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Setup Time Optimization in the Roll-Up Process on a Motorcycle Buffer Production Line Using Kaizen

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Abstract— *This article presents the application of Kaizen, through the implementation of a device that reduces setup time in the routing process of a production line of shock absorbers for motorcycles in the factory Amazon Motocicle Ltda, installed in the industrial hub of Manaus. Through field research the problem was identified. Kaizen reduced process setup time and increased productivity. In this way it was possible to improve the efficiency of the process in the production line by 50%, to gain productivity and to guarantee customer satisfaction.*

Keywords— ***Kaizen, Device Implementation, Productivity increase.***

I. INTRODUCTION

Seeking excellence in their daily manufacturing processes, companies have been forced to seek the improvement of their processes and ensure even more the quality of what is being produced. In the production process, several factors contribute to the accomplishment of daily tasks, which are qualified labor to handle machines correctly, tools appropriate to the process and a rigid control of how the production process is being executed, in order to gain productivity and avoid unnecessary costs for the company.

The present study will present Kaizen's application in the production process in the assembly line of shock absorbers at the company Amazon Motocicle Ltda, located in the industrial hub of Manaus for ten years, with the implementation of a device in the process of roller drive of the shock absorber. This improvement reduced the process setup time from ten minutes to five minutes, thereby increasing production line productivity and generating more profits for the company.

According to [1], companies exist to generate results, and these results are the final products generated from numerous activities called processes. The continuous improvement has as starting point the need to increase efficiency and effectiveness, the results of the activities carried out by the company's professionals.

In order to optimize the set-up time in the assembly line of shock absorbers, more specifically the roller routing process of the shock absorber, there was a lack of a device that facilitated the adjustment of the machine at the time of the setup, that is, at the time of changing a model from buffer to another.

Given this, the lack of a device to facilitate the setup resulted in a ten-minute stop line for adjustment, which led to loss of production and consequent generation of costs for the company, since it was necessary to reach the production plan with overtime after employees.

In view of the above, the present study aims to increase the productivity of shock absorbers and reduce costs with production delays. Thus, it aims to gain productivity by reducing setup time, maintaining and controlling quality, and reducing costs with production losses.

Field research was used to know the damper routing process, the quantitative research to obtain the number of the loss of productivity with the stop of the line for setup, the bibliographic research in books, in order to obtain information on the problem addressed in this study.

II. THEORETICAL REFERENCE

It will be presented the theoretical reference on the process of continuous improvement and kaizen philosophy.

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2.1 Continuous Improvement

Companies seek continuous improvement every day to maintain their prices and achieve the highest quality of their products or services, and for this they use the quality tools in the search to find the improvement that their daily manufacturing processes need.

In the productive process, it is necessary to have a systemic view, where it is possible to always be seeking improvement of the processes and that these improvements can be implemented in the shortest time possible, to increase productivity, improve the performance of the productive sector, but without losing the focus on product quality and through that, bring better results to the company.

Regarding processes, [2] says that for productivity improvement, an excellent tool is process management, and with this tool it is possible to have a better use of the people involved in the process, especially the managers responsible for the production of the products , in order to obtain better results from the daily activities of the company. In order to use this tool, it is indispensable to know well the processes performed and apply, aiming at continuous improvement, reduction of losses and increase of productivity.

The implementation of the improvement in the assembly line of shock absorbers, arose from the great knowledge of the management about its daily processes, as with the increase of the daily production, a better performance of the production line was needed and the people involved with the continuous improvement, aiming to bring better productivity indicators. Putting into practice what [2] mentions the main steps for the correct functioning of the management system, which includes: planning, controlling, reporting and evaluation. For the four steps to work correctly, it is necessary to bring together the people involved in the improvement processes and actions and to show the results achieved, if necessary, re-evaluate what was planned.

2.2 Kaizen For Increased Productivity

On productivity, [3] says that productivity is the production in relation to the time of production with direct labor, where it aims to increase productivity, without labor costs, in order to seek better yields with the efficiency in the processes productive.

For [3], planning or execution is not enough, it is necessary to control and monitor their performance and their results in this productive process, to ensure that they are satisfactory. For this, a rigorous monitoring of the degree of efficiency and effectiveness is necessary, to make corrections in the shortest time possible. All this process will result in more agility and flexibility of the productive process.

Agility in the process, is the purpose of the implementation performed on the assembly line of motorcycle dampers, seeking to improve the process, but maintain the excellent quality of the shock absorber produced. For this, controlling the improvement made was essential to achieve the expected results.

The companies aim to reduce costs and optimize their processes, in this sense continuous improvement is essential, because through these improvements in the production process, the reduction of waste raw materials, time with rework and activities is achieved which do not add value to the company.

Continuously improving processes is to optimize your production processes, reducing unnecessary time and avoiding production costs for the company, and especially, not passing these costs on to the customer.

According to [1], continuous improvement seeks the constant improvement of organizational processes and the great goal of continuous improvement is to increase its capacity to effectively serve its customers, improve their processes and increase productivity without losing focus of quality. product.

For [3], the main objective of continuous improvement is to interfere or even modify factors related to the performance of a process, in order to obtain the expected result.

Bringing the concept addressed by the authors about continuous improvement, the implementation of a device that reduced setup time in the damper routing process was a way to improve the performance of the process, increasing its productive capacity and reaching an expected result that was the daily production gain.

In his work [1] he mentions that the process of analysis and improvement of process, aims to identify the process or group of processes that are not functioning properly and, with this, damaging the performance of the organization.

According to [4], obtaining information about the process performance, analyzing the outputs of the products generated by the processes is important, however, the best information about the behavior of the processes will be obtained by analyzing each process one by one, monitoring their variables and their performance . Having stipulated a goal to be achieved by each process in a production line, for example through this analysis and the collection of correct data, one can verify if there are abnormalities in the process and can apply the necessary actions for its correction . Also in this context, for [5], there are two types of actions, those made in the middle

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of the process, where they are generally the most economical, because they prevent variations and prevent the characteristics of the process from distancing themselves from the values stipulated by the company. On the other hand, the actions performed in the output generate results, but they are more expensive because they will have to understand which process is abnormal and it will take more time to find its root cause and take the action of containment.

Taking into account Machado's citation, this concept of analyzing the processes according to their characteristics was the essential one to identify the problem in the process of the damper routing, since it was the only process in which production was lost due to setup delay, and through concrete data collection the improvement was applied with the introduction of a device that lowered the time spent in case of a model change in the production line.

In his work [6], he mentions that in the productive process, when something does not go as planned, one must seek to understand the reasons for not reaching planning, in which four steps are important:

• Analyze and show what exactly is making the process difficult;

• Record the difficulties as documented information to move to the responsible management of the processes;

• Communicate, through documented information, those responsible, in order to obtain the subsidies to take the improvement actions;

• Perform the improvement actions to correct and prevent the problems in the processes.

For [7], it says that the work of process analysis and improvement, aims to identify the process or group of processes that are not functioning properly, hampering the performance of the organization.

In his work [8] raises important questions to be asked to obtain knowledge regarding the processes, such as:

• Where the process begins;

• What activities occur during the process;

• Method of how activities are developed in the process;

• What inputs are used;

• What is its execution time;

• Who is directly responsible for the process

Regarding the authors' citation, if a production line has a goal to be fulfilled daily and the processes have a setup time and if for some reason the results are not expected, something is abnormal and this at the end of the day, month or year, causes a huge loss to the company, since the loss of productivity entails enormous losses for the company. So it is necessary to do a very detailed analysis of the process in order to discover the ones ready to make the correct improvements and avoid greater losses of productivity in the process.

For [9], three actions are extremely important for the control of processes:

• Establish control planning, which will include the goal of desired values and the methods that will be used to achieve process control;

• Maintaining the control level, once the control is reached, maintenance is necessary. If it is not maintained, one must review the methods used to discover the root causes and make a new treatment for its proper functioning;

• Changing your control guideline, where you must change the procedures to achieve your level of control.

III. SCIENTIFIC METHODOLOGY

For the elaboration of this study, we used bibliographical research in books, the field research with the quantitative research method and informal interview with the assembly line manager of shock absorbers.

For [10], a field of extreme importance in the bibliographical survey is the field research, because it will provide a great review of the literature on the subject. The bibliographic research determines the objectives, the construction of hypotheses and help offering elements to support the choice of the theme proposed by the study.

In the field survey, we analyzed the production plan of the assembly line of shock absorbers, and observed all the processes, in order to raise the data for the implementation proposal. In this observation, it was identified the problem in the process of roller drive of the damper, where it was wasting a lot of time in the setup and damaging the closing of the daily production plan. Then, improvement was implemented through a device that facilitated the exchange of one model to another with a shorter time.

According to [11], field research relies on specific techniques that seek the objective of obtaining information or seeking knowledge about a problem, in which a response is sought, a proof or discover the relationships between them.

Through the field research, the processes were observed in the assembly line of the buffer, as it helped to collect the data referring to the problem addressed by the study. With the quantitative research, data were obtained through documents that show the significant productivity losses with the high setup time of the damper routing process.

In order to obtain more information on the problem of the high set-up time and the loss of productivity in the

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assembly line of shock absorbers, an interview was conducted with the production line manager, who reported and showed productivity losses with the process setup. In the interview it was suggested to implement another device that facilitated the exchange of one model to another, reducing this setup time and gaining productivity.

3.1 Company Characterization

The present article on the reduction of setup time in the routing process in a production line of motorcycle dampers was carried out at the company Amazon Motocile ltda, located in the Industrial Pole of Manaus. The company has been operating for 10 years in the market and has 1,600 employees.

Amazon Motocicle ltda, manufactures rear and front shock absorbers, top table, steering column for motorcycles and has as customer the largest motorcycle manufacturer in Brazil.

To provide excellent products to its customer, the company has high-tech machinery to produce its products that undergo a rigorous testing system such as Damping machines to ensure its functionality and breakout tests to ensure the safety of the motorcycle driver .

The company is the only one in the world to introduce the first front spring without spring on one side, proving once again that with studies and technology in its favor, it can stand out from its competitors, keeping the its excellent quality of its products. For this, its employees receive constant training to improve their knowledge and to be able to perform their daily activities with better performance, with focus on safety and quality.

IV. RESULTS ANALYSIS

The problem of the loss of productivity in the assembly line of shock absorbers with the high setup time in the roller routing process of the shock absorber, the implementation was to install another device that facilitated the exchange, in case of change of models in the production line. This device reduced setup time from ten minutes to five minutes, thereby reducing productivity loss and increasing production line efficiency and lowering costs for the company by reducing overtime to achieve the daily production schedule.

For the better understanding of the implementation, we used the quality flowchart tool, where it will show the whole process of the damper assembly and the flowchart of the damper routing process, showing the before and after the implementation of the device. The graphs will also be shown, showing the losses before device implementation and the gain in productivity after the implementation of the device.

According to [12] and [13] the use of flowcharts aims to identify possible causes of problems that occur in manufacturing processes, verifying unnecessary tasks in the process or making improvements.

Fig. 1: Flowchart of the damper assembly process

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Analyzing the assembly process of the damper, shown in the flowchart, and seeking to improve productivity, because it was not possible to close the daily production plan, in this search, the bottleneck of parts that returned to the beginning of the line was identified, mainly in the start of the shift and in model exchanges.

In order to identify this problem more deeply, the production time of each process was removed in order to discover the true root cause and which process was delaying productivity. Table 01 below shows the times of each process on the damper assembly line.

Table. 1: Buffer assembly process time

Process Times					
Default time: 09 seconds					
Process	Machine Time	Man Time	N° of Parts	Total Cycle	Neck
Pre-assembly of the valve	0	6	1	6,0	9,0
Piston pre-assembly	0	8	1	8,0	9,0
Riveting	5	3	1	8,0	9,0
Spring / Retainer Introduction	0	7	1	7,0	9,0
Oil Injection	3	4	1	7,0	9,0
Damper routing	7	2	1	9,0	9,0
Damping	5	2	1	7,0	9,0
Introduction of Spring	1	4	1	5,0	9,0
Support Torque	7	1	1	8,0	9,0
Bucha Introduction	2	5	1	7,0	9,0
Final Inspection / Storage	0	8	1	8,0	9,0

At the end of the analysis of the process times, it was identified that the damper routing process worked on the bottleneck, that is, at the limit of the process time to process a part.

At this default time of 9 seconds per piece, the operator can not waste any time, otherwise passes raw parts without the roller routing of the shock absorber. It was also identified that the process had setup time of ten minutes, in the exchanges of models, and the others were doing their setup in five minutes.

Regarding this programmed loss, that is, the setup, the company already has as programming this loss of five minutes of stop for adjustments of each process in case of changes of models, resulting in thirty-three pieces lost for the setup. However, the roulette process was set up for ten minutes, twice the time programmed by the company, that is, losing sixty-six pieces, 50% more than scheduled.

Before this confirmation of the setup time, another analysis was done on how to improve the process and reduce this time, in seeking and gaining this lost productivity. In this improvement process, the production line management was involved, along with the company's Kaizen team.

In this search for the solution, and analyzing the roller rotor of the shock absorber, it was concluded that the method of changing the adjustment device of the machine was making difficult the quick change in the time of the setup, thus affecting the productivity at the end of the day.

To solve this problem and perform the necessary improvement, another machine adjustment device was designed and designed by the company's technical design team. The idea was that the new device would facilitate and speed up the adjustment of the machine in case of model changes, making the process agile and productive.

The implementation of the adjusting device has significantly reduced productivity loss because the operator is able to perform its setup time within the time of up to five minutes, which is the time of the other damper assembly processes as well, reducing the loss of productivity in the process.

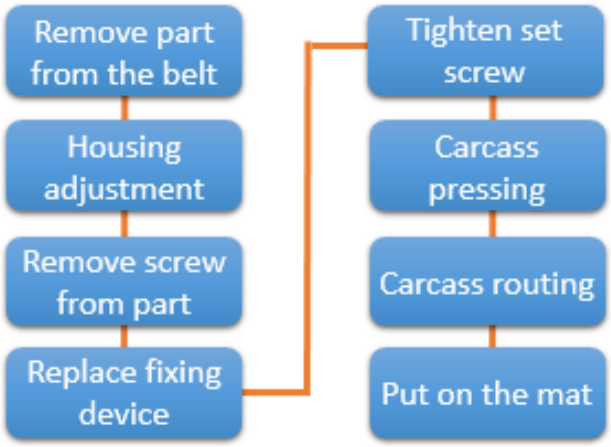

Fig. 2: Rotation process before device deployment

The flowchart in Figure 02 demonstrates the roller routing process of the damper before the implementation of the new device for improvement.

Figure 03 below demonstrates the setup process on the damper rotor machine.

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Fig. 3: Damper attachment device

It can be observed before the implantation of the improvement device, where the operator makes multiple adjustments in the machine in case of a model change in the production line.

Shown in Figure 4, the flow chart of the damper routing process, after the implementation of the device.

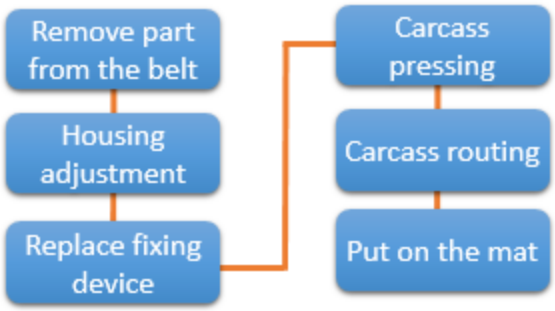

Fig. 4: Process flowchart after device deployment

In this process the activities that did not add value to the process were reduced, and the activities in the posts were redistributed.

Figure 5 below demonstrates the change of device in the roulette machine with the improvement achieved through a new fastening device where the operator only withdraws a dowel pin from the device to perform a change from one model to another, reducing the time setup and gaining productivity.

Fig.5: New damper attachment device

Regarding the new device, in addition to facilitating the exchange of one model for another, the significant reduction was the time from ten minutes to five minutes of machine stopped for adjustments, increasing the efficiency of the process with the focus on the daily production productivity gain . These five extra minutes in the setup resulted in a significant loss of thirty-three pieces at each model exchange for machine adjustments and production reporting,

Table 2 is based on the year 2018 and shows the monthly production of shock absorbers in the production line in the year.

Table. 1:Monthly production of shock absorbers - year 2018

Production of shock absorbers year 2018	
Month	Produção Mensal
January	67.200
February	61.500
March	98.400
April	82.000
May	88.200
June	52.000
July	66.300
August	89.700
September	72.000
October	84.000
November	69.700
December	56.000
Total Production	820.700 Peças

Based on the production of shock absorbers in the first six months of 2018, the graph of Figure 6 demonstrates

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the monthly loss of parts due to the high set-up time in the roller routing process of the shock absorber, where there was a ten minute machine time stop for adjustments, 50% more than programmed. The data shown in the chart in relation to the losses are only due to the roller routing process of the damper and its setup time, with a daily loss of 33 pieces in the first seven months of 2018.

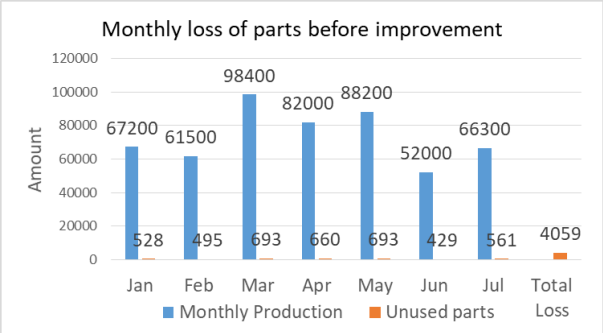

Fig. 6: Loss of parts before improvement

According to graph data, it is possible to visualize the great loss of productivity, due to a single process and its high setup time. The total loss shown is a huge loss to the organization, because in order to achieve its productivity goal, it needed to have overtime, generating more expenses and affecting its profitability.

With the implementation of the new device, to facilitate the exchange of one model to another at the time the setup, a significant reduction of 50% in time was obtained, leaving a setup time of ten minutes to five minutes, totally reducing the loss with high setup time.

The graph in Figure 7 demonstrates the production in the last 5 months of 2018, showing the Kaizen result in the process of damper routing with the implementation of an adjustment facilitation device at the time of the process setup.

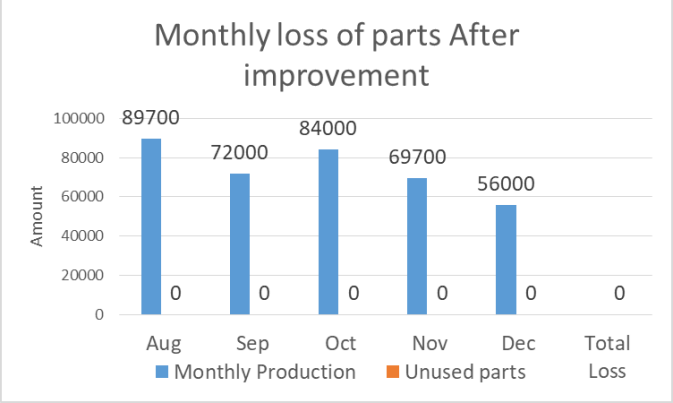

Fig. 7: Loss of parts after improvement

As shown in the chart, after the implementation of the new machine adjustment device, the daily losses of thirty-three pieces have been eliminated, as the operator by means of the fast adjustment of the roulette machine, can make its setup in five minutes, thus improving the process performance and gaining productivity.

V. FINAL CONSIDERATIONS

The main purpose of this study was to present a Kaizen in the production process in a production line of motorcycle dampers, more specifically in the process of damper routing.

The improvement was based on studies, analyzes, interviews with production operators and area managers, carried out at Amazon Motocicle ltda. Through the analysis of the process times and observation of the production process, it was verified the high setup time in the roller routing process of the shock absorber, where the improvement work was carried out, with the implementation of a new machine adjustment device that facilitated and accelerated the in case of a change from one model to another.

The main gain with the implementation of this device is the productivity at the end of the day, the month, the year, as it ended the daily loss of thirty-three pieces, coming from ten minutes of setup, where the ideal setup is five minutes.

The quest for continuous improvement and process innovation is a method that every organization should do to improve its processes and stay in the highly competitive market, where it is tirelessly seeking to reduce costs and increase productivity.

The improvement implemented in the process, reduced the losses in the process setup by 50%, keeping the loss scheduled for setup within the time stipulated by the company. The application of Kaizen in the process brought increased process efficiency and increased productivity.

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