Implementation of the Lean Manufacturing 6S Technique - Case Study

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Abstract. Lean Manufacturing is an integrated socio-technical system, whose main objective is to eliminate waste. One of the basic techniques of Lean Manufacturing is the 6S technique which helps to improve productivity. The 6S technique is not only the basis for all improvements, but also it supports the positive motivation of employees and ensures a pleasant working environment and fewer quality problems. Last but not the least, it contributes greatly to the company image. In this paper, aspects about the 6S technique implementation on a manufacturing company of upholstered furniture are presented, the process being implemented from 2020. The progress of the 6S technique indicators (Safety, Sort, Straighten, Shine, Standardize and Sustain) were monitored and corrective measures were applied for the occurred problems. The implementation of the 6S technique was successful in both production and office areas and great improvements were noticed, as following: increase of workers and machines safety, stocks level reducing, quality improving, mistakes prevention by visual management, over-processing and waste elimination. One of the major benefits of the applying the 6S technique in the company is considered the employees morale increase because anyone works more efficiently in an orderly and clean workplace.

Keywords: Lean principles · 6S technique · quality · safety · indicators

1 Introduction

Lean production is a strategy that use a set of tools and principles in order to eliminate waste for an enterprise's performance improvement. Eiji Toyoda brought in the concept of continuous production flow in Japan, in the early 50's, soon after the end of the Second World War. Then, in 1960, Taiichi Ohno, in 1960, introduced the concept of Toyota Production System (TPS) focused on reducing waste, considering all aspects of the production process and using a variety of techniques and tools for eliminating waste, stocks and execution time decrease, delivery performance increase, quality and productivity improvement. The Toyota Production System (TPS) is a "manufacturing philosophy" that integrates a set of principles, methods, tools, for finding and applying ideas for improvement, optimization, step-by-step innovation in workflows (workstations, production lines, etc.). After the 1980s the value of the products for the customer was given by low costs, the availability of products with high quality and flexibility

I. Dumitru et al. (Eds.): ICOME 2022, AHE 15, pp. 476–488, 2023.
https://doi.org/10.2991/978-94-6463-152-4_53

of producers to manufacture according to market requirements. The concept was introduced and developed in the United States as Lean Manufacturing by the three major American automakers in the early 1990s. Lean relies on the Toyota production system and was adapted by Womack and Jones in 1995 for Western companies, referring to the real basic capabilities [1]. After 2000, the value of the products for the customer was given by the flexibility of production, the high quality and the low costs associated with the availability of the products [2].

The most used methods and instruments applied to implement Lean in a company are the following: Value Stream Mapping (VSM), Visual Factory, 5S, Total Productive Maintenance (TPM), Standardized work, Kanban, Error Proofing or Poka-Yoke, Quick Changeover, Just in Time (JIT), Six Sigma, Kaizen and so on [3]. The practical solutions found by some people in certain situations and at certain times have led to the emergence of the Lean tools listed above, which is why empiricism and specificity make them almost impossible to use, as described by their creators. There seem to be more tools in the literature because similar Lean methods or tools have appeared and been described by different names, but they are just evolutions or modifications of best practices encountered in many places and under different names, most of the time. Every company wishing to become a Lean company applies those specific tools, methods and methodologies to make the production process more efficient.

In [4] it is given an attempt to define Lean Production conceptually, so it is said that "it uses the just-in-time practices and aims at the rational use of resources, the strategies to improve the production process and the elimination of waste, and the use of managerial scientific techniques. It is, however, difficult to formulate a complete definition encompassing all the elements of Lean Production, which is in constantly developing itself. Thus, today's definition reflects the current image, which at some point in the future will no longer be valid. Lean Production includes, on the one hand, a strategy which depends on a set of tools and, on the other hand, the Lean thinking, which focuses both internally by reducing costs, and externally to increase customer satisfaction". In [5] it is proposed the following definition to capture the many facets of lean production: Lean production is an integrated social and technical system that has as main objective to eliminate waste by concurrently reducing or minimizing supplier, customer, and internal variability. Lean Manufacturing regarded as a successor of the TPS applies the instruments developed formerly by Toyota. Additionally, new principles have been added to establish the patterns for the company's better functioning. One of them is to identify and clarify the value stream for the product by designing a so-called value stream map [6].

The most common approaches used by the companies on their first stages towards transforming their organization into one Lean are the Value stream mapping (VSM) and 5S tools [7].

Value Stream Map (VSM) is an essential technique, being the first step in applying Lean in a company. The application methodology consists in determining and analyzing the flow of materials and information necessary to provide a product or service to the customer, being focused on identifying the processes that produce added value to the product [8]. Following the application of VSM, a diagram is made containing all the necessary phases of the flow of information and materials, necessary to be completed from

Fig. 1. Phases of 6S Technique [11]

the receipt of an order to the delivery of the product to the beneficiary. VSM is a tool for identifying losses in order to reduce and eliminate them by the manufacturing company, suppliers and beneficiaries. The mapping of the value stream consists in the graphical representation of the flows of materials and people involved in the manufacturing process and the information that lead to the shaping of some products or services. Determining VSM can be a repetitive process, but it is a mandatory and necessary condition for improvement.

The 5S method was developed in Japan by the researcher Hiroyuki Hirano [9]. The 5S process (Sort, Shine, Set, Standardize, and Sustain) or simply 5S is a concept considered the foundation of Lean implementation in a company. It is a technique that allows discipline to develop, waste elimination, standards setting, etc. Thus, a well-organized work-place is safer, more efficient and more productive. The 5S principles implementation involves crucial elements in global competitiveness such as risks and waste reducing and elimination, a key to worker safety [10]. For this reason, in recent years, 5S has been extended to 6S by adding "Safety" (Fig. 1).

Sorting is the method of freeing up the work space and removing all unnecessary objects, such as programs, test parts, drawings, old or damaged tools, accessories, unused materials, and so on. Sorting means correct selection of the right things to be kept and elimination of what is useless.

Set is the second step of the 5S and means to set locations (boundaries), to arrange the necessary objects in the workplace in such a way that they are easy to be found or identified and in a logical order for quicker access and use.

Shine is a process to make everything shiny meaning the cleanliness of everything that represents the workplace: floor, cars, cabinets, etc. Sources of dirt must be detected, sources of leaks must be remedied, and sufficient materials must be provided to clean each workplace.

Standardization means maintaining the state obtained by establishing standard rules, customs, and procedures. The main purpose of the standardization phase is creating best practices and get them implemented by each worker regularly at the workplace. Standardized work is obtained with standards easy to be understood by everyone at the workplace, using standardized equipment, displaying standard panel procedures ('visual management'), using checklists.

Sustain aims to ensure the discipline and commitment of all employees to maintain the obtained results, to setup a clean environment and to maintain it as an ongoing process forever.

Safety is the process of making workplace safe by creating better working condition for workers. It is ensured by the use of appropriate tools, the use of protective equipment where needed (overalls, gloves, goggles, masks, helmets, etc.), by keeping the access corridors free and storage of protective equipment in predetermined and easily accessible locations.

So, the 6S technique is not just about cleanliness, it's about the organization and safety in the workplace, marking and labeling, process flow improving, making work climate healthy and safe, auditing to determine progress, and maintaining improved results. The 6S technique powerfully helps in achieving continuous improvement in the work performance and efficiency of any industry. The 6S technique delivers neat and clean, well-organized, safe working environment to the workers and increases the performance of workers in the company.

2 Case Study

This paper explains the implementation of the 6S technique in a company that has, as main activity, the production of upholstered furniture to quality and design standards certified in the European Union, its mission being to obtain comfort and elegance inside homes around the world. Being a relatively new company, it was considered necessary to implement the Lean principles in order to improve the quality of production and products. The philosophy of "continuous improvement", respectively each process can and must be evaluated and continuously improved in terms of time required, used resources, product quality and other aspects relevant to the process.

It was initially determined that there was no Value Stream Map (VSM) in the company. The Value Stream Map is a visual representation of the value stream, with all aspects clearly indicated. Then, all the elements represented in the value stream map are associated with durations-times for the production cycle, duration of stocks consumption and adjustment times, so that we finally can determine the total time required for a product to go through the described flow.

The Value Stream Map capitalizes the opportunities for improvement in order to achieve a higher level of performance. It is recommended to make an ideal map, which highlights the ways to improve the introduction of all known Lean Manufacturing specific methods. The added-value flow map included all the actions (both added-value and non-added-value) currently performed to get the product to go through the main specific technology processes. There were taken into account the flow of materials (external sources of supply, stocks, production plan according to the estimated market demand, production process, means of transport, working staff) and information flow (manual and electronic information flows) including all the elements that contribute to the carrying out the production process in a company, for the Value Stream Map drawing up. The Value Stream Map drawing up started with the identification of losses and their removal techniques and continued with the Cycle Time determination for each operation of the technological process. After determining the Value Stream Map (VSM), the technological flow shown in Fig. 2 and Fig. 3 was obtained.

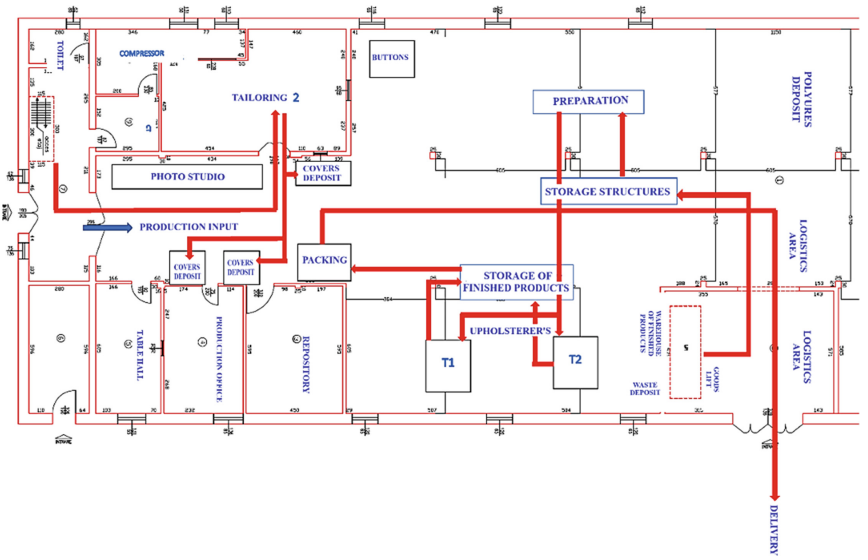

Fig. 2. Ground floor technological flow

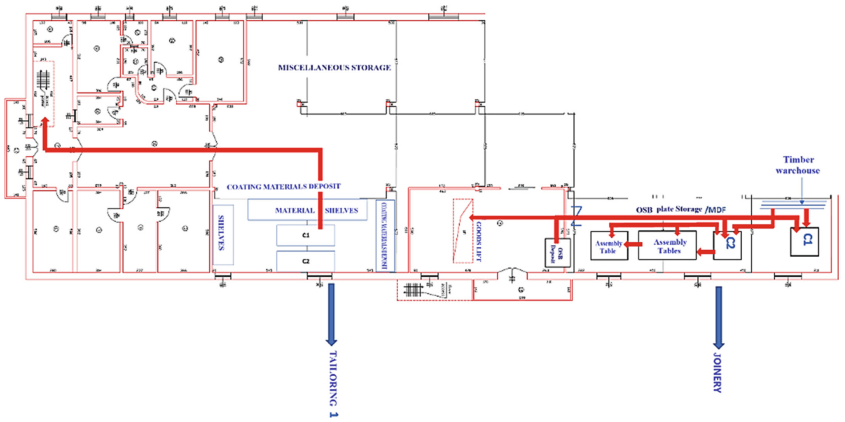

Fig. 3. Technological flow at the first floor

From the Figs. 2 and 3 can be observed that the new technological flow starts from the floor, in 2 ways: from the OSB plate storage, the materials used to obtain the wooden skeleton are distributed to the Assembly tables and then to the Joinery, simultaneously with the distribution of the covering materials from the Coating Materials Deposit to the Tailoring 1. From the 2 workshops floor (Joinery and Tailoring 1), the semi-finished products go to the ground floor at the same time, following the technological routes: Tailoring 1 – Tailoring 2 - Cover Deposit and Joinery - Storage Structures Preparation, respectively. Both arrive at the Upholstery workshop at the same time (T1 and T2), then Storage of Finished Products, Packing and Delivery. By the simultaneous start of the 2

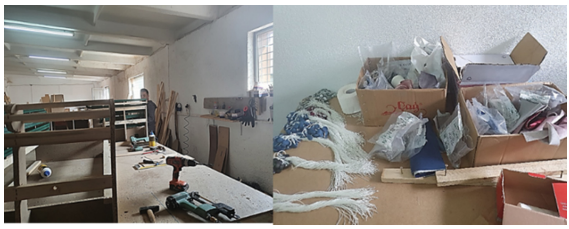

Fig. 4. Initial state in the company regarding Sort, the first 6S indicator

Fig. 5. Initial state in the company regarding Stabilization, the second 6S indicator

sub-flows (both for the construction of the sofa skeleton and the covering materials) the added value of the flow was achieved, by eliminating the losses due to waiting times, inefficient transport inside the company and the company's penalty.

The implementation of the 6S technique started in 2020 and the first step in implementing of the 6S technique in the company was to perform an audit to determine the initial context, preceding the start of the 6S technique application.

The audit highlighted the following:

- the sorting of the materials, respectively first indicator of the 6S technique, was not performed at all, for any stage during the manufacturing process (Fig. 4).
- regarding the stabilization, the second 6S indicator, Fig. 5, there were areas where the necessary objects at work were not arranged in order to facilitate their use, the tools were not organized in the order in which they were used during the operation in the production process.
- regarding Shine, the third 6S indicator, major deficiencies were found in the initial situation in the company, there were no procedures or a plan to keep the workplace clean (Fig. 6).
- regarding the Standardization, the fourth indicator of 6S, the lack of the necessary procedures for the specific operations performance was found at each workstation, there were no procedures for the way of carrying out the manufacturing process and on each operation.

In the next step it was established the scoring mode for each indicator of the 6S technique, presented in Table 1. As it is shown in Table 1, the maximum value that can be obtained for each indicator of the 6S technique is 10, converted in a score from 0 to 5 for more effective graphical representation, meaning that the maximum obtained value regarding the implementation of 6S is 30 per month by accumulating grades.

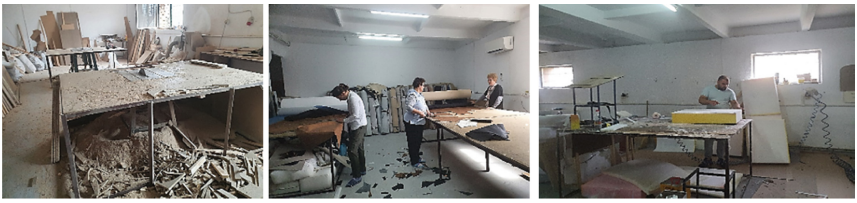

Fig. 6. Initial state in the company regarding Shine, the third indicator of 6S

Table 1. Scoring of 6S method indicators and monitored problems

Scoring					
0	1	2	3	4	5
0	1–2	3–4	5–6	7–8	9–10
Not started, zero effort	Activity started, slight effort	Widespread activity, still many opportunities improvement	Minimum acceptable level sustained for a least one month	Best in Class result, Manager/Superintendent review, sustained for 1 month	Best Practice; World Class; General Manager review, sustained for a least 6 months

SORT		
No	Checked Item	Description
1	Components, materials and parts	Only items required for current operations are in stock in the area. Post-processing waste is placed in clearly marked containers.
2	Machines, workbenches, cabinets and furniture.	Only items needed to perform specific current work are located in the area. There are no unnecessary machines, tools or furniture in the area.
3	Tools, instruments, equipment	All instruments, bodies and devices in the area are used regularly. Any items that are used less than once a day are stored outside the bookmarks.
4	Panels	No old, broken or dirty ads are shown. All bulletins are arranged in a correct and neat manner.
5	First general impression	Your overall impression should tell you that this is the best you've seen for a manufacturing environment.

(*continued*)

Table 1. (*continued*)

Scoring		
STRAIGHTEN		
No	Checked Item	Description
6	Appearance of the area	Machines, equipment, workbenches and so on are arranged in a logical and neat way to streamline the production flow through the work area.
7	Levels, walkways, and floor markings	The lines on the floor clearly mark the corridors, walkways, work areas, storage areas and hazardous areas.

…

SHINE		
No	Checked Item	Description
13	Appearance of the rooms floor, building floor	All floors are clean and free of debris, oil and dirt. Floor cleaning is usually done at appropriate pre-set intervals.
14	Cleaning products	All cleaning equipment (trash cans, brooms, floor sweepers, etc.) is stored in a neat manner. It is obvious where they are and this place is available when needed.

…

STANDARDIZE		
No	Checked Item	Description
18	Visual control	The display panels are present in each production work area and are accessible to everyone in the area.
19	Weekly/monthly audit.	The 6S audit is carried out in each work area at least monthly, the results are shared with all workers and the objectives for new levels are set with action elements.

…

SUSTAIN		
No	Checked Item	Description
22	Maintenance	Employees are adequately trained to maintain equipment that is working properly. A Preventive Maintenance program is in place and functions at a high level.

(*continued*)

(*continued*)

SUSTAIN		
No	Checked Item	Description
23	Area Responsibility	Each area of the 6S method implementation operation, inside and outside, falls under the responsibility of a manager with 6S auditing and assignment authority.

…

SAFETY		
No	Checked Item	Description
26	Hazardous Material Storage	Liquids, solvents, flammables, and other chemicals are properly labeled and stored.
27	Emergency Access	Safety devices are clearly marked, highly visible and unobstructed. Emergency exit routes are marked and exit signs, lights, etc. are in good condition.
28	Personal Protection Equipment	All employees are properly using the required Person Protective Equipment for their job classification
29	Power Sources	Electrical, mechanical, hydraulic, pneumatic and gravity energy sources are identified. Color coding is used to identify the type of utility.
30	SUBO (Safe and Unsafe Behavior Observations)	Safety issues are discussed among team members and root causes and action plans are developed with help from the SUBO team.
32	Ergonomics	All work areas and work surfaces meet company ergonomic standards. Operations performed by staff put little or no stress on their hands, arms and back.

A questionnaire was completed for each of the 6S indicators, for each area of the manufacturing process. The evaluation of the 6S method implementation consisted of the weekly monitoring in the first 2 months, and then the monthly monitoring of the achievement of each of the 6S indicators, using the scoring sheet presented as an example in the Fig. 7.

Thus, monthly actions to ensure 100% for the 6S technique implementation means a global score of 120 points for the 6 indicators (Sort, Straighten, Shine, Standardization, Sustain, Safety).

The results obtained after the constant monitoring of the implementation of the 6S technique indicators in November 2020 are presented in Fig. 8.

Figure 8 shows that, in the first month (November, 2020) from the beginning of the 6S technique implementation in this company, the best values were obtained for

3S Shine

No	Questions	Evaluation							Evaluation criteria	Comments / Recommendations
3.1	Are the machines, objects or workplaces completely clean and free of impurities? For example, oil, grease, cardboard, glue, adhesives, plastics, etc.								0 - 10 The area is not cleaned Cleaned but not enough everywhere Completely cleaned, including covered areas	the area is not cleaned
3.2	Is the work environment, such as the floor, walls, windows, free of impurities / clean? For example, oil stains, grease, cardboard, paint, etc								0 - 10 The area is not cleaned Cleaned but not enough everywhere Completely cleaned, including covered areas	the area is not cleaned
3.3	Are the objects (tools or test equipment) free of impurities / clean? For example, oil stains, grease, paint (also tools and equipment that have not been used recently and that are in storage boxes / holders and are part of the evaluation)								0 - 10 The area is not cleaned Cleaned but not enough everywhere Completely cleaned, including covered areas	the area is not cleaned
3.4	Is it defined how to achieve cleanliness and ensure continuity? (Cleaning plans must define everything required, including periodicity of cleaning)								0 - 10 It is not defined It is defined but not complete or not in use It is completely defined and applied	it is not defined
3.5	Is there a list of all the cleaning supplies needed at the workplace? For example, broom, cloth, detergent, etc								0 - 10 Not available Partially available or incomplete / not tidy. It is available, complete and tidy	Partially
	Earned points								50 maximum number of points	
	Result (%)									
Additional remarks of the auditor										

Fig. 7. Example of rubrics for indicators, for Shine, the third indicator of 6S

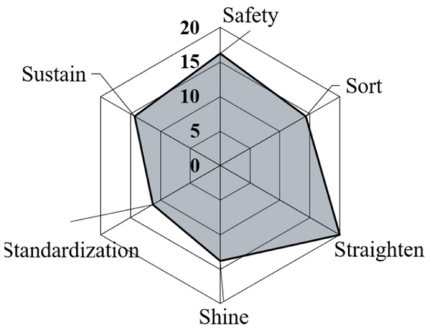

Fig. 8. Average marks obtained at 6S implementation in November 2020

Straighten and Safety. The lowest index values were attained for Standardization, Shine and Sustain. The values for the Standardization and Sustain application indicators were somewhat expected to be lower, as they started to be monitored from the second month, respectively December 2020. The application stage of the 6S technique at the end of December 2020 has shown that:

- in terms of Stabilization and Shine, signs have appeared at every workplace in the company regarding compliance and order;
- the opaque boxes were replaced with transparent ones, boxes of different colors were purchased for each type of material in the warehouse, as a result of applying Sorting indicator;
- the various tools were arranged in order of use during the production process, following the application of Straighten indicator;
- there were concerns about cleanliness and sorting, too;
- measures taken for Standardization indicator: each warehouse was numbered and the row was numbered, then the shelves were numbered followed by the boxes, so that the storage places being very easy to be found; the order of the operations was placed on visual panels, each element necessary to be used in the production process was

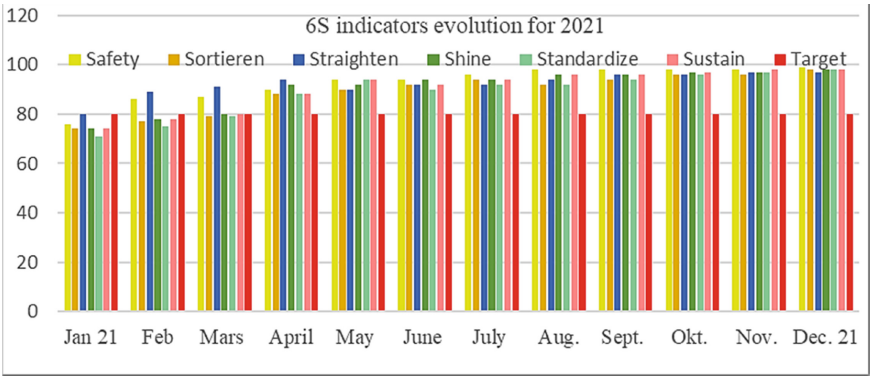

Fig. 9. 6S indicators evolution for 2021

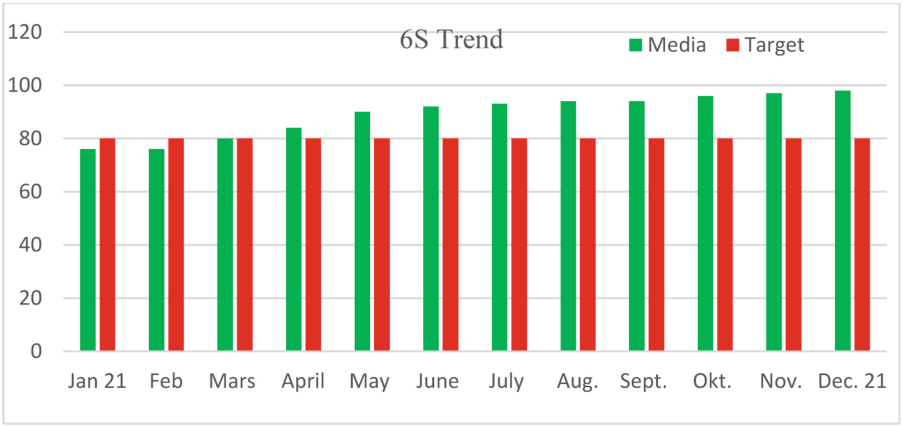

Fig. 10. The degree of the 6S technique implementation in the company during 2021

designated and presented in visual mapping with a different color, depending on the time of operation.

– a training was carried out and visual warnings were placed at each workplace in order to ensure Safety indicator.

The 6S technique implementation measures were continued with monthly monitoring of their degree of application within the company. Figure 9 shows the degree of their implementation during 2021.

Figures 9 and 10 show the upward trend in 6S technique application in the company, so that, the objective was accomplished beginning with April 2021, after 6 months of application, in the epidemiological context of the Covid-19 pandemic.

The evolution of the 6S technique implementation media compared to the objective is shown in Fig. 10. So, it may be noticed that the increasing of 6S technique implementation media in 2021 and the objective accomplishment in March.

Fig. 11. Aspects of the 6S technique implementation observed at the end of the contract

The images in Fig. 11 show aspects of the 6S technique implementation, the cleanliness and order existing during the production process in the company at the end of the contract.

3 Conclusions

The 6S technique is one of the basic principles of Lean manufacturing and this study provides important aspects about its implementation in a manufacturing company of production of upholstered furniture. The implementation of the 6S technique started in 2020. The progress of the 6S technique indicators (Safety, Sort, Straighten, Shine, Standardize and Sustain) were monitored and corrective measures were applied for the occurred problems. The implementation of the 6S technique was successful in both productive and office areas and significant improvements were attained:

- Work safety: the dangers are more easily identified and prevented by creating a visual workplace;
- Reducing the level of stocks by keeping only useful landmarks at work, excess inventories can be identified and eliminated;
- Improving quality by creating a climate of discipline;
- Visual management has helped to prevent mistakes and reduce the number of scraps;
- The lead time of a finished product was reduced by eliminating wasted time looking for tools, clutter and inefficient movement;
- Elimination of over-processing due to incorrect positioning of templates;
- Elimination of waste due to unnecessary travel by making the production flow more efficient;
- Increasing the morale of employees, because anyone works more efficiently in an orderly and clean workplace.

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