

# Implementation of 5S lean tool in a higher education institution

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**Abstract.** 5S method has been applied in Higher Education Institutions (HEIs) abroad to eliminate waste and improve working conditions. Many workshops and laboratories in Moroccan higher technical education institutions (HTEIs) are characterized by the presence of bad working conditions and waste because of the bad organization of workplace, but there is no HEI that has applied this method to solve this problem. The aim of this paper is to emphasize the importance of applying 5S method in HEIs. To achieve this objective, a structured 9-step approach was used, which takes into account the obstacles to implementing Lean Higher Education (LHE) before applying 5S. A case study is carried out on an automotive workshop in a HTEI in Morocco. The results show improvements in working conditions, safety and the quality of teaching-learning. In addition, a decrease in time needed to find materials, tools and documents. This time is considered a time of non-value-added in the teaching-learning process (waste of waiting and motion). HEIs that want to improve activities in workshops, laboratories and teaching-learning process can simply follow the steps presented in this paper and make teaching-learning and research work more efficient. This research is the first of its kind of the application of 5S in Moroccan HEIs. Lean tools in higher education can benefit both faculty and students (teaching-learning process).

**Keywords:** Lean Higher Education, 5S, Technical higher education.

## 1 Introduction

For several decades, Toyota Motor Company has developed the Lean methodology to establish operational excellence as a strategic cornerstone. This methodology is a set of principles and practices focalized on the elimination of different forms of waste (Muda in Japanese). Origins of Lean are related to Total Quality Management (TQM) and Just-In-Time (JIT) that are based on Fordism[1]. Taiichi Ohno, who is an engineer at Toyota studied Fordism, developed a new production system called Toyota Production System

(TPS)[2]. This new form of company organization has gradually established in the face of the Fordism. Outside of Toyota, TPS is often referred to 'Lean', this term has popularized in a famous book titled 'The Machine That Changed the World' [3]. A Lean approach is a systematic approach that is used to identify and eliminate seven forms of waste through continuous progress (overproduction, waiting, transport, extra processing, inventory, motion or movement, and defects)[4]. In [5], there is an eighth waste which is related to the human aspect that has been neglected in the seven wastes which is "Unused employee creativity".

Lean Thinking, or adoption of this way of thinking, makes it possible to go beyond the purely curative framework of hunting down waste and improving performance. Lean principles should implement in a preventive manner when developing products, processes, activities, etc.

The development of attitudes and skills for Lean thinking is linked to the development of competent employees through training and personal development programs. These programs train employees to master the five principles of Lean thinking: specify value, identify the value stream, flow, pull and pursuit perfection [6]. Lean is a universal improvement approach that can be applied to many organizations in different countries [7]. The manufacturing sector has achieved significant improvements by using Lean in different companies. These good results encourage other sectors, which are far from the manufacturing sector, to engage in this adventure of improvement, such as service sectors (banking, healthcare and education) [8].

Several Higher Education Institutions (HEIs) have applied Lean Higher Education (LHE) to improve efficiency of university processes by systematically eliminating waste [9]. For this reason, many HEIs have been using LHE in different countries around the world, before an educational roadmap was elaborated. The first HEIs in the USA that used LHE to improve their processes are the following: "University of Central Oklahoma, University of Iowa, University of New Orleans, Bowling Green State University, and University of Scranton" [8]. Lean has been widely used in higher education sector, but a very few universities adopted Lean Six Sigma (LSS) for improving the efficiency and effectiveness of HEIs processes[9]. The HEIs are considered by public opinion as inefficient, expensive and labor intensive [10]. So, since 2000, the HEIs have started improvement initiatives with Lean [8], in order to respond to external pressures to change.

In higher education, waste occurs in both academic and non-academic processes [11]. In order to eliminate it, several HEIs have implemented LHE. These institutions have already applied Lean tools which comes before the application of the Lean philosophy (Lean culture). The 5S method is one of the most widely used Lean tools for organizing workplaces and eliminating waste. This method is applied in a laboratory at a HEI in Serbia [12]. The obtained results show that there is an improvement in working conditions and eliminating waste. There is another example of the application of the 5S which is the HEI in India, the application of this method permitted this institution to organize the workplace: decreased wastage, increased workspace, optimized quality as well as productivity was increased via monitoring and organized environment[13]. In Morocco, the application of Lean tools in higher education is in the initial stages, and there are few studies on the application of these tools, but there are no studies on the

application of 5S tool. The research problem of this paper is that 5S has been applied in HEIs abroad to eliminate waste and improve the performance of services offered to faculty and students. Many workshops and laboratories in Moroccan higher technical education institutions (HTEIs) are characterized by the presence of bad working conditions and waste because of the bad organization of workplace, but there is no HEI that has applied this method to solve this problem. The aim of this paper is to emphasize the importance of applying 5S method in HEIs.

This paper focuses on the application of 5S in higher education, and more specifically in the HEIs of Morocco. The chosen institution for this study is located in Beni Mellal, Morocco, which is a HTEI. In this context, we will address the following research questions: How can the 5S method be applied in the context of Moroccan higher education? and what are the benefits of applying 5S in this institution?

After this short introduction, this paper will be structured as the following: The second section presents the literature review. The third section presents the methodology used in this paper. The fourth section presents the case study. The fifth section presents discussion of results and the last section, is a conclusion to this work.

## 2 Literature Review

One of the primary functions of HEIs is teaching and learning. The educational system consists of complex processes which create a difficulty to identify the appropriate process. For example, teaching and learning should be added in one process (teaching-learning process), and teaching does not classify far from learning. If there are no other secondary processes (administration, library, etc.), which are also needed in teaching-learning process to improve the quality of providing education, a HEI cannot deliver its services (education) to their ‘customers’. Academic processes are improved by faculty members who used LHE to improve teaching-learning, curriculum and assessment processes. Non-Academic processes are improved by using the Lean thinking in administrative, business, and support processes.

### 2.1 Academic Processes

#### Teaching-learning process

Teaching is considered the main value-creating activity in higher education system, but there is little change in teaching methods used by faculty to teach for many decades [14]. Several universities used a lot of change initiatives, including Lean, to improve teaching process. In [15], Kaizen method was an effective process for enhancing graduate business school courses and value propositions for students. For example, eliminating overprocessing (waste) such as duplicate teaching materials: journal articles or case studies used in two courses. In [16], the LSS methodology is deployed in a teaching-learning process in computer science engineering at an Indian university to improve its quality by decreasing process cycle time and reducing waste. In [17], different types of wastes are identified and eliminated by using Lean Thinking in a course review process. LSS is used to improve tutoring services (walk-in tutors) at the University of

Dayton (USA) [18]. According to last reference, the impact of these improvements provide equilibrium between tutor utilization and student wait time. This result encourages other schools in engineering and business in the same university to deliver additional financial support for tutoring services.

### **Curriculum process**

University curriculum is designed to prepare and to make student ready for the next life experience: professional career or pursuit of study in a master or doctoral cycle. LSS methodologies can be applied to find the most suitable preparation, competencies and skills for the degree path. LSS allows administrators and faculty to know the importance of external customers, especially headhunter who will be employing the graduate or HEI who will be accepting them [19]. In [15], connections between courses are identified in order to deliver a more thematically homogenous Executive Master's Program (EMP) that based on strategic thinking and leadership. In [20], the application of the LSS framework enables the "curriculum development team" to identify important variables for the redesign an academic program in order to obtain maximum performance. Finally, in [21], Lean principles are used to guide the development of educational program.

### **Assessment processes**

Assessment process is the process of measuring the level of student learning. In [22], the fishbone diagram is used to identify the causes of the few pass the exams, which can be reduced by using existing resources to increase the pass the exams. In [21], Lean principles can improve course assessment processes.

## **2.2 Non-Academic Processes**

### **Administrative and business processes**

Attraction and maintaining of students is essential to the global success of the university enterprise. A drop in student enrollment is considered as a threat that can destroy the university enterprise foundations [19]. To overcome this problem, in [23], Lean is used to improve an enrolment process in an Italian university. After using this method, there are several results including: (1) the number of employees reduced to 5 employees rather than 15, (2) the average queuing time decreased to 17 minutes rather than 1h 44, (3) the process cycle efficiency or service efficiency is improved from 10.7 % to 21.6 %. In [24], a small group of undergraduate students at Oakland University can rapidly study Lean principles, tools and practices. These students applied this learning to improve an administrative process of their university. LSS tools and methods can be used in university processes, in order to reduce costs and improve quality and productivity in financial and administrative processes in the university context [25]. In [26], LSS methodology is introduced in an Irish university by using a method called DMAIC (Define, Measure, Analyze, Improve and Control) that supports simplification of some administrative processes. Several improvements are accomplished, especially: customer satisfaction, cost reduction, cycle time reduction and waste reduction (rework and error reduction).

### **Student support processes**

Lean used to improve advising processes of the Department of Management, Marketing, and International Business (MMIB) at Stephen F. Austin State University [27]. Libraries of universities have used Lean thinking to improve their performance. For example, Library existed in University of Chicago's Joseph Regenstein which applied process mapping and continuous improvement to improve shelving [28]. In addition, Lean is applied in the libraries of Wichita State University in order to reduce materials processing time (from 25 to 15 days) [29].

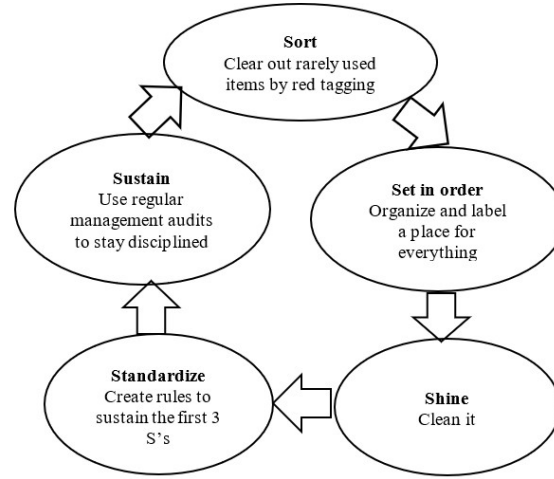
### 2.3 5S Method

When the Americans visited Japanese factories (in the 1970s and 1980s), the first reaction of them is invariably: the factories are so clean so you can eat at the floor. For the Japanese, it was simply a matter of pride. Why does anyone want to live in a pigsty? But their efforts aren't limited to making the factory which looked neat and tidy. In Japan, there's the 5S method comprises a series of activities which aim to eliminate the waste that contributes errors, defects and injuries in the workplace [30]. Table 1 presents the 5S (seiri, seiton, seiso, seiketsu and shitsuke, translated into English):

**Table 1.** 5S method [30].

5 S	Description
Sort	Sort items and keep only what's necessary, throwing away what's not.
Set in order	A place for everything and everything in its place.
Shine	The cleaning process often acts as a form of inspection, highlighting abnormal, pre-failure conditions that could adversely affect quality or cause machine failure.
Standardize	Develop systems and procedures to maintain and control the first three Ss
Sustain	Maintaining a stable workplace is an ongoing process of continuous improvement.

5S method create a continuous process of improving the working environment (Fig.1). The Lean thinking is not about using 5S method to organize and label materials, tools and waste which to maintain a clean, shiny environment, but 5S is a tool used by lean systems to ensure smooth flow to takt time. 5S makes problems visible and, if used in a sophisticated way, can be part of the visual control process of a well-planned Lean system [30].



**Fig. 1.** The 5S [30].

### 3 Methodology

The idea for the project was launched in September 2022 by the authors when they were trying to find a research topic. At the end of October 2022, the project idea was finally presented to the institution's management who responded positively. A 5S expert who is also a member of the 5S team project was charged to organize a 5S training session for other team members and other relevant stakeholders. This training gave the 5S team members a good understanding of the main 5S concepts, and how this method can be implemented in the automotive workshop environment. The creation of the project plan and the organization of the project began at the same time (November 2022).

A 9-step approach is used, which is an action-based approach. The 9 steps followed to implement 5S are as follows:

#### 3.1 Step 1: Top management's commitment

Becoming a Lean organization takes time and effort [31]. It requires top management commitment to the ongoing training and support for cultural change at all levels [32], [33]. In [34], the implementation of LHE without the commitment and support of managers to foster a culture of continuous improvement, and the lack of knowledge among senior managers about the benefits of LHE are two barriers to use the LHE. The institution's management supported this project and created a favorable environment for implementing the 5S after explaining the benefits of Lean and specifically the 5S in educational services.

### 3.2 Step 2: Launching a training program

To reduce employees' fears, it is necessary to train them, because training is a highly effective communication. Training is seen as a communication activity that can lead to acquire information and/or change attitude or behavior [35]. During LHE training, employees learn different concepts and tools (e.g., 5S) as well as the purpose of the 5S project, which will clearly explain to them. This training reduce resistance to change (e.g., fear of the unknown) and increasing acceptance of change. Once employees have been given the training and tools they need to carry out Lean, their acceptance of the Lean initiative increases [36]. Training reduces or eliminates the awkward use of specific terminology, techniques and tools of the manufacturing sector in higher education sector [31].

The 5S training program was launched with examples of successful 5S implementation in industry. But also, successful examples of 5S projects in HEIs to show that the 5S method is applicable in this context. This training including how 5S is implemented, what are its benefits and how it is longed.

### 3.3 Step 3: Organizational structure plan

The 5S method is very much focused on sustainability and the group work environment. The chances of project success are high, when the group members are motivated to use this method for making changes. The creation of the 5S team is based on the principle of respect and equality for all. This principle can also be seen in the creation of the 5S team, whose members work at either the lowest or highest level. All members of the 5S team were encouraged and motivated to work towards a shared goal because of the inclusive environment.

### 3.4 Step 4: Formulating 5S goals aligned with strategic goals of the institution

The strategic vision of the reform (2015-2030) drawn up by the Higher Council for Education, Training, and Scientific Research in Morocco, this strategic vision focuses on improving the working conditions of educational actors (teachers and researchers) and enhancing the quality of student learning [37]. The application of the 5S project in HEIs follows this strategic vision, which is also the strategic vision of HEIs. The chances of success for the 5S improvement project are high, since a weak link between the strategic objectives of an HEI and continuous improvement projects is considered an obstacle to the success of a continuous improvement project in HEIs[34].

To reduce LHE team members' fear of the unknown, it is necessary to develop effective communication based on listening, dialogue and explanation at every stage of the change process. In the upstream of the project, it's necessary to ensure that each member has clearly identified the project's goals and objectives[38].

The 5S team also carefully drafted its objectives, as shown below:

1. Optimize workshop space;
2. Improve working conditions;
3. Improve workshop safety;
4. Minimize time spent searching for materials;
5. Improve the quality of teaching and learning.

To achieve the desired objectives, it is very important to understand the practical scenario, the design policies and the objectives accordingly. The 5S team therefore carefully analyzed the current state and selected objectives that were practically achievable, seemed realistic and could be measured. It also ensured that the people involved in this goal formulation and definition exercise should clearly know about what they are doing.

### **3.5 Step 5 - Master plan for 5S implementation**

The 5S team needs to take the right approach in drawing up a master plan for its implementation. To this end, the participants drew up a flawless master plan. The 5S team visited the institution's workshops and did a few exercises to understand the institution as a whole:

1. Understanding the different workshops and laboratories (automotive, renewable energies, etc.).
2. Understanding the materials and equipment used by faculty (type, function, associated problems and losses, if any).
3. Interaction with faculty to understand their inspiration, attitude, etc.

The project team created a presentation for management including answers to various interesting questions based on the above approach.

1. Understand the current state of the institution's workshops and laboratories.
2. Expectations and benefits of the 5S method.
3. How will 5S be implemented?
4. What is the sequence required for implementation?
5. Audit structure of 5S method and periodicity of review.

Management supported the recommendations made for 5S implementation. It also proposed that training and a feasibility study be carried out to ensure the successful implementation of 5S. The plan also included the finer details of the training required and the resources needed to train the various stakeholders, as well as the technical and financial support needed to do this. The scarcity of resources (time, budget, personnel resources, etc.) is considered as an obstacle to the success of LHE [34]. But in this project, the resources are available to make it happen.

### **3.6 Step 6: Feasibility study**

If the Lean team in public universities consists of motivated employees, the Lean project will be a real chance of success [38]. To develop a baseline for 5S implementation in the institution, the 5S project team undertook a feasibility study, which will help management to assess results, implementation progress and even formulate goals. The feasibility study consists in checking the current state of the equipment, forecasting future state, assessing the qualified human resources required, the cleanliness and orderliness of the institution, and the organizational culture. The results of the feasibility study presented to management, who agreed to select a pilot workshop from among the institution's workshops and laboratories.



### **3.7 Step 7: Selecting the pilot workshop**

The pilot workshop must be one that requires significant improvement that results of improvements appeared quickly. Team project chose the automotive workshop, because the chances of rapid success in this workshop are high: The faculty and students using this workshop had knowledge of Lean and its tools (e.g., 5S) and the workshop was very close to manufacturing workshops in factories. What's more, the 5S project team is well acquainted with the materials and equipment available in the workshop, and also the various practical tasks carried out there. The factors influencing the choice of the automotive workshop can be summed up by an understanding of the improved process. On the other hand, the lack of understanding of the improved process in higher education is seen as an obstacle of LHE implementation [34].

### **3.8 Step 8: Plant-wide application**

The feasibility study was carried out in the pilot workshop over a period of 13 weeks. The whole process ran smoothly and produced positive results that are helping to pave the way for the institution-wide implementation of 5S.

### **3.9 Step 9: Control and act**

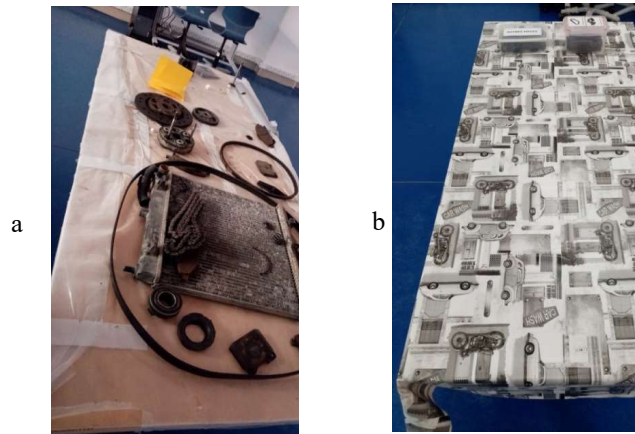
The audit enables us to identify discrepancies and opportunities for successfully implementing the 5S project. The practical part of the audit is carried out on the automotive workshop. After the launch of the 5S project, the progress audit is generally carried out at the end of each week until the end of the 5S project (13 times). After control, adjustments and reassessment are needed: when results don't match expectations, adjustments and reassessment are necessary. In addition, it is necessary to promote a culture of continuous improvement: this means emphasizing the development of a culture where the organization learns from its experience, innovates and adapts constantly.

## **4 Case Study: 5S In the Automotive Workshop**

Table 2 to 5 show four problems solved by using the 5S method and Fig. 2 to 5 show before and after images of the 5S implementation in the institution's automotive workshop.

**Table 2.** Analys of problem 1 and remedy.

Problem 1	The didactic tools are spread out above the table, taking up a lot of space.
Problem analysis	Faculty are used to leaving didactic tools on the table.
Root cause	Places of the didactic tools are not defined
Remedy	All didactic tools are placed in cupboards or boxes according to their size.
Action	<ul style="list-style-type: none"> <li>• Use plastic boxes for small teaching materials.</li> <li>• Use cupboards for large teaching materials.</li> <li>• Change the tablecloth for one that's easy to clean.</li> </ul>
Benefits:	Direct: <ul style="list-style-type: none"> <li>• Better housekeeping</li> <li>• Clean work table</li> </ul> Indirect: <ul style="list-style-type: none"> <li>• Effective use of space</li> <li>• Increased cleanliness in the automotive workshop</li> </ul> Faculty and students' motivation and moral are increased

**Fig. 2.** Implementation of the solution for problem 1: (a) before, (b) after.

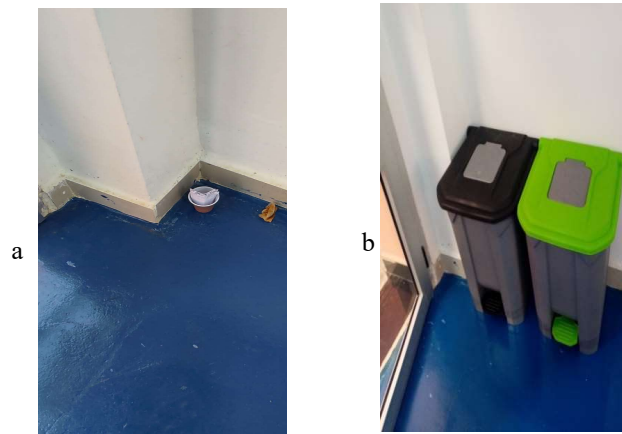
**Table 3.** Analys of problem 2 and remedy.

Problem 2	Faculty waste their time looking for the materials, tools and documents which are needed to carry out practical work.
Problem analysis	Faculty are used to put materials, tools and documents in any cupboard.
Root cause	The location of materials, tools and documents is not defined.
Remedy	Materials, tools and documents are stored in cupboard by name (e.g., voltmeters, cables, etc.).
Action	Gather the same materials, tools and documents in a single cupboard by using labels.
Benefits	Direct: <ul style="list-style-type: none"> <li>• Materials search time is decreased</li> <li>• Get two empty cupboards</li> <li>• Better housekeeping</li> </ul> Indirect: <ul style="list-style-type: none"> <li>• Effective use of space</li> </ul> Faculty motivation and moral are increased

**Fig. 3.** Implementation of the solution for problem 2: (a) before, (b) after.

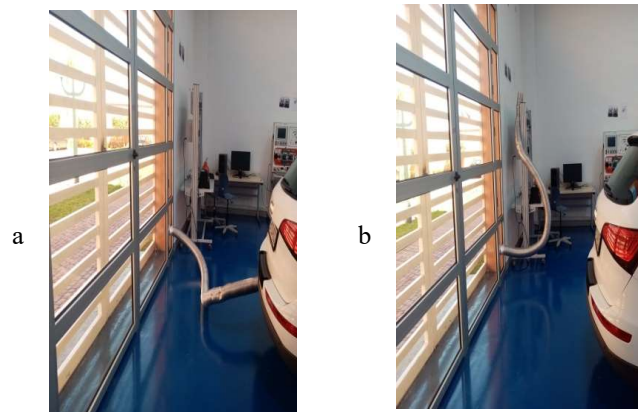
**Table 4.** Analys of problem 3 and remedy.

Problem 3	Waste in the workshop (leaves, coffee cups, water bottles, empty markers, etc.)
Problem analysis	Faculty and students are used to throw waste anywhere.
Root cause	There is no wastebasket in the workshop
Remedy	Collect waste in a wastebasket
Action	Put a wastebasket in the workshop
Benefits:	Direct: <ul style="list-style-type: none"> <li>• Clean work space</li> <li>• Better housekeeping</li> </ul> Indirect: <p>Faculty and students' motivation and moral are increased</p>

**Fig. 4.** Implementation of the solution for problem 3: (a) before, (b) after.

**Table 5.** Analys of problem 4 and remedy.

Problem 4	Damage exhaust pipe and carbon dioxide emissions in the workshop.
Problem analysis	The exhaust pipe is always on the ground, and students can damage it during practical work on the training vehicle.
Root cause	There is no wall-mounting system for the exhaust pipe. It simply rests on the ground.
Remedy	Fix the exhaust pipe on the wall while the training car is stationary
Action	Use a pipe clamp to secure the pipe on the wall.
Benefits:	Direct: <ul style="list-style-type: none"> <li>• Increase exhaust pipe lifetime.</li> <li>• Safety of students and faculty increased</li> </ul> Indirect: <ul style="list-style-type: none"> <li>• Minimizes workshop clutter and frees up space.</li> </ul> Work environment containing clean air.

**Fig. 5.** Implementation of the solution for problem 4: (a) before, (b) after.

## 5 Discussion

The application of 5S began with sorting. This phase eliminated items and documents that weren't necessary. But necessary items and documents were kept in easily accessible locations (cupboards). For the purpose of reducing the amount of floor space required and cupboard space, unnecessary items and documents were eliminated.

Sorting is followed by set in order. Every equipment or didactic model placement was marked, also the materials and the tools are coded and placed in cupboards. What

is more, nothing should be placed on the ground and frequently used materials and tools are placed at the top of the cupboards for easy access.

The last step is followed by cleaning step. The emphasis is on keeping the workplace clean. Unwanted and unnecessary items are removed, so we can concentrate on other things.

A 5S project can be very rewarding, as it helps to de-clutter the workplace and organize the environment. However, if it is not maintained, the 5S project will be unsuccessful. This is the fourth step comes in: standardization. Through standardization, best practices are compared and approved. Among the standards which developed by the institution is the location of the exhaust pipe. Finding the exhaust pipe which mounted on the stationary training car is an immediate notification of non-compliance with procedures.

The fifth phase is the sustainable phase. The sustainability of the 5S project is a measure of its success. The results of the weekly audits are posted on information boards. This enables everyone involved to see what improvements need to be made in the automotive workshop. The 5S training program has also been developed. Therefore, the faculty and students who carry out their practical work in this workshop have benefited from this training, in order to set up a 5S culture.

The implementation of 5S method resulted in overall benefits for the automotive workshop. The results show an improvement in working conditions, safety and the quality of teaching and learning. In addition to this, it reduced the time needed to find materials, tools and documents. Reducing this time has also reduced two types of waste: waiting (students wait for the teacher to find materials, tools and documents to do the practical work) and motion (teacher moves around the workshop looking for materials, tools and documents). The improved workspace gives two empty cupboards. In the future, these cupboards can be used in the same workshop without making new purchases. Also, they can be used in another workshop or laboratory when the 5S method is generalized in the institution. The 5S method is not generalized throughout the institution (step 8), because the study is limited to applying it in the pilot workshop (step 7).

A 5S audit was carried out (step 9) to check that the objectives had been achieved. The audit is carried out on an ongoing basis (at the end of each week), instead of just once at the end of the project. Answers to audit questions allow us to correct deviations from objectives. Audit scores during the analysis period give us an increasing trend, which has enabled us to achieve the final objectives without delaying the project.

By following the four phases indicated by the acronym PDCA (Plan, Do, Check and Act), organizations can tackle problems in a systematic way. This promotes a structured approach to problem solving. The 9-step approach can be structured into the 4 steps of the PDCA method. The first step (Plan) is made up of steps 1 to 6. The second step (Do) contains steps 7 and 8. The third and fourth steps (Check and Act) are grouped together in step 9.

5S method can also be applied in higher education by following the 9 implementation steps. This method has made it possible to organize workplaces in higher education like in the industry. This result is supported by a study which applies the 5S in a laboratory at a HEI in Serbia [12]. The obtained results show that there is an improvement in storage space, transportation facilities and workplaces to simulate the production of

a water pump. Another study support this result, which is about the application of the 5S in an Indian HEI, the application of this method permitted this institution to increase working conditions and decrease waste[13].

There's another similarity with a study that also tried to introduce Lean principles and tools into Moroccan higher education [39]. In the last study, principles of Lean (the first two principles) and the process mapping tool are applied in an engineering school. It's difficult to measure the direct impact in the reality if we apply the principles of lean and process mapping. But the obtained results by the application of 5S are observable. These results may encourage other institutions to adopt Lean tools.

Lean tools (PDCA, Kaizen, Ishikawa, Value stream and 7 wastes) have been successfully applied in concrete cases, whether in teaching processes or in support and management processes at an engineering school in Morocco [40]. These tools do not include the 5S method, which is the first step before launching a continuous improvement project.

The HEIs that have used Lean tools to improve their processes are HTEIs. The main reason is that Lean tools are taught in the curriculum of these institutions. LHE has a real chance of success in HTEIs, because the Lean philosophy and these tools are taught in the training program, especially for industrial and mechanical engineering courses. Faculty and students in these branches have the skills needed to implement continuous improvement projects in their institutions, as the knowledge of Lean is a key factor in the success of LHE.

If HEIs want to accelerate the application phase of Lean tools and move quickly to the phase of establishing a Lean culture, they need to use Lean tools that give visible and rapid results in the field, such as 5S. This is why selecting the right project is considered a key success factor for LHE [34]. In the developed approach for implementing 5S (9 steps), the authors have tried to take into account the obstacles to implementing LHE before applying 5S in order to increase the chances of success.

## 6 Conclusion

Lean concepts and tools have been transferred to higher education, which has used them extensively and successfully. Since 2000, LHE has demonstrated great potential for improving HEIs and the offered services to students, faculty, etc. The case study clearly shows that the 5S tool is flexible and universal. It can be easily applied in all HEIs in Morocco and abroad. It focuses on eliminating waste and creating a value-added in teaching-learning process. Direct and indirect benefits are obtained through the implementation of 5S method. The last method should be considered as a long-term thinking process that must be used by everyone to improve the institution services.

Implementing 5S method in the automotive workshop helps both faculty and students in teaching-learning process. In this way, faculty can implement clear procedures that enable them to easily return materials to the right place in the cupboards, without wasting time. As first-year students have not yet visited companies and production systems to familiarize themselves with examples of the use of lean thinking. The automotive workshop is in fact their first contact with this type of thinking. What's more, under

the conditions of the automotive workshop, students can now learn the steps involved in implementing the 5S method, so they can apply it in their future workplaces. Besides, faculty at this THEI use the example of 5S application in teaching Lean principles and tools in the production management module.

The 5S method can be applied horizontally on a large scale in other workshops and laboratories in the same institution, and it can be applied to almost all the institution's equipment and material. HEIs that want to improve activities in workshops, laboratories and the teaching process can simply follow the nine steps presented in this paper in order to make research and teaching work more efficient.

This study is limited to the application of only one Lean tool, 5S, and is not the complete Lean philosophy (Lean principles, 8 wastes, JIT, Kaizen, etc.). To enhance student's learning and the task of faculty, it is necessary to apply the Lean philosophy in their teaching-learning. Finally, the organization of lessons, exercises and practical activities by faculty must take into account the need to systematically eliminate waste in teaching-learning processes.

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