THE USE OF LEAN MANUFACTURING TOOLS TO IMPROVEMENT OF LOGISTIC PROCESSES

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Abstract

Production logistics, just like any other functional area of an enterprise, must be constantly optimized and improved to meet the requirements of growing competition in terms of technology and in terms of customer satisfaction. The efficiency of logistics processes in the production system depends on the use of various methods and tools offered by modern management concepts. Currently, one of the most effective concepts used to improve processes in enterprises is Lean Manufacturing. Due to the choice and application of proper for a particular process Lean tool the enterprise is able to gain many advantages e.g. decline in quantity of shortages, shorten time of orders completing, improve productivity, meet supply deadlines, decline in stocks. The aim of the article is to present suggestions for improvements for the assembly process, using the work standardization. The developed standard concerned the method of movement of operators between workstations, which significantly affected the work efficiency.

Keywords: Lean Manufacturing, standardization, logistic process

1. INTRODUCTION

Work standardization is one of the basic tools of the Lean Manufacturing concept in improving work and developing the stability and repeatability of the production process. Almost all processes carried out in enterprises depend on standardization. Thanks to it, it is easier to observe processes, measure them, notice discrepancies and identify problems. By means of uniform methods and criteria, it promotes consistency in action. Standardization - as the fourth step in the implementation of the 5S rules - creates the rules necessary to maintain the improvements achieved thanks to the first three steps (sort, set in order, shine). First, you need to improve processes and then standardize them, that is, define them in such a way that each employee knows what they are and how they should be performed. Without the standard, the effectiveness of improvements introduced to achieve it can not be measured. In industry, standards are applied in two aspects of production: in product specifications and quality, to eliminate shortages and in the analysis and improvement of processes aimed at eliminating waste [1,2]. The development of standards for the implementation of individual stages of the production process in the enterprise contributes to: increasing work efficiency, by performing activities in accordance with specified rules, improving the quality of tasks performed, determining fixed volume of stocks, setting standards for performing individual activities [3]. The article presents the results of the analysis conducted on the assembly line concerning the movement of operators between positions during the work shift. Due to the lack of a valid standard, the employees moved chaotically, which affected the efficiency of their work and the efficiency of the entire production line. On the basis of observations of operators' work and production data, the most effective way of staff turnover was determined and a new standard was proposed. As a research method a case study was chosen in regard of the usefulness of problems solving within processes management in the enterprise as well as methods and tools used to make effective and sensible decisions. The source of the data was the information handed in by the enterprise and the observations and analysis of the ongoing process.

2. THE ESSENCE OF STANDARD AND STANDARDIZATION

Standardization means an unambiguous way of performing activities that enables tasks to be carried out in the same way, with the same quality, at the same time, at the same cost [1]. However, a standard is defined as a procedure or rule that accurately describes specific requirements. Standards are the basis for activities improving the current state and allow achieving the intended goals of the company. Standards should be based on facts and analysis, should be followed and documented and clearly presented to employees [2].

Two types of standards are distinguished in the literature: the first is management standards referring to the internal goal of employees management, and the second are operational standards regarding the ways of performing work. According to Masaaki Imai [4], if the applicable standards are respected and employees perform tasks without deviations from the norm, then the process remains under control. The next step is to modify the current state and raise the standard to a higher level in accordance with the PDCA cycle. Standards should [4]:

- present the best, easiest and safest way of performing work,
- be a criterion for measuring work,
- show the relationship between cause and effect,
- give the basis for maintaining the level and improvement,
- be objective, simple and clear,
- be the basis for training,
- be the basis for control and diagnosis,
- prevent errors.

Currently, the concept of work standardization is strongly related to the concept of Lean Manufacturing, however, its beginnings appeared in the 1920s, when H. Ford introduced the first elements of standardization to his production plants [5]. The standardization of work according to H. Ford means that each of the processes is implemented in the same way by all employees. The standardization of work should ensure the creation of standards, schemes of the most effective work methods, guaranteeing process stability and the certainty that operations at the workplace will be carried out according to the same steps, achieving the same results every time. The work standardization is based on defining the individual stages of the process in relation to the adopted criteria (e.g. time, quality, performance) so that their effectiveness can be assessed. The developed and optimal at a given moment sequence of activities becomes a valid standard that can be improved, thus improving the process [1]. When improving the process, it should be remembered that an important element is also the aspect of work safety - the implemented solutions should include safe working conditions and reduce the number of potential accidents [6].

The specificity of work standardization criteria is focused on the most important factors of the competitiveness of a production company: customer, employee (and their participation in the functioning of the company), continuous improvement of workplaces (kaizen) and properly organized production area. During standardization of work, losses in the process should be eliminated (in accordance with the Lean Manufacturing concept), thanks to which production costs will be reduced, operators' work efficiency will increase, production time will be shortened due to the elimination of unnecessary activities or expectations [7,8].

The standard documentation used in manufacturing enterprises may take many forms, however, the most commonly used document - due to the simplicity of execution and low costs of development and implementation - is the work standardization card. The card is intended to present the work schedule applicable at a given workplace, and thanks to it it is possible to identify and eliminate irregularities or losses [1]. The stages of developing the standardization card are shown in **Figure 1**.

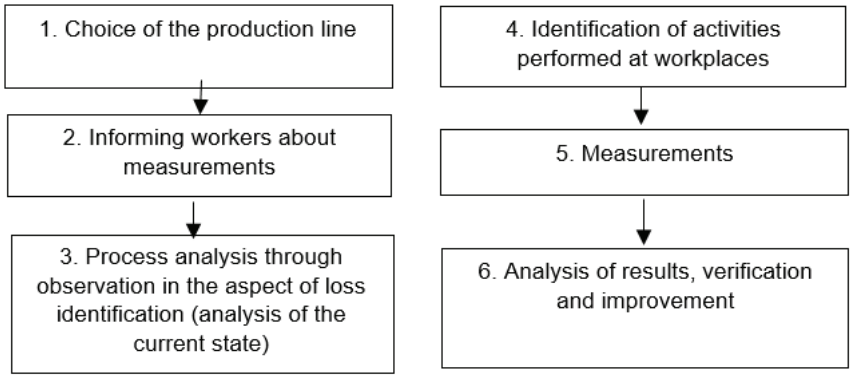

Figure 1 The stages of developing the standardization card [1,7]

3. PROCESS IMPROVEMENT WITH THE USE OF JOB STANDARDIZATION - CASE STUDY

The assembly line consisting of 19 workstations has been analysed, with 9 people working on each shift, and 19 operations are performed. The line has the shape of the letter "U" with one input and one output, having a single-stream setting (**Figure 2**). Stations no. 4, 7, 15 are automatic and the others are manual. Due to the lack of a standard concerning the movement of operators between workstations, and as a result of a negative impact on the line's efficiency, defining a new standard of work was proposed. In the first stage of the analysis, observations of the operators were made, and then a new method of staff turnover in the form of a new standard was established. Regarding the limited possibility of publishing all data, the article presents some of the results.

During the observation of the production line, it was noticed that on different shifts, with a different staffing, the pattern of movement between the stands is chaotic, which leads to losses and negatively affects the work efficiency (**Figure 2**).

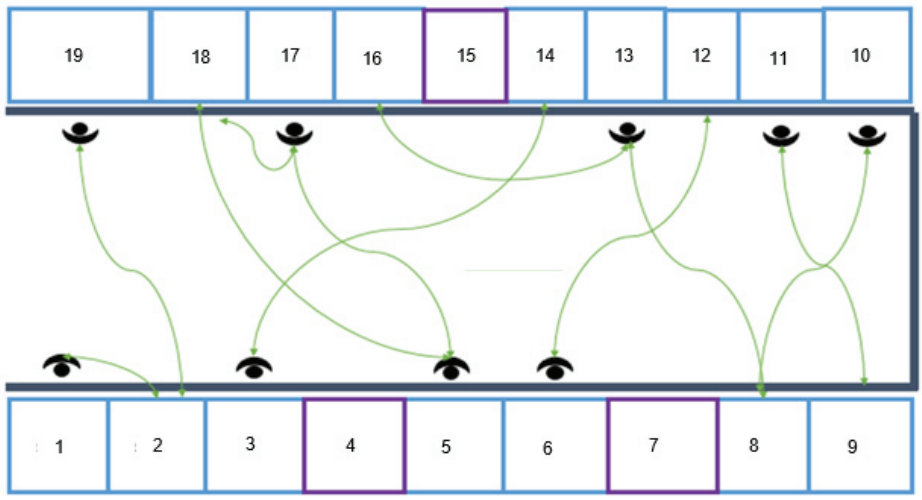

Figure 2 A sample scheme of movement of operators before the implementation of the standard

Observation results:

- variable assembly line performance on various shifts,
- different work efficiency of individual operators,
- different patterns of employee rotation between positions,

- waiting for parts related to the fact that one employee changes between the two most time-consuming operations, which affects the work efficiency of another operator (loss in the form of waiting and inactivity)
- occurrence of losses: unnecessary moves, excessive movement, waiting,
- problem with the adaptation of new employees.

In order to develop the most optimal rotation scheme between workplaces, the performance of the production line was evaluated. **Table 1** presents the theoretical assembly time (DT, Design Time) for each operation performed at workstations - designated in the company by means of the MTM method (Methods-time measurement). MTM belongs to the predetermined motion time system, which are the basic tool in the development of optimal working methods. Each operation is "spread out" into elementary activities and assigns time for each activity to be performed. Each single move is evaluated based on tables containing normative times. The time that has been set by MTM corresponds to the time that can be achieved by the average employee during the whole day of their work. This time corresponds to the employee's efficiency level of 100 %, which referring to a specific job, creates a model performance (used as a set pattern for other employees). Taking into account the individual predispositions of employees, their performance may vary at different levels. For the analysed production line, the total DT is 273 s. The most occupied position is No. 2 (DT is 28.5 s), which is the bottleneck of the process.

Table 1 Design Time for workstations

Number of workstation	DT (s)	Number of workstation	DT (s)
1	16.1	11	23.2
2	28.5	12	15.6
3	11.8	13	13.5
4	18.4	14	9.5
5	15.8	15	10.5
6	15.3	16	15.9
7	21.8	17	8.2
8	12.3	18	16.4
9	14.1	19	12.5
10	13.2		

As DT is only a reference time, in practice the actual assembly time (OT, Operation Time) is also used, which is the time actually needed to perform a given operation. The actual time of individual operations is measured using a stopwatch - the average time set for the whole production line OT is 316 s.

On the basis of DT and OT indicators, the effectiveness index of the analysed production process (KE, Key Efficiency) was calculated, which is indispensable for continuous monitoring of the implementation of the objectives of individual production lines in the enterprise. KE ratio is determined based on the formula:

$$KE = \frac{DT}{OT} 100\% \quad (1)$$

where:

DT - design time (s)

OT - operation time (s)

Based on the calculations, the KE factor for the analysed assembly line amounted to 86.4 % (which means that the line should work at the efficiency level of 86.4 % in order to achieve the operational goal). In order to verify the efficiency of assembly lines (especially in the aspect of identified problems), data from one working week were collected and an average efficiency ratio of 84.2 % was obtained. To maintain the efficiency of the line at the designated level, it is necessary to improve work of the operators and to achieve an uninterrupted flow of materials.

Knowing the total DT (273 s), total OT (316 s) and the number of operators working on the production line (9 people), theoretical and actual assembly time per person was calculated (DTp, OTp):

$$DTp = \frac{DT}{p} \tag{2}$$

$$OTp = \frac{OT}{p} \tag{3}$$

where:

p - number of operators

The theoretical assembly time per one operator (DTp) informs about the maximum time that one operator should dedicate to assemble one product. For the analysed production line, the maximum time for each operator is 30 s. Because the number of workstations is greater than the number of operators, and the times of all manual activities are shorter than DTp (**Table 1**), operators must move between positions. However, the total time of their work (assembly) can not exceed DT per person. This means that one operator can not devote more than 30 seconds to perform activities related to the production of one product.

When developing a new operator rotation scheme, it was considered that:

- combining DTp positions <30 s,
- the distance between the positions was as short as possible,
- one non-rotating and experienced worker worked at the bottleneck (workstation No. 2) - the bottleneck is the most time-consuming activity that limits the flow of material; always keep the stock before you enter the bottleneck, so as not to increase the time while waiting for the product.

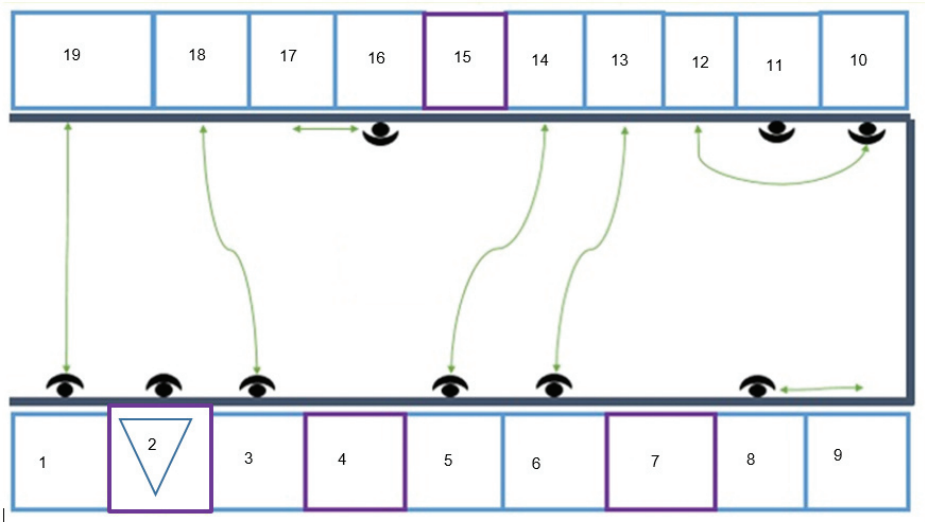

Figure 3 A new scheme of operators rotation on the assembly line

As a result of the carried out analysis, a new employee rotation scheme was proposed on the production line (**Figure 3**), which should be documented in the form of a standard of work and respected.

The proposed standard should include:

- name of the line, description of the process, date and number of the document,
- people who prepared the documentation and approved it,
- process symbols,
- rules in force at the bottleneck position,
- calculation of rotation and rotating stations,
- operator rotation scheme (**Figure 3**).

4. CONCLUSION

The proposal to introduce a new standard on the method of operators rotation between positions can bring many benefits, primarily will increase the productivity of operators and the entire assembly line (achieving the operational goal of 86.4 %), will reduce or limit identified losses (unnecessary movements, unnecessary movement, expectation), will ensure repeatability of the process and improve the flow of materials. Introduction and observance of the new rotation standard will facilitate communication between employees, will be the basis for training (especially for new employees), because it will present the most effective, easiest and safest way of working on the production line. It should be added that improvement of production flows (through the application of standardization) is also a component of the knowledge management system, due to the essence and importance of the problem in the efficiency of companies [9].

REFERENCES

[1] ANTOSZ, K., PACANA, A., STADNICKA, D. and ZIELECKI, W. *Narzędzia Lean Manufacturing*. Rzeszów: Oficyna Wydawnicza Politechniki Rzeszowskiej, 2005. pp. 153-156.

[2] THE PRODUCTIVITY PRESS DEVELOPMENT TEAM. *Standaryzacja pracy na hali produkcyjnej*. Wrocław: Wydawnictwo ProdPublishing.com, 2010. pp. 12-13.

[3] TROJANOWSKA, J., KOLIŃSKA, K., KOLIŃSKI, A. Stosowanie narzędzi Lean w przedsiębiorstwach produkcyjnych jako skuteczny sposób walki z kryzysem gospodarczym. *Problemy Zarządzania*. 2011. vol. 9, no.1 (31), pp. 42-43.

[4] IMAI, M. *Gemba Kaizen. Zdroworozsądkowe, niskokosztowe podejście do zarządzania*. Warszawa: Wydawnictwo MT Biznes, 2006. pp. 91-97.

[5] LIKER, Jeffrey K. *Droga Toyoty. 14 zasad zarządzania wiodącej firmy produkcyjnej świata*. Warszawa: Wydawnictwo MT Biznes, 2005. p. 225.

[6] MAŁYSA, T., NOWACKI, K. and LIS, T. The correlation between structure of employment and accidents at work in metallurgical enterprises. In *METAL 2017: 26th International Conference on Metallurgy and Materials*. Ostrava: TANGER, 2017, p. 2244.

[7] KOLIŃSKA, K., KOLIŃSKI, A. Zastosowanie standaryzacji pracy w celu poprawy efektywności produkcji. *Zeszyty Naukowe Politechniki Poznańskiej: Organizacja i Zarządzanie.* 2013. no. 61, pp. 64-66.

[8] KUCZYŃSKA-CHAŁADA, M., FURMAN, J. The process of improvement with the application of lean manufacturing in a steel company. In *METAL 2016: 25th Anniversary International Conference on Metallurgy and Materials*. Ostrava: TANGER, 2016, p. 1895.

[9] GAJDZIK, B. Concentration on knowledge and change management at metallurgical company. *METALURGIJA.* 2008. vol. 47, issue: 2, pp.142-144.