Chapter 9

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BOST METHOD IN THE CONTEXT OF VERIFICATION OF QUALIFICATIONS INCOMPATIBILITY FACTORS IN ROLLING MILL

Abstract: In the chapter the results of research on importance of the factors determining the 7th principle of Toyota management in the company producing the heavy plates (steel sheet) was presented. There were presented the method of quality control during entire production process and the results of the BOST survey were presented. The characteristic importance rank of factors of t 7th principle of Toyota management in the research company was following: (*CS*; *GW*; *ME*; *UP*) >*TI*>*EP*.

Key words: BOST method, visual control, quality control, rolling plants, heavy plates.

9.1. The concept of quality control and its types

The term control is derived from the French - "controle" and literally means, according to the encyclopedia: "to manage, plan, issue the command, control, manipulate" (SŁOWIŃSKI B. 2011).There are two following methods of control (HAMROL A. 2002, 11, SŁOWIŃSKI B. 2011):

- control of the process, treated for carrying out the process,
- receiving control, defined in terms of the inspection.

Both in the process control, as well as in the receiving control in turn distinguished, two types of control: complete and random. From this group is often used the random one, due to lower costs, faster analysis.

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It consists in fact an examination of a randomly selected sample (e.g. the copy of analyzed detal), with a low frequencies, and making statistical evaluation of the results. Statistical control of receiver based on standards, such as in the case of testing the quality of the finished production on a standard PN-ISO 2859-1 +AC 1 (HAMROL A. 2005, SŁOWIŃSKI B. 2011).

Furthermore, the statistical control of the receiver are primarily analyzed following parameters (HAMROL A. 2005, SŁOWIŃSKI B. 2011).

n – sample size,

A_c – maximum number of incompatible units that may occur in sample,

AQL – acceptable defectiveness defining as percentage amount of defective products in relation to the 100 units of the product.

In turn, statistical process control is to monitor the whole process and distinguish between two types of variation: normal, also called random and specific, that is the system.

The monitoring is usually carried out using the concept ofShewart control cards. The methodology for constructing control charts and their use is described in detail in the standard PN-ISO 8258-1 +AC 1 (HAMROL A. 2005, SŁOWIŃSKI B. 2011).

Quality control in production processes depending on the stage of the production cycle is divided into the following (PRUSAK W. 2006, SŁOWIŃSKI B. 2011): initial inspection (input), acceptance control, the final control (outputs).

9.2. Control methods applied in the production of heavy plates

In the metallurgical industry company, which manufactures heavy plates, the control process is performed on almost all stages of the production process, from the control of the input materials, finishing with quality control of finished sheets on specially prepared slatted control floor.

Initially, the raw materials delivered to the steelworks go through review process in order to prevent the entry of the plant material with an increased level of radiation. For this purpose all kinds are monitored possible radioactive contamination.Identification of products is also available on all stages of production. It begins with giving a sequence number to every steel smelting. Subsequently, all the ingots are subjected to spray marking which assigning the sequence number, including the area of the ingot in a particular sequence. In the next stage, following the rolling, the band are hand-labeled and subsequent numbers corresponding to the assignment of the operative plan for concrete ingots.

The process of marking includes giving the following indications: the manufacturer's mark, steel grade, the number of bands and a sheet of bandwidth, as well as heat number and the individual number of the marking person.

Subsequent to passing through factorycontrol, there is manually transmitted quality control mark. In the final stage of the sheet are labeled using specific templates for painting. It includes the following components as standard painting: the white halos surrounding the permanent marking, sheet dimensions (ie, length, width, thickness), the recipient's name, confirmation number, type of acceptance (ABS).

Then, in individual laboratories (spectrometric, special analyzes, non-destructive testing and strength, metallographic) are examined individual physicochemical parameters of steel for compliance with the relevant standards.Prepared ingots are also subject to the labeling using the spray method and obtain the so-called. sequence and the serial number of the of the ingot in the sequence. Consecutively ingots are subjected to a visual inspection which is followed by the removal of any non-compliance with fire apparatus. During this stage are mitigated all kinds scales, tears, cracks and other damage to a depth of more than 2 mm. Control shall be subject to particularly following parameters: the state of the surface of ingots, compliance chemical composition of each ingots and assumed dimensions, as well as the results of the Bauman test.

In turn, the rolling mill department particularly controls the following parameters: the temperature prevailing at the input of the pre-cage, as well as the width and thickness of the band (roughing rolling) and the length, thickness and temperature of the intermediates before the deformation in each of the passages (finishing rolling).

Moreover sheet before cutting into sheets of suitable size shall be subjected to visual inspection. It involves particularly the discovery of faulty products as scales, cracks, tears and possible removal by grinding them. Permissible is however, the occurrence on metal sheets sagging, cracking, pittingand the features, but not more than 2% of the nominal sheet thickness.

In addition, the so-called control slatted floor the verification of the following dimensions of sheet: length, width, thickness and flatness of the surface. Then, after passing through the metal cutting process, get on control grates, which are subjected to visual inspection and ultrasonic testing.

The quality control process carried out in the heavy plate rolling mill is conductedin many ways, it is multistage process. Manufactured sheets are transportedto the recipients only after the fulfillment of all the required quality standards.

For most of these qualitative tests the employees are responsible. People work in quality control department, at all levels of production of steel sheets must be aware of the responsibility of their work, they must also be aware of the need to comply with both proprietary ISO standards, but also pay special attention to the procedure introduced in the company.

9.3. Ishikawa diagram illustrating the causes of non-compliancein the production of heavy plates

Plates produced are widely used in construction, particularly as a structural element of heavy equipment, as well as the construction of ships, large diameter pipes, boilers and storage tanks.However, during

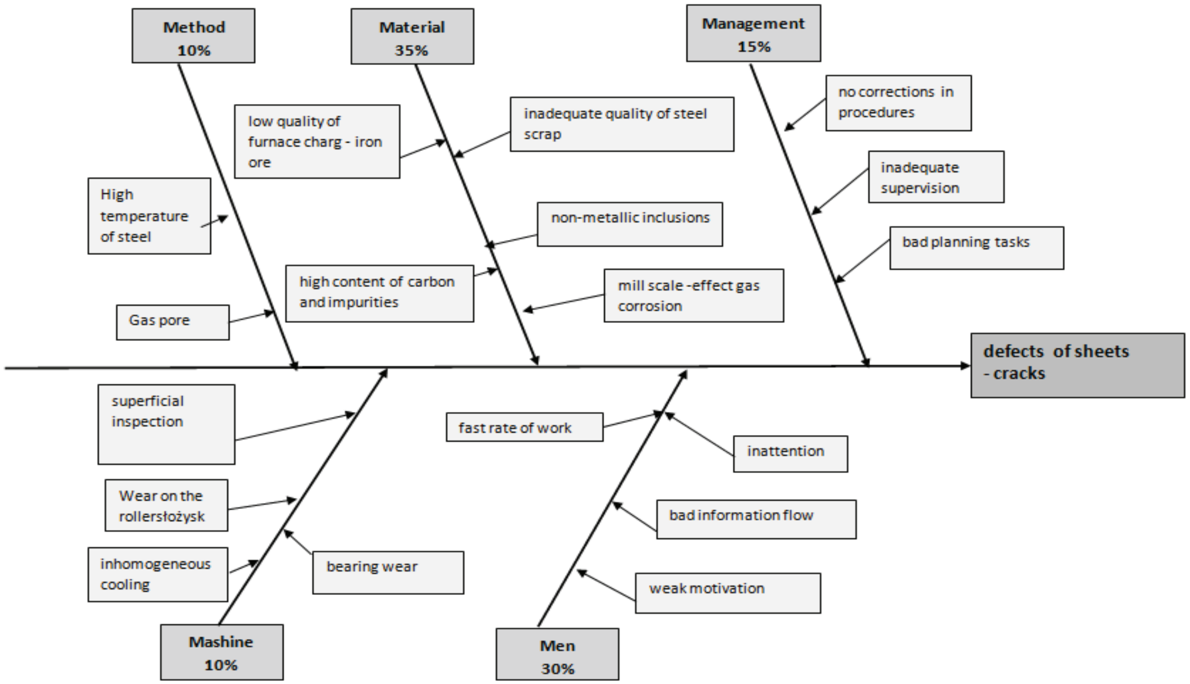

Fig. 9.1. Ishikawa diagram showing the occurrence of defects in metal plates in the form of cracks.

Source: own study based on materials from company producing the heavy plates the manufacturing process plates problems occur with the appearance of defects of the products in the form of cracks.The cause of this defect were interpreted using the Ishikawa diagram.

As it is clearly seen on the analysis set out in the Ishikawa diagram, the material is the main cause of non-compliance resulting (cracks) in the production of plates (35% of the total causes). The biggest reason for appearing in the material cracks are caused by non-metallic inclusions as a result of used steelmaking technology. Their accumulation on the surface, in turn, shrinkage cavity or shrinkage porosity in the ingot affect the deterioration of the sealing material during rolling. These inclusions formed in the steel strip-like structure and combine weaken the structure of the steel, and to form a delamination crack. Another reason for the cracks caused by the inadequate quality of the material is steel scrap, as well as charge materials to the furnace. Another problem is the effect of gas corrosion or mill scale, as well as contamination of steel sulfur and phosphorus.

Besides the material, the next major cause of non-compliance resulting in the sheets are caused by human errors (30 % of all causes). They arise mainly from too rapid work and poor motivation of employees. In turn, the errors resulting from the fault of the machine are natural and obvious and are not too significant problem for companies. Mainly due to the natural operation of machinery and equipment, which is common and obvious A bigger problem is the management of a team of people, as is evident asynchronous distribution of each task in time. Analyzing the turn method, it will be noticed that it is not a very significant cause of cracking. There are cases of improperly conducted ingot rolling process and formation of gas bubbles due to the release from the air such as oxygen, nitrogen and hydrogen at the time of pouring into molds, but this is not a phenomenon often occurring in the enterprise.

9.4. The BOST analysis in terms of control process support

The quality control procedures are well known in all companies that submit their articles of control. An important aspect is of course the proper training of personnel involved in product quality inspection. But the very important question should be stated, if the one-time training or failure to certain standards can affect the quality of the least visual products. It is in this aspect of the much-needed seems to be a survey BOST, which thanks to its wide range of thematic (based on the principles of the Toyota Management) allows the conscious control of workers opinions, thus allowing to take remedial measures in order to change attitudes and awareness of employees.

In order to obtain the necessary data in this study used a survey technique called BOST questionnaire. Respondents were aware of the purpose of research undertaken and received information about the anonymityof voluntary research.

In addition, the employees were instructed on how to properly mark the selected answers in the appropriate boxes. The survey was conducted among employees of companies producing plates working at different levels of the organization.

The survey questions relating directly to the employees concerned and their classification into different groups:

- gender,
- education,
- age,
- seniority,
- mode of employment.

The BOST method name is derived from the first two letters of the surname and the name of its creator, ie, Stanislaw Borkowski, and created by the author of a scientific discipline that focuses on the relationship between man and machine, and among people with a focus on process approach, Japanese culture and continuous improvement –

Toyotarity(BORKOWSKIS.2012a, BORKOWSKI S. 2012b, BORKOWSKI S. 2012c). For a set of 14 basic principles of Toyota's management include the following points (BORKOWSKI S. 2012, BORKOWSKI S. 2012, LIKER J.K. 2005), however, this chapter is mainly devoted to 7thprinciple of Toyota's Management System, which reads: "The use of visual control, in order to reveal all the problems".

Of all the questions contained in the questionnaire BOST have selected a question to analyze companies on the steel industry. BOST survey was carried out on workers in the plant. The task of the respondents were to answer the following question:***What is the most important element in the visual control?***The elements of the visual control, which were to be evaluated were following: *cleanliness* (CS), *flow* (EP), *information boards* (TI), *participation in production places* (UP), *monitoring* (ME) and *graphical presentation of results* (GW) (BORKOWSKI S. 2012A).

CS *Cleanliness, order*
EP *Flow*
TI *Information boards*
UP *Participation in production*
ME *Monitoring*
GW *Graphical presentation of results*

Employees were asked to assess the following factors on a scale of 1 to 6. At the same time the most important factor in their opinion, was getting note 6, while the factor that among the employees seemed to be the least important received aevaluation 1.

The numerical statement of the evaluations of 7th principle of Toyota's management factor was made among the employees in the rolling mill and the results are shown in Table 9.1.

Respondents considered that cleanliness and order, graphical visualization of results, monitoring and participation in production are the most important factors that should be improved in order to reference the largest effects. In contrast, the least important area of the respondents found information boards and flow.

Based on the survey it can be created the series or factors validity ranks for individual evaluation. It is also very important a movements of number of factors, including the growing importance of each factor.

Diagonal transition of the factors in created ranks, or it similar to the the diagonal indicates unanimity of employees evaluation.

Table 9.1. 7th principle. Numerical combination of the factors' importance

Evaluation	**Factors' indicator**					
	CS	**EP**	**TI**	**UP**	**ME**	**GW**
1	0	0	7	2	2	2
2	3	4	1	0	2	3
3	3	3	2	3	0	2
4	2	4	2	2	3	0
5	2	2	0	3	3	3
6	3	0	1	3	3	3

Source: own study

The ranks of the factors validity, for factors describing the 7th principle of Toyota management in terms of toyotarity and BOST questionnaire:

Evaluation 1:

$$TI > (GW; ME; UP) > (CS; EP) \quad (9.1)$$

Evaluation 2:

$$EP > (CS; GW) > ME > TI > UP \quad (9.2)$$

Evaluation 3:

$$(CS; EP; UP) > (GW; TI) > ME \quad (9.3)$$

Evaluation 4:

$$EP > ME > (CS; TI; UP) > GW \quad (9.4)$$

Evaluation 5:

$$(GW; \mathrm{M}E; \mathrm{U}P) > CS; EP > TI \tag{9.5}$$

Evaluation 6:

$$(CS; GW; ME; UP) > TI > EP \tag{9.6}$$

Clearly diagonal movements of factor cleanliness and order in the ranks clearly demonstrates the validity of the compatibility and consistency of responses provided. It should however, be undertaken a thorough analysis of whether this is a problem observed by the employees, or the lack of preserved standards of cleanliness and order. However, respondents may just appreciate the attention to cleanliness and order, and they are aware that they are directly involved in creating the quality of the product which are the heavy plates.

9.5. Summary

In the chapter the results of BOST survey for importance evaluation of factors of the 7th principle of Toyota management, requiring use of the visual control The research was conducted in the company that produce the heavy plates (steel sheets).

On the basis of the results of research, the importance rank of the factors in the research company was following: (CS; GW; ME; UP) > TI > EP. So the factors: *Cleanliness*(CS),*graphical presentation of results* (GW), *monitoring* (ME), *participation in production places* (UP), were indicatedthe most important factors of the visual control in the company, while the least important the factor *flow* (EP).

Thus, complicated and multi-step process quality control (including visual control) requires improvement to some extent. The BOST research provide strong support for the improvement of the quality of metallurgical products by improving the situation on the labor of persons responsible for carrying out the inspection by the proper flow of information.

Bibliography

1. BORKOWSKI S. 2012a. *Dokumenty zawierające wymyślony termin (TOYOTARYZM) oraz zawierające nazwę i strukturę opracowanej metody (BOST). Potwierdzenie daty.* „AAK” Kancelaria Patentowa s.c. Częstochowa.
2. BORKOWSKI S. 2012b.*Zasady zarządzania Toyoty w pytaniach. Wyniki badań BOST.*Wydawnictwo Menedżerskie PTM. Warszawa.
3. BORKOWSKI S. 2012c.*Toyotaryzm. Wyniki badań BOST.*Wydawnictwo Menedżerskie PTM. Warszawa.
4. Hamrol A. 2005. *Zarządzanie jakością z przykładami*, PWN, Warszawa.
5. LIKER J.K. 2005. *Droga Toyoty. 14 zasad zarządzania wiodącej firmy produkcyjnej świata*. MT Biznes. Warszawa.
6. PN-EN ISO 9000:2001,Systemy zarządzania jakością. Podstawy i terminologia, Polski Komitet Normalizacyjny, Warszawa 2001.
7. PN-ISO 8402, Zarządzanie jakością i zapewnienie jakości, Terminologia, Polski Komitet Normalizacyjny, Warszawa 1996.
8. PRUSAK W. 2006.*Zarządzanie jakością. Wybrane elementy*. Wydawnictwo Politechniki Poznańskiej. Poznań.
9. SŁOWIŃSKI B. 2011.*Zarządzanie i inżynieria jakości*. Wydawnictwo Uczelniane Politechniki Koszalińskiej. Koszalin.