



## Analysis of accidents in the context of work safety culture

**A. Kania \***, **K. Cesarz-Andraczke**, **K. Więcek**, **R. Babilas**

Institute of Engineering Materials and Biomaterials, Silesian University of Technology,  
ul. Konarskiego 18a, 44-100 Gliwice, Poland

\* Corresponding e-mail address: aneta.kania@polsl.pl

### ABSTRACT

**Purpose:** The article presents an analysis of accidents in the selected enterprise from the automotive industry. The analysis includes two workplaces: machine operator and warehouseman.

**Design/methodology/approach:** The analysis of accidents at work in a selected production company includes the period from the beginning of 2016 to half of the 2018 year using the method based on the TOH model. This method determines three factors of accident causes: technical, organizational and human (TOH).

**Findings:** In the paper, the workplaces analysis taking into account activities, type of work, working position and accidents at work is presented. The analysis of work accidents includes the age group, work experience etc. The TOH model determines causes related to accidental events.

**Research limitations/implications:** The accidents at work are the result of a low or undesirable safety culture. Because of that, the safety culture should be constantly developed, maintained and continuously improved.

**Originality/value:** Many methods and procedures can be used to investigate accidents at work. The TOH model is one of them. It determines the direct and indirect causes of accidents. Based on them, the corrective actions can be proposed and implemented.

**Keywords:** Safety and health management, Accidents at work, TOH model, Direct and indirect causes of accidents

### Reference to this paper should be given in the following way:

A. Kania, K. Cesarz-Andraczke, K. Więcek, R. Babilas, Analysis of accidents in the context of work safety culture, Journal of Achievements in Materials and Manufacturing Engineering 94/1-2 (2019) 41-48.

### INDUSTRIAL MANAGEMENT AND ORGANISATION

## 1. Introduction

Occupational health and safety culture is a collection of social, organizational, psychological factors that introduce activities to protect health and life at work as well as

outside of work [1]. The safety culture should be constantly developed and maintained at a high level and continuously improved. The following elements should be taken to shaping the safety culture [2]:

- physical work environment (organization of workplace, tools, machines, devices),

- employee attitude (respect the health and safety regulations, cooperation, transfer information to others),
- employee's personality (knowledge, ability, motivation).

Safety culture can be implemented in many ways but it is important that the previously listed elements can influence each other.

Analysis of accidents at work and training employees are the factors shaping the safety culture. An accident can be defined as a result of dangerous conditions and behaviour. The accidents at work are the result of a low or undesirable safety culture [3]. They happen all over the world and several hundred or thousand people die every year (and several million victims become disabled) [4]. That is why it is important for the enterprise and for the employer to seek to minimize the threats [5,6]. The good practice is the elimination of threats at the beginning, it means at source.

An analysis of accidents should be realized in a detailed and reliable way to introduce appropriate corrective actions [7,8]. Thanks to them the probability of similar hazardous events in the future can be reduced. Top management should set a good example of behaviour for employee and should be actively involved in activities to improve health and safety conditions [9].

The work aims to analyse the accidents at work in a selected production company from the beginning of 2016 to half of 2018 using the method based on the TOH model (based on Technical, Organizational and Human factors). The investigation includes two workplaces: machine operator and warehouseman.

## 2. Issues related to the work accidents

An accident at work is a sudden event caused by an external reason, resulting in injury or death, which took place in connection with work [10,11]. The accident without injury to the person is qualified as a potentially accidental event. The suddenness of an event is immediate (unexpected) disclosure of an external cause resulting in the specific effects. A factor that affects humans, but not occurs in the body is defined as an external cause. The relationship with work is normative. It happened when the event occurred [10,12]:

- 1) "during or in connection with the performance of normal activities or instructions of superiors,
- 2) during or in connection with the performance by an employee acting to the benefit of the employer, even without instructions,

- 3) during the time when the employee remains at the disposal of the employer on the way between the employer's office, and the place of performance of the obligation arising from the employment relationship".

The occupational accidents are divided into the following groups [10,12]:

- fatal accident – an accident that resulted in death within a period not exceeding six months of the date of the accident,
- serious accident – it is qualified as a result of a serious injury that has occurred,
- group accident – an accident in which at least two people become injured.

### 2.1. TOH method

Many methods and procedures can be used to investigate accidents at work. One of them is the TOH method. It is based on a checklist of accidents causes and is included in a format of Statistical accident card for accidents at work. This method implies that every accident at work occurs due to technical (T), organizational (O), and human (H) causes. The post-accident team analyses the event according to the diagram is shown in Figure 1. At first, the group analyses the technical, organizational and human causes. The result of an analysis is to determine indirect and the direct causes of accidents at work [13].

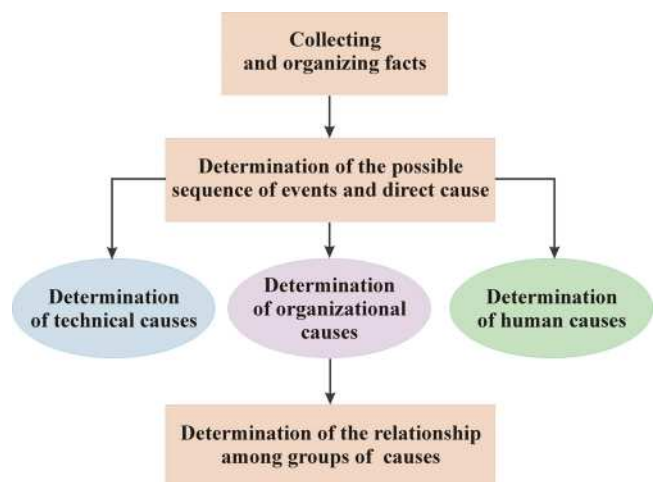


Fig. 1. TOH method [13]

Examples of technical, organizational and human causes is presented in Table 1.

Table 1.

Examples of technical, organizational and human causes [14]

Technical (T)	Organizational (O)	Human (H)
construction defects of an element	lack of supervision	wrong service of machines and devices
insufficient material strength	inadequate selection of personal protective equipment	failure to comply with safety rules
improper use of an agent	inadequate division of labour	performing tasks which do not belong to the scope of duties

### 3. Analysis of accidents at work in the selected enterprise

An analysed enterprise X is a company which belongs to the automotive industry. The enterprise attaches importance to the occupational health and safety. “Zero accidents” is the main goal of the organization. The company implemented Occupational Health and Safety Management System in accordance with PN-N 18001 and OHSAS 18001, and Environmental Management System in accordance with ISO 14001, and the Quality Management System for the automotive industry (IATF 16949).

#### 3.1. Analysis of the workplaces

The analysis of accidents in the enterprise includes two workplaces:

- machine operator,
- warehouseman.

The majority of employees at the workplaces are men, due to the production process that requires lifting, moving products, semi-finished products with a weight above 10 kg used in the production. 710 men and 192 women are employed at the machine operator workplace. The 95 men work in the warehouse, and the 40 men in the maintenance.

At the machine operator workplace the following activities are performed:

- production of components and finished products,
- using: machines, devices and hand tools, power tools,
- setting the process parameters,
- manual transport,
- using transport equipment,
- process and parts control,
- contact and use of chemical substances,
- cleaning the workplace,
- record-keeping, using computer [Team Leader],
- personnel management [Team Leader].

The general characteristics of the machine operator workplace is presented in Table 2. Moreover, the charac-

teristics of the work accidents at this workplace is shown in Table 3.

Table 2.

Work characteristics at the machine operator workplace

mode of operation	multi-shift
hours of work	8 h
break time	20 min
working position	mostly standing
type of work	mainly physical effort

Table 3.

Information about the work accidents at the machine operator workplace

Date of the event	Cause of the event	Effect of the event
04.09.2017	unfortunate movement during downloading a component from the slip	overload and stretching of the back muscles
21.09.2017	worker was struck by a product (oily product) that fell from his hands	sprain of the left ankle joint
13.10.2017	worker was struck by a component that fell from a transport gear	bruise of the metatarsus of the left foot

At the warehouseman workplace the following activities are performed:

- service of the warehouse,
- unloading and loading of materials,
- manual transport,
- quantitative and qualitative control of deliveries,
- using the internal transport devices with mechanical propulsion,
- using hand tools (knives, clamps, scanners, hand printers),

- issue and receive of materials,
- use of chemical substances,
- cleaning the workplace,
- record-keeping, using computer [Coordinator],
- personnel management [Coordinator].

The general characteristics of the warehouseman workplace is presented in Table 4. The characteristics of the work accidents at this workplace is shown in Table 5.

Table 4.

Work characteristics at the warehouseman workplace

mode of operation	multi-shift
hours of work	8 h
break time	20 min
working position	mostly standing
type of work	mainly physical effort

Table 5.

Information about the work accidents at the warehouseman workplace

Date of the event	Cause of the event	Effect of the event
25.05.2016	worker was struck by a container	contused wound of the left forehead area
19.07.2016	worker was struck by a forklift truck with components during unloading of material	contusion
27.09.2016	muscle overload during lifting the package	acute overload pain in the spine
01.06.2017	worker's hands were trapped between the forklift truck with components and the semitrailer truck	contusion of the right metacarpus
15.01.2018	worker was struck by a forklift truck with components	break of the right foot bone

From 2016 to 2018 (first half of 2018 year) 23 accidents were reported (Tab. 6). In this period there was no fatal accidents. The workers employed at machine operator and warehouseman workplaces suffered accidents (Fig. 2).

Table 6.

Number of accidents at work in the analyzed enterprise in 2016-2018

Type of accidents	2016	2017	2018	
light	10	6	6	
hard	-	1	-	
fatal	-	-	-	
TOTAL	10	7	6	TOTAL: 23

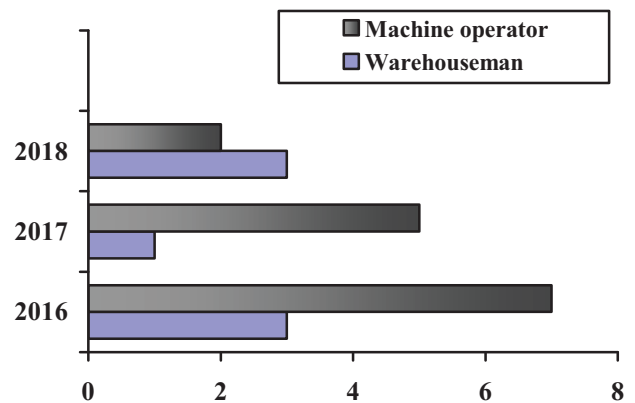


Fig. 2. Number of accidents at the machine operator and warehouseman workplaces in the analysed enterprise in 2016-2018

In the 2016 and 2017 operators of machines suffered over half of accidents. In the 2018 year an increase of the amount of accidents among warehousemen was reported. Increase of the number of accidents at the machine operator workplace may result from a larger number of operators (720) employed in the company in relation to warehousemen (96).

An analysis of the accident due to the employees' age established following age ranges: 18-25 years, 26-30 years, 31-35 years, 36-40 years, 41-45 years, 46-50 years, 51-55 years, 56-60 years.

However, due to the experience at the workplace, three groups of employees were established:

- 1<sup>st</sup> group (0-2 years of experience),
- 2<sup>nd</sup> group (3-5 years of experience),
- 3<sup>rd</sup> group (over 5 years of experience).

When comparing the age range with employee experience, it can be stated that the employees who are more than 31-35 years old and work in a workplace of over 5 years meet with an accident (Figs. 3 and 4).

In the first group there are following causes of accidents:

- insufficient knowledge and skills of employees during the work,
- inefficient training for new employees,
- disregard for basic OHS (Occupational Health and Safety) regulations,
- lack of knowledge about the occurrence of a hazard.

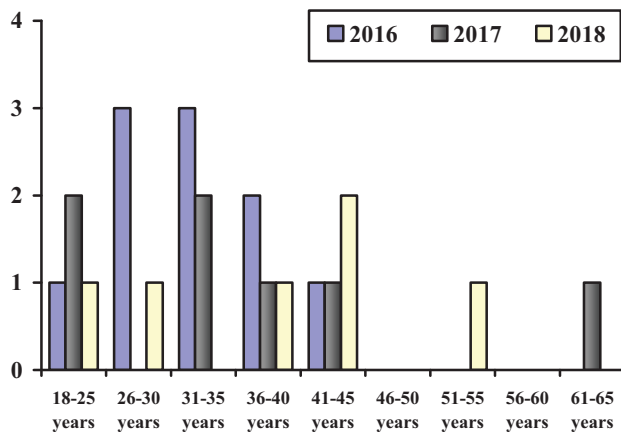


Fig. 3. Number of accidents at work in the analysed enterprise in 2016-2018 depending on the age of employees

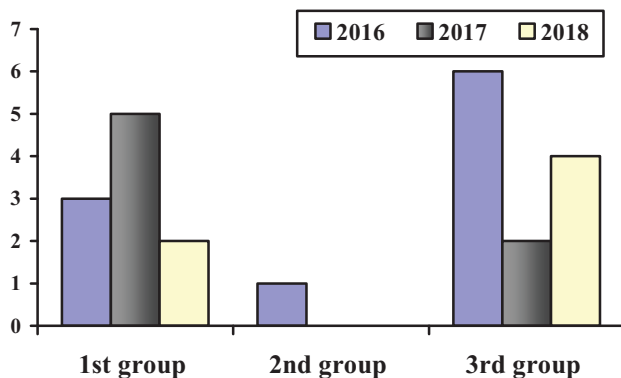


Fig. 4. Number of accidents at work in the analysed enterprise in 2016-2018 depending on the employee experience

In the third group there are following causes of accidents:

- disregarding the hazard,
- disregard the safety instructions,
- doing activities routinely,
- non-use of individual or collective protection measures,
- work monotony.

#### 4. Analysis of accidents at work by TOH method

In the enterprise the analysis of accidents at work is based on the analysis of the causes, called TOH analysis. For technical (T), organizational (O), and human (H) reasons related to accidental events, several examples were selected:

- T – technical:
  - lack of barriers, cover, incorrect security operations,
  - no UR review, incorrect review,
  - consumption of materials/machine parts (poor technical condition),
  - using the machine in the wrong way,
  - wrong tool selection, incorrect use,
  - unserviceable tool,
  - loss of control over the tool.
- O – organizational:
  - bad or no instructions, procedures,
  - lack of supervision (admission of control),
  - lack or incorrect communication (transfer of findings),
  - incorrect organization of the workplace,
  - lack or incorrect training in health and safety at work.
- H – human:
  - lack of knowledge (ignorance of the hazards),
  - failure to comply with health and safety rules/instructions,
  - missing or incomplete competences/qualifications (including research, training),
  - little experience,
  - insufficient focus on the activities performed,
  - non-use by the employee of personal protective equipment/protective devices.

Figures 5-7 summarize the analysed work-related accidents in 2016-2018 taking into account their causes by the TOH method. The data for analysis comes from post-accident protocols.

According to the data presented in Figure 5, the most common, repeated technical causes of the accident are the loss of control over the tool and the lack of barriers or incorrect operation of the protection. This information should be passed to technologists, engineers responsible for the machines. When starting a new machine, they should pay special attention to the use of appropriate protection for a particular type of machine. It should also consider additional protection against losing control of the tool.

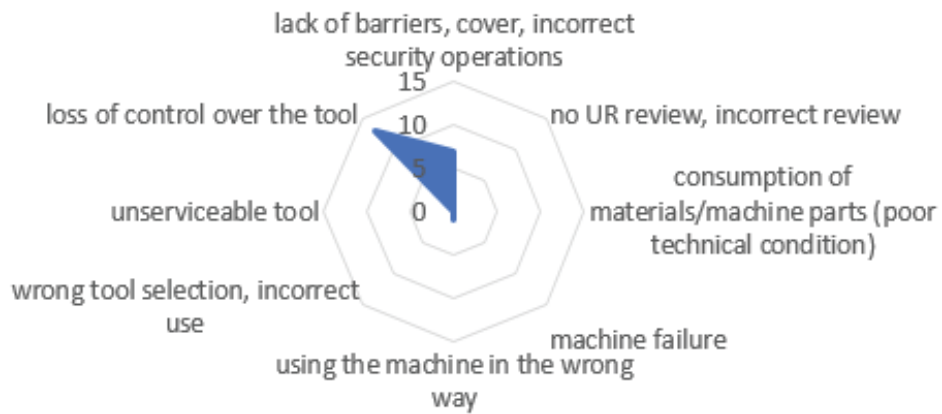


Fig. 5. Analysis of accidents at work in the analysed enterprise by TOH method (Technical causes)

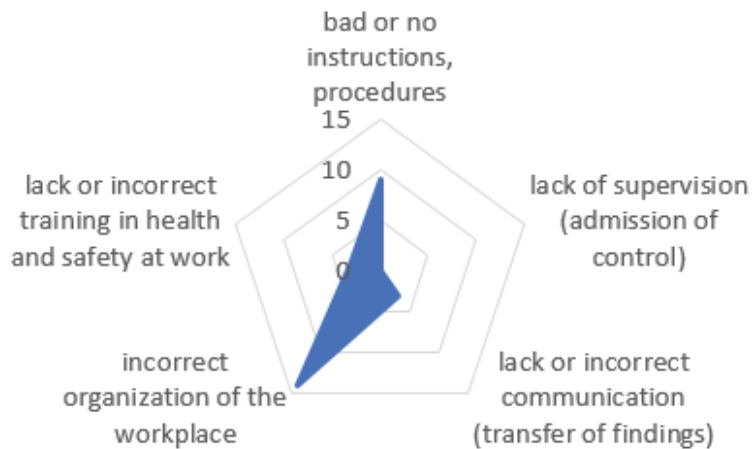


Fig. 6. Analysis of accidents at work in the analysed enterprise by TOH method (Organizational causes)



Fig. 7. Analysis of accidents at work in the analysed enterprise by TOH method (Human causes)

The main organizational problem (Fig. 6) in an enterprise is inadequate organization of the workplace and wrong or lack of instructions, and procedures. The inappropriate organization introduces a mess in the workplace, which means that the employee cannot concentrate on the work and loses time, e.g. searching for a device.

After analysing the most common causes of accidents, the company should introduce or update instructions, and procedures. In addition, it should involve in this corrective action not only those employees responsible for the area, but also the employees of the area.

The group concerning human causes in the analysed enterprise (Fig. 7) has the majority of the mentioned causes. Many of the accidents are caused by dismissal of the hazard by employees or insufficient attention to the activity being performed. The company should introduce additional training on the hazards occurring in the company.

Another way to solve this problem is to mark in the safety instructions places that are particularly dangerous on a given machine (for example, in a photo of the machine it can be mark the place where the hot surface is located).

Thanks to this, each employee will have a clear indication of where is the hazard. Considering the reason in the previous group, which is the lack of instructions, procedures, it can be concluded that the employees do not have sufficient knowledge about the proper transport of the material factor, because no one has previously established the appropriate rules.

## 5. Conclusions

The period from 2016 to first half of 2018 was selected to analyse the accidents in the production enterprise. Two workplaces: machine operator and warehouseman, and 23 accidents at work were analysed. Most accidents were noted in quarters III, IV, because during these periods holidays and feasts take place. Moreover, concentration difficulty at work among employees was observed. The temperature is also increased in the summer period, which negatively affects the performance of activities at workplaces.

The employees who are over 35 years old with a minimum of five years of work experience most suffer accidents than younger people. That is because of routine during the activities. The employees with long years of service do not accept changes at workplaces.

The employees who have worked in the company for at least two years (and even less than one year) contribute to 43% of all reported accidents. They do not have the experience and skills required at the workplace. Most

of them did not work in production. It is important to devote more time, in the beginning, to the employees development.

In the analysed company, there was a problem with manual transport. The employees do not follow the rules of proper parts transport. Manual transport instructions are also missing or they are incomprehensible to employees. A meeting with employees' representatives should be organized. They will help in preparing understandable instructions.

Mistakes made by the employees are the main causes of accidents. They do not attach much importance in the performance of tasks, and for the most part they do their work on "memory". Additional training should be introduced to increase awareness of the risk. Movies about specific threats are a good idea to warn employees against threats. Most of them will better remember the content of the movie than the dry theory presented by a trainer.

## References

- [1] K. Łakomy, K. Nowacki, W. Ociecek, Safety culture of women work in the industrial enterprise, *Science Notebooks of the Malopolska School of Economics in Tarnow* 3/31 (2016) 131-140 (in Polish).
- [2] Z. Żurkowski, Safety culture in enterprise, *Organization and Management* 77 (2015) 323-330 (in Polish).
- [3] R. Studenski, Safety culture in enterprise, *Safety Work* 9 (2000) 1-4 (in Polish).
- [4] J. Rut, A. Pytel, Analysis of accidents at work for the needs of reduction of occupational risk on the example of selected enterprise, *Scientific Works of the Academy Jan Długosz in Czestochowa: Technology, Information Technology, Security Engineering II* (2014) 345-361 (in Polish).
- [5] K. Jørgensen, Prevention of "simple accidents at work" with major consequences, *Safety Science* 81 (2016) 46-58, DOI: <https://doi.org/10.1016/j.ssci.2015.01.017>.
- [6] A. Barkhordari, B. Malmir, M. Malakoutikhah, An analysis of individual and social factors affecting occupational accidents, *Safety and Health at Work* 10/2 (2019) 205-212, DOI: <https://doi.org/10.1016/j.shaw.2019.01.002>.
- [7] J. Ajslev, E.L. Dastjerdi, J. Dyreborg, P. Kines, K.Ch. Jeschke, E. Sundstrup, M.D. Jakobsen, N. Fallentin, L.L. Andersen, Safety climate and accidents at work: cross-sectional study among 15 000 workers of the general working population, *Safety Science* 91 (2017) 320-325, DOI: <https://doi.org/10.1016/j.ssci.2016.08.029>.

- [8] P. Trávníček, L. Kotek, P. Junga, T. Koutny, J. Novotná, T. Vítez, Prevention of accidents to storage tanks for liquid products used in agriculture, *Process Safety and Environmental Protection* 128 (2019) 193-202, DOI: <https://doi.org/10.1016/j.psep.2019.05.035>.
- [9] S.A. Silva, H. Carvalho, M.J. Oliveira, T. Fialho, C.G. Soares, C. Jacinto, Organizational practices for learning with work accidents throughout their information cycle, *Safety Science* 99A (2017) 102-114, DOI: <https://doi.org/10.1016/j.ssci.2016.12.016>.
- [10] The act of 30 October 2002 on social insurance for accidents at work and occupational diseases, *Journal of Laws*.
- [11] E.C. Silva, Accidents and the technology, *Journal of Loss Prevention in the Process Industries* 49B (2017) 319-325, DOI: <https://doi.org/10.1016/j.jlp.2017.07.015>.
- [12] A. Kaźmierczak, Guide for health and safety service – tasks, authority, responsibility, ODDK Publishing House, Gdansk, 2017 (in Polish).
- [13] B. Hola, Qualitative and quantitative modeling of accidents in construction, Wroclaw University of Technology Publishing House, Wroclaw, 2008 (in Polish).
- [14] D. Koradecka, Occupational health and safety, Central Institute for Labor Protection, Warsaw, 2008 (in Polish).