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SELECTED ELEMENTS OF QUALITY MANAGEMENT SYSTEM IN METALLURGICAL ENTERPRISE

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The article evaluates selected elements of a quality management system based on data obtained from one of the Polish steelworks. Analysis of the data obtained from 2018 indicated the importance of external factors not always directly dependent on the steelworks. Taking into account these considerations associated with proximal and distal elements of the enterprise environment, allowed the possible occurrence of a significant hazard to be indicated.

Keywords: steel industry, rolling mill, quality management system, external factors (energy), Poland

INTRODUCTION

In most Polish companies in the metallurgical sector, the quality management system is based on the standards of the ISO 9000:2015 (International Organization for Standardization) series, which are usually part of the Integrated Management System. Seven principles of quality management [1] are included in the discussed standards, which are intended to help management improve the organization in a more effective and efficient way. In addition to such obvious phrases as leadership, a process approach, people's involvement or evidence-based decision making, improvement taking into account changes in the internal and external environment and customer orientation implemented through, among others, understanding current and future customer needs is recommended. Such records prove that quality, or rather the process of shaping it, is not something clearly defined or limited to certain areas of business management.

In the literature on the subject [2, 3], one can find suggestions that quality as a discipline is becoming increasingly more "ubiquitous". Currently, the content of the concept of product quality includes not only the technical or production aspect, but also the market aspect, including the ecological one. The center of gravity of ensuring product properties and features has shifted to ensuring working conditions (work culture) and the quality of connections with the environment and social responsibility. Quality understood in this way - consistent also with the understanding of it by Genichi Taguchi - is to a certain extent reflected in the integrated management system which most often combines such aspects as quality, safety and environmental management.

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The aforementioned key aspect affecting the functioning of the organization (environment) is one of the chapters (Chapter 4) of a uniform structure in the ISO standards - defined in Annex SL. According to the terminology of the standard, internal factors such as values, culture, knowledge or effects of the organization's activities and external factors, such as the legal, technological, competitive, market, cultural, social and economic environment should be taken into account [4]. Considering the fact that the organization is in constant interaction with the environment and the fact that both types of factors are often directly or indirectly interrelated, context issues should be monitored and verified on a regular basis. As the authors of paper [5] noted, identifying the mentioned factors seems to be a less complicated process for large enterprises (e.g. in the steel, mining, energy industries) than in smaller organizations. In larger business units, analyzing the environment using such tools as SWOT (Strengths, Weaknesses, Opportunities and Threats) or PEST (Political, Economic, Social, Technological) is often standard. These analyses are usually carried out in the area of marketing or business, not quality. The obvious issue of communication related to the flow of information as well as the way of documenting these little technological requirements within ISO remains open [5].

ANALYSIS OF REVEALED NONCONFORMITIES

The analysis includes data from 2018 received from the cell of the quality control department of one of the steelworks operating for over one hundred years in Poland. For over ten years there has been an integrated management system in the steelworks that was created as a result of combining separate management systems of such aspects as: quality (ISO 9001: 2015), the environment (ISO 14001: 2015), energy (ISO 5001: 2011), and occupational health and safety (PN-N-18001: 2004).

In addition, the offered products have numerous certificates (eg CE - Conformité Européenne, in accordance with Directive 97/23 / EG or VdTÜV, DBS 918002-2 and UDT - Technical Inspection Authority), which enable the design and manufacture of products used in various branches of domestic and foreign industry.

The quality analysis includes the two basic departments of the steelworks, i.e. rolling mill and steel mill. The use of the production capacity in the steel mill ranged from 24,9 % to 84,6 % in 2018. In the case of the rolling mill, this value ranged from 17,7 % to 60 % because the production capacity is 41 % higher (than in the steel mill). In the discussed period, the rolling mill used only ingots from the parent steel mill (distribution of production in relation to the average - Figure 1) and the number of nonconformities detected ranged from 7,58 % to 41,27 % of the annual production - Figure 2.

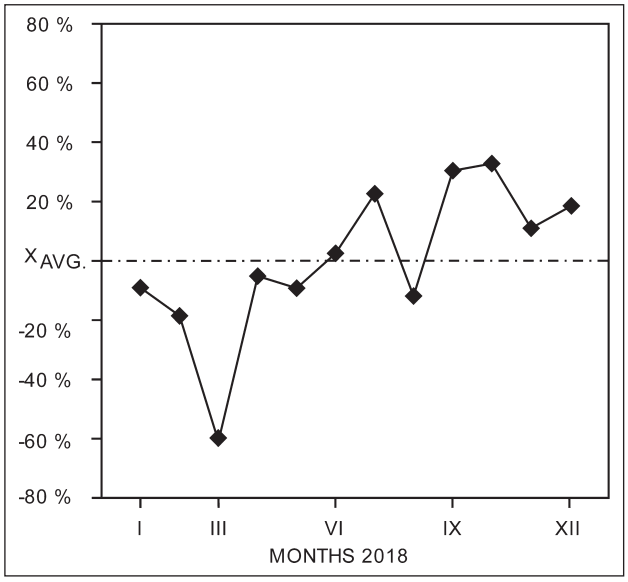

Figure 1 Percentage of production diversification in relation to its average value in 2018

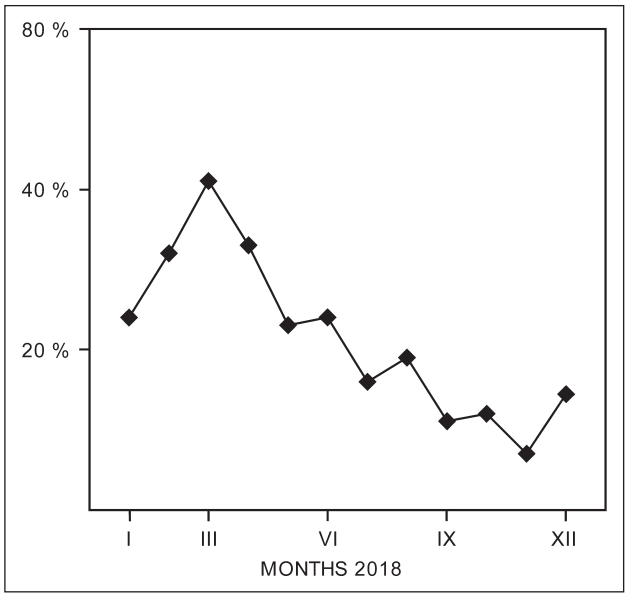

Figure 2 Percentage of revealed nonconformities - rolling mill department

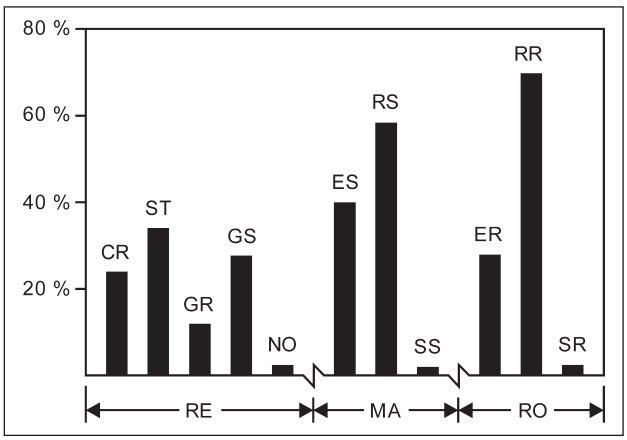

Figure 3 Percentage share of individual nonconformities in individual groups

Where: RE - repairs (CR - current repairs, ST - additional straightening, GR - grinding for reasons caused by steel mill, GS - grinding for reasons caused by rolling mill), MA - materials (ES - explanations for reasons caused by steel mill, RS - reclassification for reasons caused by the steel mill, SS - scrap for reasons caused by steel mill), RO - rolling (ER - explanations for reasons caused by rolling mill, RR - reclassification for reasons caused by rolling mill, SR - scrap for reasons caused by rolling mill)

The thus revealed non-compliances covered their respective items included in three main groups: repairs (current repairs, additional straightening, grinding – cause of rolling mill, grinding – cause of steel mill, additional standardization), material (explanation - cause of steel mill, reclassification - cause of steel mill, scrap - cause of steel mill), rolling (explanations - cause of rolling mill, reclassification - cause of rolling mill, scrap - cause of rolling mill).

Definitely the highest number of nonconformities found were qualified to the repair category - from 6,53 % to 38,17 % in the remaining cases analogically, material - from 0,31 % to 1,61 %, rolling - from 0,61 % to 1,49 %.The detailed percentage share of particular items in a given category is shown in Figure 3. The presented data show that in the repairs group in the analyzed period the largest share was played by additional straightening (34 %), in the material group - reclassification (58,3 %), which also dominated (69,7 %) in rolling nonconformities.

In the discussed steelworks, within the framework of the integrated management system, a number of partial objectives defined for admissible values for individual indicators per year were determined (for the given aspects - quality, environment, occupational health and safety). Selecting their type and limit value is based on many years of experience and takes into account the specifics of a given unit. In the case of quality management, the number of revealed nonconformities in relation to production at the level of 0,95 % for the rolling mill Figure 4 and 1,25 % for the steel mill Figure 5 per year were considered admissible.

There are apparent contradictions between the data presented in Figure 2 and Figure 4. However, they arise only from the method adopted by the steelworks for classifying and qualifying the revealed nonconformi-

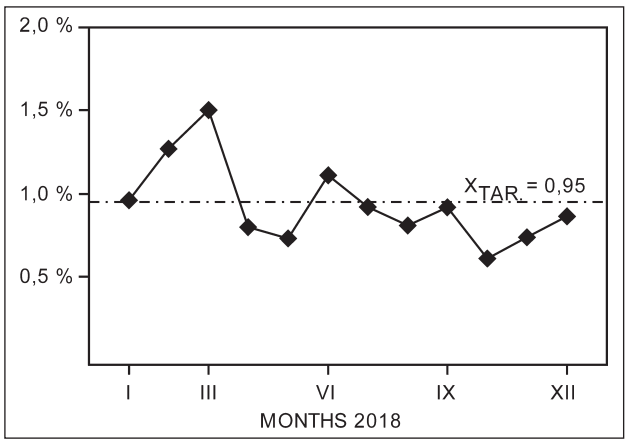

Figure 4 Percentage (in relation to production) level of revealed nonconformities for rolling mill department in 2018, where: X_{TAR} – admissible size

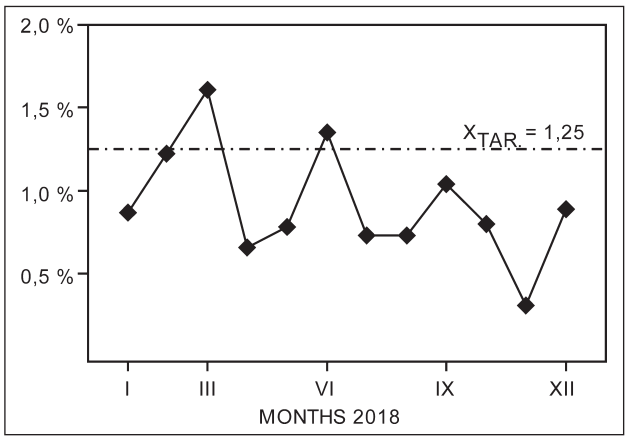

Figure 5 Percentage (in relation to production) level of revealed nonconformities for steel mill department in 2018, where: X_{TAR} – admissible size

ties. As previously presented, the defective products in the rolling mill department were divided into three basic categories, i.e. repairs, material and rolling. The material and rolling groups were automatically assigned to individual departments; in the first case, to the steel mill in the second to the rolling mill. The most numerous category of repair was treated as a set of nonconformities noticed and removed during the production process. Their occurrence was registered by the quality management system but was not included in the annual assessment of the level of quality - with regard to the admissible level.

On the other hand, the nonconformities whose causes originate in the processes carried out within the steel mill are revealed during preparation of the product in the rolling mill. This is due to the specificity of metallurgical production and the method of product control adopted in the quality management system. Figure 6 shows the percentage share (within a given group) of causes of nonconformities related to casts in 2018 for the steel mill in question.

The preliminary analysis of the presented data precludes the possibility of obtaining significant statistical distributions or making substantive generalizations.

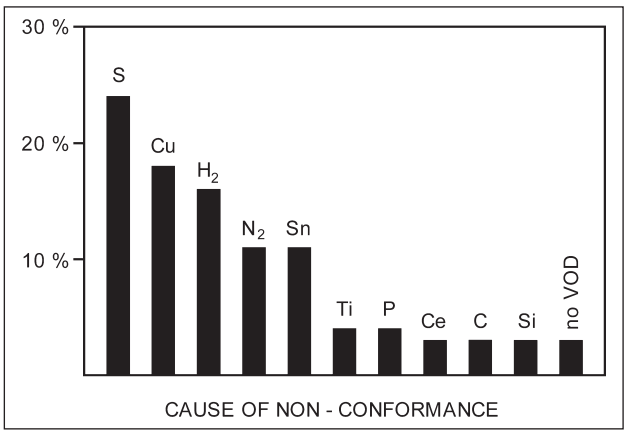

Figure 6 Percentage share of causes of cast failures

The use of the production capacity per year depending on the department ranged from 45 % to 64 %, which in effect meant a differentiation of production in relation to its average value, reaching a level of 60 % per month. Such significant differences, and thus the lack of continuity and rhythmicity of production could somehow indirectly affect the quality of the product. This assumption is confirmed by at least a cursory comparison of the presented graphs - the decrease in production correlates with the increase in revealed nonconformities.

For many years this steelworks has been producing the same product from a strictly defined group of steel grades. This situation made it possible to develop a technological regime, which assured the proper course of manufacturing processes. However, the lack of a stable order portfolio temporarily changes certain important conditions. The analyzed steelworks produces steel using an electric furnace, whose charge constitutes 80 % scrap, 15 % pig iron and 15 % ferroalloys. Scrap is therefore the basic input material and with such unstable production volumes can be purchased irregularly or even accidentally obtained from the market - this may indicate the main causes of nonconformities associated with the casts.

Despite the encountered problems, the analyzed steelworks in the examined period never exceeded the admissible claim rate (max. 0,02 % of the value of claims in relation to the value of sales) which proves the good work of the quality cell and especially the final inspection services.

SUMMARY

Currently, the Polish steel industry, after years of restructuring and investing in the latest technologies, is undergoing a period of uncertainty. Metallurgical enterprises, due to the nature of their production, occupy quite a specific position on the market. Unlike many other industries, they may in a very limited way offer a new or modified product. By offering a group of precisely defined products, they decide to compete in the sphere of quality and price. Of course, both these aspects are indirectly related to each other because poor

quality raises production costs, and so may affect the final price of the product. Currently, however, electricity prices is one of the basic problems of Polish steelworks. There are justified fears that if the emission allowance price (EU ETS) continues to grow, the energy price for industry may soon be, for example, over 80 % - 100 % higher than in Germany [6]. These differences (up to 60 %) play a significant role today.

In the case of the steelworks in question (the price of energy can be up to 40 % of costs in electric steel mills) is an excessive burden and results in a partial loss of competitiveness - steel costs are generated in the steel mill, not in the rolling mill (e.g. slab prices match the prices of imported plates [7]). As a result, the lack of a permanent order portfolio translates into downtime, irregular production and finally, as demonstrated in the article, an increased amount of nonconformities. Of course, even irregular production does not justify the excessive amount of "repairs" (i.e. to 38,17 % of production) in the rolling mill department. Accordingly, a maintained and serviced technological line and experienced technical staff should ensure the desired level of quality.

Another issue, not analyzed in the article, is the issue of human resources that is an important problem related to the Polish steel industry. There is a real threat of a generation gap because a significant proportion of specialists are approaching retirement age. The education of successors is a long-term process (studies plus a few years of practice) and in some way is dependent on the forecasted economic situation for the whole industry. The issue of employment stability and financial conditions will be one of the key factors determining the quality of staff in the coming years. In the perspective of the need to further reduce costs, e.g. through automation and digitization, highly qualified specialists from various fields are required to work in digitized steelworks (including advanced analytics, anticipating events that are yet to take place) [7].

The analyzed steelworks currently operates in the conditions of an unstable market. The production technology used by it and external factors (e.g. the price of energy) prevent future production planning (supplier, recipient). Such a situation not only makes it difficult, for example, to ensure quality, but also limits the possibilities of innovative activities that would increase the competitiveness of the steelworks.

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Note: The professional translator for English language is Christine Frank-Szarecka, Czestochowa, Poland