FROM 5S METHODOLOGY TO LEAN LAYOUT: EVIDENCE FROM AUTOMOBILE INDUSTRY

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Abstract

This paper proposes a complementary approach to implementing 5S and Lean Layout methodologies on the shop floor. It presents the development of a process improvement project that implements both methodologies. Lean Layout improves processes by increasing visibility of the processes' flow and 5S methodology organises the workplace to increase productivity and reduce waste. The process improvement project follows DMAIC methodology and utilises Lean Management tools such as 5S inspections and Time Measurement Sheets. The influence on process output value and the difficulty to develop a solution determine an action plan to eliminate process deficiencies. Initial 5S inspections reveal several non-conformities with the workplace standards. Analysis tools such as Ishikawa diagram and the action plan relate these process problems with the shop floor layout. Poor results in 5S inspections thus determine arguments for developing Lean Layout methodology. This paper provides an analysis of the current problems of the given production line, the root causes of problems and a specific proposal for its improvement. Specifically, this project combines 5S and Lean Layout methodologies and investigates their relationship and impact on process improvement. The same framework is applicable in other organisations both in and outside the automobile industry.

Key words: Time Measurement Sheet, Workplace, Work Flow, Process Improvement

JEL Code: M10,M11, M19

Introduction

Nowadays most companies operate in a turbulent marketplace that continuously changes and develops, so companies have to actively look for market opportunities and means of gaining competitive advantages. One of the ways how to do this concentrates on increasing effectiveness of processes by implementing Lean Management principles. Two of the key methodologies of Lean Management are 5S and Lean Layout. This research paper shows the influence of 5S methodology over Lean Layout planning and it evidences processes effectiveness improvement after Lean Layout implementation. Therefore the research investigates how 5S methodology influences changes in the layout.

The DMAIC framework facilitates the successfully combination of 5S and Lean Layout methodologies. At the beginning, it is crucial to analyse the current state of the production line, to look for problems and to identify root causes of these problems. The analysis develops solutions for implementation.. Finally, the realized changes have to be monitored and maintained.

1 Basics of Lean Management

Lean Management is an approach that aims to achieve more effective processes by seeking perfection, eliminating waste, increasing quality of production and improving workflow. The result of implementing Lean Management is an organization in which processes are as effective as possible and there is no waste of material, time, and labour. All this helps to satisfy customers’ demands and deliver products at the right time, right quantity and quality (Kazmierski, 2016).

This research paper uses DMAIC procedure as a framework for the process improvement. DMAIC is an acronym for Define, Measure, Analyse, Improve and Control. Different Lean Management tools, like Work Combination Table or Value Stream Mapping, are used in each phase of the DMAIC procedure (Rahani & al-Ashraf, 2012).

1.1 The 5S Methodology

This methodology is one of the easiest and most basic tools to implement Lean Management (Hirano, 1995). The 5S stands for Sort, Set in order, Shine, Standardize, and Sustain. The methodology concentrates on improving the workplace by keeping it tidy, clean and organized. Cooperation and effectively communication with management are important characteristics to successfully implement 5S (Kazmierski, 2016). It is also essential to control the involvement of employees with the new practices after 5S implementation. The 5S Inspection Sheet facilitates this control.

The main advantages of 5S methodology are its low implementation costs, productivity increase and waste reduction (Jaca, Viles, Paipa-Galeano, Santos, & Mateo, 2014). The 5S belongs to standard methodologies used in the automobile industry, but it has applicability in other areas such as healthcare (Kanamori, Sow, Castro, Matsuno, & et al., 2015).

1.2 Lean Layout

Lean Layout is a tool for creating a lean workplace, i.e. a workplace where all sources of waste are minimalised. The U-shape is the usual recommendation for a Lean Layout (Pujo, El Khabous, & Ounnar, 2015). In production plants the shop floor layout depicts the placement of individual machinery, material and other equipment. The layout usually includes exact dimensions of the workplace and of all the equipment (Soltantabar, Farsijani, & Hajnassiri, 2009).

Before creating a Lean Layout, the current layout and the state of the workplace have to be analysed. Improvements to the workplace can be then suggested to make the workflow smoother. Lean Layout minimises the walking time of employees, increases the effectiveness of employees' movements and therefore shortens the production time (Salleh & Zain, 2011).

2 From 5S to Lean Layout

Process improvement project follows each phase of DMAIC methodology. Moreover, this paper excludes the presentation of the Define phase and it focuses on the phases Measure, Analyse and Improve to reveal the influence of the 5S methodology in the layout. The phase Control is also important because it is essential to monitor and sustain the designed and implemented changes.

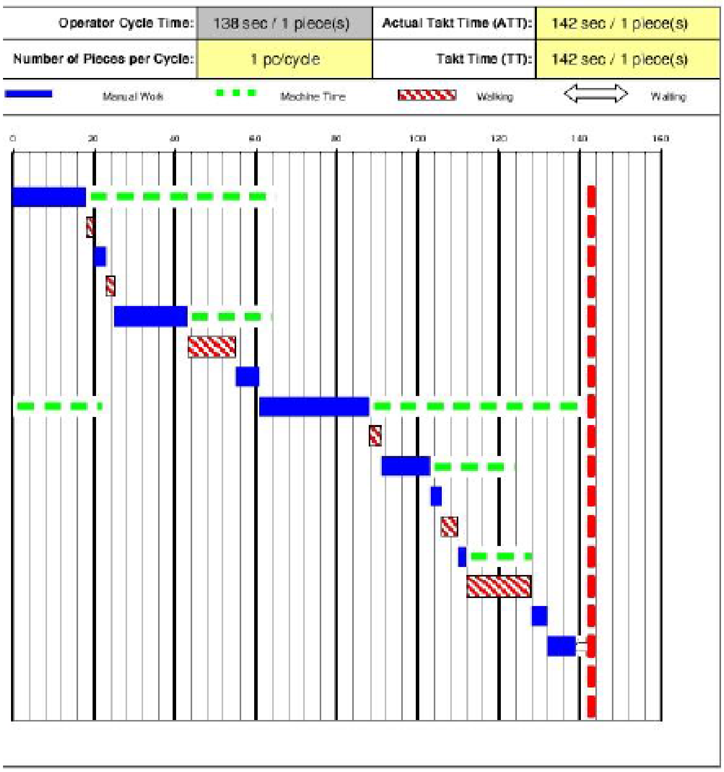
2.1 The 5S inspection and evaluation of current situation

First of all, it is necessary to do 5S inspection to determine current state of the workplace and then to analyse the findings. There are three operators on the production line and it is necessary to do 5S inspection for each one of them separately. The 5S inspection sheet used in this case is divided into three parts: Least serious non-conformities, critical non-conformities and fatal non-conformities. The final result of the inspection depends on the number of non-conformities and on their seriousness.

In this case non-conformities found during 5S inspection included misplaced tools and equipment, unlabelled materials and final products are not stored correctly. If the workplace meets all 5S standards its evaluation is 100% but if not a certain percentage is deducted based on the category and seriousness of the non-conformity. The results on the investigated production line were 95%, 70% and 40%. Any results lower than 90% are not satisfactory and it is necessary to change something at the workplace.

After finishing 5S inspection it is suitable to check the standardization of the workplace using Lean management tools. In this case Time Measurements Sheet, Work Combination Table and Standard Operation Sheet were used. Time Measurement Sheet is created for each operator separately and it shows individual phases of the production process and durations of each action of the operator. After completing Time Measurement Sheet follows Work Combination Table (see Figure 1) which is a graphical representation of the data recorded in Time Measurement Sheet. These two tools reveal if the operators perform actions in the correct order, if there is excessive walking and waiting time and if the production standards can be fulfilled. Finally it is necessary to complete Standard Operation Sheet which is detailed layout of the workplace. It depicts positions of machines and other equipment on the production line as well as the movements of the operators. These tools found following problems: excessive operator´s walking, inappropriate transport of defects, useless and excess inventories, randomly placed welding material among others.

Fig. 1: Work Combination Table



2.2 Analysis of Non-Conformities

Based on the identified problems it is necessary to find root causes of these problems. A suitable tool for this task is Ishikawa diagram. Ishikawa diagram divides the possible causes into six categories: Material, people, machinery, processes, environment and measurement. In this case Ishikawa diagram led to root causes such as wrong filling of the machine, lack of standards, actions are completed in wrong order, inadequate skills of operators, waste of material, slow logistics of final products and big distances between machines (unsatisfactory layout). Based on these root causes it is possible to suggest improvements.

A part of this analysis has to be an action plan which sets the priorities for improvement. An action plan to eliminate process deficiencies is developed based on the influence to the process output value and the difficulty to develop a solution. Based on this analysis it is crucial to solve these problems: The operators are not following work standards and operators incorrectly transport material to the machines or transport of final products to containers, transport of defects to repairman and excessive walking.

3 Design of Lean Layout

The key change suggested is the change of layout. The improvement of the layout is based on findings of 5S inspection and findings of other used analysis tools. The non-conformities found during 5S inspection included misplaced tools and equipment, unlabelled materials and final products are not stored correctly. The change of layout should prevent these problems found during 5S inspection and it could motivate employees to maintain workplace in order. Better layout should decrease walking time of operators which is a problem identified by the other tools.

Changes of layout in this case are shown in Figure 2 and Figure 3. Changes of layout in Figure 2 consist of a mirror reflection of the highlighted machinery. The result of this improvement is decreasing walking time of operator 2 and it solves the problem of incorrect transport of final products. This Lean Layout should motivate operators to handle and store finished products properly. Figure 3 shows changes of workplace layout of operator 3 by swapping the position of machines to improve process workflow. This improvement decreases the walking time of operator 3 so he will have enough time to complete his work and he will have also more time to put tools and equipment at the right place. Better movement of the operator on the production line should prevent misplacement of tools, materials and products.

Fig. 2: Changes of layout of the workplace of the operator 2

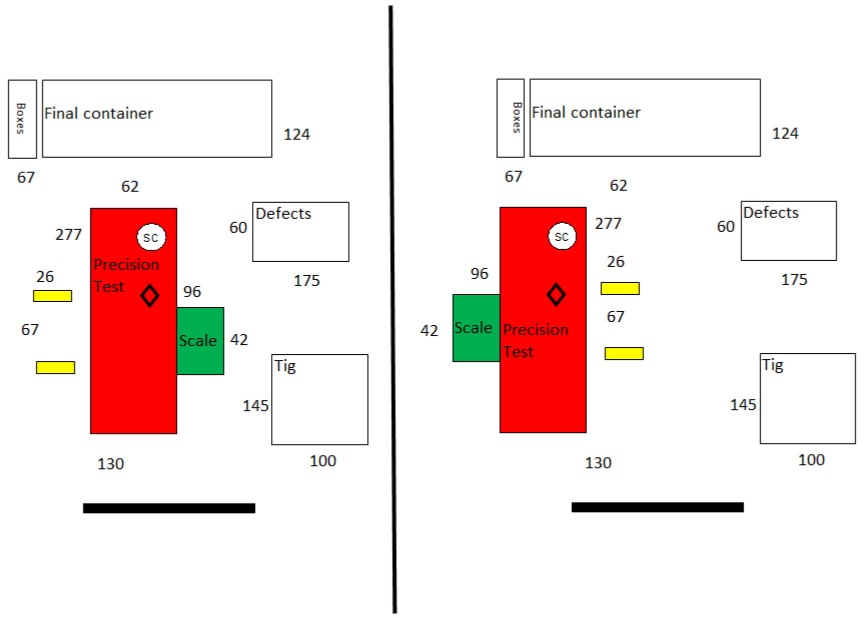
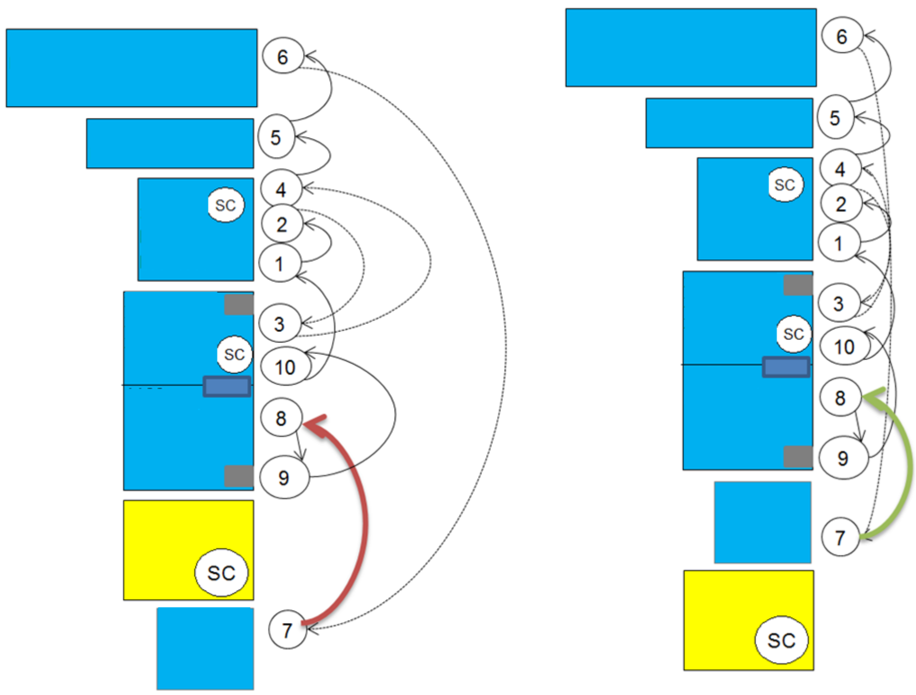


Fig. 3: Change of layout of the workplace of operator 3



The following table summarises the changes of the layout based on the implementation of the 5S methodology. The first column shows the revealed problem from the 5S inspection. The second one states the possible reasons of the problem and the third one suggests possible solutions. The next column assesses the impact of the problem on the final value of the product and the next column shows expected difficulty of solving the problem. To established priorities these two columns are multiplied and the one with the highest score has the highest priority in terms of implementing of solution. The last column shows a change in the layout based on the 5S inspection and respective solution.

Tab. 1: Analysis of results of 5S inspection

5S inspection	Argument	Solution	Impact on Value	Difficulty of solution	Impact x Difficulty	Layout modification
Unorganized workplace	Finished products outside of final container, final containers are far away from the workplace	New place for containers	6	5	30	YES
Unorganized workplace	Mislabelled boxes with materials	New labels, training, education and control	4	3	12	NO
Unorganized workplace	Boxes with materials are not in designated places, operator have to walk around them	New boxes system. Training, better design of layout	7	5	35	YES
Bins are out of their places	Bins are mislabelled and out of their places	New labels, training, better and more frequent control	3	2	6	NO
Tools out of their places	Boxes are far from the workplace. It takes more time to keep tools in order than leave them in disorder on the table	New place for boxes, training, change of layout	6	5	30	YES
Personal items at the production line	Personal items are not stored properly, increasing possibility of injury or damage of machinery	Introduce a specific place for personal item, training, education and control	3	3	9	NO
Documentation is not at the right place	Documentation is stored far away from the production place, in case documentation is needed operator has to walk across whole production line	Introduce a new system to storage documentation, training, education and control	5	5	25	YES

The table shows that four out of the seven issues found with the 5S inspection require layout change. The Work Combination table and the analysis of non-conformities confirm these issues and the need of layout change. The issues with higher impact on value usually require layout change. However, the solutions for these issues have higher assessment on difficulty of their implementation. Moreover, since the majority of changes require layout change, the effort is worth it. A single robust implementation of layout change has higher impact in the process and solves several issues at once.

Conclusion

The aim of this research paper is to investigate the influence of 5S methodology on layout changes. This research paper presents the results from Measure, Analyse and Improve phases of DMAIC methodology. The phase Measure included 5S inspection and other tools such as Time Measurement Sheet, Work Combination Table and Standard Operation Sheet. The phase Analyse comprised Ishikawa diagram which identify the root causes and action plan that set the priorities for improvements. This all led to the improve phase where Lean Layout was designed.

The 5S methodology revealed non-conformities at the workplace which were analysed to find root causes and then based on these root causes Lean Layouts were designed. For example 5S inspection revealed misplaced tools and equipment. This suggests that the operator does not have time to store tools properly. An improved Lean Layout decreases the operator walking time so he has enough time to complete production and meets 5S standards.

To summarize, the paper evidences that the 5S methodology in combination with Lean Layout improves processes efficiency. The 5S inspections highlight problems on the shop floor and changes in layout facilitates its improvement. This means that the correct implementation of 5S derives in layout changes. Data collected during the 5S inspection shows key areas needing improvement. Then, the 5S methodology provides basis for successful changes in layout.

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