

# Enhancement of the industrial performances through Value Stream Mapping method: case study in an Algerian company

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**Abstract**— currently, the industrial market witnessing an intense competition that drives the manufacturing firms to accelerate their production tasks to present their products early with lowest costs possible. The work presented in this paper investigates an application a lean manufacturing approach in the Algerian industry. The proposed approach aims to reduce the waste in a manufacturing process through using Value Stream Mapping method. The effectiveness of the proposed approach has been validated with a real case study and obtained acceptable improvements in cycle time, lead time and manpower

**Keywords**—Lean Manufacturing, Takt time, Value Stream Mapping.

## I. INTRODUCTION

The concept of lean was first coined through Womack and Jones (1990) book 'The Machine That Changed the World'. The lean manufacturing it is a Japanese philosophy developed by Toyota for the purpose of reducing cost and cycle time throughout the entire manufacturing process while continuing to improve product performance [1] through using a set of effective tools and methods like VSM, TPM, 5S. However, Value Stream Mapping is one of best tools of Lean Manufacturing. Value Stream Mapping has emerged as the best way to implement lean manufacturing in recent years [2]. However, the Value Stream Mapping is an effective lean manufacturing tool used to visualize any manufacturing process. In addition, it can be sued as a diagnosis method for identifying the different kinds of waste.

The implementation of this kind of management approaches is concretely neglected in the Algerian industry. Therefore, this study focuses on the implementation of a Lean manufacturing framework to improve the performances of an Algerian company by using the Value Stream Mapping method for reducing or eliminating the deferent kind waste exiting in a manufacturing process. This paper is structured as follows: section 2 provides review research papers on LM, six sigma and lean six sigma. Section 3 presents the proposed lean

six sigma methodology. Section 4 describes the data used and the implementation of lean six sigma approach. Section 5 discusses research the results and the conclusion of the presented work.

## II. RELATED WORKS

Lean manufacturing is based on the fundamental goals of Toyota production system (TPS) which aims at continuously minimizing waste to maximize flow. Nevertheless, VSM it is a graphical presentation which is used as a technique for analyzing both material and information flows [3]. According to [4] the application of Value Stream Mapping is based on five consistent steps: create a current VSM, analyze the current map, identify root causes of waste, create a future state VSM, and implement the final plan. Numerous research showed that the aforementioned steps have been widely implemented with success in different industrial sectors.

[5] Investigated the importance of Lean Manufacturing in an Indian auto components company. Through using VSM method, the obtained results showed that the lean manufacturing has a positive impact on TAKT time, process inventory level, total lead and cycle time.

[6] Proposed an application of VSM method in an auto-parts manufacturing organization to reduce the wastes existing in the manufacturing process. The obtained results showed acceptable improvements in cycle time, work in process inventory and in production lead times.

[7] Proposed an application of Value Stream Mapping (VSM) for enabling leanness in an indian company, through determining the various type wastes followed by an improvement methodology. The obtained results show acceptable optimizations in productivity, quality and throughput time reduction.

[8] used the Value Stream Mapping method to reduce the waste in a production. The obtained results showed improvements in production lead-time and value added time

[9] investigated an application of Value Stream Mapping (VSM) method in a casting organization, the obtained results showed acceptable improvements regarding value added time, cycle time

### III. METHOD

The lean manufacturing method used in this work is Value Stream Mapping and has been used for waste minimization, in order to improve the industrial performances of an Algerian company. The methodology followed during this study is shown in Fig.1.

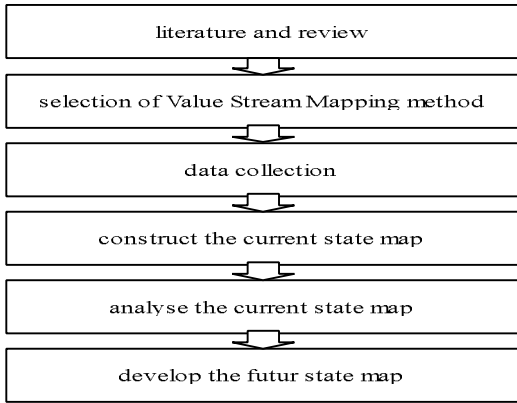


Fig.1 the proposed approach

In this paper, the Value Stream Mapping was selected as a method to treat the problem faced by the manufacturing process. At first, the needed data were collected with the help of leader's company through a practical stage of two months (Mars and April, 2017). In the second step, based on the collected data, the current state map was constructed, and in each operation the value-added and non-value-added activities were identified. In the third step, a simple analysis procedure was performed using Takt time and the diagram of Ishikawa to identify the causes of the defined waste. Then, Pareto and brainstorming methods were introduced to determine the impact degree of each cause on the performances of the manufacturing process. Finally, the future state map was constructed based a set of improvement opportunities and the obtained results are discussed.

### IV. CASE STUDY

This section describes the implementation of the proposed approach. Where it was applied in an SME business that seeks to improve their performances; this company produces gas bottles using a manufacturing process that is composed of three workshops, as it is shown in Fig.2:

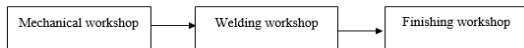


Fig.2 workshops of the manufacturing process

The proposed approach is focused on the mechanical workshop, because it is a critical part of the manufacturing process. This workshop is divided into two production lines; these latter are organized into a set of operations, as shown in Fig.3.

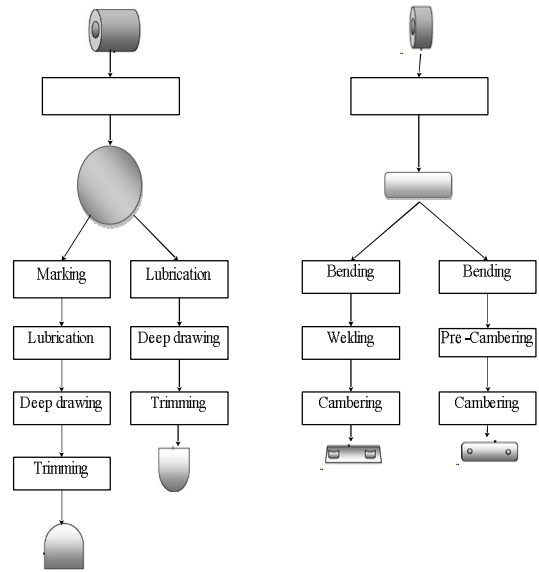


Fig.3 Manufacturing process of the mechanical workshop [10]

#### A. current state map

The current state map describes the actual situation of the manufacturing process that allows detecting the different sources of waste. The initial step to create a Value Stream Map is to gather data that reflects the current status of the system [5]. The values used in the actual state map were collected based on the empirical observation and by using a chronometer device for measuring the different types of time (cycle time, NVAT, VAT). The current state map is drawn in two parts, the first represents the production line of upper and the higher deep drawing (Fig.4), and the second represents the of feet and collars production line (Fig.5).

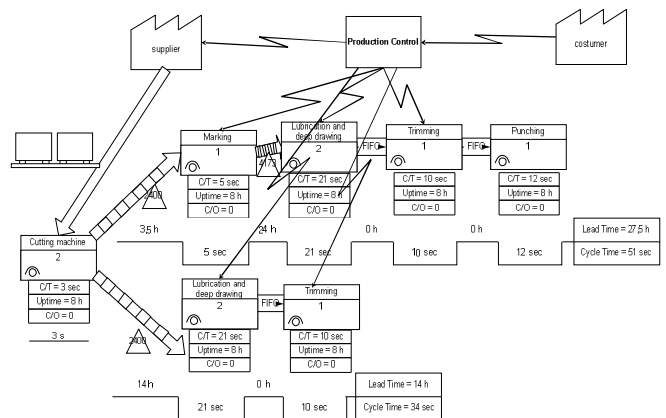
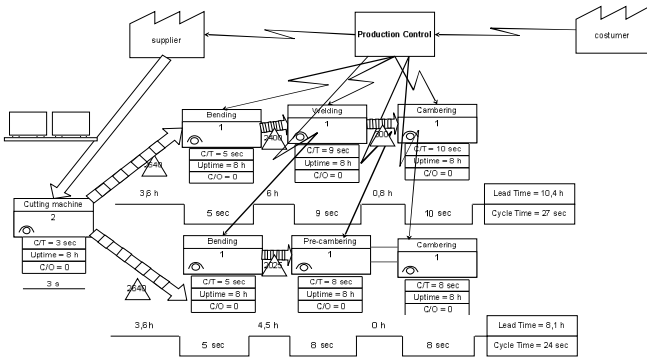


Fig.4 Current state map of the higher and lower deep drawing process.



**Fig.5** Current state map of foot and collar process

**B. Analysis of the current state map**

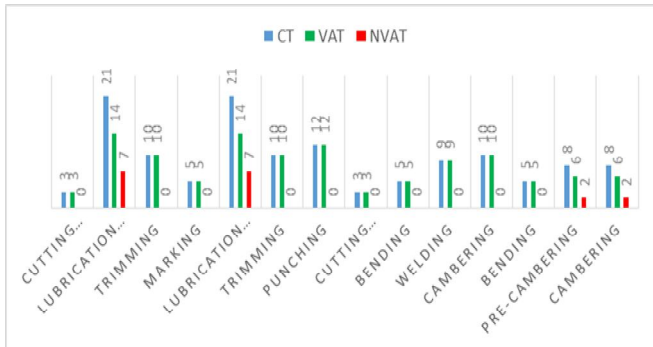
The analysis performed in this part is highlighted finding solutions for each problem encountered while executing each task in the manufacturing process. Therefore the aim of this section is to determine the deep causes of wastes, in order to allow the selection of lean tools that make the production more leanness. The current state map shows that:

Non-value-added activities are split between unnecessary movements and transport time.

The difference between the cadences of machines caused in a large amount of WIP, as shown in the current state.

*a) Time analysis*

The production time is one of the important indicators that its analysis should be taken into count to find the possibility of reducing it. The cycle time of each operation in the mechanical workshop is divided into value added time and non-value added time (Fig.6).

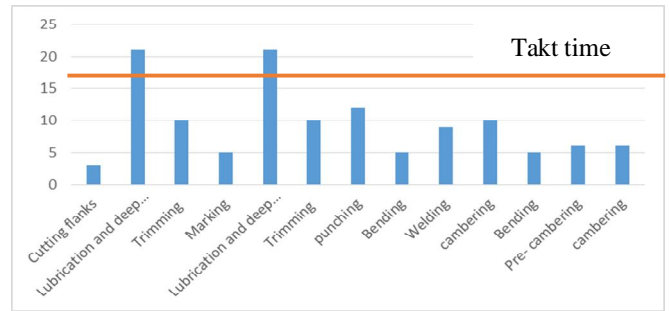


**Fig.6** Current state of the cycle time

*b) Takt time*

The German word Takt means precise time cycle, rhythm or interval; it also refers to the conductor's baton and music beat [11]. Takt time is calculated by dividing available working time per shift (in sec) with the customer demand per shift. This company received about 1277 bottles as a daily customer's demand. A team is in charge, works 8 hours a day with 30-minutes of break, 23 days per month.

$$\text{Takt time BAG} = \frac{(8-0.5) \times 3600 \times 23}{1277 \times 23} = 21 \text{ s}$$

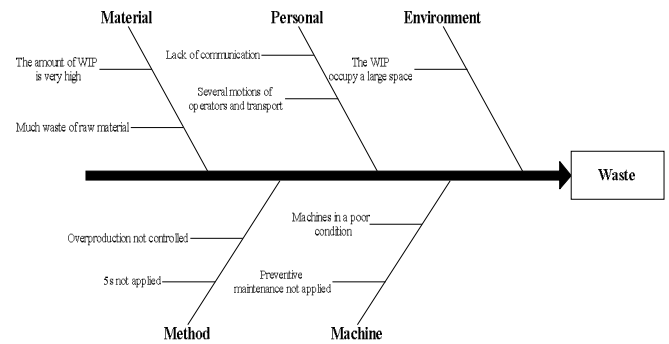


**Fig.7** The cycle time comparison with Takt time.

In most of operations, we notice that the Takt time is bigger than the cycle time. This situation causes in another type of waste, which is defined by the overproduction that has been proved in the current state map by the large amount of WIP.

*c) Diagram of Ishikawa*

At this point, Ishikawa diagram (Fig.8) is used to determine the defects appearing in the process, in order to help us investigating and analyzing the causes of waste.



**Fig.8** Ishikawa diagram.

For a deeper analysis, we chose the voting method to determine the importance degree of each cause. To do this, we asked the leaders' company to give a weight between 1 and 15 for each cause. The most wasteful cause will have the highest weight, then the causes of waste were grouped together to facilitate their processing as in Table 1:

**TABLE I:** Preparatory table for the Pareto diagram.

causes	Weight	%Cumulative
Several motions of operators and transport	15	31
The amount of WIP is very high	13	57
Overproduction not controlled	10	78
The WIP occupy a large space	3	84
5s not applied	3	90
Preventive maintenance not applied	2	94
Lack of communication	1	96
Much waste of raw material	1	98
Machines in a poor condition	1	100

From Table 1, it is possible to represent the Pareto diagram on Microsoft Excel, as shown in Fig.9.

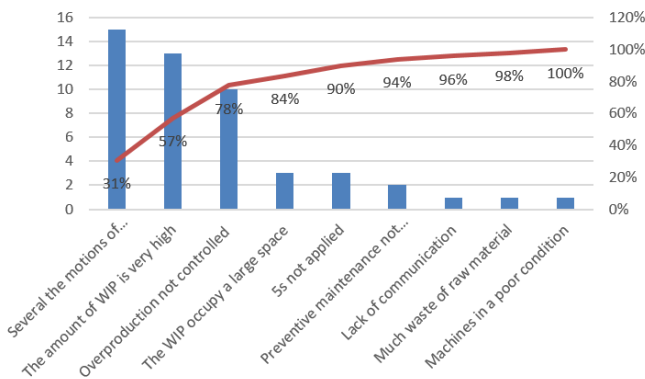


Fig.9 Pareto chart

According to the principle of Pareto, 80 per cent of waste comes from 20 per cent of causes. Therefore, the improvement priority should be adapted to the following causes:

- ✓ Several motions of operators and transport.
- ✓ The amount of WIP is too high and occupies a large of space.
- ✓ No overproduction control.

The three causes of waste are linked among them, which mean that reducing unnecessary gestures and controlling overproduction have a positive impact on the volume of WIP.

C. Futur state map

After the current state map analysis, the causes which have a great influence on the performance of the production were identified. Therefore, the future state map has been developed by proposing a set of solutions in form of an action plan (Table 2) to remedy the following problems:

- Eliminate the unnecessary motions and reduce cycle time.
- Eliminate the bottlenecks that are caused by the overproduction problem

At this point, we propose a set of modification and improvement solutions to remedy the previous problems:

**Cellular manufacturing:** Reduce the shop-floor space for manufacturing workshop Decrease the production time through reducing of transport activities

**5s:** It is an organization workplace method that can be used to ensure the ergonomic conditions, reduce the time of research tools

**TPM:** Reduce the intervention time and increase the productivity rate. Increase the operators' expertise.

**Poka yoke:** it is a simple improvement process that used to reduce the defect rate and facilitate performing the process tasks without error.

The proposed solutions helped us to make an acceptable improvement in the cycle time, lead-time, transport time and WIP. The results achieved are presented in the future state map as shown in Fig.10 and Fig.11 respectively.

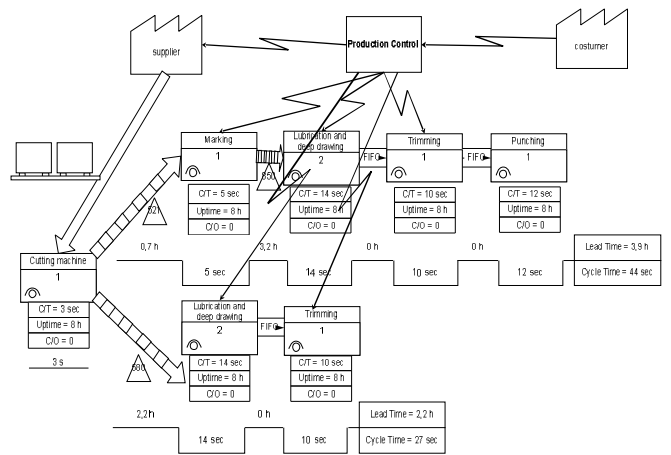


Fig.10 Future state map of higher and lower deep drawing process

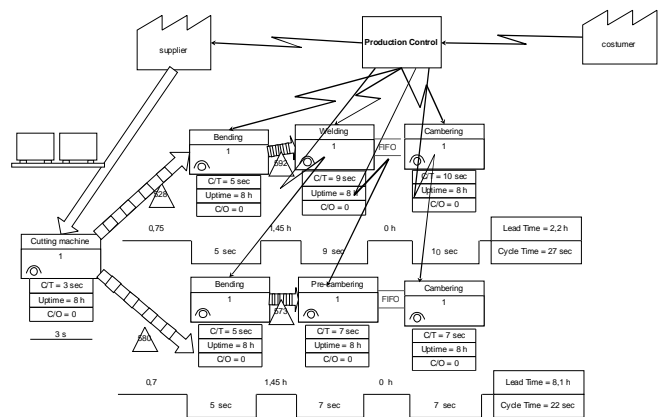


Fig.11 Future state map of feet and collars manufacturing process

V. RESULTS AND DISCUSSION

The implementation of Value Stream Mapping method achieves acceptable improvements for the company. The principle of Value Stream Mapping allows us to encompass the data concerning the current state map, then we launched an analysis using the Cause-and-effect diagram to detect the different causes of waste. These latter are treated by the principle of Pareto, which allows identifying the causes that have a great influence on the process. To obtain an optimized future state map, we proposed an action plan, which contains a set of tools that contributed to the results presented in Table 2:

TABLE II the obtained results

	Parameters	Current state	Future state
<b>Cycle time</b>	Deep drawing	68 second	68 second
	Foot and collar	55 second	49 second
<b>Lead time</b>	Deep drawing	41,5 hour	6,1 hour
	Feet and collars	18,6 hour	4,35 hour
<b>Value added time</b>		112 second	112 second
<b>Non value added time</b>		338 second	28 second
<b>Manpower</b>		18	16

## VI. CONCLUSION

Today Lean manufacturing is recognized as an improvement strategy that increases process performance resulting in enhanced customer satisfaction and reduced production time. However, in the most of Algerian companies, the lean manufacturing is concretely neglected, so the purpose of our work is to spread the importance of lean manufacturing in the Algerian industry, given to the difficult economic crisis it is experiencing. The focus of this research was to implement the Value Stream Mapping method in a metal manufacturing process that pursues improving their performances. The results showed: 10.9% reduction in cycle time for feet and collars manufacture, 85.3% and 76.61% reduction in lead time of deep drawing and feet and collars manufacture, respectively, 97.71% reduction in non-value added time of the over the mechanical workshop. Finally, the number of operators was reduced by two operators. Therefore the results obtained from this study will motivate other Algerian companies to implement lean manufacturing approach in their manufacturing processes. For future research, we propose to broaden the improvement area and orient the lean manufacturing approach toward the concept of sustainability.

## VII. REFERENCES

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