Periodica Polytechnica
Transportation Engineering

43(3), pp. 168-171, 2015
DOI: 10.3311/PPtr.7962

RESEARCH ARTICLE

Analysis of Quality Control Results in the Lift Truck Elements Production

Agnieszka Czajkowska[1], Renata Stasiak-Betlejewska[2*],
Atul B. Borade[3]

Received 10 February 2015; accepted after revision 18 February 2015

Abstract
The paper presents research findings concerning control results within the lift truck production elements process. Research aim is determine nonconformities responsible for law quality level of final product. The quality management tools such as Pareto – Lorenz diagram and relationship diagram were used in the presented research findings analysis. Pareto-Lorenz diagram was used to identify the nonconformities hierarchy in the production process and the relationship diagram allowed identifying causes of most common nonconformities occurrence.

Keywords
Quality, production, Pareto-Lorenz diagram

[1] Department of Strength of Materials and Concrete Structures,
Faculty of Civil Engineering and Architecture, Kielce University of Technology,
al. Tysiąclecia Państwa Polskiego, 25-314 Kielce, Poland

[2] Institute of Production Engineering, Czestochowa University of Technology,
ul. Dąbrowskiego 69, 42-201 Częstochowa, Poland

[3] Mechanical Engineering Department,
Jawaharlal Darda Institute of Engineering and Technology,
Yavatmal 445001, Maharashtra, India

[*] Corresponding author, e-mail: renatastasiak@wp.pl

1 Introduction

Failure to comply with the quality of semi-finished and finished products can cause not only a very big problems in the product utilization, but it can cause an accidents in the extreme cases. As the most common examples of using the steel structures are the supporting structures of production halls, warehouses, the steel structures of the rail and bus stations, gas stations, self-service stores.

Today's vehicles equipped with conventional cruise control systems are able to maintain steady speed set by the driver by adjusting the longitudinal control forces acting on the vehicle, i.e activating the throttle or the brake. Nowadays adaptive cruise control systems are becoming widespread among premium and middle class cars. This device enables the vehicle to follow the speed set by the driver and if the lane is occupied, it follows preceding vehicles automatically at a predefined safe distance (Mihály et al., 2014).

The only way to avoid or at least minimize the risk of nonconformities occurrence in the steel structures production is Total Quality Management (TQM) use (Ćwikliński and Obora, 2009; Czajkowska et al., 2013; Sebestyén and Tóth, 2014). It means taking care of quality at every stage of the production from the design stage through the production to the finished product delivery stage to the customer (Borkowski et al., 2013). The Quality Management involves the entire enterprise organization and it is related to each process involved in producing a finished product (Dubey et al., 2015). The quality of the finished product depends on many factors which must be subject to a process of continuous improvement (Herz and Flämig, 2014). (Fig. 1).

The quality of used materials depends on the quality of raw materials (Borkowski et al., 2011). Taking into consideration high-quality materials it must be ensured the proper functioning of the manufacturing processes. There is a large number of elements affecting its proper exploitation in the manufacturing process (Carrillo and Chinowsky, 2006). An important element is the proper functioning of machines and equipment. Total Productive Maintenance (TPM) plays a great role in the achieving the appropriate product quality (Singh et al., 2013).

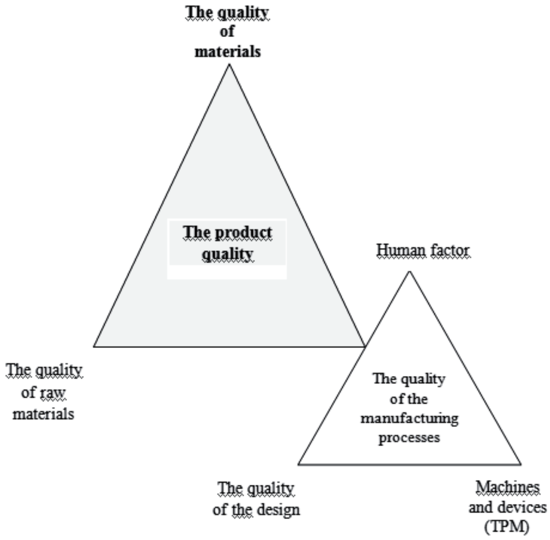

Fig. 1 Interdependence of factors affecting the finished product quality.

The introduction of TPM assumes the responsibility for the maintenance of the machinery in perfect condition. The scheme is designed to maximize the efficiency of machinery and equipment over the duration of its use (Borkowski and Ulewicz, 2009).

Caring for the proper functioning of the processes involved in the production is organized to obtain the reliable functional product satisfying customers demand (Bajor and Babić, 2014). Nowadays, customers are becoming more aware of their needs and the opportunities offered by the market (Uhrich and Tombs, 2014). The degree of customer satisfaction depends on successful enterprise. The article presents the quality assessment of products manufactured by a large company producing steel structures.

2 Research findings and discussion

The examined company X produces steel structures for the construction companies and it was established in 1945. In 1982 the company was expanded in terms of technical and technological equipment and there was extended the offered product range. The company is a leader in the European market as a manufacturer of construction machinery and construction equipment. The analysed company manufactures steel for: industrial buildings, industrial technological structures, steel structures of the railway stations, cellular towers, masts and others.

The research object presented in the article is the element of the lift truck construction element in the form of the ride chassis frame. The ride chassis frame is a structural component of the lift trucks, which forms the chassis skeleton. The article analyzes the quality of the mentioned element, which is an essential component of lift trucks used for loading and unloading operations. The typical structure of the lift truck includes the following items: welded steel frame, brake, hydraulic pump, infinitely variable lowering speed through specially designed valve, safety overload valve before lifting loads.

Operations in the manufacturing process of the ride chassis frame are as follows:

1. Storage of materials.
2. Transportation of materials for the position control.
3. Materials control.
4. Pre-treatment operation. Cleaning materials, sandblasting.
5. Transport of materials to the cutting position.
6. Treatment correct. Thermal cutting and machining of materials.
7. Transport for assembly line.
8. Installation and tacking.
9. Welding of frame elements.
10. Quality control or pressure test.
11. Finish operation. Final welding of the main elements.
12. Installation of equipment.
13. Welding equipment.
14. Cleaning after welding.
15. Maintenance and protection of machined surfaces.
16. Transport to the finished goods warehouse

Based on data of the quality control department in the analysed company, 13 nonconformities in the production process were identified (Table 1).

Table 1 Nonconformities in the lift track ride chassis frame elements production

Nonconformity symbol	Nonconformity name	Percentage share [%]	Accumulated share [%]
N_1	Improper dimensions after welding	34,9	34,9
N_2	Pitting after roasting	24,1	59
N_3	Poor surface quality	16,3	75,3
N_4	Improperly cleaned surface after welding	6,1	81,4
N_5	Wrong frame geometry	4,2	85,6
N_6	The weld crack	3,75	89,35
N_7	Unsymmetrical weld	3,2	92,55
N_8	Omission of the frame-mounted components	2,2	94,75
N_9	The porosity of the welds	1,6	96,35
N_{10}	Deformed elements	1,32	97,67
N_{11}	Corrosion of machined surfaces	1,1	98,77
N_{12}	Deformation of the surface	0,56	99,33
N_{13}	Damaged threads	0,67	100

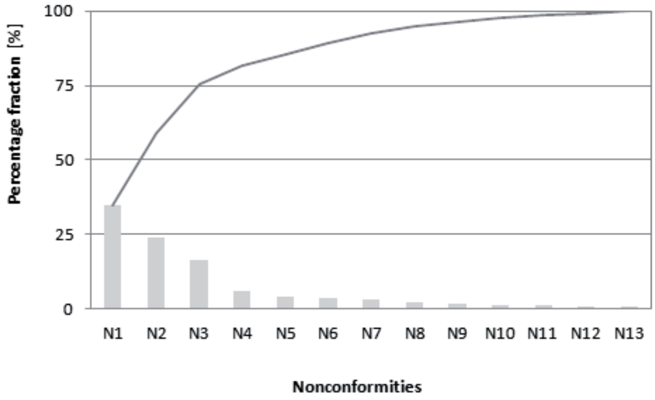

Fig. 2 Pareto – Lorenz diagram for nonconformities identified in the lift track ride chassis frame production.

Nonconformities have been prioritized by using the Pareto-Lorenz diagram. In accordance with Pareto principle it was concluded that 20% of the causes are responsible for 80% of the errors (Borkowski and Selejdak, 2011). It was presented graphically in Fig. 2.

The analysis of the research findings (Fig. 2) shows that three nonconformities constitute 75.3% of all existing nonconformities including: N_1 – improper dimensions after welding, N_2 - pitting after roasting, N_3 – Poor quality of the machined surface.

Crucial advantage of the production control results in the analysed company is the fact that there are rarely identified mechanical damages or deformations of the ride chassis frame due to workers' inattention (Rasouli et al., 2014) The reason for N_1 nonconformity (improper dimensions after welding) is likely incorrectly programmed machine, what is caused by failure to observe instructions or oversight. N_2 nonconformity (pitting after roasting) is also caused by a program error, where the reason is device poor condition and consequently human error. Determining of the relationship between the causes of nonconformities was performed in the form of the relationship diagram (Fig. 3).

Analysing the relationship diagram (Fig. 3), it can be concluded, that low quality of the machined surface is worn machining tool due to lack of maintenance, staff error, failure to observe the instructions. Failure to follow instructions also influenced on occurrence of improperly cleaned surfaces after welding. These causes can be minimized by applying the continuous improvement principle. Adhere to the plans of control, carefully carry out scheduled maintenance of equipment (control frequent cutting tool). Staff training should be conducted.

3 Conclusion

The continuing evolution of the economy forcing companies to adapt to changing conditions, and thus the continuous development. The principles of continuous improvement must be followed at every stage of the manufacturing process and preventive measures cannot be forget. Quality should be taken into account in all areas of business planning, people management, technology use, used procedures, machinery, equipment, etc. All these elements must be continuously improved.

The analysed company is a representative competitive partner in the steel structures. Its competitiveness can be significantly improved after placing greater emphasis on preventive measures and preventive actions. In the long term the resources allocated to preventive actions are much smaller than the costs associated with the repair of the device and a loss in the form of non-compliant with the specifications of the product.

The analysis of the study results showed that during the production process there is a sufficient number of control, what result in the rare low-grade material occurrence. It should be

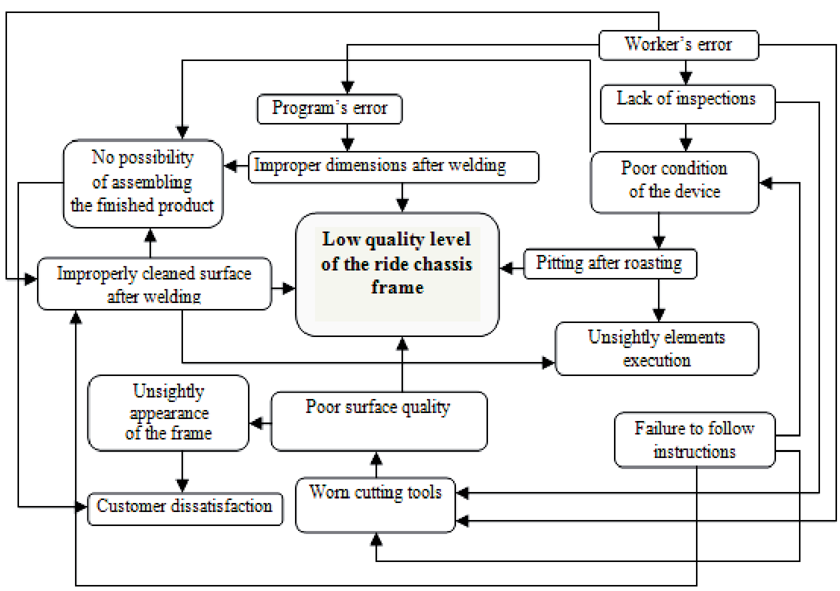

Fig. 3 The relationship diagram for nonconformities identified in the lift track ride chassis frame production.

emphasized, that staff training in compliance with the existing instructions and the time limits of machinery and equipment maintenance plays great role in the quality level maintenance. It seems that the problem in the analysed enterprise is insufficient attention devoted to TPM (Total Productive Maintenance). Occurring nonconformities are often caused by wear and tear of tools, error resulting from the operation of the machine.

Acknowledgement

The project presented in this article is supported by the scientific program of the "Improving quality of processes, products and services" BW 615/201/07. This project is supported by the Polish Ministry of Science and Higher Education.

References

Bajor, I., Babić, D. (2014) Reverse Logistics Retail Level Return. *International Journal for Traffic and Transport Engineering*. 4 (2). pp. 161-170. DOI: 10.7708/ijtte.2014.4(2).03

Barcik, J., Kupka, M., Wala, A. (1998) Technologia metali. (Metal Technology.) In: *Metalurgia ekstrakcyjna*. (Extractive Metallurgy.) Katowice: Silesian University Editing. (in Polish)

Borkowski, S., Ulewicz, R. (2009) *Zarządzanie Produkcją. Systemy Produkcyjne*. (Production Management, Production Systems.) Oficyna Wydawnicza Humanitas, Sosnowiec 2009. (in Polish)

Borkowski, S., Stasiak-Betlejewska, R., Náprstková, N. (2011) The Kaizen philosophy in the aluminium products improvement. *Manufacturing Technology*. 11 (11). pp. 2-5.

Borkowski, S., Stasiak-Betlejewska, R., Torok, A. (2013) Theoretical Investigation of Supply Chain Service Level in Hungary and Poland. *Transport and Telecommunication*. 14 (2). pp. 93-101. DOI: 10.2478/ttj-2013-0008

Borkowski, S., Selejdak J. (2011) Quality of iron casting. In: Borkowski, S., Rosak – Szyrocka, J. (ed.) *Quality Improvement*. Slovakia: Publisher Tripsoft.

Carrillo, P., Chinowsky, P. (2006) Exploiting knowledge management: The engineering and construction perspective. *Journal of Management in Engineering*. 22 (1). pp. 2-10. DOI: 10.1061/(ASCE)0742-597X(2006)22:1(2)

Corejowa, T., Borkowski, S. (2004) *Instrumenty rozwiązywania problemów w zarządzaniu*. (Instruments in the management of problem solving.) Humanitas. Sosnowiec. pp. 42-43. (in Polish)

Ćwiklicki, M., Obora, H. (2009) Metody TQM w zarządzaniu firmą. (TQM methods in the management of the company.) In: *Practical examples of applications*. (Praktyczne przykłady zastosowań.), Warszawa: Poltext. (in Polish)

Czajkowska, A., Kossakowski, P., Stasiak-Betlejewska, R. (2013) Metody zarządzania odlewnią w warunkach złożonego i zmiennego otoczenia. (Foundry management methods in the conditions of a complex and changing environment.) In: Sipa, M. (ed.) *Wyzwania globalne i lokalne zarządzania podmiotami gospodarczymi*. (Challenges of managing global and local economic actors.) Sekcja Wydawnicza Wydziału Zarządzania Częstochowa Univeristy. (in Polish)

Dubey, R., Gunasekaran, A., Ali, S. S. (2015) Exploring the relationship between leadership, operational practices, institutional pressures and environmental performance: A framework for green supply chain. *International Journal of Production Economics*. 160 (2). pp. 120-132. DOI: 10.1016/j.ijpe.2014.10.001

Herz, N., Flämig, H. (2014) Understanding supply chain management concepts in the context of port logistics: an explanatory framework. *Transport*. 29 (4). pp. 376-385. DOI: 10.3846/16484142.2014.982173

Mihály, A., Németh, B., Gáspár, P. (2014) Integrated vehicle control of in-wheel electric vehicle. *Periodica Polytechnica Transportation Engineering*. 42 (1). pp. 19-25. DOI: 10.3311/PPtr.7280

Obora, H., Ćwiklicki, M. (2008) Kompleksowe wykorzystanie 7 nowych metod TQM. (Comprehensive use of 7 new methods of TQM.) *Problemy jakości*. (Quality problems.) 8. (in Polish)

Rasouli, R., Rashidi, M., Hamidi, M. (2014) A Model for the Relationship between Work Attitudes and Beliefs of Knowledge Workers with Their Turnover Intention. *Periodica Polytechnica Social and Management Sciences*. 22 (2). pp. 149-155. DOI: 10.3311/PPso.7626

Sebestyén, Z., Tóth, T. (2014) A Revised Interpretation of Risk in Project Management. *Periodica Polytechnica Social and Management Sciences*. 22 (2). pp. 119-128. DOI: 10.3311/PPso.7740

Singh, R., Gohil, A. M., Shah, D. B., Desai, S. (2013) Total Productive Maintenance (TPM) Implementation in a Machine Shop: A Case Study. *Procedia Engineering*. 51. pp. 592-599. DOI: 10.1016/j.proeng.2013.01.084

Stasiak-Betlejewska, R. (2012) Value engineering as the way of quality problems solving in the steel construction management. *Manufacturing Technology*. 12 (13). pp. 242-247.

Uhrich, S., Tombs, A. (2014) Retail customers' self-awareness: The deindividuation effects of others. *Journal of Business Research*. 67 (7). pp. 1439-1446. DOI: 10.1016/j.jbusres.2013.07.023