



**AN EVALUATION OF VALIDITY OF THE SECOND TOYOTA'S MANAGEMENT PRINCIPLE FACTORS  
WITH THE USE OF THE BOST RESEARCH IN A CHOSEN PRODUCTION COMPANY**

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**Abstract:**

The paper presents the assumptions and method of significance evaluation of the second Toyota's management principle in the production process of chosen company manufacturing flexible packaging for the food industry. Opinions about examined topic were obtained from the company's production workers with the use of innovative BOST questionnaire survey. An analysis of responses using basic statistical parameters, Pareto-Lorenz diagram and ABC method, correlation coefficients were conducted and the results of using different graphical forms were presented. As the results of the analysis it was identified the series of validity of factors of the second Toyota's management principle, which is in the examined company as follows: continuous system of disclosing problems (CP) > stop production when it detects a problem of quality (PE) > the use of visual control (SW) > standard tasks, processes, documents (SZ) > the use only reliable technology (ST) > delegate authority down (EU).

**Key words:** *the BOST study, second Toyota's management principle factors, statistical analysis, validity ranking*

**INTRODUCTION. THE IMPORTANCE OF THE SECOND TOYOTA'S MANAGEMENT PRINCIPLE AND METHOD OF ITS EVALUATION IN THE BOST RESEARCH**

In 2004, dr Jeffrey Liker, professor of industrial engineering at the University of Michigan, published a book the *Toyota Way*. In this publication, Liker showed the Toyota Way philosophy as a system designed to provide the tools for people to continually improve their work. The whole system is reduced to 14 principles. Second principle of the Toyota management requires "create continuous process flow to bring problems to the surface." This principle is based on the assumption that work processes should be redesigned to ensure their continuous flow generating high added value, try to eliminate - preferably totally - periods of process stages' inactivity or waiting for someone to realize it, to create a fast flow of material and information and link people and process in such a way as to reveal the problems as soon as they arise and make the flow as visible part of the whole culture of the organization - this is the key to a true process of continuous improvement and development of people [9].

Surveys and the method known as *BOST - the Toyota management principles in questions* (the name of the research method is an acronym created from the first two letters of the surname and the name of its creator i.e. Stanislaw Borkowski, director of the Institute of Production Engineering, Faculty of Management, Technical University of Czestochowa, the name is legally protected), is a tool that allows to translate the importance of the Toyota management principles into questions and it allows to assess the usage of management approach adhered at Toyota company among manufacturing and service companies in Poland in practice [2, 3, 4].

The issue of evaluation of second principle of Toyota management has appeared in the BOST survey in question marked as E3 and it is described as set of six factors. For the evaluation the factors of the second Toyota management principle it was used a six ordinal scale described numerically. Content of question marked as E3 is following: What is the most important factor in the production process? In the box fill 1, 2, 3, 4, 5, 6 (6 as the most important element) [3, 4].

CP - Continuous system of disclosing problems

PE - Stop production when it detects a problem of quality

SZ - Standard tasks, processes, documents

EU - Delegate authority down

ST - The use only reliable technology

SW - The use of visual control

The BOST research – Toyota's management principles in questions was conducted in the chosen company manufacturing flexible packaging for the food industry in order to obtain an opinion on the validity of the factors of second Toyota's management principle in manufacturing process. The BOST study involved thirty respondents, they were the production workers of the analyzed company.

**RESEARCHES RESULTS FOR THE EVALUATION OF VALIDITY OF FACTORS OF THE SECOND TOYOTA'S MANAGEMENT PRINCIPLE**

*Structure of respondents characteristics*

In the BOST survey, respondents who was taken a part in the studies, are divided due to such features as (in brackets there are characteristics used in the BOST survey): *gender* (MK), *education* (EC), *age* (WI), *seniority* (SC), *mobility* (MR) and *mode of employment* (TR).

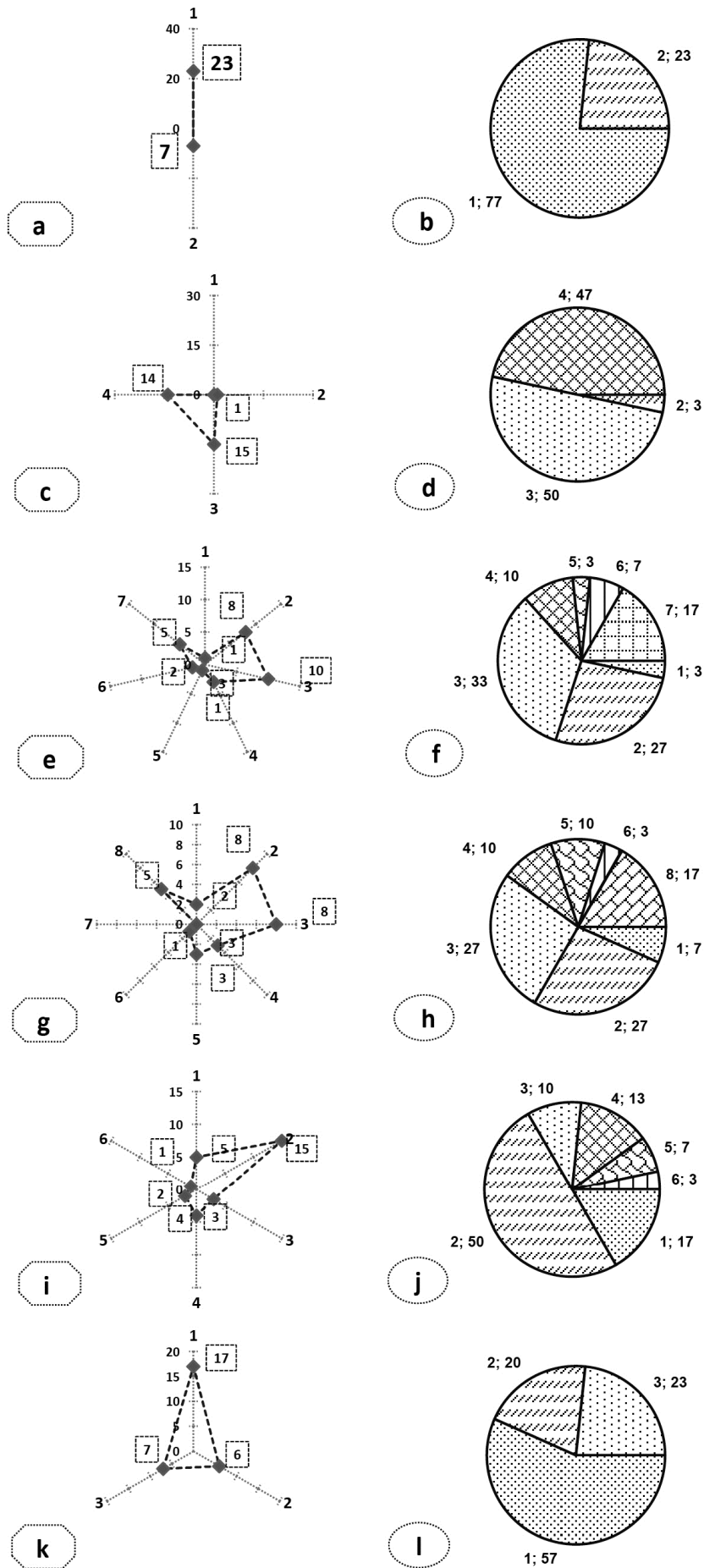


Fig. 1 Numerical (radar charts) and percentage (pie charts) characteristic of respondents features with respect to: a), b) gender, c), d) education, e), f) age, g), h) work experience, i), j) mobility, k), l) mode of employment. Refer to company producing flexible packaging for the food industry

Presented features allow to precise the structure of human potential in the analysed company. Partition of respondents' personal characteristics based on the BOST survey is presented in Table 1.

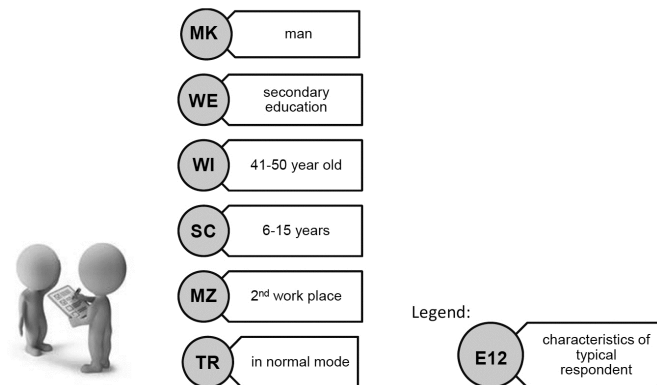
**Table 1**  
*Features of respondents. Characteristic*

Sym- bol	Determination of characteristics and legend					
	MK	WE	WI	SC	MR	TR
1	Man	Primary	< 30	< 5	1	Normal
2	Woman	Profession- ally	31 – 40	6 to 10	2	Transfer
3		Secondary	41 – 50	11 to 15	3	Finance
4		Higher	51 – 55	15 to 20	4	
5			56 – 60	21 to 25	5	
6			61 – 65	26 to 30	6	
7			> 66	31 to 35		
8				> 36		

Figure 1 shows the results of the analysis of respondents' classification according to mentioned characteristics in the researched company. Radar charts show the numerical structure of votes and pie charts show percentage structure of respondents' personal characteristics.

Most respondents in the analyzed company i.e. 77% are men. 47% of respondents declared higher education and 50% pointed to the secondary education, the vocational education indicated group of 3% respondents. Respondents were mostly aged "41 to 50 years" (33%) and the next most common age ranges are "31 to 40" (27%) and "over 66" (10%). Most indicated seniority is "from 6 to 15 years" (54%). The question "your current job/place is your place of work" most respondents pointed to second job (50%) and the majority i.e. 57% of respondents were employed in "normal" mode.

Based on the Figure 2 there was created profile of the typical respondent involved in the BOST survey.

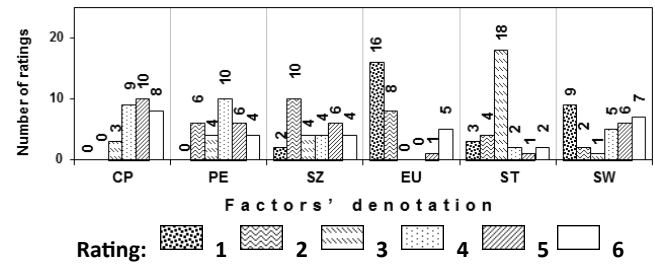


**Fig. 2 „Metrics” profile of typical respondents participating in the BOST research. Refer to company manufacturing flexible packaging for the food industry**

*Evaluation structure*

Numerical and percentage summary of answers in a range of validity of the factors of production process were done. The results are presented in Table 2.

Figure 3 shows the numerical structure of ratings of factors of second Toyota's management principle.



**Fig. 3 Second principle. Analysis of ratings distribution of factors of the second Toyota's management principle**

The chart presents the relationship between the number of the type of ratings (1 to 6) and the individual types of factors. It easily points to ratings that appeared most frequently, and so, in case of factor identified as:

- CP was rating „5”, for
- PE – „3”,
- SZ – „2”,
- EU – „1”,
- ST – „3”,
- SW – „1”.

*Statistical analysis of the results*

By using radar graphs, the distribution of answers regarding the validity of factors of second Toyota's management principle was shown [5, 6]. Radar charts were shown in Figure 4.

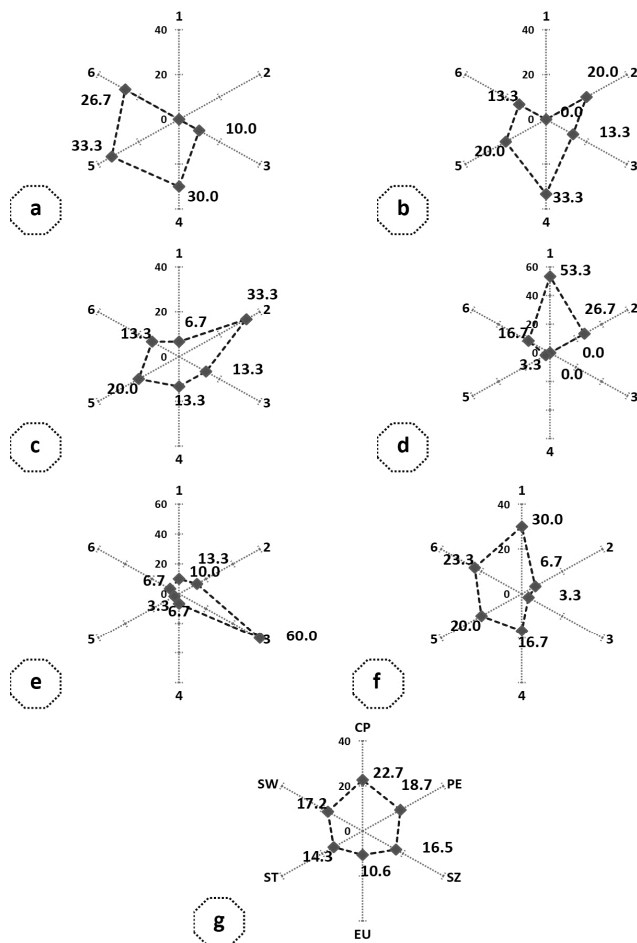
As a result of analysis of the radar charts it can be concluded that, in the case of factor:

- continuous disclosure system problems (CP) - the rating that was chosen the most commonly by respondents was "5" (33.3%). Next in frequency occurrences ratings are "4" (30%) and "6" (26.6%). Ratings "1" and "2" were used at all. This factor is important in respondents opinion because the system used to identify problems for the shop floor can eliminate the problem at source,
- stop production when it detects a problem of quality (PE) – the rating that appears most often is rating "4" (33.3%), the next ratings the most frequently chosen are 2 and 5 (20%), and 3 and 6 (13.3%). Rating of "1" was not used by the respondents. There is a clear disproportion between ratings assigned by the respondents, there is no conclusive opinion about the importance of this factor in the production process in the examined company. In some processes occurring in the company, the interruption of production in the event of a problem is possible and is done, in some cases the analysis of nonconformities and problems are conducted *post time*,
- standard tasks, processes, documents (SZ) – the most often chosen answer by respondents was "2" (33.3%), the ratings "3", "4" and "6" were indicated by 13.3% of respondents, the rating "5" - 20%. This factor was the lowest rated by 6.7% of respondents. This factor is irrelevant according to respondents. Knowledge of tasks, processes and documents is required at the stage of training bench. The employee does not have to, when production starts, familiarize themselves

**Table 2**  
**Second principle. Numerical and percentage summary of validity of factors of the second Toyota's management principle**

Evaluation	Factors' denotation											
	CP		PE		SZ		EU		ST		SW	
	L	%	L	%	L	%	L	%	L	%	L	%
1	0	0.0	0	0.0	2	6.6	16	53.3	3	10	9	30
2	0	0.0	6	20	10	33.3	8	26.6	4	13.3	2	6.6
3	3	10	4	13.3	4	13.3	0	0.0	18	60	1	3.3
4	9	30	10	33.3	4	13.3	0	0.0	2	6.6	5	16.6
5	10	33.3	6	20	6	20	1	3.3	1	3.3	6	20
6	8	26.6	4	13.3	4	13.3	5	16.6	2	6.6	7	23.3

with the process instructions every time, e.g. printing machine,



**Fig. 4 Second principle. Radar graphs – evaluation structure of factors importance:**  
 a) CP, b) PE, c) SZ, d) EU, e) ST, f) SW, g) average

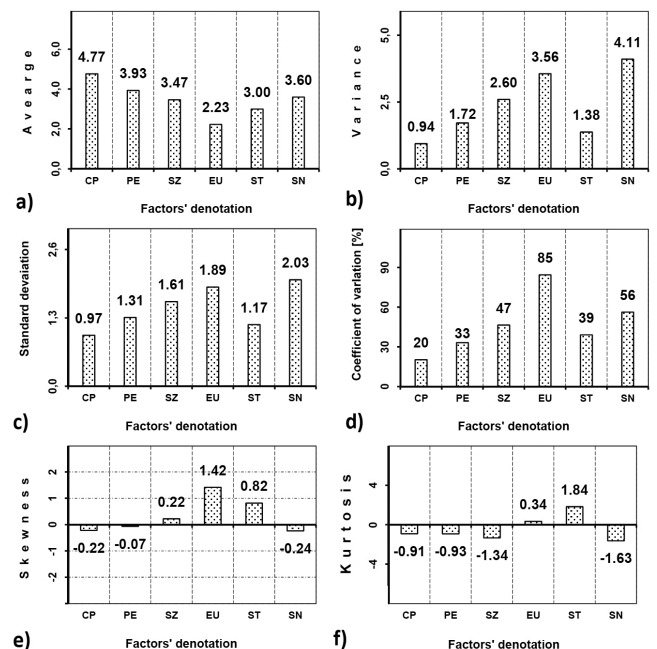
- *delegate authority down* (EU) - share of the lowest ratings, i.e. "1" and "2" represents as much as 80%. Ratings "3" and "4" were not used. Respondents believe that this factor does not occur as often in the process and therefore it has no effect on its correct flow, hence the poor ratings of this factor,
- *the use of only reliable technology* (ST) - rating "3" was the rating which was the most frequently indicated by respondents (60% of answers), the lowest rating "1" received 10% of responses, while the highest "5" only 3.3%. The majority of respondents believe that the use only reliable technology is important, but not the most important in the smooth running of the produc-

tion process, the reliable technology itself does not determine the production without nonconformities, there are many other factors which affect the manufacturing processes, which are more important for employees in its smooth course,

- *the use of visual control* (SW) - the most common rating is "1" (30%), the highest rating "6" was indicated by 23.3% of respondents. Visual control tools at present in company environment, but their meaning is differently perceived by the employees, due to their different intensity in the workplace. Workers who come into contact with the visual control and their tools every day, say that they are an essential element in the management of production process, where the participation of visual control tools is small, ratings are lower.

Figure 4g shows the average results of ratings given by particular factors.

Basic statistical parameters such as *mean, variance, standard deviation, coefficient of variation, skewness and kurtosis* [10, 11] were calculated for evaluation the structure of the ratings to the factors of second Toyota management principle. The results were shown in graphical way in Figure 5.



**Fig. 5 Second principle. Comparison:**  
 a) average, b) standard deviation, c) variance, d) coefficient of variation, e) skewness, f) kurtosis for factors of the second Toyota's management principle

The statistical analysis of the answers indicate, that:

- on average, the highest rated factor of production process is *the continuous disclosure system problems* (CP), the diversification of opinion is the lowest in this case ( $s = 0.97$ ), which means that people are most agreed on the importance of this factor, the worst evaluated one was the factor of *delegate authority down* (EU) - average rating amounts 2.23, this factor has had at the same time high dispersion in ratings around the mean value ( $s = 1.89$ ). The factor that has had the most diversified ratings measured by the standard deviation is the factor *the use of visual control* (SW) ( $s = 2.03$ ),
- coefficient of variation indicates the factor *delegate authority down* (EU) as the factor which has had the greatest relative diversity of ratings,
- factors marked as SZ, EU and ST have had the distribution right-asymmetric (the right arm of distribution extended, this distribution had the average value greater than median) in the case of the factors marked as CP, EP and SW distribution is left-asymmetric (the left arm of distribution, this distribution extended has had the average value less than median),
- factors identified as CP, EP, SZ and SW have a distribution flattened than a normal distribution, while the factors identified as ST and EU more slender than the normal distribution.

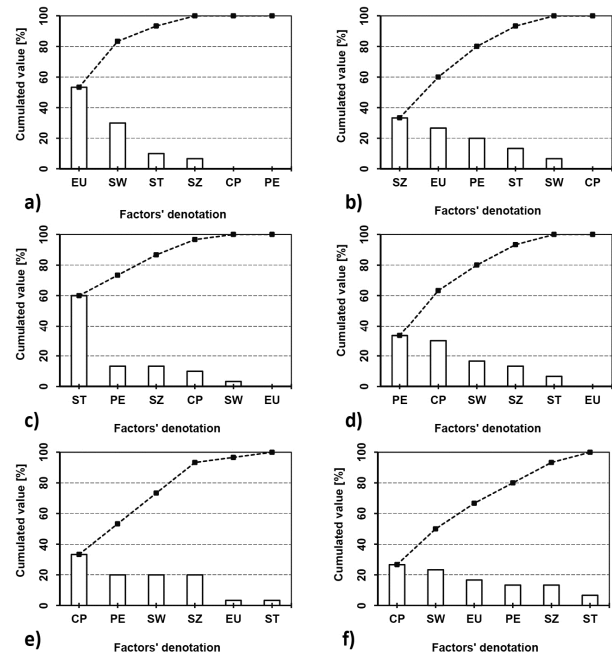
*Construction of series validity on the basis of Pareto-Lorenz diagrams and ABC method*

Pareto chart is a tool for prioritization of factors influencing on the research phenomenon. It is a graphic image, showing both relative and absolute distribution of the types of errors, problems or their causes [1, 14]

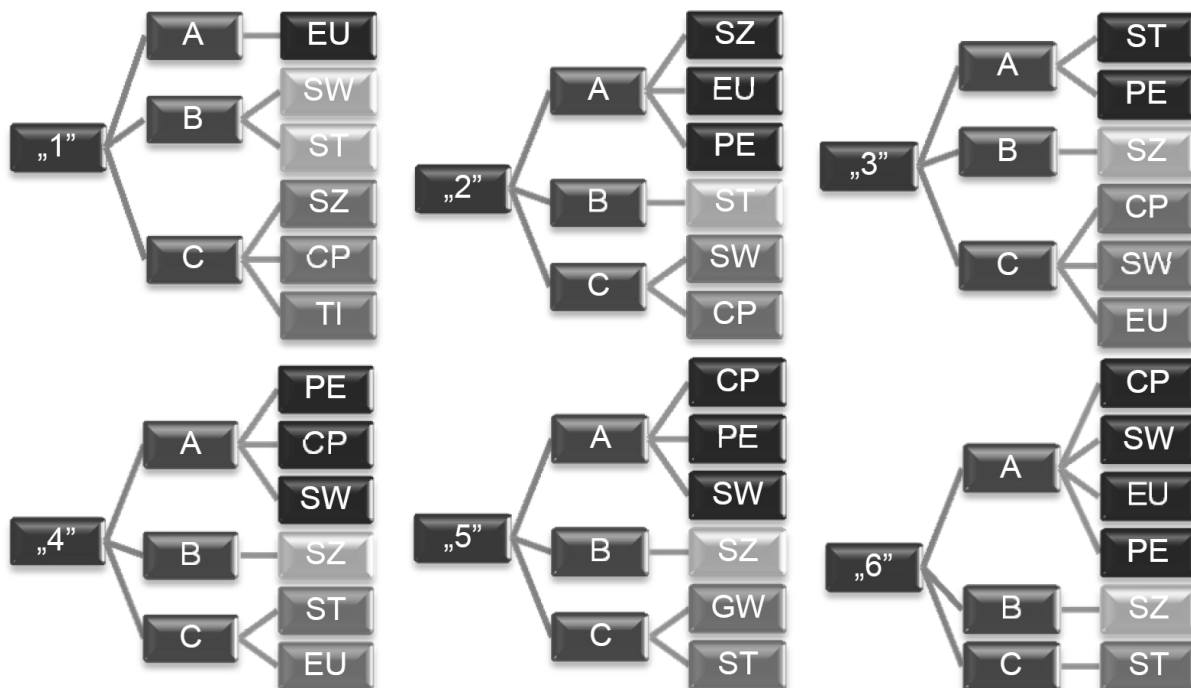
Concept of ABC method can be used to divide the factors into three groups:

- factors will belong to Part A if the cumulated percentage of assessments is less or equal to 80%,
- factors will belong to Part B if the cumulated percentage of assessments is less or equal to 95%,
- factors will belong to Part C if the cumulated percentage of assessments is greater than 95%.

Pareto chart and ABC method were used to determine the relative importance of factors within the individual ratings and dividing them into three groups: A, B and C. Pareto-Lorenz diagrams of structure validity of the second Toyota's management principle in relation to every ratings [8, 14] are shown in Figure 6.



**Fig. 6 Second principle. Pareto-Lorenz diagrams of factors importance for evaluation: a) „1”, b) „2”, c) „3”, d) „4, e) „5”, f) „6”**



**Fig. 7 Second principle. Results of ABC method used to determine importance of factors for evaluations: a) „1”, b) „2”, c) „3”, d) „4, e) „5”, f) „6”**

Obtained quantification results of the factors validity of second Toyota management principle based on Pareto-Lorenz diagrams, were brought to build the importance ranks between individual ratings:

Rating „1”: EU > SW > ST > SZ > (CP; PE)

Rating „2”: SZ > EU > PE > ST > SW > CP

Rating „3”: ST > (PE; SZ) > CP > SW > EU

Rating „4”: PE > CP > SW > SZ > ST > EU

Rating „5”: CP > (PE; SW; SZ) > (EU; ST)

Rating „6”: CP > SW > EU > (PE; SZ) > ST

Results of classification of the individual factors to the A, B and C areas in the ABC method for each of 1 to 6 rating [7, 14] are shown in Figure 7.

As the results of applying the Pareto-Lorenz diagram and the ABC method it can be stated that in case of 1 and 3 rating, they are the factors (1 or 2 out of 6) that reflect the classic principle of 20-80, so 20% of the factors represented 80% of the factors of the type of ratings. The most consistent opinions about the validity (its absence, the rating "1") were noted for the factors identified as EU.

Summarizing series of factors of validity the second Toyota management principle [12] is shown in Figure 8.



Fig. 8 Second principle. Series of validity of factors of the second Toyota's management principle in the examined company

On the basis of the series of validity it could be stated which factor was the most important and which was the least important in the production process of examined company. The most important factor in the production process in respondents opinion was *continuous disclosure system problems* (CP), the least important factor was *delegated authority down* (EU).

Maps of numbers

On the Figure 9 was shown the map of numbers takes into account the relationship between ratings on the factor *continuous disclosure system problems* (CP) and the individual characteristics of the respondents [3, 4, 6]. Analysis showed which group of respondents admitted which ratings.

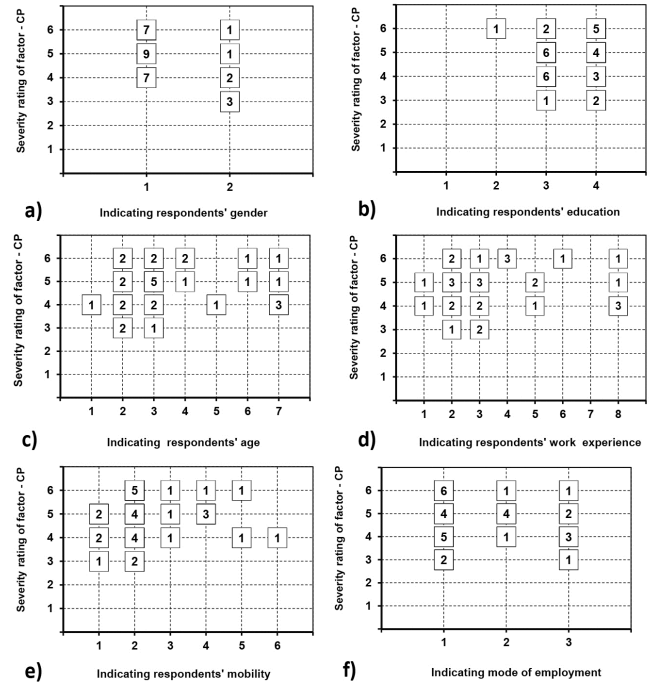


Fig. 9 Second principle. Map of the rating number of CP factor depending on the characteristics of respondents: a) gender, b) education, c) age, d) work experience, e) mobility, f) mode of employment

Summary of ratings assigned by the respondents the most often divided due to the personal characteristics was shown in Table 3.

Respondents evaluating CP factor the best are: men, with higher education, between the ages of 41-50, with work experience from 6 to 10 years, whose current job is the second work place, working in normal mode.

If we considered the rating below 3 as poor rating and more than 3 as good rating, it can point to those respondents who rated the factors the lowest, and they are: women, with secondary or higher education, aged between 31-50, with work experience between 6 and 15 years, whose current job is the first or the second, who were engaged in normal mode or due to better financial conditions.

Correlation graphs

The analysis and evaluation of the impact of personal respondents characteristics, such as: *gender* (MK), *education* (EC), *age* (WI), *seniority* (SC), *mobility* (MR) and *mode*

Table 3

Second principle. Statement of ratings assigned mostly on CP factor due to the personal characteristics of respondents

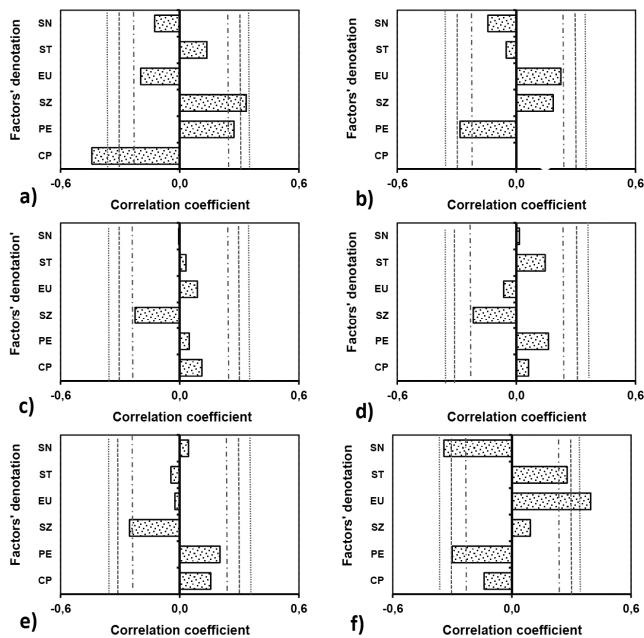
Symbol	Determination of features and ratings the most frequently occurring											
	MK	M <sub>o</sub>	WE	M <sub>o</sub>	WI	M <sub>o</sub>	SC	M <sub>o</sub>	MR	M <sub>o</sub>	TR	M <sub>o</sub>
1	Man	5	Primary	x	< 30	4	< 5	4/5	1	4/5	Normal	6
2	Woman	3	Professionally	6	31 – 40	3-6	6 to 10	5	2	6	Transfer	5
3			Secondary	5/4	41 – 50	5	11 to 15	5	3	4/5/6	Finance	4
4			Higher	6	51 – 55	6	15 to 20	6	4	5		
5					56 – 60	4	21 to 25	5	5	4/6		
6					61 – 65	5/6	26 to 30	6	6	4		
7					> 66	4	31 to 35	x				
8							> 36	4				

Legend: M<sub>o</sub> – rating most frequently occurring



of employment (TR) on score of validity of factors of second Toyota management principles was conducted. To find out whether there is a relationship (correlation) between ratings on factors of second Toyota management principle and respondents' characteristics it was used the correlation coefficient. The assumption adopted for the verification was to check whether the evaluation of factors of the second Toyota management principle differ statistically significantly with regard to the individual characteristics of the respondents in the examined company. Direction of the correlation relationship indicates the correlation coefficient sign, if the correlation coefficient is negative it means that with the increasing (decreasing) in the value of one variable decreases (increases) the value of the other variable, if the correlation is positive (positive) during increase values of one variable the other values of variable is increasing the same. Although correlation relationships do not give any preference to particular characteristics in terms of cause and effect, it can intuitively feel some dependencies between them to suggest such relationship. For example, personal characteristics in relation to the ratings on factors examined are more the cause than the effect. The effect can be treated as the dependent variable and the cause as an independent variable. Occurring correlation dependencies do not necessarily mean that there is relationship between cause and effect, but it cannot rule out.

The results of the correlation analysis were shown in Figure 10 in the form of so-called correlation graphs [3, 4, 13].



**Fig. 10 Second principle. Correlation graphs of factors ratings depending on the characteristics of the respondents: a) gender, b) education, c) age, d) work experience, e) mobility, f) mode of employment.  $\alpha = 0.2$  (internal lines),  $\alpha = 0.1$  (the center line),  $\alpha = 0.05$  (external lines)**

In the analysis, the correlation coefficient indicates that on significance level  $\alpha = 0.05$ , it can be concluded that the respondents differ statistically significantly due to:

- gender (MK) in the evaluation on factors identified as CP, the nature of this relationship is negative,
- employment mode (TR) in the evaluation on factors identified as EU (positive correlation).

On the significance level  $\alpha = 0.1$  it can be concluded that the respondents vary statistically significantly due to:

- gender (MK) in the evaluation on factors identified as SZ (negative correlation),
- employment mode (TR) in the evaluation on factors identified as SW and PE (negative correlation).

On the significance level  $\alpha = 0.2$  it can be concluded that the respondents vary statistically significantly due to:

- gender (MK) in the evaluation on factors identified as PE (negative correlation),
- education (EC) in the evaluation on factors identified as PE (negative correlation),
- mobility (MRI) in the evaluation on factors identified as SZ (negative correlation),
- employment mode (TR) in the evaluation on factors identified as ST (positive correlation).

**CONCLUSIONS**

The BOST research was carried out in the company producing flexible packaging for the food industry aimed at obtaining information on the importance of factors of second Toyota management principle in ongoing production process. The analysis clearly shows that the major factors, according to the respondents or production workers, are factors such as *continuous disclosure system problems* (CP) (the most important), the interruption of production when it detects a problem of quality (PE) and *the use of visual control* (SW), in turn the *standard tasks, processes, documents are less important* (SZ), *the use of reliable technology* (ST) and *delegated authority down* (EU) (the least important). What does this validity series of factors of second Toyota management principle result from? Continuous and smooth process, revealing the problems inherent in the culture of the corresponding interrupt the processes that occur in the examined company. Interruption of process provides in-depth analysis of the problem in order to find the root cause and this purpose is to eliminate the likelihood of making the same mistake or error forwarding to the next steps in the process. Due to the presence of managers on the shop floor, their active participation in solving the problems at the place of their inception ("gemba gembutsu"), employees perceive this (system) problem-solving as extremely helpful and efficient, hence their highest ratings. Managers are aware of what happens in the employees' workplace or on the shop floor. If they have problems they go to "gemba" and carefully check the situation in such way that they may be familiar with the true, free from "noise" in the data. On the basis on these data, they take corrective action, which are much more effective than in the case of decisions based solely on submitted reports. Managers all the time of their work reside in the "gemba" and therefore they are able to answer the question directly related to the manufacturing process and specific issues associated with them, asked by employees, introduce the recent changes as a result of the detection of irregularities.

*Delegated authority down* is that element that was assessed the worst by the employees, its role in the production process is small in examined company. This is due to the fact that management does not advocate participation and delegation. This is due to the fact that management does not advocate participation and delegation. Every em-

ployee knows their objectives and targets placed in front of them related to the work done by them, he was familiarized with it at the stage of training bench, managers also realize the aims and objectives brought to them, each has a clearly defined division of responsibilities. In the case of key decisions, managers make them alone without consulting them with their team.

The BOST research was a valuable source of information on the extent of utilization of one of Toyota management principle into practice of realized production processes in the examined company. The conclusions of the analysis can be used to increase efficiency in the management of these processes and factors according to the assumptions of Toyota.

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