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# AN ANALYSIS OF THE CAUSES OF COMPLAINTS ABOUT STEEL SHEETS IN METALLURGICAL PRODUCT QUALITY MANAGEMENT SYSTEMS

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The publication presents the causes of complaints about metallurgical products, illustrated with an example of steel sheets, with a particular focus on the reasons having their source in the human factor. The publication has been based on direct research and analysis of complaints made available by a metallurgical plant. The obtained results have been enriched with theoretical considerations on quality management systems for metallurgical products.

*Key words*: metallurgical products, steel sheets, quality management system, complaints

## INTRODUCTION

Social and economic changes resulting from technical, technological and organisational development have contributed to a greater importance of production enterprise competitiveness. One of competitiveness components is the quality of products, understood as an advantage over other enterprises. Offering better quality products than competitors is a way of building the company's competitiveness. Quality competitiveness is conditioned by the product's fulfilment of all the requirements that determine its functions and attractiveness for the purchaser [1].

In the case of metallurgical products, the final quality is determined mainly by physical attributes, such as: chemical composition, physical and chemical properties, precision of workmanship, functionality etc. Particular physical and chemical properties of metallurgical products must comply with both the production standards in force and the specific character of the customer's order. Before being put on the market, metallurgical products are subject to quality control. Although it is computerized, this process depends on the precision of measurements taken by the staff. The results of product quality evaluation may vary in their degree of accuracy, depending on particular employees who take measurements. The publication presents issues related to the causes of complaints, with a special focus on reasons having their source in the human factor. Basic causes of an organisation's low efficiency include improper organisation of work and the fact that employees are not sufficiently motivated toward the goals set by the organisation [2]. A case study was carried out in a metallurgical plant producing steel sheets.

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## PRODUCT QUALITY MANAGEMENT SYSTEMS IN METALLURGICAL PLANTS

The increasing competition on the market as well as growing demands of purchasers forced enterprises to implement product quality management systems in accordance with the assumptions of ISO 9001 standard. Product quality management is a set of coordinated activities related to quality in the context of the functioning of the whole enterprise [3]. A product quality management system is a component of the company's management system. There is a correlation between the improvement of the company's functioning and the improvement of goods quality [4].

Enterprises develop and implement a vast array of methodological quality management instruments (for example 5S – tidiness, orderliness, cleanliness, standardization, discipline, Six Sigma – in statistics sigma is a standard deviation of a variable, six sigma means 3, 4, defects per million, FMEA – Failure Mode and Effects Analysis, SMED − Single Minute Exchange of Die, TMP – Total Productive Maintenance, SPC – Statistical Process Control, benchmarking, Knowledge Management, FMS − Flexibility Manufacturing System, LM – Lean Management, BSC – Balanced Scorecard, Kaizen). Product quality is a key aim of enterprise management as well as a standard (requirement) of World Class Manufacturing – WCM [5]. Characteristic features of production plants striving for management through quality include among others product innovation, process improvement, commitment of staff, delivery timeliness indicator, a high number of support services (transport, assembly), permanent control over product quality and cost accounting (striving for a competitive advantage through elimination of wastage). Although implementation of quality management systems is a voluntary activity of enterprises, an increasing number of companies have certified quality management systems.

When observing the changes in metallurgical plants, researchers noticed that the first quality management systems appeared in the years 1993-1994. The first metallurgical plant to implement a quality management system was Huta (Foundry) Ferrum S.A., followed by Bumar Łabędy S.A. Implementation of quality management systems intensified at the end of 1990s and in the first years of the new era. At the end of 2001, approximately 4000 companies in Poland had quality management system certificates [6]. The first quality management systems in metallurgical plants complied with the standard at the time - ISO 9001:2000. Apart from the already mentioned plants, foundries which had certificates of conformity with the quoted standard included: Huta (Foundry) Zawiercie S.A., Huta Buczek SA in Sosnowiec, Huta Jedność in Siemianowice Śląskie, Huta Łaziska, Huta Batory SA in Chorzów, Huta Pokój SA in Ruda Śląska, Huta Florian in Świętochłowice, Huta Baildon SA in Katowice, Huta Katowice w Dąbrowa Górnicza, Huta Łabędy in Gliwice. Approximately 85 % of the companies having certificates of conformity with ISO standards were awarded certificates of conformity with ISO 9000 standards, about 7 % - ISO 14001, while the remaining ones had certificates of conformity with other standards. Quality management systems were also first to be implemented in metallurgical plants (before environment management systems). Striving for systems integration, metallurgical plants made use of interactions between the already functioning quality management systems and environment management systems (ISO 14001) which were being implemented at the time [7]. In August 2002 the biggest production plant in the Silesian Province – Huta Katowice, basing on its experiences with the quality management system, proceeded to implement an environment management system (in accordance with ISO 14001:1996) and OSH management system (PN-N 18001:1999 at the time) [8]. The establishment of Polskie Huty Stali SA (PHS) concern, consisting of four foundries (Sendzimir, Katowice, Florian, Cedler), involved a necessity of integrating particular management systems, first the ones in particular departments of the concern and next - in the whole enterprise. After the enterprise was purchased by a strategic investor (currently ArcelorMittal), the certificates were updated (another issue of standards) and the systems were further integrated. In September 2010 ArcelorMittal Poland received a certificate confirming the functioning of a quality management system (ISO 9001:2008), an environment management system (ISO 14001:2004) and an OSH management system (PN 18001:2004; BS OHSAS 18001:2007). Currently, companies without certified quality management systems do not exist on Polish metallurgical market[1] .The obtaining of certificates of conformity with ISO 9000 series standards by metallurgical plants was the starting point on the way to management through quality. Metallurgical enterprises proceeded to streamline the organisation of work, improve their productivity, implement incentive systems aimed at continual improvement of the enterprise (motivation through results), enhance the quality of manufactured goods (conformity of products with subsequent standards allowing the products to be placed on a particular market) etc. Gradually, the activities of the plants were rewarded (titles, honourable mentions for performance excellence – Performance Excellence Award, „Firma dobrze widziana" („Well-seen Company") – Business Center Club). Over time quality became a foundation for WCM – World Class Manufacturing in metallurgical plants belonging to global capital groups (e.g. ArcelorMittal Poland). Starting with certified quality management systems in conformity with ISO 9000 standards, through the assumptions of TQM (Total Quality Management) concept as a manner of management focused on quality, which was based on co-operation of all enterprise members and aimed at achieving a long-term success by satisfying the customers and providing benefits for employees and society [9], companies went on to implement the methodologies and instruments of particular pillars of WCM, among which quality is one of the 10 columns of world class manufacturing. Figure 1 presents levels of management improvement through quality in metallurgical plants.

Despite a wide range of product quality control instruments in enterprises, there are cases of product nonconformity, which are subject to complaints. The major causes of complaints include material, mechanical and human factors. Using an example of steel sheets, we have presented the reasons for complaints in particular categories of factors.

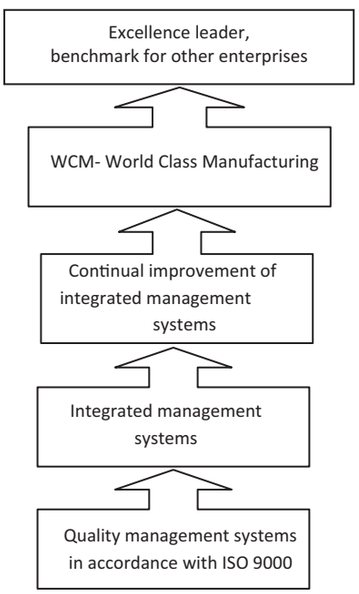


**Figure 1** Levels of improvement in metallurgical plants

[1] The analysis covered 22 companies in the metallurgical (steel-making) sector in Poland (author: B.Gajdzik)

## AN ANALYSIS OF THE CAUSES OF COMPLAINTS ABOUT STEEL SHEETS

The analysis has been based on research carried out in a plant producing steel sheets, which has a certificate of quality management system conformity with ISO 9001 standard. Using the information made available by the enterprise as well as direct investigations, the researchers determined the most common causes of complaints. The main material factors included: cold shuts, surface cracks, material delamination, corrosion pits, uneven application of a zinc or aluminium layer. The latter factor exerts a considerable influence on the very process of cutting. Differences in material thickness cause its uneven reeling and a possibility of its subsequent damage. In the process of DC01 black steel sheet cutting the reeled strips tend to overlap, which is due to release of stresses in the cold rolling process. Mechanical factors include mainly possibilities of scratching or bending the material, damages caused by improper transport of merchandise and a possibility of knife crumbling in the cutting process. In steel treatment processes it is very important to properly select and train employees, as the whole production cycle depends on their performance of duties. The reasons for complaints which reflect employees' errors include most frequently incorrect measurements, improper setting of machine parameters or an error in material records. The company staff play an important role and can considerably influence production processes, with regard to both quantity and quality. A very important factor included in the group of human factors is measurement error. The accuracy of measurement is defined by a measurement error, which is a difference between the measurement result and the measured value. A cause of this non-conformity, which accompanies every measurement, is the influence of various unavoidable factors disturbing the measurement. The impact of each factor causes a partial error, whereas the co-operation of all the other interfering factors results in a pooled error. Measurement errors depend mainly on the measurement tool, the employee taking the measurement, the method of measurement, environmental conditions and result calculation. Errors related to the measurement tool have a few sources. The most important ones include calibration errors, which result from improper comparison between the indications of the measurement tool and the control tool (it has to be remembered that the control tool indication is also burdened with error); friction errors, which result chiefly from inhibiting factors and prevent a mobile element of the tool from reaching a proper position; errors due to clearances in the mechanism, which cause indeterminacy of measurement indications; temperature errors, which may be caused either by a change of the tool element dimensions or a change in their different material properties, e.g. modulus of elasticity, magnetic properties during a measurement from vertical to horizontal position. Apart from these general sources, each

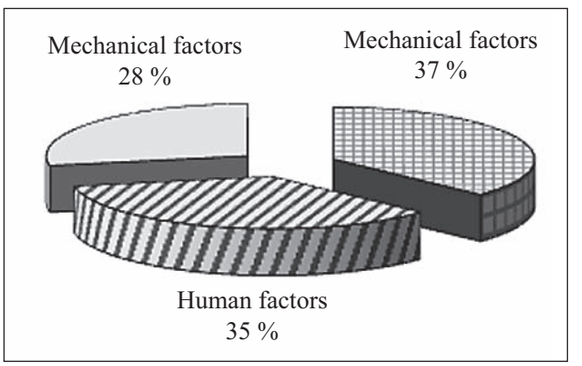


**Figure 2** Factors involved in steel sheets complaints (share in total complaints)

measurement tool has a number of individual errors, which need to be analysed. Errors caused by employees taking a measurement result from the imperfection of human senses and include: a limited ability to properly assess a distance by the human eye. Moreover, an error frequently results from an improper position of the observing eye in relation to the scale (this is a so-called parallactic error). In order to avoid this unfavourable phenomenon, modern tools are equipped with a digital reading. An important role in measurements is played by psychological errors, which result from certain tendencies, e.g. a tendency to always read off a slightly lower (or higher) value, to round numbers to certain privileged digits in the process of interpolation etc. Errors related to measurement result calculations occur mainly because an improper principle of error compensation in a series of measurements is applied or because the indicated values are rounded off. The percentage share of all the accepted complaints in the company on the basis of collected information has been shown in Figure 2.

The enterprise subjected to analysis sells more than 75 000 pcs of steel sheet annually. For the four quarters of 2009/2012 it sold 212 959 pieces (without IV quarter 2010). The highest sale levels were recorded in the spring and summer period. Sale details have been presented in Figure 3.

As part of research, the level of complaints about metallurgical products was compared with the sale. To this end, a percentage share of complaints in relation to sale in 2009/2012 was computed. The percentage share of complaints in particular quarters was lower than the assumed one (Figure 4).

The analysed company explains that its relatively good results in the level of complaints are due to comprehensive monitoring of the production, continual improvement of the offered services quality as well as employee trainings. According to the quality management system assumptions, improvement is a constant and vital aim of the enterprise. The employees take part in training courses in the field of quality. Continuing professional development is a key assumption of the enterprise management. The system of employee training

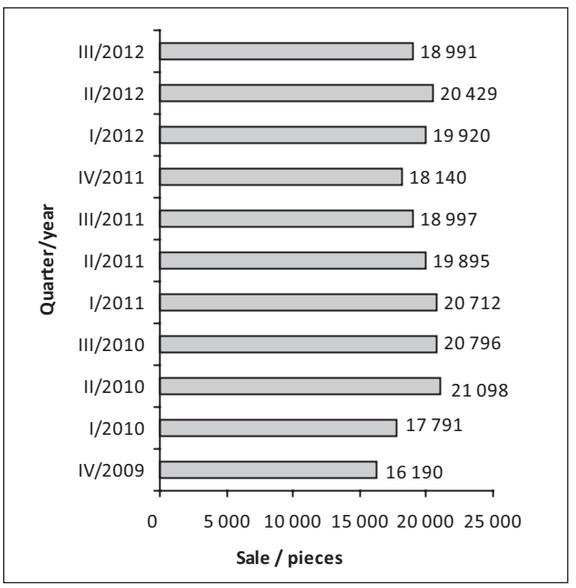


**Figure 3** The sale of steel sheets in the analysed enterprise for the year 2009/2012

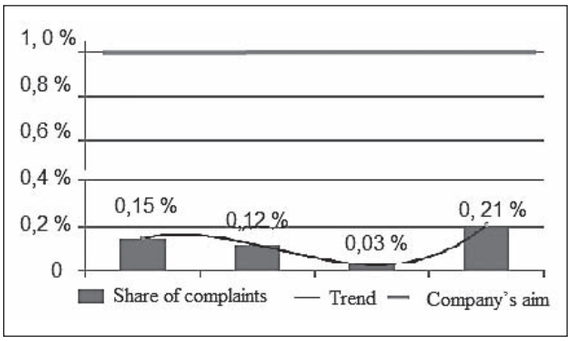


**Figure 4** The share of complaints in the total sale of products for the year 2009/2012

organisation is aimed at improving their professional skills and widening the scope of licences as well as acquiring knowledge in the field of quality management. The company organises: internal, external, obligatory, specialist and professional development trainings. Training needs are established on the basis of analysis of periodical employee assessment, the completed trainings, qualifications and certificates as well as skills within the scope of machine operation. The direct investigations included evaluation of the course of trainings as well as their usefulness. 70 % out of 30 surveyed people assessed them as very good, the remaining ones gave a good mark (Figure 5).

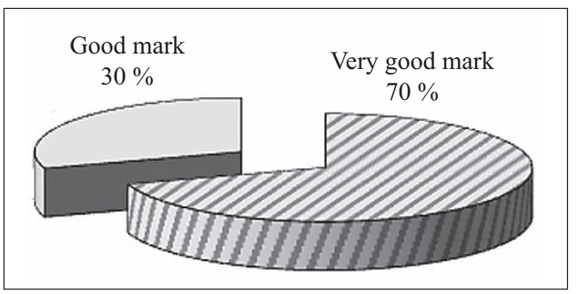


**Figure 5** An evaluation of the course and effectiveness of production employee trainings

## CONCLUSIONS

The main causes of complaints about steel sheets produced by the analysed enterprise are material factors, which include cold shuts, surface scratches, material delamination, corrosion pits, uneven application of a zinc or aluminium layer. The above quoted reasons accounted for 37 % of all complaints in the metallurgical plant. Another category of complaints was related to employee errors, which occurred at the stage of production and/or product quality control (35 %). The last item concerned mechanical damage of steel sheets during transport, loading, packing etc.

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**Note:** The responsible translator for English language is Z. Dragon, Gliwice, Poland