

WELLSO 2016 - III International Scientific Symposium on Lifelong Wellbeing in the World

Synergistic Effects of Stream Mapping

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Abstract

<http://dx.doi.org/10.15405/epsbs.2017.01.47>

The concept of lean production is a modern direction of the control system development that provides humanization of the modern society and promotes the idea of people's well-being in the broadest sense. This study shows how using the lean production tools to ensure a synergistic integration of process optimization in the production of led equipment in the innovative enterprises, to increase its competitiveness, to provide the qualitative products to the consumer and quality of work life of employees and their productivity. The analysis of survey data leads to the conclusion that the main tool for the optimization of the process of production is mapping which allows analyzing the whole process of production, to reveal the problem places, and to bring improvements on the basis of the analysis. It has a direct impact on the company's performance, ensures welfare of employees of the enterprise, improves the quality of life for all participants in the proceedings. Suggestions for future research are presented.

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Keywords: Wellbeing, Lean Production, mapping of a stream, process, losses.

1. Introduction

According to the science of subjective well-being (Durayappah, 2011), it is not sufficient for a person to experience "good feelings", he/she also needs: meaningful activity in which he/she is involved emotionally and which allows him/her to feel their own competence and independence; the stock of inner resources that help him/her cope with life's difficulties and be resilient to changing external circumstances. The feeling of well-being associated with the presence of the family, material security, health, education and involvement into the public life. The transformation of the external



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environment, the emergence of new production forms and forms of communication, increased mobility of people and the stresses associated with these processes violate a sustainable model of prosperity. The solution of this problem is connected with the discussion on the allocation of new social sectors along with the existing - state and commercial one. Peter F. Drucker (1994, & 2001) assigns to this sector the task of organizing the health and well-being, and opposed to attention that people still spend most of their time on production. From this position, the ownership of the citizen to the public and industrial processes and the awareness of self-importance in a common cause play an important role in the welfare. This hypothesis successfully proves the performance of the company using the management concept Lean production. Workers involved in the overall process and accept responsibility not only for their labor, giving them material rewards, but also for all the activities of the firm. The awareness of responsibility for the formation of the living environment of the workers themselves and future generations is reflected in the well-being of employees and financial performance. In this study, the concept of the "Lean Production" is an example (Lareau, 2003) where the system of the organization of production is directed on the continuous improvement of the organization activity and achievement of its long-term competitiveness (Pande, 2001, & Rother, 1999) and improving the emotional background of the employees (Miller, 2004, & Hozak, 2015).

Strategic target of any company is the leadership. The principles of work of the company have to correspond completely to the principles of the general quality management and consist in the full satisfaction of the consumers with the quality and cost of production, and the satisfaction of the distributors with the service (Liker, 2004).

In the works of scientists (Wader, 2002, & Womack, & Jones 2003) it is shown map development of a Value Stream Mapping (VSM) as a form of the "Lean Production". VSM gives the chance to see bottlenecks in the process and on the basis of its analysis to reveal unproductive expenses and operations, to develop the plan of improvements (Krogh *et al.* 2000)

The process of Value Stream Mapping will be considered on the example of the innovative enterprise that produces LED lamps. At present the enterprise produces about fifty models of lamps and searchlights of different functions.

The enterprise is responsible for the architectural and guarantee supervision of products at all stages of life cycle – from design development to the dismantle and utilization of the main components (Talawadekar, 1994, & Plotnikova, 2014).

Nowadays the company grows and increases outputs. So in 2014 the revenue of the company from the sale of finished goods was more than 230 million rubles. In 2015 the share of light-emitting diodes made 5% of the world market of production of LED lamps.

2. The use of tools in the productions of the organization

This tool allows displaying schematically the movement of materials and information streams that are necessary for the execution of the consumer's order. In other words, the card helps to see the whole process and sources of problems, and also to show informational and material communications between these streams. On this production the process optimization began with the use of this tool.

Work on the value stream mapping has begun with the statement of the purposes. The purpose of the mapping of the production line is process optimization; reduction of losses when performing operations; acceleration of the production line; increase in productivity.

The plant works on continuous improvement of processes by introduction of methods and tools of the “Lean Production” system. Due to the optimization of production there was a change of some processes of life cycle.

2.1. *The process of production “As it is”*

The application of mapping happens in a production sector which consists of four stages of assembly of the lamp. At this time four assemblers worked at a factory.

Formation of VSM the current state (“As It Is”) is a longer stage of mapping. Here in details all stages of process from the entrance of resources to the exit of the ready lamp are considered, necessary parameters of each stage are defined and fixed. The manager of a stream has to pass entirely the whole considered stream and to see with his own eyes the gradual transformation of a product. Formation of current state assumes the visual representation of a stream and data collection. It is necessary to determine the value and losses in process most precisely. The accompanying logistics and a control system is fully considered and studied.

The whole processes of production was fixed on a video camera within 120 min. 15 lamps “Diora 60”, were produced and were ready to shipment. It was necessary, as the process provides needs technical breaks each hour for 10 minutes, the video shouldn't be interrupted at least 50 min in order to have objective data.

After the whole information is collected, it is necessary to make its analysis. The analysis assumes processing of collected information for the definition of the places of the influence which greatly influence the considered process. The main task of the analysis is definition which operations create values for the consumer, and which operations need to be eliminated or as much as possible to reduce time for their carrying out. All further work depends on the quality of carrying out work of this stage.

The Table 1 shows the operations which are carried out on the wiring 1.

The losses of the 1st sort are shown in yellow color, the losses of the 2st sort are shown in green color, and the processes which add a value are painted in red color in the table.

The general time of each operation, average execution time and a percent from the general time which is spent for the first stage of the assembly are calculated here.

Table 1. The data of the process of the production.

Description	Number, pcs	General time, s	Average time per 1 pc	% from general time
Takes the body	10	48	4,8	2,77
Unpacks the body	10	61	6,1	3,50
Throw out the paper	10	4	0,4	0,23
Visual monitoring	10	32	3,2	1,88
Takes a socket spanner	5	1	0,3	0,08
Installation of a sealing bolt	10	110	11,0	6,34
Puts a socket spanner	5	1	0,3	0,08
Checking of a socket spanner	1	7	6,7	0,39

Wire installation	10	121	12,1	6,99
Fixing of a wire by means of a sealing bolt	10	157	15,7	9,06
Installation LP	10	137	13,7	7,91
Takes a fastener driving machine	10	4	0,4	0,21
Mounting LP	40	169	4,2	9,76
Puts a fastener driving machine	10	4	0,4	0,23
Mounting of a bracket	100	673	6,7	38,93
Examines the wire socket	3	55	18,2	3,15
Sends to correct a spoilage	3	15	4,9	0,85
Completion of a bracket mounting	2	99	49,6	5,74
Delivery to the next stage	10	33	3,3	1,89

According to these data the card of a stream of a current state is also under the construction.

For the representing of each operation the drawing is used, for example:

- if this movement is of a material stream, so the operation is represented by means of an arrow;
- if the product expects an action over itself, so the operation is represented in the form of a triangle;
- ordinary operations such as "put", "took", "twisted", etc. are designated by a rectangle.

Under the consistently represented process the information is placed: about the time spent for operations of each of three sorts (Table 2), the time of a cycle, the step time, and the efficiency of a stream (Table 3).

Table 2. Time on losses.

Wiring table No. 1

	t, s.	%
General time	1729	100
Losses of the 1st sort	175	10
Losses of the 2st sort	309	18
Processes which add a value	1245	72

Table 3. Cycle time, time of a step and efficiency.

	Time of a step	Cycle time	Efficiency, M
Wiring table No. 1	2,88	2,88	0,72
Wiring table No. 2	2,68	2,68	0,34
Wiring table No. 3	2,81	2,81	0,12
Wiring table No. 4	8,95	8,95	0,20
Production of Diora 60	8,95	17,31	0,30

During the analysis of process the main problems became clear:

- Check of a socket spanner.
- Distribution of operations on stages are uneven, the assemblers sometimes sit without work because work at the previous stage isn't finished yet.
- Survey of the socket of a wire.
- Sending for the purpose to correct spoilage.
- Completion of bracket mounting.
- The inconvenient arrangement of working tools on a table. It takes much time for their searches, etc.

2.2. The process of production "As it has to be"

The formation stage of the future condition of VSM ("As It Has to Be") assumes the comparison of the opportunities of a stream revealed in the course of the analysis with some necessary requirements to the maximum efficiency of the process.

At the beginning of map development "As It Has to Be" it is necessary to choose the main direction of optimization of processes. In this case the following operations were chosen:

- Forming of a continuous stream.
- Elimination of losses.
- Alignment of stages of process, balancing.
- Acceleration of all stages of process.

In the practical way it became clear that in the future the most useful way at the creation of cards will be the adherence to a certain list of questions. When developing the concept of the future state it is necessary to make a draft version of answers to the questions in the order given below.

Key questions for the transition to the future state:

1. What is the time of a step? It is necessary to study available working hours of working processes of a stream which will be as close as possible to the consumer.
2. Will the production be produced for a supermarket from which consumer's pulling will be created, or is it necessary to transfer it to the shipment directly? The answer to this question depends on several factors, such as the products bought by the consumer, reliability of processes and the characteristic of production. Production directly on shipment will demand either big reliability and short time of implementation of the order, existence of a stream from the order before the delivery, or large insurance supplies. Fortunately, performance time from the order to the delivery includes only processes from the process setting a rhythm to the delivery.
3. In what point of a production chain (setting a rhythm to process) the schedule of production will be formed? (It must be kept in mind that movement of all materials that are lower on a stream from the process setting a rhythm it is necessary to carry out in the form of a stream.)
4. How is it necessary to level production streams (listed products) in the process setting a rhythm?

5. What portions of finished goods will be consistently made, and be shipped in the process setting a rhythm?
6. What improvements of processes will be necessary that the stream of creation of value was formed according to the established requirements to the project of the future state? (Here it should be noted some places where any improvements of the equipment and procedures, for example, reduction of time of the equipment readjustment or reduction of time of idle times will be required.)

Proceeding from the answers it is necessary to mark the main ideas of the future state in the red color directly on the map of current state. As soon as vision of future state is carefully analyzed, it is possible to pass to the map development of the future state.

Answers to the questions will appear by the analysis of the card of the current state because the analysis of current state is made, it is necessary to time operations for the card of the future state (Table 4).

Table 4. Calculations of time of operations for the card of future state.

Description	Number, pcs	General time, s	Average time per 1 pc	% from general time
Takes the body	10	48	4,8	3,09
Unpacks the body	10	61	6,1	3,90
Throw out the paper	10	4	0,4	0,26
Visual monitoring	10	32	3,2	2,09
Takes a socket spanner	5	1	0,3	0,09
Installation of a sealing bolt	10	110	11,0	7,05
Puts a socket spanner	5	1	0,3	0,09
Wire installation	10	121	12,1	7,78
Fixing of a wire by means of a sealing bolt	10	157	15,7	10,0
Installation LP	10	4	0,4	0,23
Takes a fastener driving machine	40	306	7,6	19,67
Mounting LP	10	4	0,4	0,26
Puts a fastener driving machine	100	673	6,7	43,31
Delivery to the next stage	10	33	3,3	2,10

At map development "as it has to be" the improvements which have to happen, assume reduction of number of operations. These operations don't add value to the final product for the consumer and slow down the whole stream of the production.

The purpose consists in creation of a chain of processes in which individual processes are connected with their consumers, or in a continuous stream, and each process has to make whenever possible only what is necessary for consumers and when it is necessary for them.

Taking into account actions for improvements the card of a stream "as it has to be" it is presented in the Appendix B.

For comparison the results of calculations of current state of process and future state (Table 5) are presented in the table.

Table 5. Cycle time, time of a step and efficiency.

Current stream state	Time of a step, c	Future stream state	Time of a step, c
Wiring table No. 1	2,88	Wiring table No. 1	2,59
Wiring table No. 2	2,68	Wiring table No. 2	1,86
Wiring table No. 3	2,81	Wiring table No. 3	2,39
Wiring table No. 4	8,95	Wiring table No. 4	6,16
General time of a step	8,95	General time of a step	6,16
Number of details during a working day	60	Number of details during a working day	88

Time of a step is used to synchronize the rate of production with the rate of sales, especially in the process setting a rhythm. It is the reference point giving a rhythm in which process has to make production. He helps to understand how the process works and what it is necessary to improve. On cards of the future state the time of a step is specified in lists of parameters of process.

Production according to the time of a step seems simple; however it is necessary to pay attention to:

- fast response to problems (within a step time);
- elimination of the reasons, unplanned idle times.

The time of a step for the assembled lamp is 4,20 but by the application of actions for improvement time of a step will become 3,88. Such size of time of a step means that for satisfaction of inquiries of the consumer with the production line of the innovative enterprise during the whole shift each 3,88 min. It is necessary to release one ready-made lamp. This time doesn't consider time of idle time and production of spoilage.

From the above told follows that now on the line 60 lamps are made every day, but it is possible to make 88 lamps. That is when there will be the order of 90 pieces, so the team of assemblers can execute the order by this time of a step during the 8th hour working day. At the average price of one LED Diora-669 lamp of 8 000 rubles, for one such order it is possible to get profits 224 000 rubles more, than during the work in the current conditions. That means the economic efficiency of introduction of instruments of economical production.

For full information in addition to the algorithm of mapping of a stream of creation of value, it is recommended to make methodical recommendations, which allow reaching a bigger result when using this method.

In such a way, by the detailed analysis of time spent for the actions which are creating or not creating value it is necessary to carry out measurements for several times and to write down time in seconds. It will allow to carry out more conveniently calculations and to find losses, which can be missed when rounding time in hours.

Principles and practice of the concept of "lean production" provides a synergistic effect which leads the worker to action and special thinking that is one of the few options which are open today in the era of low growth and economic stagnation. Employees receive significant satisfaction from the understanding of the entire production process, that they are directly involved in the reorganization and improvement of this process, with immediate feedback from improvements. Lean psychology

contributes to the decline of spoilage and adds value for clients through the support, extension of the useful new thinking and motivation.

3. Conclusion

On the basis of the above material, one can come to the conclusion that the management philosophy is based on the philosophy of involvement of all employees in the process of solving current problems, the creation of an atmosphere of joint construction of a value stream. Building partnerships with employees, suppliers or customers in this context means "a thinking company".

The developed cards can be exposed eventually to various completions because the industry develops and together with it requirements of higher normative and legislative documents change. Therefore, the quality of the developed production grows.

The application of these recommendations will promote the increase of efficiency of projects' implementation in the sphere of lean production and to the formation of a production system of the organization.

Producing products of high quality and high efficiency which meet modern needs, a society committed to the progress, development and prosperity of its people, thereby improving the quality of life.

Acknowledgements

This work was performed by the author in collaboration with Tomsk Polytechnic University within the project in Evaluation and enhancement of social, economic and emotional wellbeing of older adults under the Agreement No.14.Z50.31.0029

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