

The management of production value stream factors in a foundry

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Abstract

Connection of two value streams: production and human resources were proposed as a new approach to the production process. To assess the factors of production value streams the elements of the top of the Toyota's house as well as fourth and sixth Toyota's managing principles were used. On the basis of the feedback from respondents –the foundry workers, there can be determined the validity of series of decisive factors' importance that equalizes the work load and requires the standardization.

Key words: value streams, Toyota way, BOST researches.

1. Introduction

Value stream is defined and graphically presented in various ways. The standard definition of a value stream states that: the value stream is a group of all specific actions necessary for conducting a particular product (regardless of whether there are goods or a service, and nowadays more often the combination of both) during the three critical stages in managing any business: the tasks consisting of solving problems at the time of the formation of concepts, through detailed project and establishment of technology up to the start up of the production; the task of managing information, which start from the approval of the order, through establishing the detailed production plans, to the delivery, and the task of physical transformation that means processing raw materials into the final product which is delivered to the customer [1]. Identifying the entire value stream for each product (family of products) is the next step of lean thinking, the step which is very rarely taken by the companies, and which

almost all the times canvass tremendous amount of muda – wastes.

Graphically, the value stream is presented in the form of:

- a production system [2-3],
- a flowchart [3],
- an algorithm of particular actions [4],
- a manufacturing process in the terms of technology [2, 3],
- a map of processes [5, 6],
- a Toyota's house [7, 8].

The presented model of combining the streams of human resources and production value chain, in case of improvement can be expanded onto the whole production system, at that time, the model presented in Figure 1 can be obtained.

The factor which starts the value stream is an order, which includes detailed customer's requirements. These requirements have to be achieved by the mutual cooperation between the value stream, which results in giving positive outcome (processes' improvement), expressing high quality of goods that satisfy customers. The order is the result not only triggering creation of product value stream, but as well controls its speed. Stabilization

(one of the production value streams factors) can be reached by knowing the actual state. The main objective of hereof study is to recognise the actual state which refers to production value stream factors in the foundry.

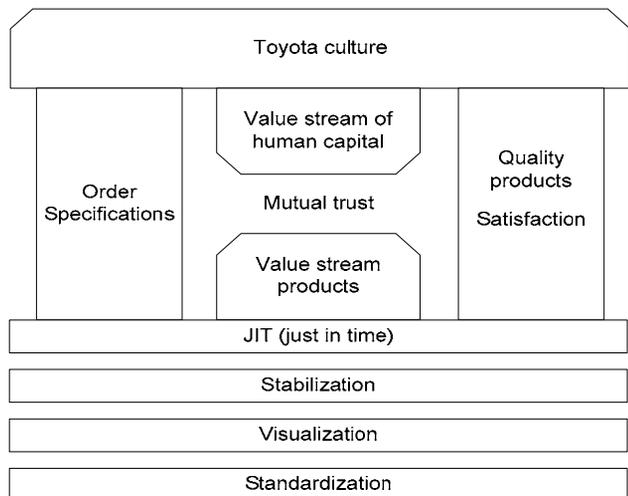


Fig. 1. Production system model with the value streams

2. Methodology and scope of the research study

The study was associated with conducting the BOST survey – Toyota's management principles in the form of questions [7] in the foundry. The survey was completed by 32 people. The aim of the survey was to gain information about the factors importance describing particular Toyota's principle and elements of the top of Toyota's house. In the latter case one question was asked, which stated: What is the most important element in your company? Please enter 1, 2, 3, 4, 5 (5 the most important element). The relevant assessment may be used only once.

JA	Quality	BP	Work safety
KO	Costs	MZ	Staff morale
CR	Lead time		

The evaluation results the importance of the factors is presented on the Table 1.

The proposed research methodology showed that each respondent – the foundry worker made a personal quantification of these given factors, grading them according to their importance from 1 to 5. From the data analysis of the Table 1 is derived, that in each column described as JA, KO, CR, BP, MZ, and in each line for the grades „1”, „2”, „3”, „4”, „5” a sum will always be equal to 32, which is a confirmation of correctly given answers by the respondents – the foundry workers. The data from the Table 1 are the basis for estimation of the frequency of the precise mark occurrence for each factor (Table 2).

The structure of this assessments in this case, as well as of the whole research paper, is presented using the pie charts. The following chart (Figure 2) of factors importance's structure that

create value stream in the area of the foundry's mission was obtained.

Table 1. Comparison of the results concerning the most important element in foundry

Rating	JA	KO	CR	BP	MZ
1	4	1	4	6	17
2	1	6	9	10	6
3	7	7	10	6	2
4	6	11	4	6	5
5	14	7	5	4	2

Table 2. Comparison of the results [%] concerning the most important element in foundry

Rating	JA	KO	CR	BP	MZ
1	12.5	3.1	12.5	18.8	53.1
2	3.1	18.8	28.1	31.3	18.8
3	21.9	21.9	31.3	18.8	6.3
4	18.8	34.4	12.5	18.8	15.6
5	43.8	21.9	15.6	12.5	6.3

According to the 73.3 % of the respondents' quality (Figure 2a) is an essential factor of the foundry's mission. Particular group of the respondents – workers (3.1%) considered quality in the mission of the foundry as less important and graded it with the note "2". The costs in the foundry (Figure 2b), as competitive element, are very clearly seen by the workers. The highest grades "4" and "5" gave in total of 57.3% of them. The significant part of the workforce (21.9%) do not have an opinion about the meaning of the costs in the foundry and graded it with a moderate note "3." An another company's competitive element is the time of completion (the order). In the case of the foundry a special process is carried out which is inconvenient both for the workers and for the environment. Work safety of the personnel should be a significant factor in the foundry mission. As the research has shown the above observation is supported only by 12.7% of the employees (graded with the highest mark of "5"). Almost 50% of the respondents (Fig. 2d) graded the work safety with the lowest grades "1" and "2". Staff morale constructed as conscientious performance of their duties, a comradeship, an identification with the foundry's objectives, responding to arising issues, self improvement and process improvement according to 53.1% of the respondents is almost an irrelevant factor. This group graded the staff morals with the note "1," the lowest grade (Fig. 2e). At the conclusion of this analysis should be given an answer to the following question: what is the factors importance's sequence for the foundry's mission? The answer to this question is given in the Figure 3, from which it can be concluded that the importance sequence is: quality (JA) – 25.2%, costs (KO) – 23.5%, time of completion (CR) – 19.4%, work safety (BP) – 18.3%, staff morals (MZ) – 13.6%.

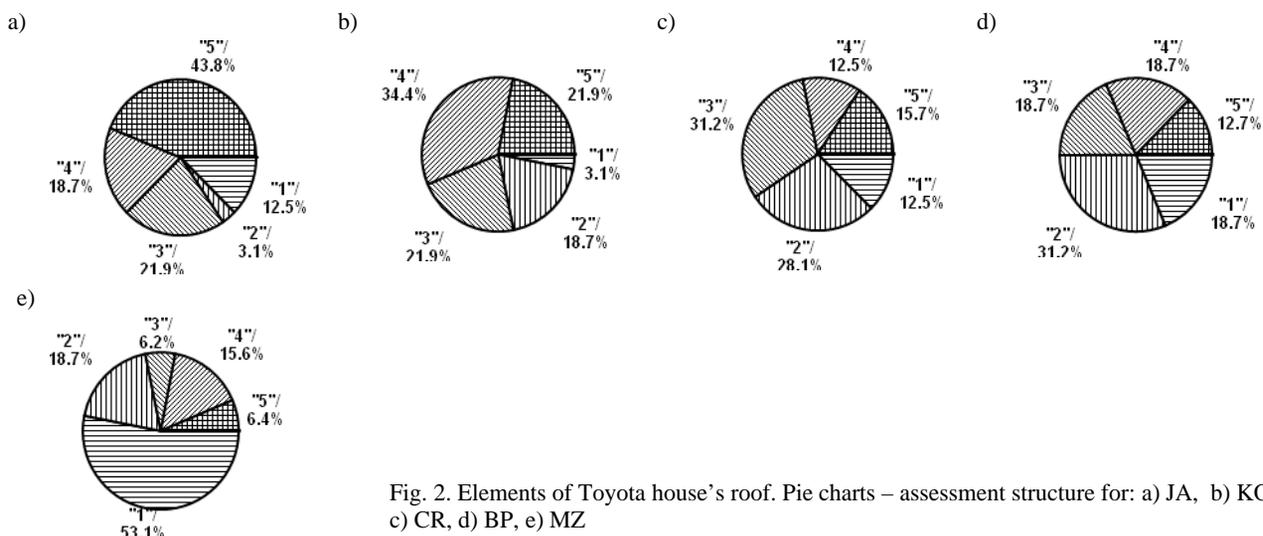


Fig. 2. Elements of Toyota house's roof. Pie charts – assessment structure for: a) JA, b) KO, c) CR, d) BP, e) MZ

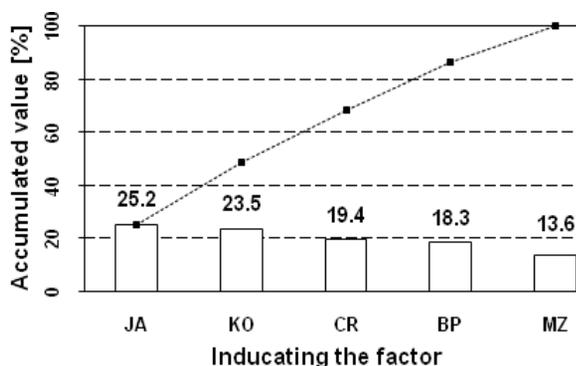


Fig. 3. Pareto-Lorenz diagram of the elements Toyota house's roof

A slight variation should be mentioned JA-KO= 1.7%, which suggests that the quality and costs in the foundry are at the same importance level. Discrepancy of results equals to 11.6% and concerns the quality and staff morals.

3. The Ability of the Foundry to Change the Production

They act similar as the elements of the top of the Toyota's house (foundry's missions). Four Toyota's principles are presented in the form of the following factors: uniformity of the employees workload, uniformity of the machines workload, short products sequences, supplies regularity. Fourth Toyota's principle concerns levelling of production, and it states as follows: Alignment of the workload (Hejjujka).

Respondents – the foundry's workers were asked to answer the following question: What factors are the most important during the realisation of the production process? Please enter 1, 2, 3, 4 (4 the most significant factor).

RO	Even load on workers
RM	Even load on machines
KW	Short product series
RD	Regular deliveries

The structure [%] of obtained valuations is presented in the Table 3. According to the established methodology and on the basis of the data from the Table 3, pie charts were built (Fig.4).

Table 3. Comparison of the results [%] concerning the most important factors for realization of the production process in foundry

Rating	RO	RM	KW	RD
1	3.1	15.6	46.9	34.4
2	28.1	18.8	25.0	28.1
3	34.4	37.5	15.6	12.5
4	34.4	28.1	12.5	25.0

Uniform workload of the employees (RO) – Fig.4a is really balanced, considered as 68.8% of the respondents marked it with the highest grades of "3" or "4". Such an approach to the implementation of the management processes' realisation in the foundry is advisable, due to the fact that each worker is occupied by performing its own duties. The processes in the foundry are conducted by machines, devices. Also in this case, even the factor of the machines workload (RM)– Fig. 4b received high grade according to the scale "3" and "4" - 65.7%. What should be highlighted here, is the fact, that according to proper organization of work, respondents – machines' operators also operate the machinery evenly. Short product series (casts) are factors that in the most reflective way correspond to the content of Toyota's fourth principle - to level out the workload when changing the

product assortment. The researched target is a foundry with high traditional principles, manufacturing small casts from a malleable cast iron. It is not suited to short-runs. Such an approach is shared by the employees. Data from the Fig. 4c indicates that 46.9% consider that the problem of short series of castings in the foundry do not occur (gave the lowest grad of "1"). This feedback is emphasized by the grade level "2" - 25%. Stable assortment

should guarantee for the supplies of regularity. Suppliers are aware of the customers' requirements, in this case the foundry. In this case, the workers' feedback is not clear. The lowest grade of "1" gave 34.4% of respondents, confirming the foregoing. The data analysis of the Fig. 4d indicates that every fourth respondent considers the lack of reliability among suppliers (grade "4" gave 25% men).

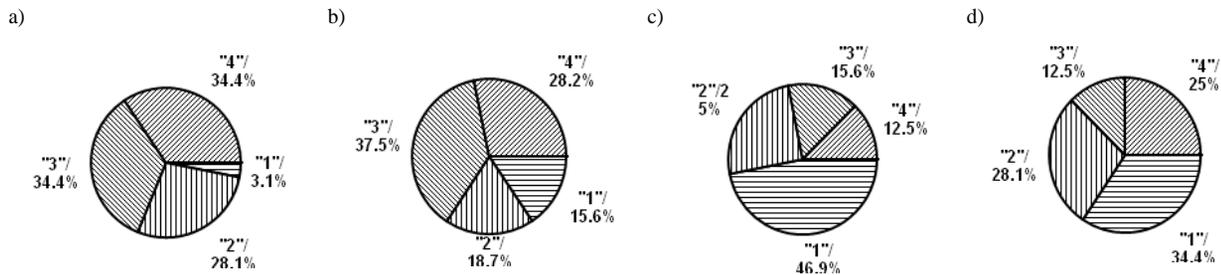


Fig. 4. Principle 1. Pie charts – assessment structure for: a) RO, b) RM, c) KW, d) RD

Series of the factors' importance that represent the fourth Toyota's principle is shown in the Figure 5, in the form of the Pareto-Lorenz diagram.

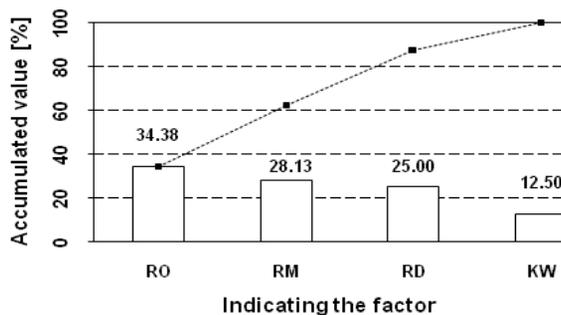


Fig. 5. Pareto-Lorenz diagram of the factors' importance representing the fourth Toyota's principle

The following sequence was obtained: uniformity of the employees' workload (RO) - 30%, levelling out the machines' workload (RM) - 27.8%, supplies' regularity (RD) - 22.8%, short series of products (castings) - 19.4%. The uniform workload of the employees and levelling out the machines' workload are almost equally perceived by the workers. Discrepancy here, equals to 10.6%, even applies to the uniformity of the employees' workload (RO) and short series of products (RW).

4. Standardization in the Foundry

Standardization is the context of the sixth Toyota's principle - routine tasks as a basis for continuous improvement and employees' empowerment. The researched issue concerns on obtaining a feedback, as to the validity of the factors, representing the sixth Toyota's principle. Respondents answered the following questions: What kind of standardization is the most important due to the constant processes' improvement in your company? Please enter 1, 2, 3, 4, 5, 6, 7 (7 the most significant element).

CW		One task completion time
PU		Processes
MP		Stores
DO		Documents
SN		Trainings
PI		Information flow
ZA		Employments

The summary outcome of this part of research is presented in the Table 4.

Table 4. Factors comparisons representing the sixth Toyota's principle

Rating	CW	PU	MP	DO	SK	PI	ZA
1	0.0	3.1	12.5	6.3	21.9	12.5	43.8
2	3.1	3.1	21.9	21.9	15.6	9.4	25.0
3	15.6	0.0	15.6	40.6	3.1	18.8	6.3
4	18.8	12.5	6.3	25.0	18.8	6.3	12.5
5	25.0	28.1	9.4	0.0	9.4	25.0	3.1
6	18.8	15.6	21.9	3.1	18.8	18.8	3.1
7	18.8	37.5	12.5	3.1	12.5	9.4	6.3

Toyota's sixth principle was presented as a set of seven factors, which may be standardized. The importance of these factors, according to respondents' - foundry workers' opinion are graphically presented in the Fig. 6.

Standardization of one task completion time (CW) obtained a different assessment (Fig. 6a). Grade "1" does not occur, grade "2" is on the level of 3.1%. This suggests that the standardization of time (CW) should be at the main focus of the respondents. However, data of this figure indicate, that standardization of analysed factor is not the most important one. Process standardization in the foundry (PU) – Fig. 6b is a critical factor, grades "6" and "7" gave 53.2% men. Also a significant proportion of respondents (26.1%) state that the issue of process standardization can be graded with "5." The lowest grades "1" and "2" are at the same low level – at 3.1%, the grade "3" does not occur. Standardization of three-stands' warehouses in the foundry (Fig. 6c), due to respondents' feedback, indicates the polarity of assessments. By taking the grade "4" as neutral, for the

rest grades the following value is received: "1"+"2"+"3"=50%, while "5"+"6"+"7"=43.8%. It can be derived from the outcome, that due to the respondents, there is no need for the standardization of three-stand warehouses in the foundry. Interesting results were obtained due to the need for standardization of documents (from production, from quality). The highest grades "6" and "7" equals to the total of 6.3% (Fig. 6d) and the lowest grade "1" received 6.3%. These results may prove that the existing documents, enabling to obtain reproducible results are already standards. In the foundry is implemented and functions the Quality Management System according to the ISO 9001:2007. The documentation is then reviewed and verified during each audit of quality.

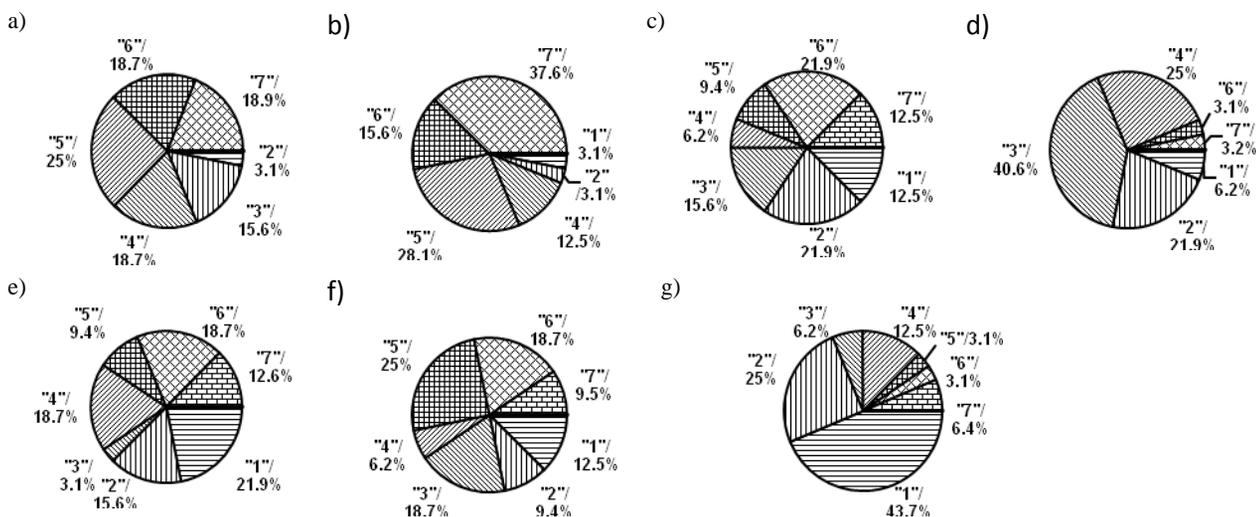


Fig. 6. Pie charts – assessment structure for: a) CW, b) PU, c) MP, d) DO, e) SN, f) PI, g) ZA

Trainings- one of the most important, the most efficient tool to improve the processes and accomplish the people by investing in the people's knowledge (Fig. 6e), obtained the highest level for the grade of "1" - 21.9%. Also a high grade level of "2" - 15.6%. What is also clear from the evaluation level of "7" - 12.6% in fact indicates no need for the training standardization. Results concerning standardization of documents and trainings indicate well-functioning of the Quality Management System. Estimating as in case of the standardization of the three-stand warehouses in the foundry get the following result: "1"+"2"+"3"=40.6%, while "5"+"6"+"7"=53.2%. From the above it can be derived, that there is needed a standardization for information flow in the foundry.

Employment (Fig.6g) is the factor which, according to the respondents, does not require standardization. Evaluation of the two lowest grades reach the level of 68.7%.

5. Summary

The research paper presents results concerning evaluation of the factors importance of production value stream in the foundry. The results were obtained by carrying out surveys on 32 workers of the daylight shift. To evaluate the importance factors of the BOST

survey was used – principles of Toyota's management system in the form of questions. There were presented the results of production value stream evaluation, and two principles (4 and 6), and the elements of the top of Toyota's house (the foundry's mission). It was stated that due to the respondents' feedback the most important factors of the foundry's mission are quality and costs, what classifies them as a future-oriented enterprise. The foundry is not prepared for the short series production, is not flexible, manufactures particular multi-sequences products. Employees are treated equally as illustrated by the results of the evaluation of their equal loading. Employees noticed a problem that requires standardization, which ensures more reproducible results, especially in the terms of quality – a factor of a great significance. Standardization also requires the completion of time for single tasks. Proper functioning of the Quality Management System is confirmed by two factors: the trainings and documentation that are not recommended for standardization.

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this effort will not be wasted. The presented research paper is the confirmation of such authors approach.

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