USE OF LEAN TOOLS FOR CONTINUOUS IMPROVEMENT IN A PRACTICAL CASE IN A MANUFACTURING INDUSTRY

Conference Proceedings ICONIS – IV 2020.
Leon-Mexico, October 22-23, 2020. Pag. 15-20

ISSN (Online): 2711-3310

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***Abstract:** Training is a wide field within the industries, this research covers the job instruction part, the technical training, based on the TWI–JI (Training Within Industry–Job Instruction) and the 4 steps training method. Simulation, based on Promodel®, propose reduce the effort to know the results in the long-term for the proposal improvements. Training within industries provide a solid foundation for the standards methods. Simulating a production line helps to see the impact of the proposed applications in the productive area and with these data decide if the pilot area could be replicated in other similar ones.*

***Keywords:** TWI, simulation, lean process*

1 INTRODUCTION

Author SPC Consulting Group (2013) says that a process adds value by producing goods or providing a service for which a customer pays. Considering that a process consumes resources, waste can occur when the resources are consumed more than necessary to produce the goods or to provide the service that the customer really wants. The attitudes and tools of the Toyota Production System (TPS) raise awareness and give new perspectives to identify waste and unexploited opportunities associated with waste reduction.

A successful Lean implementation requires organizations to achieve stability

[*] Citar: Márquez-Figueroa, L., Rodríguez, N., Perez-Domínguez, L., Romero, R., and Lopez, F. (2020). Use of lean tools for continuous improvement in a practical case in a manufacturing industry. *Conference Proceedings of the International Congress on Innovation and Sustainable*, Leon-Mexico, October 22-23, p.p. 15–20.

in methods and processes through Standardized Work, a fundamental element in the Toyota Production System. Job Instruction (JI) is the cornerstone for standard work (TWI Institute, 2019).

When a company uses Lean and Six Sigma simultaneously, dramatic improvements are achieved across the corporation much faster, and in fact, this combination is a prerequisite for rapid improvement rates. Lean Six Sigma is a methodology that maximizes shareholder value by achieving the fastest rate of improvement in customer satisfaction, cost, quality, process speed, and invested capital. (George, 2002).

2 THEORETICAL AND CONCEPTUAL FRAMEWORK

Lean manufacturing is a group of techniques that assures the performance improvement, which are logical and as they are applied, they seem to be a path to achieve more efficiency. (Dudbridge, 2011).

The benefits of a trained workforce are workplace safety increase, career development, regulatory compliance, improved quality, consistency in performing tasks, productivity increase, performance improvement and allows identify weaknesses (Alston, 2017)

Training Within Industry (TWI) is an approach that contributes the required actions to build a lean culture. Charles Allen´s four-step methodology was the basis for the development of these programs, standard work and kaizen, as shown in Table 1 (Graupp & Wrona, 2017).

TABLE 1. COMPARISON TWI STEPS/KAIZEN PROCESS. (GRAUPP & WRONA, 2017)

	Job Instruction	Job Methods	Job Relations	Kaizen
1	Prepare the worker	Break down the job	Get the facts	Observe and time current process
2	Present the operation	Question every detail	Weigh and decide	Analyze current process
3	Try out performance	Develop the new method	Take action	Implement and test new process
4	Follow up	Apply the new method	Check results	Document new standard

Simulation is useful to perform changes or activities outside the production line without affecting productivity (Amezua Hormaza, 2019).

3 METHOD

The area produces brake pads. Consist in four workstations that are: -Assemble packing box; -Shim Press; -Sensor Press; -Packing. Four workers make the job.

The Figure 1 shows the line balancing. Packing a box with four brake pads is the cycle time.

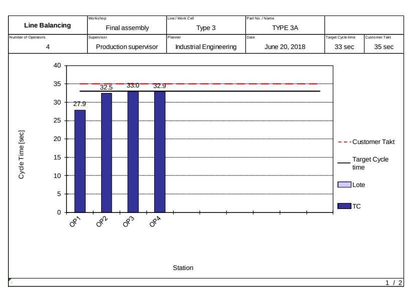

FIGURE 1. LINE BALANCING.

The Figure 2 shows the layout of the area, and Figure 3 describe the layout symbols.

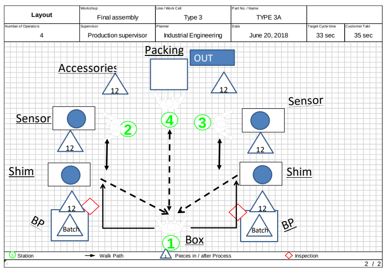

FIGURE 2. LAYOUT-AREA

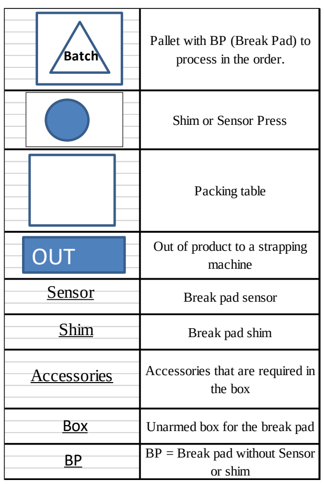

FIGURE 3. SYMBOLS-LAYOUT.

Then the Figure 4 shows the methodology flowchart to make the training in the pilot area.

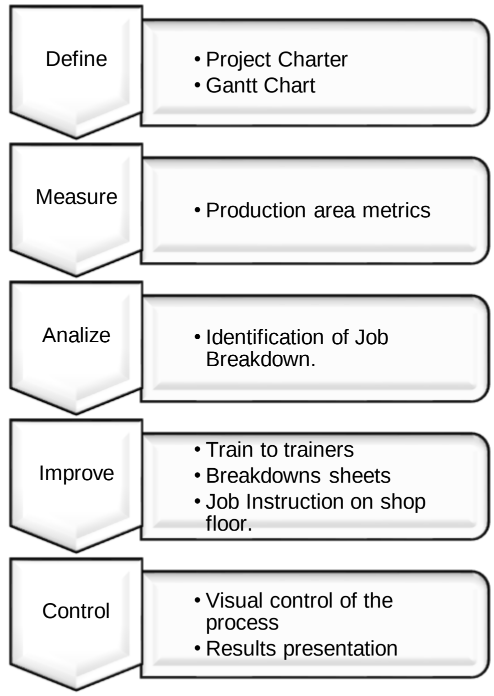

FIGURE 4. METHODOLOGY FLOWCHART.

The Table 2 shows the cycle time to make the simulation.

TABLE 2. CYCLE TIME.

Workstation	*Defects per turn*	*Days of training*	*Cycle time (seconds)*	*Cycle time before*
Brake pads Inspection	1	1	5	8
Shim press	2	3	7.52	12.25
Sensor press	3	3	12.35	20.14
Packing	10	5	34.66	46

The Figure 5 illustrate the process in Promodel®. There are 2 warehouses, raw material, and the finished goods. Four station for the press, two for shim and two for sensor, also a station for packing.

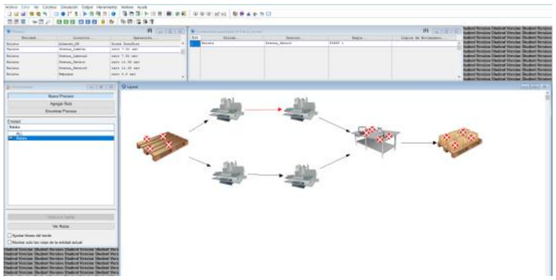

FIGURE 5. PROCESS

The Figure 6 shows the model in Promodel®.

FIGURE 6. MODEL FOR THE WORK CELL.

4 RESULTS

The results obtained in the simulation:

TABLE 3. SCOREBOARD.

Entity	Total outputs	Average time in system (sec)	Average time in operation (sec)
Brake pad	4660	14071.17	28.47

The programmed time for the simulation was 8 hours, we compare the brake pads produced from the simulation with the time cycle established by the company in Table 4.

TABLE 4. COMPARISON OF PRODUCED PARTS. (COMPANY VS SIMULATION).

	Total parts	Time cycle	Boxes with four brake pads
Company	3490	33	872.5
Simulation	4660	24.72	1165
Before Simulation	2504	46	626

The results are compared in Minitab® to see if the cycle time obtained by the simulation complies with the cycle time provided by the company.

4.1 One-way ANOVA(1):

TABLE 5. MEANS SHIM PRESS.

Factor	N	Mean	StDev	95% CI
Simulation shim press	12	7.523	0.944	(6.492, 8.555)
Before S. Shim press	12	12.257	2.247	(11.225, 13.288)

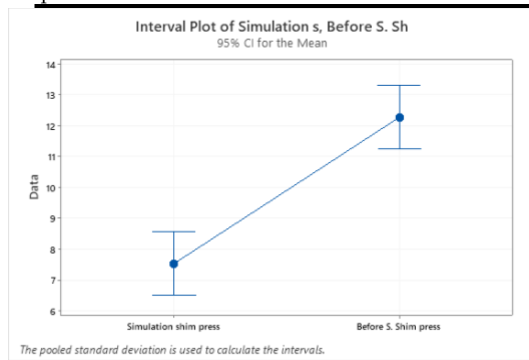

FIGURE 7. INTERVAL PLOT SHIM PRESS.

4.2 One-way ANOVA(2):

TABLE 6. MEANS PACKING

Factor	N	Mean	StDev	95% CI
Simulation packing	12	34.67	7.92	(30.11, 39.22)
Before S. Packing	12	46.00	7.29	(41.44, 50.56)

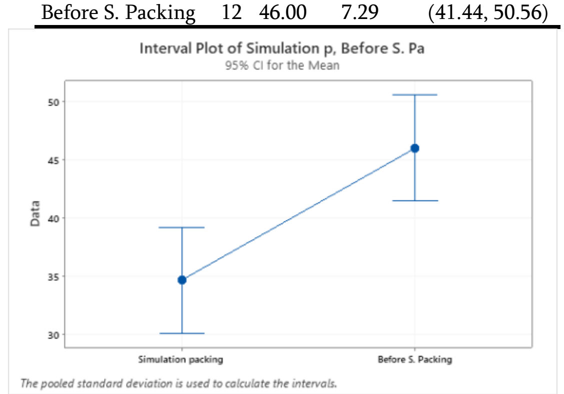

FIGURE 8. INTERVAL PLOT OF PACKING.

4.3 One-Sample T(1):

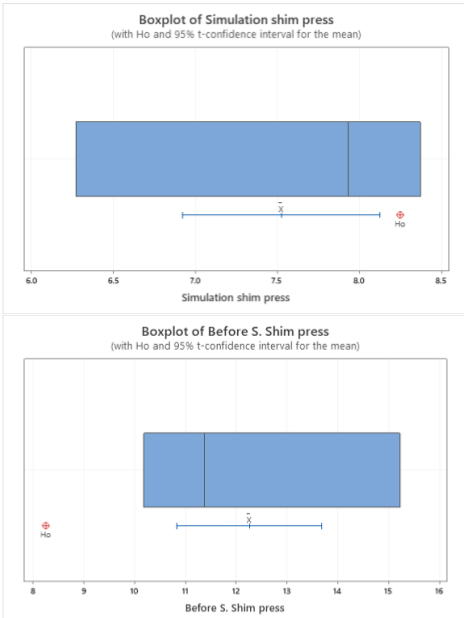

FIGURE 9 BOXPLOT OF SHIM PRESS,

4.4 One-Sample T(2):

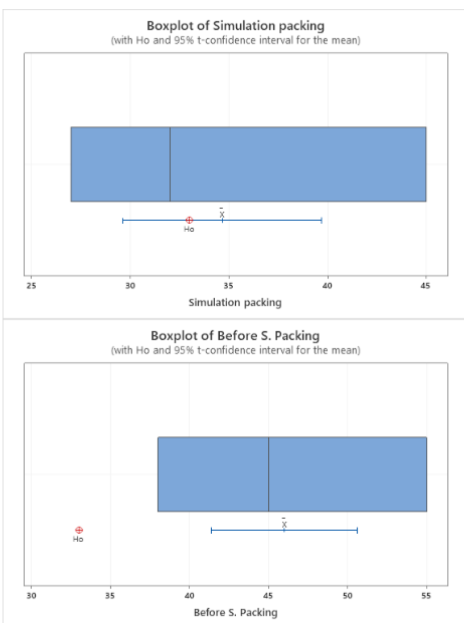

FIGURE 10. BOXPLOT OF PACKING.

5 CONCLUSIONS

As the simulation shows, the results obtained from the training show an advance that would cover the cycle time proposed by the company and would continue to largely comply with the takt time.

The use of a simulation program like Promodel® has the advantage, in applications such as the one shown, ease in obtaining long-term information, without having to compromise the objectives of the area without being sure to satisfy the demand when implementing it through the cells of the assembly area. The proposed method is validated through simulation and in this way, it is decided whether to implement it.

In this process, according to the results obtained in the simulation, it is recommended to implement the methodology proposed in the flowchart for the work cells that work with the same workstations.

Some of the benefits are as follows: 1. Cycle time reduction. 2. Costs reduction. 3. Search for new products.

The scope of this project is the use of lean manufacturing tools to reduce waste in a production area in the form of a line or cell. The limitation lies with the type of product and processes carried out in this project.

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