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# Manual of Standardized Work Laboratory Practices

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**Abstract:** Currently, technology plays a significant role in distance education, enhancing productivity and efficiency in the teaching-learning process. As a result of the COVID-19 pandemic, a proposal was developed to create a practical manual aimed at fostering the development of competencies for the course "Standardized Work from Home." This was the objective of the study. The methodological route of the PDCA cycle (Plan, Do, Check, Act) was employed to define the sequence of activities and used the Institution's reference guide. The manual includes playful activities that can be conducted in various settings, not just in the Industrial Engineering lab, focusing on topics such as capacity and efficiency calculations, time-taking techniques, process analysis, 5S systems, continuous flow, among others. These topics are particularly useful for achieving quality and productivity in processes. In conclusion, the design of remote practices was successfully achieved, allowing the course to continue, maintaining students' academic progress, and contributing to competency achievement. It is recommended to continue developing these types of resources, which, although born out of necessity during the pandemic, have proven highly beneficial for education.

**Keywords:** Distance, quality, productivity, and practices.

## Introducción

Caballero and Calderón (2017) state that during classroom teaching and learning, teachers develop strategies that allow students to better understand the information presented in class. One of these strategies is playful teaching, which helps students grasp the topics covered while fostering creativity, critical thinking, and basic problem-solving skills (p. 291). According to Candela and Benavides (2020), recreational activities are an essential strategy for learning; without them, students often perform poorly. Play is crucial in all stages of human life as it helps develop skills and abilities that contribute to meaningful learning (p. 83). In this context, Reyes (2015) asserts that play is an activity that supports the development of behavior, decision-making, interpretation, and socialization in children. When used appropriately, it becomes an effective strategy for the educational process (p. 79). Similarly, Castro and Morales (2015) propose that learning is the process of acquiring or modifying competencies, skills, knowledge, behaviors, values, and theories (pp. 4–5).

Gate and Quezada (2011) argue that higher education worldwide recognizes the need to evolve in line with changes in educational systems and labor markets, imposing new demands on universities to train graduates and professionals equipped for the increasingly globalized and expanding human activities. Specifically, they highlight the importance of developing IT-specific skills in graduates to foster the necessary abilities and competencies (p. 291). Domínguez and López (2015) emphasize the need for higher education institutions to become more resilient and integrate Information and Communication Technologies (ICT) into the training process. This reflects the urgency of improving students' technical skills and preparing them to integrate information and knowledge into society (p. 49).

In Sonora, the presence of COVID-19 has driven changes in teaching and learning, making it necessary to implement technology-mediated teaching strategies to ensure continuity and prevent setbacks for students. Information and Communication Technologies (ICT) have become essential tools for academic activities. However, several obstacles, such as significant social inequalities, lack of technical resources, and inadequate training for teachers and students in ICT use, limit their effectiveness (Carrazco, 2021, p. 1).

The Instituto Tecnológico de Sonora (ITSON) is known for its flexibility in adapting to societal demands. The current global situation has compelled the institution to modify its structural foundation to continue fostering cultural, social, and economic development successfully. However, the lack of hands-on exercises performed at home during laboratory practices has negatively impacted competency achievement and students' academic progress. This highlights the need to develop a practical manual for the laboratory course on "Standardized Work" that can be carried out remotely.

To respond, the Objective is to: Prepare a practices manual that contributes to the development of the competency of the Standardized Work subject of the Manufacturing Engineer educational program plan 2016.

## Materials and Method

**Object of Study**

The object of study is the practical manual for the Standardized Work laboratory, which will be used by students in the Manufacturing Engineering academic program.

**Materials**

To carry out this project, the following materials and tools were used:

- **Microsoft Word 2016**: Necessary for capturing and drafting the information.
- **Microsoft PowerPoint 2016**: Used to create supplementary illustrations for the practices, such as diagrams, charts, tables, etc.
- **Lego figure kits**: Required for simulating production scenarios.
- **Digital camera**: To capture reference images.
- **Stopwatch**: Used for time measurement.

**Procedure**

This section describes the steps of the methodological route followed, based on Edward Deming's PDCA (Plan-Do-Check-Act) cycle (Zapata, 2015) and the ITSON office's reference guide for creating practical manuals.

**Plan the Standardized Work Manual**

In this phase, the course content to be included in the new practical manual was reviewed. This included understanding elements such as the course competency, related competencies, general course description, competency unit, elements of competency, and required information. During this stage, the topics were selected with the help of instructors involved in designing or teaching the course. A brief summary of the manual's content was written to give readers a clear understanding of its components.

**Develop the Practices**

Based on the list of topics established during the planning phase, each practice was developed as follows:

- Assign a name and number to the practice, reflecting its content and order in the course syllabus.
- Write the purpose of the practice, clearly stating its goals based on the tool or topic applied.
- Describe the theoretical concepts of the selected topic, providing a concise synthesis.
- Outline the instructions, using clear and straightforward language to ensure reader comprehension.
- Generate the results section, detailing the data, records, tables, or evaluations derived from the practice.
- Create a conclusions section, where students can document their findings.
- Include a bibliography for further reference if needed.

**Validate the Practices**

Once a practice was fully developed, it was reviewed and performed by individuals uninvolved in its creation to ensure that the instructions were understandable and that the objectives were achievable. Adjustments were made as necessary, followed by revalidation.

**Provide Feedback**

Feedback was gathered for each exercise through timely communication, enabling corrections to be made when required.

## Results and Discussion

Following the established procedural sequence, the results are presented below:

**Planning the Practical Manual**

The practical manual to be developed corresponds to the "Standardized Work with Laboratory" course, which is part of the Manufacturing Engineering curriculum. To understand its content, the course program was reviewed, identifying aspects such as the course name, department, design committee members, general course description, the competency it supports, and the generic competencies where students develop teamwork and autonomous work skills.

The second part of the program outlines the competencies (at least two), the elements of competency, and the specific informational requirements, emphasizing resource efficiency for producing goods and services according to client demands.

After reviewing the course program, the next step was to establish, with the help of subject professors, a list of topics deemed relevant for development through practical exercises. The selected topics included: capacity and efficiency calculations, time-taking techniques, operation, process flow, and routing diagrams, one-piece flow and batch processing, waste in processes, 5S methodology, Training Within Industry (TWI), improvement and analysis techniques (5W+1H), man-machine diagrams, Yamazumi diagrams, bimanual process diagrams, and standardized work.

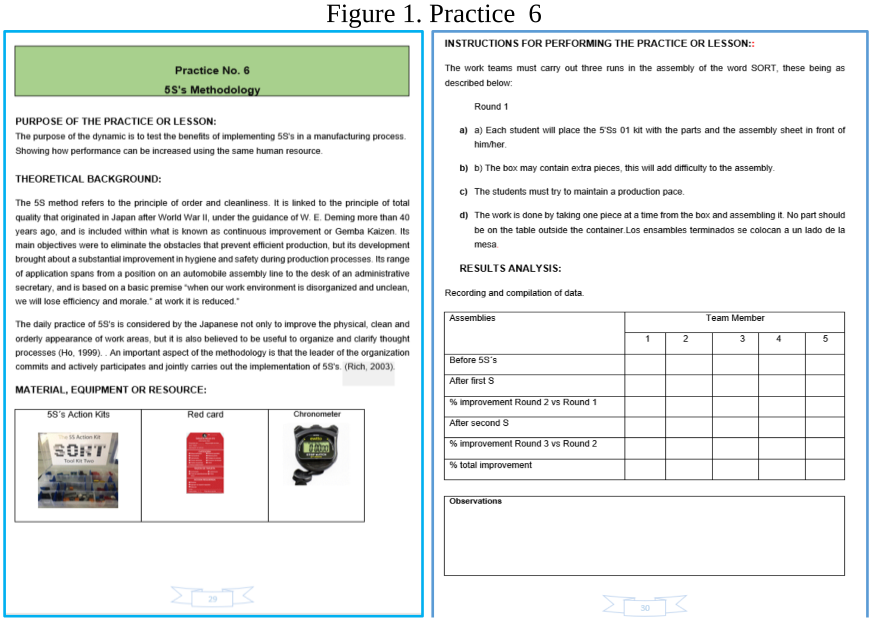
Once the topics were defined, each was researched and described theoretically, accompanied by an explanation of the purpose of the respective practice. Examples include:

- **Capacity and Efficiency Calculations**: The practice focuses on determining capacity and efficiency indicators through a simulated production process, forming the basis for quantitative improvement.
- **Time-Taking Techniques**: Students learn to measure production cycle times accurately to identify inefficiencies and reduce unnecessary time within the production cycle.
- **Process and Operation Diagrams**: Students create diagrams for operation, process flow, and routing, using these as references to analyze an assembly process.
- **One-Piece Flow and Batch Processing**: Techniques for simulating linear and continuous production lines are used to optimize workflow.
- **Waste Identification in Processes**: Students identify inefficiencies that do not add value, promoting opportunities for improvement.
- **5S Methodology**: Demonstrates the benefits of applying the 5S methodology in manufacturing to enhance productivity and quality.
- **TWI Training**: Students apply the TWI method to train operators and improve production methods.
- **5W+1H Analysis**: Students use this method to analyze processes and implement improvements.
- **Man-Machine and Yamazumi Diagrams**: Practices focus on balancing production cycles and analyzing workloads for greater efficiency.
- **Bimanual Process Diagram**: Students identify and minimize inefficient movements during tasks.
- **Standardized Work**: Students develop standardized work instructions using specific formats and tables for documentation.

**Developing the Manual**

The practices were designed to help Manufacturing Engineering students develop skills in industrial engineering and lean manufacturing techniques. Figure 1 illustrates Practice 6 from the manual, related to the 5S system, featuring objectives, theoretical summaries, required materials, result formats, and QR codes linking to supplementary resources.

Figure 1. Practice 6



**Practice No. 6**
**5S's Methodology**

PURPOSE OF THE PRACTICE OR LESSON:
The purpose of the dynamic is to test the benefits of implementing 5S's in a manufacturing process. Showing how performance can be increased using the same human resource.

THEORETICAL BACKGROUND:

The 5S method refers to the principle of order and cleanliness. It is linked to the principle of total quality that originated in Japan after World War II, under the guidance of W. E. Deming more than 40 years ago, and is included within what is known as continuous improvement or Gemba Kaizen. Its main objectives were to eliminate the obstacles that prevent efficient production, but its development brought about a substantial improvement in hygiene and safety during production processes. Its range of application spans from a position on an automobile assembly line to the desk of an administrative secretary, and is based on a basic premise "when our work environment is disorganized and unclean, we will lose efficiency and morale." at work it is reduced."

The daily practice of 5S's is considered by the Japanese not only to improve the physical, clean and orderly appearance of work areas, but it is also believed to be useful to organize and clarify thought processes (Ho, 1999). . An important aspect of the methodology is that the leader of the organization commits and actively participates and jointly carries out the implementation of 5S's. (Rich, 2003).

MATERIAL, EQUIPMENT OR RESOURCE:

| 5S´s Action Kits | Red card | Chronometer |
|---|---|---|
| | | |

INSTRUCTIONS FOR PERFORMING THE PRACTICE OR LESSON::

The work teams must carry out three runs in the assembly of the word SORT, these being as described below:

Round 1

a) a) Each student will place the 5'Ss 01 kit with the parts and the assembly sheet in front of him/her.

b) b) The box may contain extra pieces, this will add difficulty to the assembly.

c) The students must try to maintain a production pace.

d) The work is done by taking one piece at a time from the box and assembling it. No part should be on the table outside the container.Los ensambles terminados se colocan a un lado de la mesa.

RESULTS ANALYSIS:

Recording and compilation of data.

| Assemblies | Team Member | | | | |
|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 |
| Before 5S´s | | | | | |
| After first S | | | | | |
| % improvement Round 2 vs Round 1 | | | | | |
| After second S | | | | | |
| % improvement Round 3 vs Round 2 | | | | | |
| % total improvement | | | | | |

| Observations |
|---|
| |

Figure 1 illustrates Practice 6 from the manual, related to the 5S system, featuring objectives, theoretical summaries, required materials, result formats, and supplementary resources.

**Validation of the Manual and Feedback**

After completing the 12 practices, they were validated individually. Undergraduate students tested each practice and provided feedback based on application time (T), clarity of instructions (E), adequacy of information (I), and relevance to the topic (C).

Table 1. Validation of Practices

| Validation of Practices | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| P1 | | | | P2 | | | | P3 | | | | P4 | | | | P5 | | | | P6 | | | |
| T | E | I | C | T | E | I | C | T | E | I | C | T | E | I | C | T | E | I | C | T | E | I | C |
| | | | | | | | | | | | | | | | | | | | | | | | |

| P7 | | | | P8 | | | | P9 | | | | P10 | | | | P11 | | | | P12 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| T | E | I | C | T | E | I | C | T | E | I | C | T | E | I | C | T | E | I | C | T | E | I | C |
| | | | | | | | | | | | | | | | | | | | | | | | |

Complete

Observations

The validation process identified areas for improvement, such as insufficient information in Practice 2 (time-taking techniques), insufficient allocated time for Practice 6 (5S system), inadequate information in Practice 7 (TWI), and excessive length in Practice 12.

Participant feedback, including suggestions for better bin organization, visual aids, and video examples, was incorporated, enhancing the manual's quality and reliability.

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## Conclusions and Recommendations

The project successfully achieved its objective of developing a practical manual that contributes to the competency development of the "Standardized Work" course in the Manufacturing Engineering program. This effort allowed the course to remain available, ensured continuity in students' academic progress, and contributed to competency achievement.

Each of the practices can be safely carried out at home as part of daily activities, either individually or in teams, using communication applications to collaborate.It is recommended to continue working on resources of this nature, which, although initially created in response to the pandemic, have proven to be highly valuable for education.

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