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SMED TO INCREASE PRODUCTIVITY: A CASE STUDY IN AN AUTOMOBILE INDUSTRY

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RESUMO: With increasing competitiveness, companies have sought tools to obtain advantages and improvements in the production system. The Lean Manufacturing philosophy, created by the Toyota Production System, has brought several tools to help decision making, reduce production costs and increase competitive advantage. One such tool is SMED, which has the principle of reducing setup time. The purpose of this paper is to be an example of how the tool, created by the Japanese Shingeo Shingo and brought to the West after the Second World War, is applied to different types of industries, more specifically in the automobile industry. This article was based on a case study at a multinational that serves large automakers in Brazil and abroad. With the application of the tool, the factory was able to eliminate one of its great losses.

PALAVRAS CHAVE: Toyota, Lean Manufacturing, Setup, SMED

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1 INTRODUCTION

Today the industry, bringing more advanced manufacturing techniques, has evolved to a very different level than it was when mass production took shape after the industrial revolution. In the current scenario, industries are more competitive with new technologies, with a greater spread of Lean Manufacturing thinking.

As Taiichi Ohno (1988) states, "Social values have changed. Now, we cannot sell our products unless we place ourselves in the hearts of our consumers, each of whom has different concepts and tastes. Today, the industrial world has been forced to really dominate the multiple production system in small quantities".

Thanks to this new culture, coming from Toyota and Western companies, especially the auto industry, companies have been able to reduce waste and significantly increase their production and the quality of their products.

Singh & Singh (2012) consider that the Lean tools present a philosophy that does not demand great implementation. Singh & Singh further believe that a company, when developing an improvement project, should be aware that this means returning efforts to a significant improvement, but that will be achieved incrementally and in the long term, with the advantage of the proposals being economically viable.

According to Singh et al (2018) achieving "excellence in manufacturing" is essential for the survival and economic growth of any company in this era of globalization. The "industrial era" of the last century gave way to the "digital age" which, in terms of production, increases capacity and reduces product cycle times.

To compete in this ever-changing environment, companies need to seek out new methods that allow them to remain competitive and flexible and simultaneously enable their companies to respond to new demands immediately (Singh and Singh, 2010).

To compete with the competitive world, companies need to find a way to reduce setup time, eliminate waste and value-free activities, and convert downtime from set-up to regular production time (Singh et al., 1981). A tool that can be used is SMED (Single Minute Exchange of Die).

According to the creator of the tool, Shingo (1985), in his book "Revolution in Manufacturing: the System" the tool was developed to reduce and simplify setup time during the change. He further states that SMED enables organizations to respond to fluctuations in demand and results in lead time reductions while also eliminating waste during batch size changes and decreases

This work will show that the SMED methodology, when implemented correctly, can result in improved productivity and reduced waste. To this end, a case study was made in an automotive industry, which works with lean production and presents two losses of the Toyota Production System.

In Ohno's view (1997), Lean Production is the result of the elimination of seven classic types of wastes, also called losses, existing within a company.

2 LITERATURE REVIEW

2.1 SMED

SMED was developed by Shingo in 1985, who characterized it as a scientific approach to reducing set-up times, which can be applied to any type of operation and any machine. SMED is defined as the minimum time required to change the type of production activity taking into account the time the last part of a previous lot was produced in relation to the first part produced by the subsequent lot (Shingo, 1985).

The SMED, according to Shingo (2000), consists of four phases. In the first one, the internal setup conditions (which occurs with the stationary machine) and external (which occurs with the machine in operation) are not distinguishable. The objective is to analyze the current setup operation, with the participation of all those involved in the process (operators). In the second phase, which in Shingo's own opinion is the most important phase, because it is at this stage that the distinction between internal and external setup operations occurs. In the third phase there is the analysis of the setup operation, in order to verify the possibility of converting internal setup operations to external. In the last phase the analysis of each action of the internal and external setup operations is performed, seeking its rationalization through the elimination of adjustments and operations of the setup.

These phases show that SMED is composed of two main actions, analysis, and implementation, evidencing the distinction between the internal and external setup operations and the rationalization of the component elements of the setup actions. For the application of the conceptual stages of SMED, Fogliatto (2003) proposes the use of eight techniques: 1. separate internal and external operations; 2. convert internal setup to external; 3. standardize the function of the setup elements; 4. use functional fasteners on equipment or remove fasteners; 5. use intermediate devices to eliminate settings during internal setup; 6. adopt parallel operations; 7. optimize operations by eliminating the need for adjustments; and 8. mechanize operations.

According to McIntosh et al. (2000) the methodology can be separated into three parts: 1. concept; 2. methodology; and 3. improvement program. The identification and application of improvement techniques are related to each of the parties. In the context of the improvement program, Kaizen techniques are used under the focus of the work team's commitment to use the creative capacity to improve existing methods.

2.2 KAIZEN

Lean is a structured approach to quality improvement that seeks to deliver additional value by reducing waste through continuous quality improvement (Gershengorn et.al 2014). According to Garcia et. al (2014), Kaizen is not a new philosophy, its origins are in the mid twentieth century with Masaaki Imai and his book entitled "Kaizen: The Key to Japanese Competitive Advantage" which refers to the term kaizen having a possible origin in Toyota Motor.

The word Kaizen comes from Japanese origin where "kai" means change and "zen" means better, so kaizen brings us the idea of changing for the better. The Kaizen was initiated as a response to the destruction of the Japanese factory park after World War II, such as limited resources and difficulties to obtain raw material. As a result, the Japanese began to analyze ways of producing more, with more quality and less resources, optimizing the process efficiencies. Initially, Kaizen initiatives were led by Toyota Motor Company in its effort to become a global automotive leader who attempted to emphasize incremental changes, low-cost solution, employee empowerment and organizational development that maintains continuous improvement with emphasis on process improvement instead of the result (Imai, 1986).

According to Maarof (2015) Kaizen is a philosophy that promotes small improvements made as a result of continuous effort. These small improvements involve the participation of everyone in the organization from the top management to the lower-level employees.

Aoki (2008) considers that it is feasible to expand the kaizen philosophy to other countries with a different culture from the Japanese (like Brazil), but companies must implement the basic principles of kaizen, which are: continuous improvements, customer focus, open acknowledgment of the problem, development of self-discipline, creation of working teams, provision of constant feedback to employees and promotion of employee development.

Like all tools proposed by Lean, especially Kaizen, leadership support is essential to success because they are the leaders who provide the resources and pass the culture on to their subordinates.

One way for companies to implement kaizen, is with the creation of Kaizen events known as Kaizen Blitz. A Kaizen event is "a focused and structured improvement project, using a dedicated multifunctional team improve a targeted work area, with specific objectives, in an accelerated period of time "(Farris, Van Aken, Doolen, Worley, 2009).

2.2.1 PDCA

The Kaizen methodology uses the concept of the PDCA cycle, which according to Quinquiolo (2002) is a tool whose basic function is to aid in the diagnosis, analysis and prognosis of organizational problems, being extremely useful for solving problems. Few instruments are as effective for the pursuit of improvement as this method of continuous improvement, since it leads to systematic actions that accelerate the achievement of better results in order to ensure the survival and growth of organizations.

The PDCA, as illustrated by Muhammad (2015), is a continuous improvement Deming's cycle. Moreover, PDCA, an acronym for Plan, Do, Check, Act, is used for process improvement. The first step is planning which is concerned with setting up quality objectives and monitoring the process. In the second step, data are collected, and problems are recognized. In the third step, the problems are examined and analyzed. Finally, steps are followed to eliminate the problems to attain quality objectives.

According to Shiba (1997) the steps of the PDCA cycle are classified according to Table 1.

Plan	Determine analytically and quantitatively the major problems in a process or activity and how they could be solved.
Do	Implement the plan.
Check	Confirm quantitatively and analytically that the plan works and results in better performance.
Act	Modify the previous process, document the process, and revise it.

Table 1. PDCA Cycle

2.2.1.1 PLAN

This phase of Planning is divided into 4 subgroups: Problem Identification, Problem Analysis, Process Analysis and Action Plan.

a) Problem Identification

This stage clearly defines the problem and recognizes its importance. To do this, one must analyze the data and identify the problem, establish control goals, define the goal (this must have an objective, a value and a term), and implement the management in sight. A more common way to identify problems is by analyzing out-of-target results: Internal Benchmark (historical performance) and External (performance relative to other similar processes). One tool usually used to describe the phenomenon is 5W1H.

b) Problem Analysis

In this part, one must know the problem and identify the focus of action. To do this, all the available data about the problem at the place of occurrence must be raised, if possible mapping it. After data collection, data should be stratified in a variety of ways, trying to identify different aspects of the problem and prioritize the most important aspects to perform the process analysis (root cause).

c) Process Analysis

At this stage, one must discover the root causes of the problem, understand the relation of causes to the effect of the process. This is usually done using quality tools. For the collection of possible causes (hypotheses), the brainstorm and the Ishikawa are used. After the use of the tools, the consistency of the causes is analyzed (affirmation of the hypotheses).

d) Action Plan

Here a plan must be drawn up to block the fundamental causes, for this one must discuss the possible measures and define the most appropriate ones for the elimination of sources causing failures. A very used tool for the preparation of action plan is the 5W1H.

2.2.1.2 DO

The " Do " phase is the part where the action plan should be executed, in this phase it should be defined what should be done, where it will be done, by whom it will be done and when it will be done. The Kaizen leader must have strict control so that all planned actions are taken within the stipulated time frame.

2.2.1.3 CHECK

In this phase the goal is achieved through the management in sight. This step consists of analyzing the effectiveness of the actions and if the goals are not met, it is necessary to go back to the planning phase and elaborate a new action plan.

2.2.1.4 ACT

In this phase the standardization of the changes made, the manufacturing of standard operating procedures and the training of all involved in the process occurs. This step is extremely important for the improvement, because if there is no such standardization the problems here already resolved can come back again. You should also create inspection checklist to see if the measurements are being performed.

3 METHODOLOGY

The case study was carried out in an automobile industry located in Minas Gerais state of Brazil. It has about two thousand employees and customers worldwide and belongs to a multinational group that manufactures various components for automotive vehicles.

The company works with a philosophy of continuous improvement, in which all employees are motivated and gratified to perform Kaizen. A key factor for success is the participation and support of top management, and it is notable that it participates directly and indirectly in the process of designing and implementing Kaizens.

After an analysis of the plant losses, two losses were identified in a setup process: standby and moving. A project team was defined, which contained the manager, the area supervisor, two analysts, a line captain and an intern.

Since the problem to be solved is related to setup, the SMED tool will be used. The purpose of SMED is to reduce and simplify setup by reducing or eliminating losses related to the operation.

3.1 PLAN

In this phase the working group was defined and a schedule of SMED activities was elaborated (Table 2).

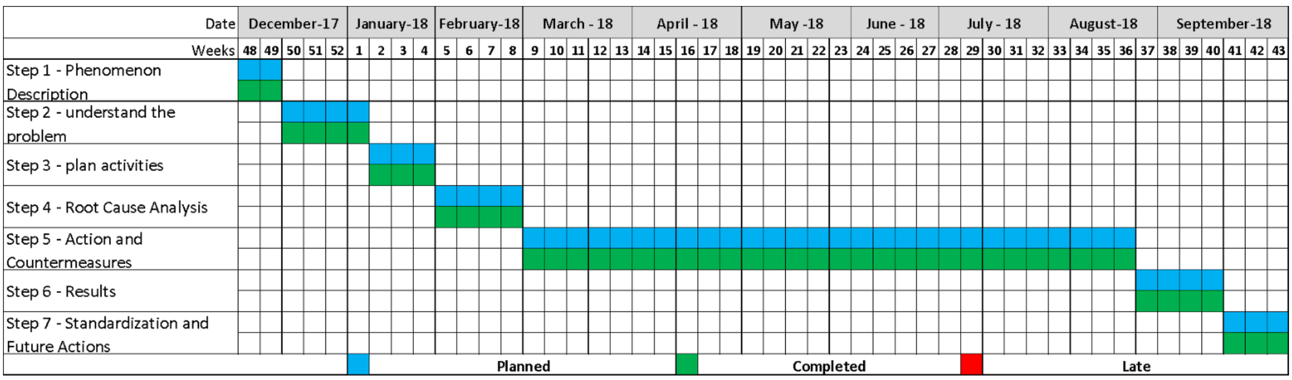

Table 2. Schedule of Activities

After the schedule was set, the goal that was to be achieved after the Kaizen release was defined. In January the setup time of the machine was 55 minutes and the goal set by the group is 9 minutes, which is equivalent to a reduction of 84% of setup time, as shown in Figure 1.

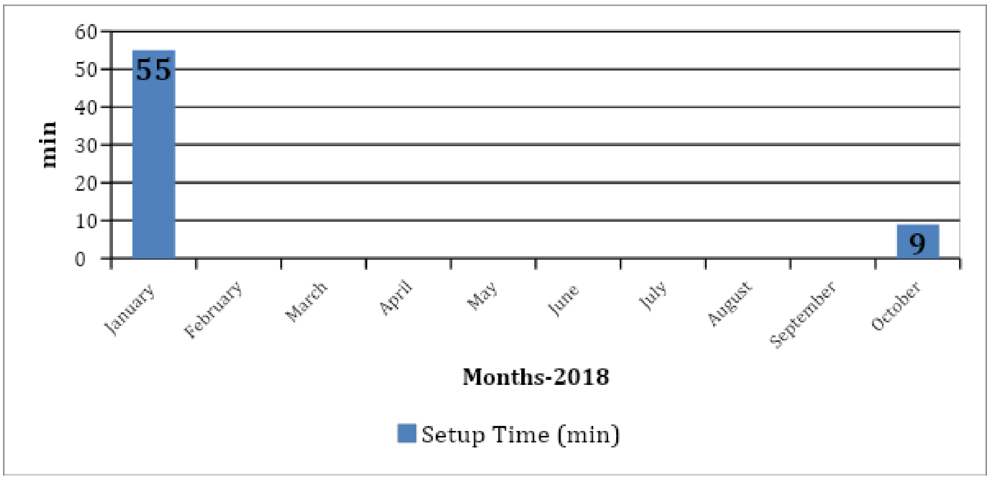

Figure 1. Setup Time Chart.

With the defined goal, the Overall Equipment Efficiency (OEE) was calculated and a loss of 41.21% was observed in the equipment (Figure 2). For the calculation of the OEE, it is necessary to know the availability, productivity and quality of the process. In availabilities there is the programmed time of use of the machine and the actual time used. Productivity has an expected production and real production, and quality has the total production and quantity of refuse. After knowing these values, the multiplication between them was performed.

Overall Equipment Effectiveness					
Machine:	Hydraulic press				
Sector:	Hardware				
Period:	02/01/2018				
Available time:	06-30-2016				
Availability	Available time	2547,8	decimal times	**76,81%**	**58,79%**
	Productive time	1956,85	decimal times		
Productivity	Expected output	695549	Parts	**76,81%**	
	Effective production	534220	Parts		
Quality	Total production	343572	Parts	**99,66%**	
	Compliant Parts	342404	Parts		
	Refuse	1168	Parts		

Graphic

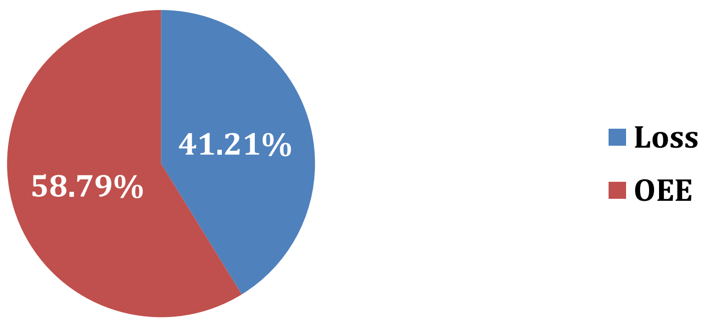

Figure 2. Calculation Table of O.E.E.

In the next process, process were entered.

Nº	Activities	Start Time	Step Time	Travelled distance (m)	Number Of People		
					Toolmaker	Operator	Assistant
1	Communicate toolmaker	00:00	03:45	231,4		1	
2	Adjust Parameter and Positioning Tool for Removal	03:45	00:26			1	
3	Close compressed air and disconnect pneumatic system	04:11	00:39		1		
4	Open back of press	04:50	00:25	6	1		
5	Pick up wrench	05:15	00:26	9	1		
6	Pick up wrench and trolley for handling	05:41	01:00	53,4		1	
7	Pre-position trolley behind the press	06:41	00:47	6		1	
8	Waiting for wrench	07:28	00:35			1	
9	Loosen the front screw	08:03	01:24		1		
10	Loosen the rear screw	09:27	01:00			1	
11	Insert parameters to move press to remove tooling	10:27	00:17		1		
12	Close rear to move press hammer	10:44	00:07			1	
13	Wait for press hammer to rise and open back	10:51	00:10		1	1	
14	Position cart and insert rollers into tool base	11:01	01:11		1	1	
15	Position trolley for tool removal	12:02	00:23		1		
16	Remove tool from press and put in trolley	12:25	01:10		1	1	1
17	Attach tool to cart with safety chain	13:35	00:27		1		
18	Carry tool to shelf	14:02	01:15	53,4	1	1	
19	Position the cart in front of the shelf	15:17	00:17		1		
20	Remove the safety chain	15:34	00:14		1	1	
21	Place the tool on the shelf	15:48	00:28				
22	Move and position the cart and open the flap for tool removal	16:16	00:45		1	1	
23	Remove tool from shelf and place cart	17:01	00:24		1	1	
24	Attach tool to cart with safety chain	17:25	00:17	6		1	

Table 3. Setup Log Sheet

For registration, the operation Layout (Figure 3) and the description of the Hydraulic Press setup process were analyzed along with the operator.

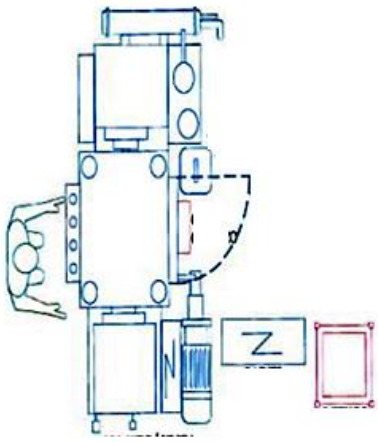

Figure 3. Layout of press operation.

The setup process consists of removing the tool that is in use and moving it to the tool cabinet. Then, move the tool to be used to the Press. It is fixed to the equipment and the first part is drilled. The piece is measured in the metrology laboratory in three-dimensional equipment. With the result approved, the setup is completed. If the part is rejected, adjustments are made to the tool until the result is achieved according to the specification through the laboratory.

After the analysis of the layout and the process, the spaghetti chart was made (Figure 4). This graph shows the path taken by the press operator to perform the setup. This graphic as done by hand with a pen on the factory floor. The graph shows the excess movement of the press operator to the tooling (a) and measuring laboratory (b).

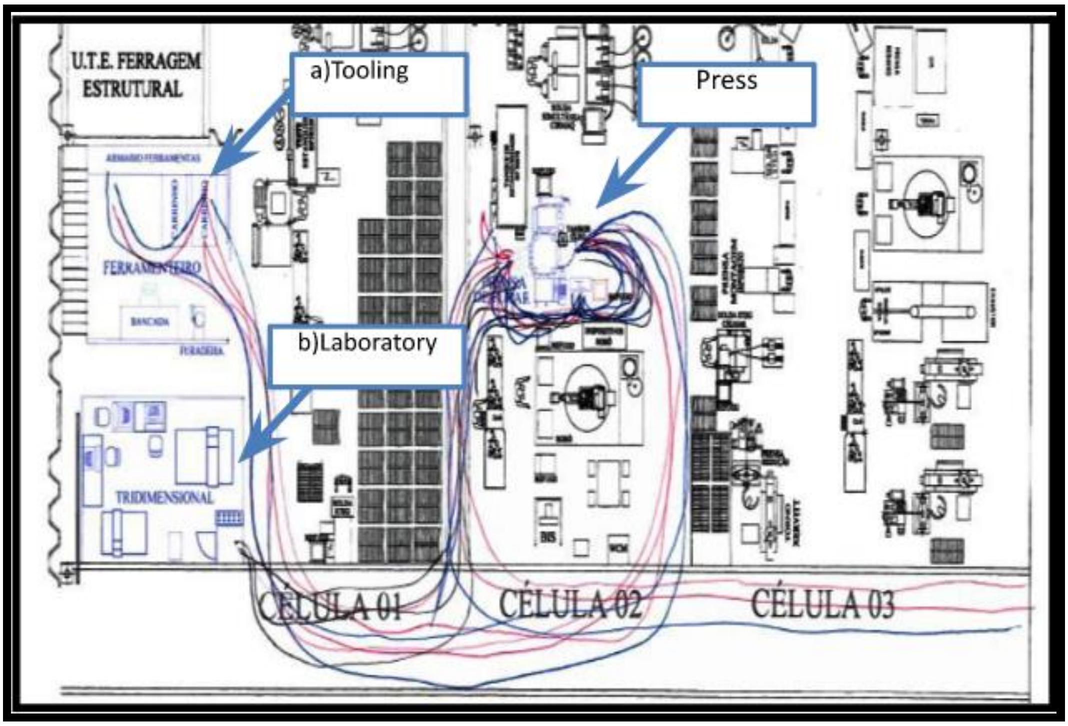

Figure 4. Spaghetti Graphic.

With the accomplishment of all these steps and of a brainstorm, some deficiencies were identified, as:

• Lack of standardization of setup activities (method);

• Lack of standardization of wrenches, nuts and bolts;

• Lack of appropriate location for placement of tools and devices;

• Deficiency in the handling and transport of tools;

• Lack of setup programming.

Finishing the planning step, the group met to analyze the setup log sheet (Table 4), in order to separate what was internal and external setup, eliminate operation and set improvement actions. Some improvements to be made are:

- New rotable table to carry mold;
- Adequacy of the door;
- Replacement of the tool transport cart;
- Manufacture of a tool cabinet;
- Replacement of the bolts by clamps;
- New tools;
- Support for new tools;
- Definition of the method of execution;
- Organization of the preparation room;
- Prioritization of setup items for measurement;
- New position for the safety block;
- New positioning of pressure gauges;
- Call Setup System.

No	Activities	Current	ECRS analysis					Improvement proposal			People			Action
		Internal time	External time	Eliminate	Combine	Reduce	Simplify	Internal time	External time	Travelled distance	Toolmaker	Operator	Assistent	
1	Communicate toolmaker	03:45		03:35										Management of the Programming Framework
2	Adjust Parameter and Positioning Tool for Removal	00:26				00:16		00:10				1		Create Front Panel Control
3	Close compressed air and disconnect pneumatic system	00:39				00:25		00:10			1			Quick change system with Poka Yoke
4	Open back of press	00:25				00:15		00:10			1			Open up door with gas spring
5	Pick up wrench	00:26					00:11	00:05			1			Tool Box on the back
6	Pick up wrench and trolley for handling	01:00							01:00		1			Pre-position cart behind the machine
7	Pre-position trolley behind the press	00:47					00:32		00:15		1			Demarcate area and set procedure
8	Waiting for wrench	00:35		00:35								1		Equal action 5
9	Loosen the front screw	01:24			00:34			00:50						Screw and tool standardization
10	Loosen the rear screw	01:00			00:10									Match with action 9

11	Insert parameters to move press to remove tooling	00:17					00:07	00:10				1		Equal action 2
12	Close rear to move press hammer	00:07		00:07								1		Remove rear door and insert curtain light
13	Wait for press hammer to rise and open back	00:10				00:05		00:05				1		Equal action 12
14	Position cart and insert rollers into tool base	01:11		01:11										Reactivate tool suspension system
15	Position trolley for tool removal	00:23				00:13		00:10			1			Equal action 7
16	Remove tool from press and put in trolley	01:10				00:40		00:30			1			Develop forklift truck
17	Attach tool to cart with safety chain	00:27					00:17		00:10		1			Reprojetar gain to hold the chain
18	Carry tool to shelf	01:15				00:15			01:00		1	1		Equal action 7
19	Position the cart in front of the shelf	00:17		00:17							1			Equal action 16
20	Remove the safety chain	00:14					00:04	00:10			1			Equal action 17
21	Place the tool on the shelf	00:28					00:13	00:15						Equal action 16
22	Move and position the cart and open the flap for tool removal	00:45					00:15	00:30			1			Removing gates
23	Remove tool from shelf and place cart	00:24					00:09	00:15			1			Equal action 16
24	Attach tool to cart with safety chain	00:17					00:17	00:10						Equal action 17

TABLE 4. Improvement proposal sheet in the setup.

As can be seen in the registration sheet (Table 4), it was proposed the elimination of the operations 1, 8, 12, 14 and 19. Operations 2, 3, 4, 13, 16 and 18 are reduced in time and the rest of the operations underwent combinations and simplifications. The action column shows what actions should be taken for proposals to be successful.

Upon completion of all previous steps, the group moves on to the second cycle of the PDCA to develop it.

3.2 DO

It is at this stage that the action plan prepared in the planning phase will be developed. A management worksheet has been created in which each proposed action has its leader in charge. When the action was completed on a timely basis, it turned green. If the action was delayed, it would have red status.

One action was the modification of the transport cart of the tooling. In the model before the improvement (figure 5), the support plate was flat, making it difficult to transfer the tooling to the cart. In the current model (figure 6), this plate has rollers, facilitating the said transfer.In this phase the standardization of the changes made, the manufacturing of standard operating procedures and the training of all involved in the process occurs. This step is extremely important for the improvement, because if there is no such standardization the problems here already resolved can come back again. You should also create inspection checklist to see if the measurements are being performed.

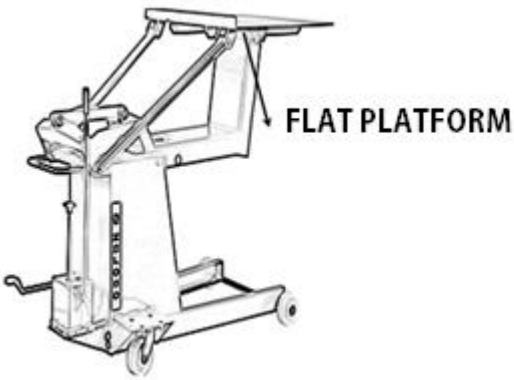

Figure 5. Cart before improvement.

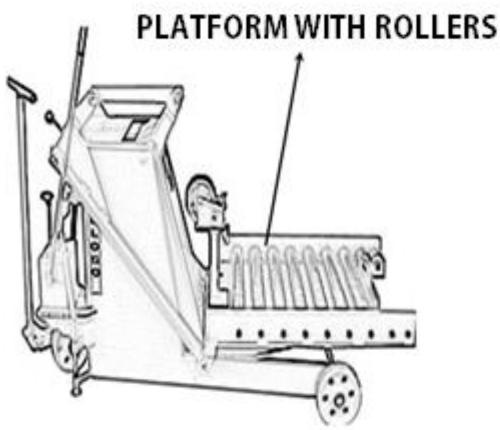

Figure 6. Cart after improvement.

The tooling cabinet as shown in figure 7, which is also in the action plan, was developed so that operators had easy access to the tools. This cabinet is made to make it easy to see the exact location of the tool and makes it easy to see when a tool is missing in the cabinet.

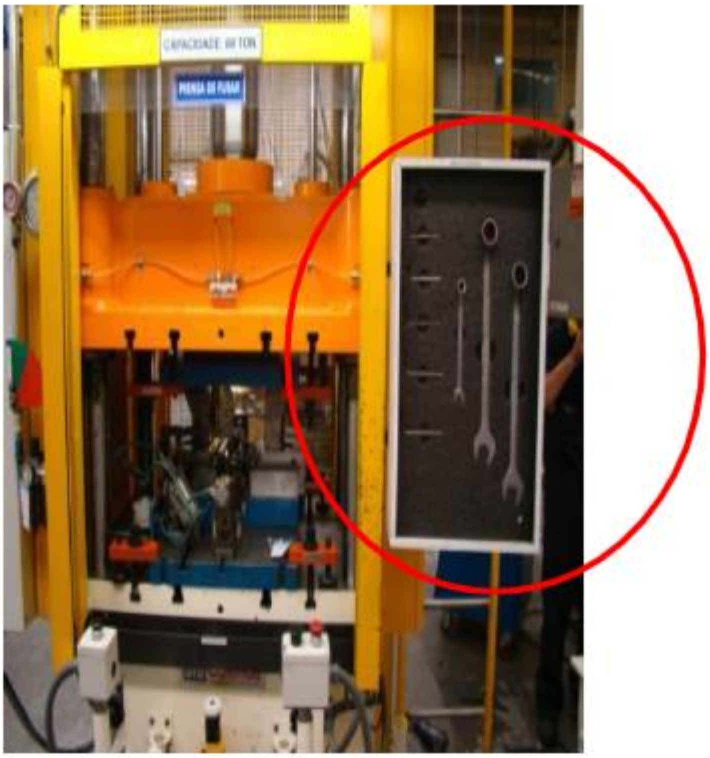

Figure 7. Tool cupboard at back of press.

Another measure taken was the replacement of the fastening screws of the tool, and the screw of figure 8 took a long time to be unscrewed due to its size. With screw replacement, time was dramatically reduced (figure 9).

Figure 8. Inadequate fixing screw.

Figure 9. Proper fixing screw.

In the laboratory analysis the parts of the setup have a marked location (figure 10). When parts are in place, the analysis should be immediate. Before, the setup pieces were placed together with other parts of the process. With this, the operator of the laboratory did not give priority to the analysis of the setup.

Figure 10. Detached area for setup parts.

After all the actions were taken, a new spaghetti chart (figure 11) was made through which it is possible to notice that the walking was significantly reduced. In the first analysis the operator walked a total of 365.2 meters and, in the new evaluation, the same walks 170 meters, a reduction of 54%.

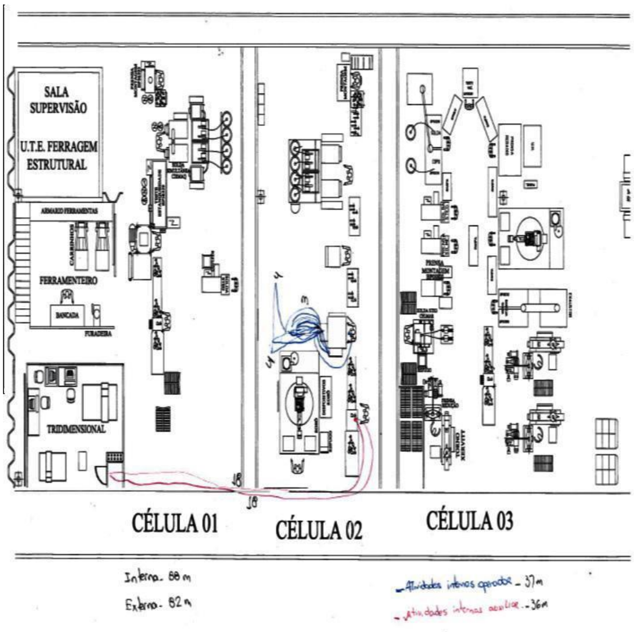

Figure 11. Spaghetti chart after improvements.

With the completion of the step developed, a new setup method was created and some steps were eliminated, replaced, and improved. Also the process was separated in internal and external setup. The external must be done at least 5 minutes before the machine stops.

Nº	Activities	Step Time	Travelled distance	Nº People		
				Toolmaker	Operator	Assistent
	External Setup (Start at least 5 minutes before stopping)					
1	Consult the programming board and call the assistent	01:00		1		
2	Position cart nº2 near the tool shelf	00:30		1		
3	Remove the tool from the shelf and put it in the cart.	00:30		1	1	
4	Secure the safety chain	00:40		1		
5	Carry tool with cart nº2 to the press	01:00		1	1	
6	Carry cart nº1 to the press at the place marked	01:00		1		
	Internal Setup					
1	Adjust parameters and position tool for removal	00:10			1	
2	Close compressed air and disconnect pneumatic system	00:10			1	
3	Catch tool for loosening tool-head bolts	00:05		1	1	
4	Loosen tool-holder fastening screws	00:50		1	1	
5	Adjust parameters to move the press for removal of the tool-head	00:10			1	
6	Move press hammer up	00:05			1	
7	Position cart nº 1 for the removal of the tool matrix	00:10		1		
8	Remove the tool-head from the press and put it in the cart.	00:30		1	1	
9	Position cart with the tool-head in the demarcated region	00:15		1	1	
10	Position cart nº 2 behind the press	00:15		1	1	
11	Remove safety chain	00:10			1	
12	Place tool-head in press	00:10		1	1	
13	Position fixing tool-head	00:15		1	1	
14	Set parameters for hammer movement for fastening	00:10			1	
15	Move press hammer down	00:10			1	
16	Position fixing screws and pre-torque	00:30		1	1	
17	Catch tool on toolbox	00:05		1	1	
18	Torque fixing screws	00:30		1	1	
19	Put tool in toolbox	00:05		1	1	
20	Connect pneumatic device	00:20			1	
21	Open compressed air log	00:05			1	
22	Set parameters for start of cycle	00:30		1		
23	Position the piece and stick to it	00:27		1		
24	Clean and inspect the part	00:55				1
25	Take the part to the laboratory	00:10				1
26	Making three-dimensional measurement	12:00				1
27	Position second piece and pierce it				1	
28	Clean and inspect the part					1

Table 5. New Setup Log Sheet.

3.3 CHECK

In this step it is verified if the implemented actions had the desired effect. After performing the proposed actions and applying the new setup model (table 5), it is verified that the initial setup of 55 minutes becomes 15.3 minutes, which represents a reduction of 72.2% of the time (Figure 12).

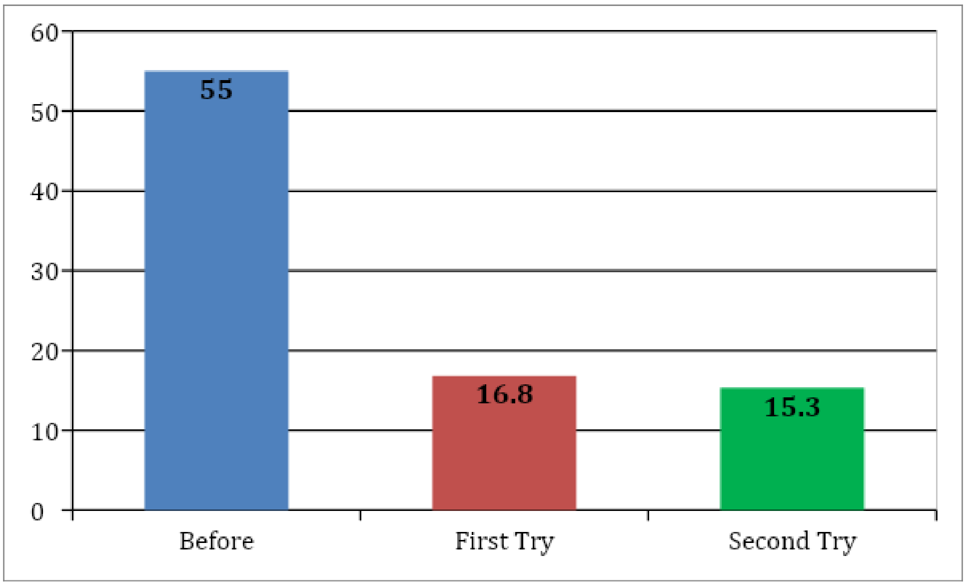

FIGURE 12. Graphic reduction time setup.

3.4 ACT

The last phase of Kaizen is the action phase, in which the group decided to validate the method and standardize the shape of the new setup. For this, a training with the operators on the new standard was carried out and a standard operating procedure was elaborated, in which the steps to be followed by the operator are detailed.

At the end of the Kaizen, a gain calculation was carried out, which showed that the cost for preparing and manufacturing the shares was U$ 5178.28 and the benefit of U$ 15146.85.

4 RESULTS AND CONCLUSIONS

Although the Kaizen methodology does not apply adequately to all improvement projects, it has focused fundamentals and the human element participation making it an extremely useful tool.

This case study shows the importance of quality tools in the industry, since several tools such as Kaizen, PDCA, SMED and Brainstorm were applied to solve a setup problem.

The initial objective proposed was an 84% reduction of time. At the end of the project, there was a reduction of 72.2%. Even without reaching the target, the gain was extremely important because the press was considered a bottleneck on the line and, after that reduction, it was no longer.

The cell where the improvement was carried out has five other machines, where they had gains with the press setup reduction project, because the operator was trained with the principles of lean manufacturing and some processes of the setup of other machines that were previously carried out with the stopped machine are now carried out with them in operation. In addition to these changes, new Kaizen designs were programmed for the other machines in the cell.

As the Kaizen tool is a continuous improvement, the search for new ways to optimize the Press setup will be made.

It is demonstrated that the tools proposed by the Toyota Production System, when done in a correct and methodological way, are very effective in solving various problems in the industry.

SMED PARA AUMENTAR A PRODUTIVIDADE: UM ESTUDO DE CASO EM UMA INDÚSTRIA AUTOMOBILIÁRIA

ABSTRACT: Com o aumento da competitividade, as empresas têm buscado ferramentas para obter vantagens e melhorias no sistema produtivo. A filosofia Lean Manufacturing, criada pelo Sistema Toyota de Produção, trouxe diversas ferramentas para auxiliar na tomada de decisões, reduzir custos de produção e aumentar a vantagem competitiva. Uma dessas ferramentas é o SMED, que tem como princípio reduzir o tempo de setup. O objetivo deste trabalho é ser um exemplo de como a ferramenta, criada pelo japonês Shingeo Shingo e trazida para o Ocidente após a Segunda Guerra Mundial, é aplicada em diversos tipos de indústrias, mais especificamente na indústria automobilística. Este artigo foi baseado em um estudo de caso em uma multinacional que atende grandes montadoras no Brasil e no exterior. Com a aplicação da ferramenta, a fábrica conseguiu eliminar um de seus grandes prejuízos.

KEYWORDS: Toyota, Lean Manufacturing, Setup, SMED

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