

Original Research Paper

Qualitative Evaluation of 5S Application Considering the Experience of Electrical Construction Experts

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Abstract: The 5S lean tool is one of the most common lean construction techniques, which can lead to safe work environments if used effectively on project sites. The purpose of this study is to provide a checklist to maximize the outcomes of the 5S approach concerning safety requirements. A grounded theory technique was used to analyze the interview data. Eighteen electrical construction experts with the snowball of construction workers, safety representatives, supervisors, site and project managers were interviewed. Ultimately, the present study simplifies 5S implementation for first-time users and outperforms the outputs of the existing users. It is expected that the presented 5S checklist will provide practical actions for safer construction sites.

Keywords: 5S Approach, Qualitative, Interview, Grounded Theory, Checklist

Introduction

In the U.S., electrical contracting is an industry valued at over \$171 billion annually based on the National Electrical Contractors Association (NECA) report, made up of over 70,000 electrical contracting firms employing over 650,000 electrical workers. The construction industry has a higher number of accidents than other sectors (Albrechtsen *et al.*, 2019) and has a non-fatal occupational injury rate of 2 per 100 employees (Bureau of Labor Statistics, 2018). OSHA (2016) stated that work-related deaths and injuries cost \$151 billion. Healthier safety climates are correlated with diminished accident rates (Sheykhfard *et al.*, 2020; Jones *et al.*, 2019; Varonen and Mattila, 2000), making safety improvement the priority of lean construction techniques, especially in the electrical construction industry.

Lean construction is an organizational method designed to reduce waste, maintain flow, decrease cost, enhance quality and safety on construction projects (Aslam *et al.*, 2020a; 2020b; Innella *et al.*, 2019; Ghanadiof, 2017; Srinivasan *et al.*, 2016; Lee *et al.*, 2019). One practical solution to minimize death and injuries at construction workplaces is applying lean techniques such as the 5S system. Table 1 lists the original five Japanese S words, their English translations and the 5S method definitions. The five phases are crucial and must be applied separately and in order. The

first three phases are operational, the fourth maintains the state reached with the previous phases and the fifth phase leads to continuous improvement at work (Jiménez *et al.*, 2015).

5S process is a lean tool that aims to show hidden problems (Meiling *et al.*, 2012) and organize work areas so as to increase efficiency and lessen waste (Salem *et al.*, 2014; 2005). Unquestionably, organized workstations can lead to high-quality production, reducing safety hazards and risks (Enshassi and Abu Zaiter, 2014). However, a few studies have utilized 5S as one of the lean methods to improve construction safety (Gambatese *et al.*, 2017; Michalska and Szewieczek, 2007; Brown and O'Rourke, 2007; Srinivasan *et al.*, 2016; Jiménez *et al.*, 2015).

The 5S approach has numerous benefits. For instance, sorting helps to minimize broken tools, scrap and obsolete jigs and fixtures (Harrington, 1991). This aids employees to work and move easier because of smoother item flow (Dudek-Burlikowska, 2006). The advantage of set in order is easy-to-use of tools and make other resources visible (Lancucki, 2001). Furthermore, shining the work area not only reduces waste, but also acts as a motivation for the employees (Dudek-Burlikowska, 2006). Noteworthy is that developing a standard helps employees know their responsibilities and perform their duties in a routine (Dudek-Burlikowska, 2006; Lancucki, 2001). Although workers should maintain discipline, indeed a reward system should take place to motivate them.

Table 1: 5S terms and definitions

Japanese term	English term	Definition
Seiri	Sort	Remove unnecessary tools and Keep essential items.
Seiton	Set in order (Storage)	Arrange materials and equipment in an orderly fashion to make the job easier to perform.
Seiso	Sweep (Shine)	Keep work areas and equipment clean to reduce waste.
Seiketsu	Standardize	Allocate rules to keep everything clean and organized.
Shitsuke	Sustain	Inspect the workstation to ensure the rules are being followed.

Table 2: Position distribution of participants among investigated companies

Role	Company 1	Company 2	Company 3	Total
Construction worker	1	0	1	2
Safety representative	3	1	2	6
Supervisor	2	2	1	5
Project manager	1	1	1	3
Site manager	1	0	1	2
Total	8	4	6	18

From the literature review, a comprehensive list of objectives, methodologies and results of miscellaneous case studies around the world from 2003 to 2020 focusing on the 5S lean strategy are summarized in Appendix A. The main objectives of 5S are improving productivity, reducing waste, continuous improvement, improving working procedures and enhancing safety (Aslam *et al.*, 2020a). However, among all of these objectives, the priority of 5S is to improve the health and safety of workers. Conspicuously, safer environments can positively affect the motivation of the workers (Jiménez *et al.*, 2015). There are a few studies that mainly investigate the objective of safety enhancement through the 5S procedure (Michalska and Szwieczek, 2007; Brown and O'Rourke, 2007; Leino *et al.*, 2014; Jiménez *et al.*, 2015; Tezel *et al.*, 2016), especially in the United States of America (Ng *et al.*, 2010; Srinivasan *et al.*, 2016; Ruiz *et al.*, 2020).

Previously, (Al Heet *et al.*, 2020) found that companies utilize collaborative practices, visual management techniques such as 5S and root cause analysis to solve their safety problems. Tezel *et al.* (2016) stated that the 5S visual system improved workplace conditions with lessened item transaction process times, savings in workspaces and a better health and safety condition. Also, (Gupta and Jain, 2015) reported that several positive changes were made to the operating procedures, tool organization, cleaning schedules and material handling. For instance, tool searching time from shop floor has been decreased from 30 to 5 min.

Although previous studies have studied the effect of lean practices on safety climate, research should be conducted to clarify 5S necessary actions in the construction sites considering safety cautions (Srinivasan *et al.*, 2016). The notion of applying the 5S method as one of the lean construction techniques is still needed more studies to minimize construction and manufacturing incidents. According to the literature, there is a gap in upgrading the 5S method based on

electrical construction experts' experience since they know the shortcomings of this approach due to problems that have already been occurred in their projects when 5S was applied. Therefore, this study aims to extract a practical checklist for 5S steps for enhancing safety at electrical workplaces based on the findings extracted from interviews.

Methodology

The research methodology diagram is demonstrated in Fig. 1. The details of the grounded theory method, data collection, interview analysis process, the interview results and the extracted checklist are included in the following sections.

Participants and Case Studies

Safety and lean experts were contacted in different firms ranged in size and expertise, including general contractors and electrical construction companies and finally, three companies in Washington and Oregon states accepted our request for an interview with their employees, supervisors and managers. Overall, safety and lean managers in 51 companies were contacted, of which 18 accepted the invitation to participate in the interview (35% response rate). The criteria to select these participants were their experience of using the 5S method in real projects (one successful and one unsuccessful) and at least 5 years of experience in the electrical construction field. They were working at different levels as construction workers, safety representatives, supervisors and project managers. The participants with an average of 10 years of experience working at different levels were interviewed. The description of the studied construction companies is described in Table 2. These 18 experts are selected from three companies with small (20 to 99 employees), medium (100 to 499 employees) and large (500+ employees).

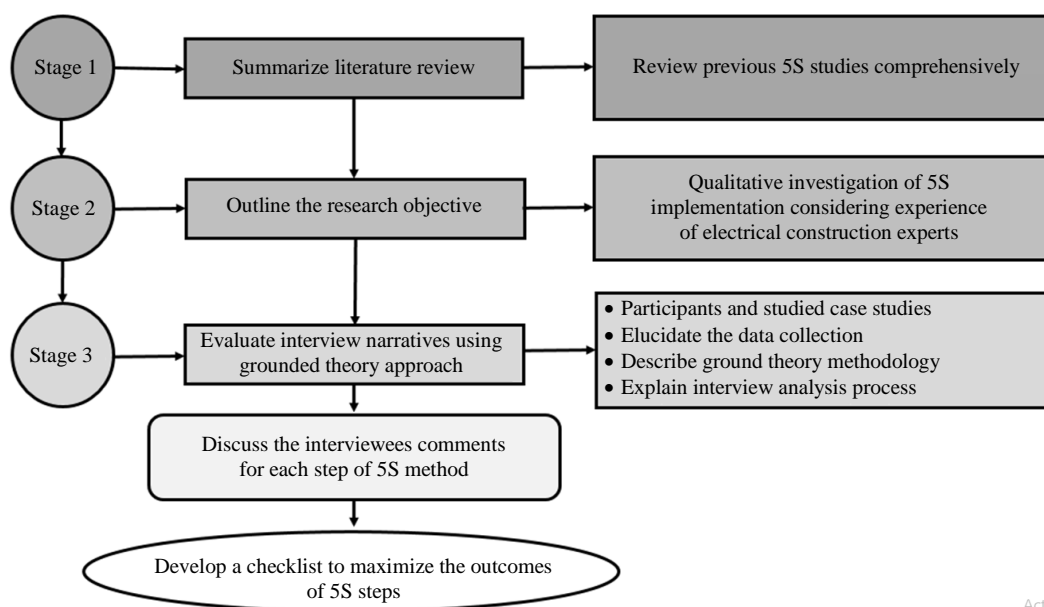


Fig. 1: A schematic explanation of the research methodology

Data Collection

Interviews were recorded using semi-structured open-ended questions that explored the nature of the interviewee's interaction with the 5S lean tool of their construction projects. Eighteen experts in lean and safety practices were questioned a set of core questions. Participants were asked to describe their role for the 5S application, which step of 5S they were responsible for, to whom they were reported and how they provided information about their performance, how they were rewarded/sanctioned for their performance, how they were trained for 5S and/or safety. The interviewees were asked to consider these questions for the two projects with which they were lately implemented 5S lean steps: A successful project and an unsuccessful project. In addition, the participants answered similar questions about each of the two projects. These core questions were followed up with open-ended, follow-up questions that led to a free flow of information controlled by the interviewee. Examples of these questions include: 'What is the purpose of each step of 5S?', what are the tips/actions to outperform 5S results for the first-time users? and which part of 5S steps correlate with safety?'

To protect the interviewees' anonymity, their projects and personal information were coded. Afterward, the audios were transcribed and prepared for thematic analysis using the MAXQDA2020 software. They were conducted in English and typically lasted 45 min to an hour. Some were conducted by phone, others in person on the participants' working location and others were invited to the University of Washington Construction

Research Center (CERC), depending on the interviewee's desire. The questions in the interview guide were not essentially followed in order due to the fact that the emphasis was placed on promoting an atmosphere in which the informant felt safe to talk about the topics honestly and openly (Albrechtsen *et al.*, 2019).

Ground Theory Approach

The purpose of qualitative content analysis is to examine the central phenomenon in detail and making it clear for the readers (Nelson, 2020; Denzin and Lincoln, 2011). In this research, a grounded theory approach was employed as the qualitative examination technique to create the checklist for 5S steps. The main objective of grounded theory is to build a theory about a phenomenon or practice through interviews and/or observation as the data collection tools (Bulawa, 2014). The researcher interpretation should not interfere with predetermined views about what the data will be in the grounded theory and let the themes to be developed naturally based on the description of interviewees (Mac Donald *et al.*, 2020).

Standard methods of grounded theory, containing the coding of data and the categories' development, were applied. Data coding aims to systemize a large amount of data (Albrechtsen *et al.*, 2019) and it was based on three steps defined by (Strauss and Corbin, 1990). The interviewee's comments were coded using three phases: (1) Open coding, (2) axial coding and (3) developing the Themes. In open coding, the transcribed interviews were assessed line by line for simple extraction of what the interviewee is saying and, in some cases, implying or not saying. Open coding requires an in-depth reading of

the data to comprehend the meaning and context of the interviewee's understanding of 5S and its relationship with safety practices. To test the reliability of the coding process, two researchers coded one interview and compared their coding. All 18 interviews were coded at this level.

To improve the accuracy of the interpretations, the validity procedure was considered. Creswell and Báez (2020) recommended multiple approaches simultaneously to improve validity. In this investigation, triangulation and member checking methods were employed to increase the validity and credibility of research findings. Triangulation is defined as the use of multiple approaches or data sources in qualitative research to develop a complete understanding of phenomena (Patton, 1999). In this study, during the interview session, the interviewees reviewed their perspectives about the accuracy and applicability of practical actions of the 5S method in real projects. For instance, both the safety representatives and project managers agreed that plan for auditing and using safety checklists are the most important steps in the 5S technique and therefore should be controlled daily. Additionally, member checking, also acknowledged as participant validation, is a method for exploring the credibility of results. Data or results are returned to participants to check for accuracy with their experiences.

Interview Analysis Process

Although open coding distributes the large amounts of data into smaller homogenous pieces, the second phase, axial coding, should be utilized. This stage is the process where data are put back together in new ways after open coding by making connections between classifications. This is done by using a coding pattern involving conditions, context, action/interactional strategies and consequences. Axial coding investigates how these classifications attach and relate, which leads to the identification of larger categories that can be utilized to describe the broader themes which stem from the data (Mac Donald *et al.*, 2020). In the present study, the interviews were evaluated line by line with coding that what the interviewee was feeling, saying, or thinking. These results were then clustered into classifications of related axial codes. As an example, interviewees' comments were coded into first an open code (5S management tool, reduce accidents), then to the axial code (Safety enhancement); finally, to the broader theme (effects).

Results

In the following sections, each step of the 5S process will be discussed in order to explain how these steps

have been performed in reality and what was their effect considering the analysis of the interviews. Although 5S has already been applied in practice successfully, it needs to be upgraded to overcome its shortcomings. For instance, the challenge of the sort step is to identify what is required to do the work (Leino *et al.*, 2014).

Sort Step

The main purpose of the Sort step is to first differentiate required (essential) items from undesirable (needless) items in the workplace and then to remove the unwanted materials and tools that should be stored through organizing and labeling (Srinivasan *et al.*, 2016; Leino *et al.*, 2014). The challenge of the sort step is to identify what is required to do the work (Leino *et al.*, 2014). Removing unwanted items will reduce workers' exposure to messy material leading to a safety improvement in terms of minimizing hazards and risks. In this regard, the project team might use tags of different colors to indicate the number of usage. For example, a red tag may be used to imply when an item should be discarded because it is seldom or not at all used. According to different scenarios, all items with red tags are gathered and the team determines what to do with each item. A yellow tag may mark an item that might require more attention due to its potential safety effects. Table 3 summarizes the Sort step process that is used in the studied construction sites based on the interviewees' comments. Executing the Sort step at the jobsite will easily lead to items getting stored, errors being reduced and search time being decreased, all of which will, in turn, help safety enhancement.

Moreover, interviewees mentioned that Just-in-Time (JIT) delivery could also support the Sort step. JIT refers to a lean technique involving a system for the production or the shipment of an appropriate quantity of parts or goods when necessary. This technique will prevent the items from piling up at the job site. From a safety viewpoint, by adopting JIT, (1) the project team could minimize many ergonomic hazards such as back pain by determining out where to deliver each item using barcode tags; (2) workers may be less vulnerable to slipping, tripping and falling hazards at the project site (less material means less exposure to trips); and (3) workers would be less prone to equipment, leading to a lower risk of getting struck by hazards. Finally, the project team can highlight the "everything on wheels" rule, which suggests that on-wheel equipment should be used to move items at the job site. This rule may also help the workers to avoid ergonomic hazards. Such a rule can help further eliminate ergonomic hazards by supporting both the Sort step and JIT.

Set in Order (Storage) Step

Materials and tools are set in order through organizing and labeling (Srinivasan *et al.*, 2016; Leino *et al.*, 2014). The purpose of this step is to arrange items in an easy-to-find way in order to reduce the time required to find the items at the job site. This step enables the workers to not only enhance their work performance but also improve their safety. For example, items should be safely stored to avoid any ergonomic risks, scratches, or strains. To this end, one can ask the following three key questions:

- (1) What are the items that need to be positioned?
- (2) What is the needed quantity of each item?
- (3) Where should the items be placed?

Table 4 presents a summary of the Storage step considering the interviewee's routine work. This step will lead to accurate storage of items, minimizing errors in item selection and reduction of the searching time. Implementing each of these beneficial impacts promotes safety improvement.

Sweep (Shine) Step

Sweep simply means cleaning clean out any dirt, strain, filth, soot and dust from the working environment (Gupta and Jain, 2015). An interviewee mentioned that this ensures that all waste and external items are eliminated, as the work area is ready for cleaning inspection. This cleaning process also includes the maintenance of the equipment and the facilities. Sweeping and housekeeping are significant safety measures that help workers avoid accidents such as falls or trips over items. The Sweep step also includes making sure the work area is free of hazardous material or equipment. Table 5 presents a summary of the Sweep step. Applying sweep steps on the worksite can lead to a cleaner and more pleasant environment, improving quality and equipment lifespan, all of which support improved safety and lead to fewer injuries.

Standardize Step

The goal of this step is to standardize the previous three steps-sort, storage and shine-as a culture (Gupta and Jain, 2015). For this reason, a working framework is required in order to turn the steps into a routine or culture. The framework would ensure that all workers use the same process, the same names for the items and the same signage/floor marking format, shapes, colors, etc. In our case, this framework was carried out based on visual management, which helps workers act quickly when facing any hazard. The lean visualization tool is about efficiently transmitting crucial information to the workers by placing various signs and labels around the

construction site. Workers may recall signs like workflows, performance targets and specific required actions. This posting includes signs related to safety, schedule and quality. In other words, the efficient communication of the key information to the workers could be accomplished by placing signs and labels around the job site, emphasizing safety, scheduling and quality regulations. These visuals can help workers remember important elements for their operations, such as workflow, performance targets and specific required actions. Table 6 presents a summary of the standardized step. Adopting the workplace standardization step leads to simplifying activities to remove possible risks, achieving standardized work procedures, minimizing errors and improving effectiveness through visual management, all of which enhance safety.

Sustain Step

The Sustain step's goal is to maintain a workplace with a safety culture that contains 5S practices. Meeting this objective requires the commitment of workers to a healthy and safe working environment. This step contains other approaches such as 5 why's and quality improvement. Workers should be prepared to embrace the proposed improvement and to implement the new strategies. The Sustain step is summarized in Table 7.

Using a workstation, workers should not go to the construction trailers to check a part of the implementing drawings. Implementing the Sustain step leads to better working practices and teamwork, a stable and safe environment and the provision of safety managers with the data for safety enhancement purposes.

Discussion

How to Maximize the Outcomes of 5S Steps?

The grounded theory examination was focused on the interviewee's narratives to extract practical actions for each step of the 5S lean technique. Table 8 are the activities that guide the practitioners to apply each step of the 5S method successfully. It is noticeable that these actions are based on the interviewee's lessons learned from previous projects, including challenges, failures and successes who have applied 5S in their projects. To ensure the results' accuracy, the 5S steps actions have been back-checked by interviewees.

Even though the practical tips, summarized in Table 8, have had positive effects on the proper performance of the 5S process, some barriers need to be addressed. First, it is very hard to achieve the highest level of safety unless it is contractually obligated for the

project. In other words, safety should be part of a contract. Second, direct financial improvement should be clarified; otherwise, companies will not understand the value of 5S and safety integration.

Table 3: Sort step

When	Why	How	Goal
Every morning	To remove undesirable items	Throw it out, when in doubt	To distinguish “required” items from “undesirable” items in the workplace and then remove those items that are unwanted.

Table 4: Storage parts

When	Why	How	Goal
Every morning	To minimize the time taken for searching	Select a place for everything	To assemble items in a manner such that they can be found simply

Table 5: Storage details

When	Why	How	Goal
Every morning	To decrease defects	Clean and correct shortcomings	To make the workplace unrestricted of dirt and stains

Table 6: Standardizing information

When	Why	How	Goal
Every day	To prevent repeating the same mistakes	Create daily standards based on the first three steps.	To transform the standards into a culture

Table 7: Sustain data

When	Why	How	Goal
Every day	To keep the set standards	Generate simple solutions	To have a healthy and safe working environment

Table 8: A quick guide for maximizing the effects of the 5S program

5S steps	Action
Sort	<ul style="list-style-type: none"> • Identify the use-frequency of items or equipment (e.g., daily, weekly, monthly). • Ask workers from different trades regarding malfunctioning equipment and tools as well as out-of-date/needless items on site. • Implement the tagging technique (e.g., red tag for unnecessary items and yellow tag for items of safety concern). • Get rid of tagged items that need to be verified before taking any action • Store items that are problematic to classify temporarily. • Diminish the amount of material and equipment on the site to the minimum mandatory amount. • Sort a disposal process that includes resale, reuse, recycling and waste disposal.
Set in order (storage)	<ul style="list-style-type: none"> • Store items in the accessible and controllable spots such as toolboxes, Conexus, lay down areas and storage yards • Limit the height of storage spaces for heavy items and materials to help workers pick up and move them. • Highlight potential safety hazards that workers may face in storage areas. • Storing items are based on their function and label them to simplify their easy retrieval.
Sweep (Shine)	<ul style="list-style-type: none"> • Define cleaning guidelines that include goals and duties. • Inspect the work area after every shift. • Clean the workplace after every shift. • Assure the items, equipment and material are cleaned and ready to use. • Check for oil spills, excess fluids, leaks, equipment damage, worn-out cables, burned-out bulbs, etc. • Shine lighting to identify dirt and dust easily.
Standardize	<ul style="list-style-type: none"> • Place visual signs through the work area that remind workers of proper and improper workstation setup. • Allocate roles and expectations of individuals’ accountability to keep the culture of cleanliness. • Systematize checklists to perform routine audits and regular maintenance.
Sustain	<ul style="list-style-type: none"> • Assure workers know about required procedures and obtain feedback. • Offer training and coaching. • Encourage workers to speak up about how procedures can be done better to reward them for their contribution. • Plan for auditing and using safety checklists.

Conclusion

In the current study, the application of grounded theory has led to the development of practical actions (Table 8) to outperform the 5S system performance in the electrical construction work zones. It should be noted that these quick guides can easily be applied as a checklist that covers fundamental tips in the 5S methodology. Based on the interview analysis, the following conclusions, which are based on the expert's experience in real projects using the 5S method, can be drawn:

- The results confirm that removing unwanted equipment in the sort step can diminish workers' exposure to disorganized material. This leads to a safety enhancement due to hazard and risk control strategy. Furthermore, Just-in-Time delivery could also support the sort step by preventing the items from piling up at the job site
- The research findings also revealed that setting materials and equipment in order actively minimize human errors for item selection and diminish the searching time. This means saving time and money. Indeed, safety will be improved accordingly
- Considering the interviews, Sweep step benefits are: a cleaner environment, improved quality and equipment lifespan, all of which support improved safety and lead to fewer accidents
- Applying grounded theory provided evidence that adopting a standard simplifies job duties and remove possible hazards. Conspicuously, visualization can play an essential role in this matter
- The interviewees' narrative analysis results showed that executing the Sustain step leads to better teamwork, a safe environment and the provision of safety managers with the data for safety augmentation purposes

In conclusion, the results of this study will provide practical guidelines and ideas to support employees at the performing level and project managers at the management levels in order to create a safer work environment. It is expected that these practical activities outperform the outcome of existing 5S users or maximize their impact for the first time users.

Limitations and Future Research

The results of this qualitative study should not be generalized to the whole construction industry due to the following limitations. Firstly, only 18 experts in the construction companies were interviewed that which may limit the validity of the study. Second, we visited

just three job sites implementing 5S for safety. There is a chance that the 5S safety mechanism could be suitable just for a specific type of project and/or product. Third, even validity and credibility approaches were employed, coding of the interviewees in the grounded theory method could be affected by the bias of the researchers. However, it was crucial to let the classifications emerge from the data in the absence of standardized classifications. By doing so, researchers' bias is likely and the interpretation of the words of the interviewees might be influenced by the researchers (Mac Donald *et al.*, 2020). Despite these limitations, the study still provides a significant contribution to the practices of safety by helping workers and managers adopt reliable safety methods and integrate them into 5S steps. Ultimately, future research can test the proposed checklist through a mixed-methods analysis to explore the strength/weaknesses of it in electrical construction work environments.

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Author's Contributions

Mohammad Sadra Fardhosseini: Writing part of introduction, collecting data, writing part of discussion and the results.

Mostafa Soltaninejad: Writing the title, the abstract and the introduction, methodology and Appendix. Discussing the results.

Ali Karji: Helping with introduction, data collection, results, discussion and conclusion.

Zahra Ghorbani: Helping with data collection and conclusion.

Omidreza Ghanadijof: Proofread the paper and leading and advising the study direction on data collection, methodology, discussion and conclusion.

Ethics

This article is original and contains unpublished material. It is confirmed that all of the authors have read and approved the manuscript and there are no ethical issues involved.

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Appendix A: Summary of 5S case studies based on objectives, methodologies and results (2003-2020)

Objective	Methodology	Results	Case study	Reference
Improve productivity	Visual observation, presentations	A decrease in the demand for storage space, minimum movement and handling on-site, better site access and a less cluttered workplace were reported.	Singapore	Low and Ang (2003)
Continues Improvement, reducing waste	Interview using questionnaire	Lean philosophy should not be restricted to a set of rules or tools. It must be approached as a system of thinking and behavior.	USA	Diekmann <i>et al.</i> (2004)
Continues Improvement	Visual observation using photos, interviews, documentary analysis	There is a need for behavioral alterations and training for the operational use of the 5S lean tool.	USA	Salem <i>et al.</i> (2005)
Improve working procedures, enhance safety, reduce waste	Interviews through h control questions	5S not only reduced costs, waste and pollution but also enhanced the machines' efficiency.	Poland	Michalska and Szewieczek (2007)
Improve working procedures	Analyzing the Japanese companies that use 5S as a core management method and utilize their organizational websites	The importance of both the technical (visible) and philosophical (invisible) approach is required for each of the 5S components and are discussed in a managerial rather than a cultural framework.	Japan	Gapp <i>et al.</i> (2008)
Continues improvement	Visual control the changes through before and after pictures	Improvement in productivity, efficiency and quality of work was detected.	Romania	Titu <i>et al.</i> (2010)
Enhance safety	Using weekly checklists prepared based on a set of criteria created for 5S categories	The results revealed that the culture of accountability can lead to a safer and more efficient execution of construction work.	USA	Ng <i>et al.</i> (2010)
Continues Improvement	5S audit through pre-and post-questionnaires	5S practice is an effective method since it improved housekeeping, environmental performance, health and safety standards in the workplace.	Malaysia	Ab Rahman <i>et al.</i> (2010)
Continues improvement	Arranging and cleaning the floor, presentation of progress by a report	Enhancing worker confidence and increasing productivity was observed.	UAE	Al-Aomar (2011)
Improve working procedures	Visual observation, documentary analysis and interviews	There is a relationship between the 5S implementation effort and Lean-Kaizen.	Mexico	Park <i>et al.</i> (2012)
Improve working procedures	Visual Observation using feedback before and after photography	Each concept of 5S helped to resolve the problem and lack that the company had faced before.	Malaysia	Sorooshian <i>et al.</i> (2012)
Enhance safety	Weekly safety inspection	The number of accidents associated with slips and trips reduced.	Norway	Leino <i>et al.</i> (2014)
Continuous improvement, reducing waste and maintaining the material flow	Visiting in-person, arranging interviews and presentations	Best managerial practices based on 5S principles are described and the most significant principles associated with the success of the 5S method are defined and discussed for 5 Japanese factories.	Japan	Jaca <i>et al.</i> (2014)
Improve working procedures	Internal audit using daily checking and weekly report	Reducing waste and time of access to the materials and needed tools, cleaning and orderly workplace, safety increase at the working place, productivity increase, improving discipline, stress-reducing and quick detection of problems were reported.	Romania	Filip and Marasuc-Klein (2015)
Enhance Safety	Visual control using before and after photos as the measurement tool	The new 5S culture improved the working environment and increased the motivation of the staff involved.	Spain	Jiménez <i>et al.</i> (2015)
Improve productivity and efficiency	Weekly audit using evaluation forms as well as before and after photos	Several positive changes were made to the operating procedures, tool organization, cleaning schedules and material handling. For instance, tool searching time from shop floor has been decreased from 30 to 5 min.	India	Gupta and Jain (2015)
Improve working procedures	Compares a top-down and a bottom-up implementation approach	The wastes and overall delay were essentially reduced. Ultimately, the paper showed how digital technologies can support field execution by enhancing data collection and decision making.	France	Berroir <i>et al.</i> (2015)
Enhance safety, Improve productivity and efficiency	Applying four visual systems/ tools (i.e., 5S or visual workplace structuring, visual performance system, visual indicator and visual control)	The findings identified the 5S visual system improved workplace conditions with lessened item transaction process times, savings in workspaces and a better health and safety condition.	UK	Tezel <i>et al.</i> (2016)
Enhance Safety	Quantitative measuring by a pre- and post-test of 5S event for the study and control groups	5S magnificently upgraded the safety climate of the workers. Besides, it enhanced the cycle time, improved productivity and floor area utilization.	USA	Srinivasan <i>et al.</i> (2016)
Improve productivity	Visual control by a checklist and calculate productivity based on attendance time	The correlation showed a positive relation between 5S levels and productivity.	Romania	Veres <i>et al.</i> (2018)
Improve working procedures, enhance safety	Training and 5S implementation were carried out on-site to study its effects	5S favor the occupational safety and health of the workers. Also, it enhanced accident rate indicators, training hours, average downtime, repaired equipment and work overload.	Ecuador	Ruiz <i>et al.</i> (2020)
Continues Improvement	Interview, site visits and codifying the interview data into major categories	Findings indicated that companies utilize collaborative practices, visual management techniques, 5S and root cause analysis to solve problems.	USA	Al Heet <i>et al.</i> (2020)