

USE OF TOYOTA PRINCIPLES IN QUESTIONS TO ASSESS THE IMPORTANCE OF WORK SAFETY IN THE HEAVY INDUSTRY

doi: 10.2478/czoto-2022-0009

Date of submission of the article to the Editor: 18/11/2021

Date of acceptance of the article by the Editor: 21/03/2022

Marta Jagusiak-Kocik – *orcid id: 0000-0001-6031-9169*

Czestochowa University of Technology, **Poland**

Abstract: The aim of the study was to assess the importance of the factor related with work safety in enterprises from the heavy industry sector. To achieve this aim, a method was used that is based on the principles of the Toyota Production System - the BOST survey. The survey was conducted in 8 heavy industry enterprises located in the Silesian Voivodeship. The paper presents part of the research, including the analysis of one of the questions that relates to the roof of the Toyota house - elements of the enterprise mission. This question includes the concept of work safety. Additionally, the work includes an analysis of the respondents' personal characteristics. The result of the work is the determination of the place of work safety in the analyzed enterprises according to the respondents, which may serve as a guideline in activities improving processes with an emphasis on work safety.

Keywords: work safety, Toyota management principles, BOST survey

1. INTRODUCTION

Occupational health and safety is the state of the conditions and organization of work and any behavior of employees, which ensures the required level of health and life protection against hazards that occur in the work environment (Łańcucki, 2019; PN-ISO 45001: 2018-06; Kowalik, 2020). Issues related to occupational health and safety are comprehensively regulated by European Union directives, while in Poland the labor protection system is based on the sources of law that are indicated in the Constitution of the Republic of Poland and Art. 9 of the Labor Code (Łańcucki, 2019). Effective management of occupational health and safety (Tabor, 2021) largely determines the degree of satisfaction or dissatisfaction of employees with the conditions in which they work. It contributes to their involvement in the improvement process, problem solving or innovation processes (Łunarski, 2012). Occupational health and safety management is of great importance not only due to the importance of these aspects, but also due to the growing awareness of the society (Łańcucki, 2019).

Safe working conditions are conducive to the growth of employees' creativity and transforming their ideas into activities for the benefit of the organization, achieving its goals, triggering internal motivation (Zymonik, et al., 2013) and, consequently, improving market competitiveness (Nedeliakova, et al., 2022).

Occupational health and safety management is an inseparable element of a comprehensive management system based on the quality criterion (Zymonik, et al., 2013). If the OHS system functions properly, it improves the economic performance of the enterprise, thanks to better than before management of processes in which OHS hazards may occur (Niciejewska and Kiriliuk, 2020; Niciejewska, 2021; Woźny, 2020).

The aim of the study is to assess the importance of the factor related to work safety in selected enterprises from the heavy industry sector. For this purpose, the BOST questionnaire was used - a method based on the principles of the Toyota Production System (Jagusiak-Kocik, 2016).

2. METHODOLOGY OF RESEARCH

BOST survey - Toyota management principles in questions, is a method that was created by prof. Stanisław Borkowski. The name "BOST" comes from the first two letters of the author's surname and first name and is legally protected (Borkowski, 2012a; Borkowski, 2012b; Borkowski, 2012c; Borkowski and Chuan, 2009; Borkowski and Shevtsova, 2009). The BOST survey consists of 2 parts: a survey for supervisors and a survey for employees. In this survey, each of Toyota's principles is presented as a set of factors, called areas. The BOST survey can be used both in manufacturing companies and service institutions.

12 sets of factors (areas) are included in the version of the BOST survey used in manufacturing companies. The employee version contains a set of factors describing the elements of the Toyota house roof and rules 1, 2, 3, 4, 6, 7 and 14. The BOST survey version for the supervisors contains a set of factors describing all Toyota management principles and elements of the Toyota house roof. There is a ranking scale in the survey, and respondents rate the importance of a factor on a specific scale.

The BOST survey - Toyota management principles in questions (Borkowski, 2012a; Borkowski, 2012b; Borkowski, 2012c; Borkowski and CHUAN, 2009; Borkowski and Shevtsova, 2009; Liker, 2005; Liker and Hoseus, 2009) was conducted in 8 enterprises from the heavy industry sector located in the Silesian Voivodeship. 279 production employees took part in the survey. In the case of all analyzed enterprises, they constituted over 70% of the staff, which allowed for a holistic view of the analyzed enterprises. Each enterprise, for the purposes of work, has been marked with the symbol "PC" from 1 to 8.

The heavy industry enterprises include:

- PC1 - steelworks department 1 - bar rolling mill,
- PC2 - steelworks department 2 - steel plant,
- PC3 - manufacturer of brake calipers,
- PC4 - manufacturer of glass for the automotive industry,
- PC5 - producer of mining supports,
- PC6 - producer of walls and covers made of trapezoidal sheet metal,

- PC7 - foundry,
- PC8 - producer of steel structures.

From all the questions (sets of factors) of the BOST survey, 1 element (set of factors) related to the Toyota house roof (area E1) - elements of the enterprise mission was selected for a more detailed analysis. The roof of the Toyota house presents the most important goals of each enterprise, which are: the highest quality, the lowest costs, the shortest implementation time, the greatest safety and the highest morale, and the respondents answer the question:

E1. What is the most important in your enterprise? In the box mark 1; 2; 3; 4; 5 (5 - the most important element), and they can choose from the following factors:

- quality (JA),
- costs (KO),
- execution time (CR),
- work safety (BP),
- crew morale (MZ).

In addition, the area E12 was analyzed, which concerns the personal characteristics of the respondents. In the area of E12 (respondent's characteristics), 6 personal characteristics are distinguished:

- gender (MK) - 1 - male, 2 - female,
- education (WE) - 1 - primary, 2 - vocational, 3 - secondary, 4 - higher,
- age (WI) - 1 - up to 25 years, 2 - 26 ÷ 35 years, 3 - 36 ÷ 45 years, 4 - 46 ÷ 50 years, 5 - 51 ÷ 55 years old, 6 - 56 ÷ 60 years old, 7 - 61 ÷ 65 years old, 8 - over 66 years old,
- work experience (SC) - 1 - up to 5 years, 2 - 6 ÷ 15 years, 3 - 16 ÷ 20 years, 4 - 21 ÷ 25 years, 5 - 26 ÷ 30 years, 6 - 31 ÷ 35 years, 7 - 36 ÷ 40 years, 8 - over 41 years,
- mobility (MZ) - current employment is a workplace: 1 - first, 2 - second, 3 - third, 4 - fourth, 5 - fifth, 6 - more,
- admission to work (TR) - 1 - normal, 2 - transferable, 3 - due to better financial conditions

and the surveyed employee answers by marking the appropriate number.

The results were presented in the form of radar charts (for the E12 area) and in the form of histograms of the distribution of ratings for individual factors (for the E1 area). In the paper, for practical reasons (limited space), a detailed analysis of the area E12 and E1 was presented in relation to 1 enterprise, while the responses of the respondents of all 8 enterprises were presented in the summary list of results.

3. RESULTS

In the first analyzed enterprise from the heavy industry sector - steelworks, in the bar rolling mill (PC1), the BOST survey was conducted among 40 production employees. Figure 1 presents radar charts presenting the characteristics of the respondents of this enterprise.

The vast majority of respondents from the analyzed department of the steelworks (Fig. 1a) are men - 36 people. When analyzing the feature of education (Fig. 1b), it can be concluded that 33 respondents have secondary and higher education, and 7 employees completing the BOST survey are employees with vocational education. In

terms of age (Fig. 1c), the largest group are respondents aged 26 to 35 (9 people) and 56 to 60 (8 people). The smallest group of respondents are employees aged 46 to 50 - 4 people. The most numerous group of respondents are employees with work experience (Fig. 1d) from 26 to 30 years (9 people). The mobility of the crew (Fig. 1e) indicates that for the vast majority of respondents, the surveyed steelworks bar rolling mill department is the first (for 14 people) and the second and third (11 people each) place of work, 4 respondents marked the bar rolling mill department as their 4th, 5th or 6th place of work. Admission to work (Fig. 1f) for 24 respondents took place in the normal mode, for the rest it was admission on the basis of transfer (in the case of 7 people) and due to better financial conditions (in the case of 9 people).

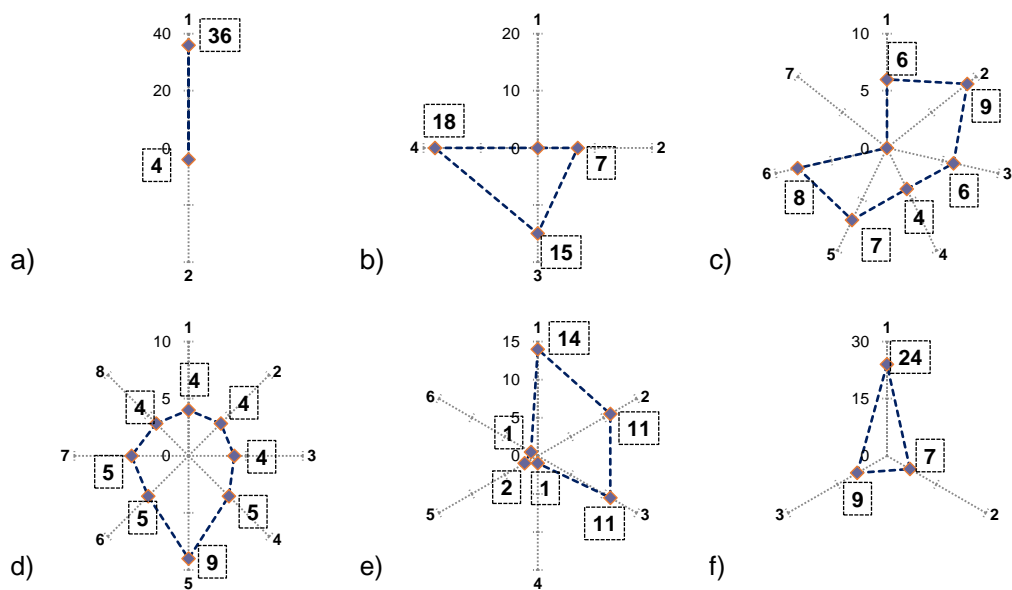


Fig. 1. Radar charts. Characteristics of the respondents (%) taking into account: a) gender, b) education, c) age, d) work experience, e) mobility, f) admission to work. It concerns a steelworks department 1 - bar rolling mill (PC1)

The analysis of the distribution of ratings for the factors describing the mission of enterprises (area E1) in the steelworks department - bar rolling mill (PC1) presented in Figure 2 shows that the factors that are the most important for the surveyed employees in the enterprise it is: quality (ME) and work safety (BP). The quality factor (JA) was given a rating of "4" by 22 respondents, and a rating of "5" by 10 respondents (80%). The importance of this factor is also confirmed by the fact that none of the respondents gave this factor a rating of "1" and "2", which means that there is no person among the respondents who would consider quality (ME) as an unimportant and insignificant factor in the enterprise.

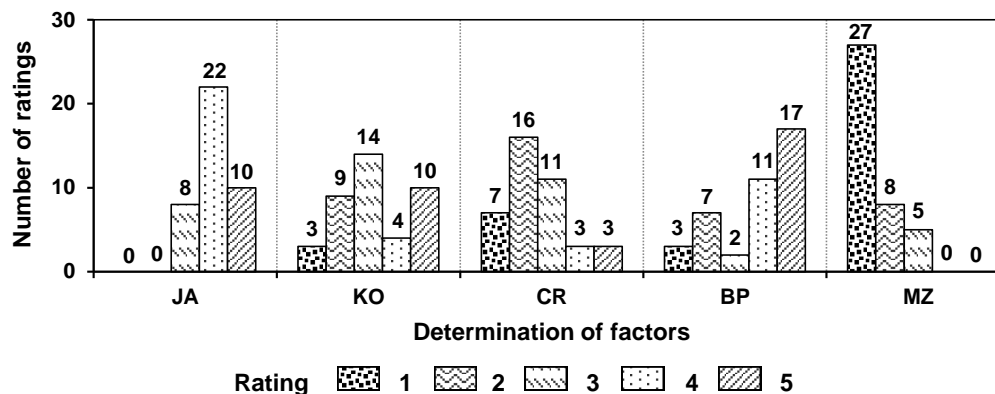


Fig. 2. Toyota house roof elements. Analysis of the distribution of grades for factors of the area E1. It concerns a steelworks department 1 - bar rolling mill (PC1)

Work safety (BP) was rated as important and very important (rating "4" and "5") by 28 surveyed employees (70%). However, 10 respondents rated this factor "1" and "2", thus considering it to be unimportant and of little importance in the examined enterprise PC1. The factor that was assessed by the respondents as the least important in the PC1 enterprise is the crew morale (MZ). As many as 27 respondents (67.5%) gave this factor a "1", considering it invalid in the surveyed enterprise. Ratings "1" and "2" were given by 35 respondents (87.5%). Analyzing Figure 2, it can also be stated that this factor did not receive any ratings of "4" and "5", which means that none of the interviewed employees assess it as important and very important in the analyzed PC1 enterprise.

4. SUMMARY OF RESULTS

In summary, out of 279 surveyed from all heavy industry enterprises:

- 216 people (77.42% of the respondents) are men, and 22.58% of the respondents, i.e. 63 people are women,
- only 10 respondents have primary education (it constitutes 3.58% of all respondents), while a similar group in terms of the size of the group are employees with vocational education (77 people, which constitutes 27.6% of all respondents) and employees with higher education - 25, 81% of all respondents (72 people), and the largest group, constituting 43.01% of all respondents (120 people), are employees with secondary education,
- the largest group (32.62% of all respondents) are employees aged 26 to 35 - 91 people. The next largest group are the respondents aged 36 to 45 (59 people, which constitutes 21.15% of all respondents) and those up to 25 years old - they constitute 13.62% of all respondents (28 people). The smallest group (6 people) are employees aged over 65 - they constitute only 2.15% of all respondents,
- 49 respondents, which is 17.56% of all respondents, have work experience from 6 to 15 years, not much less because 45 people (16.13% of all respondents) are employees with 16 to 20 years of experience, then 15.05% of the respondents are employees with work experience from 21 to 25 years (42 people), and 41 people (14.7% of the respondents) have work experience from 26 to 30 years. The smallest

group (16 people, representing only 5.73% of the respondents) are employees with over 41 years of work experience,

- the largest group (87 people) are the respondents for whom the enterprise they work for is the second place of work - they constitute over 30% of all respondents, the second and third largest group of employees, are the respondents for whom the enterprise is the third place of work (68 people, representing 24.37% of all respondents) and the first place of work (67 people, representing 24.01% of all respondents), and only for 14 people (representing 5.02% of all respondents) a given enterprise, in they work with is the 5th workplace for them,
- almost 60% of the respondents (164 people) were hired to work in the normal mode, and 23.66% of the respondents (66 people) were hired due to better financial conditions

A collective analysis of the results concerning and elements of the enterprise mission (area E1) for enterprises from the heavy industry sector is presented in Figure 3. In order to facilitate the collective analysis of the obtained results, specific assessment zones have been introduced: low-grade zone - rating "1" and "2", the zone of average rating - rating "3", the zone of high ratings - rating "4" and "5",

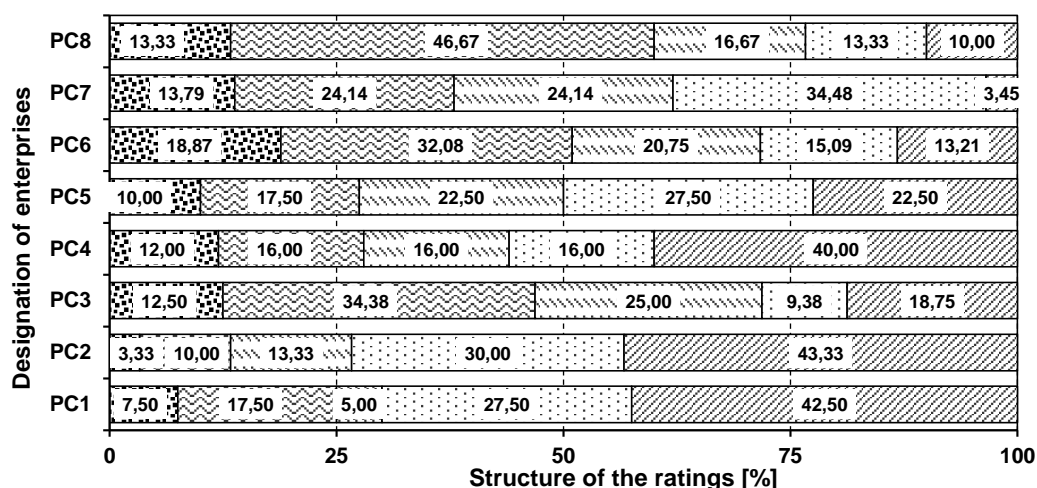


Fig. 3. Summary list of responses [%] - area E1 - heavy industry sector for the work safety factor

Figure 3 shows that:

- for the surveyed employees of both analyzed steel departments (PC1 and PC2), the factor of work safety (BP) turned out to be very important in the enterprise, scoring respectively 70% and 73.33% of the ratings "4" and "5",
- ratings "4" and "5" constitute over 50% and 50% of all votes in PC4 - producer of glass for the automotive industry and PC5 - production of mining casings. However, in the case of PC5, there are slight differences in the structure of assessments, therefore it cannot be stated with certainty whether the occupational safety factor (BP) is important for the surveyed employees,

- respectively 60% and 50.95% of votes for the lowest ratings "1" and "2" were awarded to the factor work safety (BP) in PC8 - production of steel structures and PC6 - production of walls and roofs made of trapezoidal sheet metal.

4. CONCLUSION

The paper presents an analysis of selected sets of factors in the BOST survey - Toyota management principles in the following questions: area E1 related to the mission of enterprises and area E12, i.e. the respondent's characteristics.

279 production employees from 8 heavy industry production enterprises operating in the Silesian Voivodeship took part in the BOST survey.

Figure 4 presents a list of average ratings of the importance of the analyzed sets of factors describing the mission of enterprises (area E1) for the analyzed enterprises.

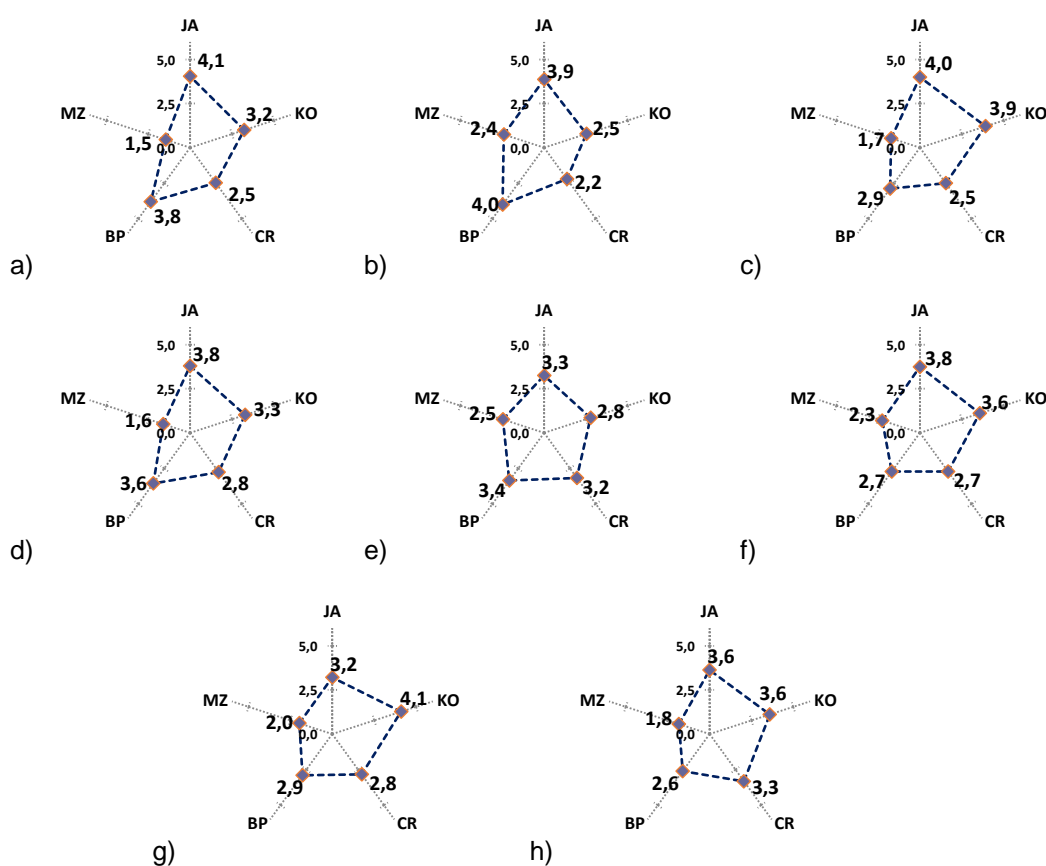


Fig. 4. Comparison of the average ratings of importance of the factors of the E1 area. It concerns enterprises from the heavy industry sector: a) PC1, b) PC2, c) PC3, d) PC4, e) PC5, f) PC6, g) PC7, h) PC8

On the basis of the Fig. 4, the series of importance of the average ratings of factors describing the Toyota house roof (area E1) for all analyzed enterprises were created.

- PC1 JA > BP > KO > CR > MZ (1)
 PC2 BP > JA > KO > MZ > CR (2)
 PC3 JA > KO > BP > CR > MZ (3)
 PC4 JA > BP > KO > CR > MZ (4)

PC5	BP > JA > CR > KO > MZ	(5)
PC6	JA > KO > (CR; BP) > MZ	(6)
PC7	KO > JA > BP > CR > MZ	(7)
PC8	(JA; KO) > CR > BP > MZ	(8)

Analyzing Figure 4 and the series of importance of the average ratings of the factors that describe the Toyota house roof, it can be noticed that in the 2 analyzed heavy industry enterprises (PC2 and PC5), the work safety factor (BP) takes the first place. This factor was ranked second in the importance of the average company ratings PC1, PC4, while the third place - in the importance of the average company ratings PC3, PC6 and PC7. It is also noted that this factor in none of the enterprises took the last place in the rankings of importance of the average ratings.

REFERENCES

- Borkowski, S., 2012a. *Dokumenty zawierające wymyślony termin (TOYOTARYZM) oraz zawierające nazwę i strukturę opracowanej metody (BOST). Potwierdzenie daty*, „AAK” KANCELARIA PATENTOWA s.c, Częstochowa.
- Borkowski, S., 2012b. *Toyotaryzm. Wyniki badań BOST*, Wydawnictwo Menedżerskie PTM, Warszawa.
- Borkowski, S., 2012c. *Zasady zarządzania Toyoty w pytaniach. Wyniki badań BOST*, Wydawnictwo Menedżerskie PTM, Warszawa.
- Borkowski, S., Chuan, T.K., 2009. *Toyotarity. Strategic areas- elements of Toyota house's roof*, Publisher Yurii V. Makovetsky, Dnipropetrovsk.
- Borkowski, S., Shevtsova, O.J. 2009. *Toyotarity. Styles of management*, Publisher Yurii V. Makovetsky, Dnipropetrovsk.
- Jagusiak-Kocik, M., 2016. PhD thesis titled *Determinants of process improvement in manufacturing enterprises*.
- Jagusiak-Kocik, M., 2021. *Determining a Quality Place in the Process of Continuous Improvement Based on the Principle of Toyota Management in Questions - a Case Study* [in:] *Quality Production Improvement. QPI 2021*, Ulewicz, R., Hadzima, B. (ed.), Publisher De Gruyter Poland, Warszawa.
- Kowalik, K., 2020. *The role of safety in service quality in the opinion of traditional and digital customers of postal service*. *Production Engineering Archives*, 26(1) 1-4.
- Liker, J.K., 2005. *Droga Toyoty - 14 zasad zarządzania wiodącej firmy produkcyjnej świata*, Wydawnictwo MT Biznes, Warszawa.
- Liker, J.K., Hoseus, M., 2009. *Kultura Toyoty. Serce i dusza filozofii Toyoty*, Wydawnictwo MT Biznes, Warszawa.
- Łańcucki, J., 2019. *Systemy zarządzania w znormalizowanym świecie*. Wydawnictwo UEP, Poznań.
- Łunarski, J., 2012. *Zarządzanie jakością. Standardy i zasady*. Wydawnictwo WNT, Warszawa.
- Nedeliaková, E., Hranický, M., Valla, M., 2022. *Risk identification methodology regarding the safety and quality of railway services*. *Production Engineering Archives*, 28(1) 21-29.
- Niciejewska, M., 2021. *Occupational health and safety management in terms of special employee needs – case study* [in:] *System Safety: Human - Technical*

Facility – Environment, Ulewicz, R., Nikolić, R. (ed.), Publisher De Gruyter Poland, Warszawa.

Niciejewska, M., Kiriliuk, O., 2020. *Occupational health and safety management in “small size” enterprises, with particular emphasis on hazards identification*. Production Engineering Archives, 26(4), 195-201.

Norma PN-ISO 45001:2018-06. *Systemy zarządzania bezpieczeństwem i higieną pracy -- Wymagania i wytyczne stosowania*.

Tabor, J., 2021. *Ranking of management factors for safe maintenance system based on Grey Systems Theory*. Production Engineering Archives, 27(3) 196-202.

Woźny, A., 2020. *Selected problems of managing work safety - case study*. Production Engineering Archives, 26(3) 99-103.

Zymonik, Z., Hamrol, A., Grudowski, P., 2013. *Zarządzanie jakością bezpieczeństwem*. Polskie Wydawnictwo Ekonomiczne, Warszawa.