekaran and Lyu, Just-in-Time is the method of producing what is needed, at the time needed, and in the amount needed (as cited in Singh & Ahuja, 2012, p.67).

5. *Kaizen (Continuous Improvement)*: Kaizen is a Japanese word whichmeans "incremental improvements" – quick and easy.

6. *PDCA (Plan, Do, Check, Act)*: The PDCA is a continuous improvement cycle, also referred to as Deming cycle or Shewhart cycle. According to Sokovic et al. (2010), PDCA cycle is an effective method of continuously seeking improvements and adopting "the right first time"approach.

7. *TQM (Total Quality Management)*: Total Quality Management is a continuous improvement strategy by management to instill a culture in the organization for delivering high-end quality products.

8. *TPM (Total Productive Maintenance)*: Total Productive Maintenance is a proactive strategy of scheduled maintenance of manufacturing equipment to prevent machine break-down or faults that will impact the quality of the product.

TPS (Toyota Production System): Toyota Production System is a production system developed by Toyota for the elimination of wasteful practices such as muda (waste), muri (overburden), and mura

9. *Quality Cycle*: A sequence of activities aimed at improving processes.

10. *ISO*: International Organization for Standardization that establishes universal standards for production of products.

11. *IMS (Integrated Management System)*: Integrated Management System is the combination of individual management systems to develop an effectiveintegrated manufacturingsystem.

2.4 Review of Literature

The review of literature serves the following purposes. First, provide an overview of 5S based on scholarly articles to provide a context for 5S implementation within organizations. It introduces the implementation strategy adopted in published works to create a framework for the implementation of 5S within an educational laboratory.

Second, it identifies the existing gap in 5S implementation in other literature. According to Singh and Ahuja (2014), "despite the simplicity of 5S, organizations have had difficulties in its implementation" (p. 274). These difficulties are closely linked to existing gaps between theory and practice of 5S that is evident in many research papers (Kobayashi, 2009). The review of literature identifies the gaps by highlighting the misconceptions regarding 5S implementations. This critical examination aided in the strategy deployed for the implementation of 5S in this research. Third, the literature review highlights the benefits of 5S from studies undertaken by other researchers, which provides a benchmark for the study's performance measurement.

The chapter is organized as follows. The first section gives a brief history and discusses diverse concepts of 5S. The second section discusses the components of 5S. The third section discusses implementation strategies and that were adopted for the study. The fourth section discusses the relationship between 5S and continuous improvement methodologies. The fifth section emphasis the applicability of 5S deployment in laboratories case studies. This section considers an educational laboratory to be a service related organization. As such, only service related case studies werediscussed. The sixth section discusses the evaluation methods used to assess the benefit of 5Simplementationand the seventh section lists some of the benefits of 5S implementation. The eighth andninth sections discuss implementation barriers and misconceptions in the adoption of 5S in organizations. The review of published literature led to a broader approach for the research described in this thesis. The approach was outlined and justified.

3. The 5S Components

The acronym of 5S have been translated into English equivalents by Hirano (1995) as sort, set in order, shine, standardize, and sustain. This is the most frequentlyused and easy to understand equivalents. Other variations include the ONCSD, 5C, and CANDO (Kobyashi, 2009). Table 1 shows the different variations. Throughout this research, the English equivalents of 5S by Hirano was used.

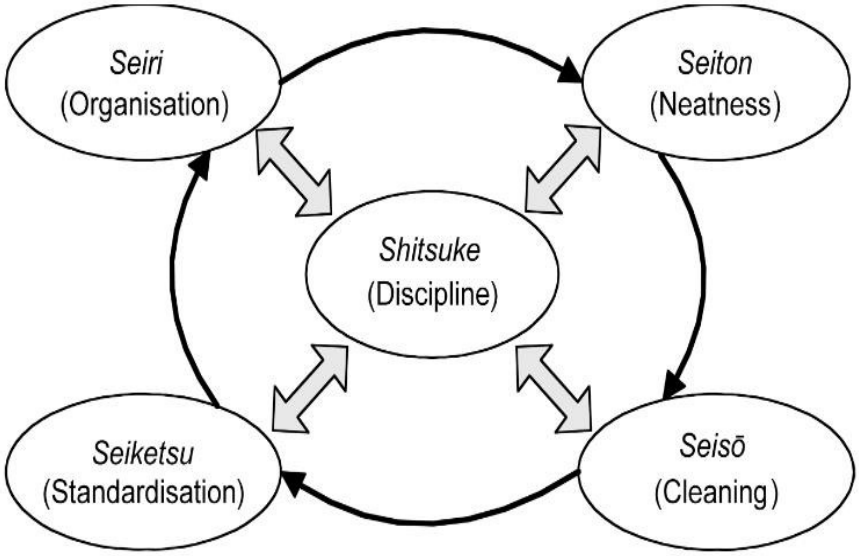

Figure 1. The relationship between 5S (ONCSD) components (Osada,1991).

3.1 5S Implementation Strategy

Organizations have adopted different strategies in the implementation of 5S. The most common strategy is implementing each phase of the 5S sequentially. However, Hirano (1995), in his book *5 Pillars of the Visual Workplace*, suggested the following strategy for 5S implementation: (1) Establish 5S promotion in the organization, (2) Establish 5S promotion plan, (3) Establish 5S campaign materials, (4) In-house education, (5) 5S implementation, and (6) 5S evaluation and follow up. According to Malik (2014), Hirano's strategy required that the simplest methodologies be executed first. The strategies adopted in more recent times in the West is largely linked toHirano's six-step strategy (Kobayashi,2009).

Another strategy widely adopted in the West is the Deming's plan, do, check, and act (PDCA) cycle. Sidhu et al. (2013), study is a notable example of applying the PDCA cycle. During the *plan* cycle, data was collected after investigations. In this cycle, training is conducted, and each member of the team is assigned duties, which are displayed on a notice board. In the *do* cycle, 5S phases are implemented in theorganization. At the third cycle *check*, evaluations are conducted to determine if 5S is successful and to discover possible areas of improvement. The last phase *act*, the 5S is continuously revisited in the organization and workers are recognized based on their commitment to 5S.

3.2 The Applicability of 5S in Laboratories

According to Jiménez et al. (2015), 5S has been applied to various kinds of laboratories in various parts of the world. Case studies on the application of 5S in these kinds of laboratories (chemical, educational, pharmaceutical) will be discussed below. This section, reviews case studies of the implementation of 5S in laboratories as a means of attaining industrial standard. In the study, *Implementing the 5S Methodology for the Graphic Communications Management Laboratory at the University of Wisconsin-Stout* (2011), 5S was implemented in the laboratory to provide a more efficient work station layout with organized and labeled storage of items and equipment. The outcome of the study showed that 5S was applicable to a film laboratory. After the implementation of 5S,the GeM lab 130, became well-organized, safer, more efficient, and cleaner. The impact of 5S implementation during the study was determined by photographs.

A study by Chitre (2010*), Implementing the 5S Methodology for Lab Management in the Quality Assurance Lab of a Flexible Packaging Converter* was conducted to organize, clean and manage the laboratory as a means of improving efficiency. The results from this study were measured through before and after pictures that showed improvements in organization of tools, cleaner environment, visual workplace, and storage space utilization. According to Chitre

(2010), for the benefits of 5S implementation to be sustained it must be adopted as a part of lean. In addition, 5S was viewed as a housekeeping technique and as such there was low management and employeeinvolvement.

Implementation of 5S in a chemical laboratory at a medical device company was done by Tran (2011). The study was conducted to implement lean six sigma principles for which 5S was a part. The need to re-organize the laboratory to improve workflow was determined. In addition, the laboratory required organization because of the clutter of unwanted supplies. After the implementation of 5S, efficiency and responsiveness were improved, which led to cost reduction. Furthermore, the distance between the workstation and materials were reduced. This caused a reduction in the distance traveled for preparing a solution from 468 feet to 245 feet. The cycle time was also reduced to an average of 30 minutes, which led to an annual labor-saving cost of$2000.

In the study *5S Methodology Implementation in the Laboratories of an Industrial Engineering University School*, 5S was implemented to optimize and improve the safetyof university engineering laboratories. Jiménez et al. (2015), justified the selection of an educational laboratory as suitable place for the implementation of 5S based on teaching space for interaction with students, the student productivity, and hands-on industrial experience. As such, the 5S methodology was deployed in four laboratories; Sheet Metal Forming and Cutting, Integrated Manufacturing Systems, Welding, and Metrology, over three months. The outcome of 5S implementation was a 30% reduction in practicums, improved control and maintenance of equipment, no laboratory accidents, reduced inventory and waste, clean environment, well-labeled equipment, and visual controls that communicated deviations or failures. This led to a cost reduction and a 25% increase in available space. According to Jiménez et al. (2015), a new culture of commitment to continuous improvement was created among the participants (faculty, staff, and students) along with a detailed knowledge of available resources in the laboratory. The next section discusses the methods of evaluating the performance of 5S and the method adopted for this research.

3.3 **Benefits of 5S Implementation**

The major benefits of implementing 5S include increased productivity, promptness, enhanced confidence, less accidents, less equipment breakdowns or downtimes, increased workspace, improved performance, and reduction in documentation (Baral, 2012), In the study *Implementation of 5s Management Method for Lean Healthcare at a Health Center in Senegal: a Qualitative Study of Staff Perception*, implementation of 5S brought about improvements in the work environment, attitude and behavior of patients and employees, quality of services efficiency,patient-centeredness,and safety (Kanamori et al., 2017). These benefits were determined by interviews with 21 participants regarding their perceived benefits of 5S implementation. In another study by Deshpande (2015), the benefits of 5S implementation included increases in productivity, reduction in equipment search time, reduction in cost and inventory, increase in workspace, well-defined walkways, increased morale, and participation of officers, staff, and workers in continuous improvement.

Conclusion

The results analyzed from the study supports the stated hypotheses in the Introduction. 5S was successfully implemented in the surveying laboratory at WKU to improve efficiency, workspace, equipment search time, work environment, and safety because of the active involvement of faculty. Literature reinforces the need for active management involvement for the successful implementation of 5S (Chitre, 2010; Douglas, 2002; Naqvi, 2013). The results from the study proved that 5S implementation within a university laboratory for standardization and to provide students with an industrialized experience is justified. These findings suggest that 5S can be successfully implemented in other academic laboratories, but may require a different plan. Since maintaining 5S, having a clean workspace, and clear aisle ways was an important factor for the surveying laboratory, the focus was on

creating audit forms and checklists to reinforce these characteristics and revisit the various phases of 5S. To encourage active participation of students in future 5S events in the surveying laboratory, frequent training should be conducted.

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