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STATISTICAL ANALYSIS OF ACCIDENTS AT WORK IN THE SELECTED MANUFACTURING ENTERPRISE

Aneta KANIA[1*], Katarzyna CESARZ-ANDRACZKE[2]

[1] Silesian University of Technology, Department of Engineering Materials and Biomaterials; aneta.kania@polsl.pl, ORCID: 0000-0003-0337-1344
[2] Silesian University of Technology, Department of Engineering Materials and Biomaterials; katarzyna.cesarz-andraczke@polsl.pl, ORCID: 0000-0001-9636-4869

Purpose: The aim of the work is to analyze the accidents at work in the selected manufacturing enterprise from automotive industry.
Methodology: The research includes three workplaces: warehouseman, machine operator and transport worker. The accidents investigation was based on the methodology and work accident model developed by the EU Statistical Office (Eurostat) as a part of the European Statistics on Accidents at Work (ESAW) project. This model includes three phases: pre-accident, accident and post-accident.
Findings: In the years 2019-21 in the selected workstations there were noted 25 accidents at work (12 accidents in 2019, 8 accidents in 2020 and 5 accidents in 2021). The accidents at work were analyzed taking into consideration: the type of injury and the part of body injured, the physical activity at the time of the accident, an event that is a deviation from normal practice, and causes of the accident.
Practical implications: The results of the analysis allow to introduce suitable corrective actions, e.g. 5S method, 'shoptalks' about occupational health and safety, suggestion submission program, etc., what influenced the reduction of accidents at work in 2020 and 2021.
Originality/value: The use of statistics for accident at work allows to evaluate the safety state in an enterprise. The statistics also allows to formulate various factors that can be used to evaluate accident rates, workstations with a special risk of accident, realization of various comparative analyzes in the area of investigation of accident situations, and corrective actions towards hazards reduction.

Keywords: accidents at work, ESAW methodology, causes of the accidents, preventive actions.

Category of the paper: Research paper.

1. Introduction

Occupational health and safety in enterprises is a subject of discussion and research conducted by organizations around the world (Alali et al., 2016). Maintaining the proper safety level in a workplace is an important element of the whole company operation (Niciejewska, 2018). Furthermore, conditions created by an employer in the working environment have a large impact on occupational safety (Rahimi Pordanjani, 2015).

The causes of accidents are usually associated with inadequate human behavior and poor work organization (Lu, 2022; Jafari et al., 2019; Dembe et al., 2005). In the work (Vasconcelos et al., 2015), there was shown that accidents at work were caused by organizational factors in the workplace, including irregularities and/or errors in the management. It also was found, that 6.9% of serious and fatal accidents in the construction industry could have been avoided if measures had been taken in the design of equipment. The level of accident rate, apart from the situation on the labor market and the financial condition of companies, is significantly affected by a level of work safety culture and technical culture in enterprises. Mohammed Abubakar et al. conducted an analytic predictive analysis using artificial neural network and survey data from 306 metal casting industry to study the relationship among workplace injuries, safety climate, and safety-related behaviors. Authors reported that an organizational safety climate mitigates workplace injuries. Moreover, safety behaviors amplify the strength of the negative impact of a safety climate on workplace injuries.

Despite the fact that in recent years there has been a downward trend in the number of accidents at work, the prevention of accidents is one of the most important tasks of both employers and employees. To make strategic decisions in the field of occupational safety, deep analyzes of data on accidents at work are used (Szóstak, 2019; Betsis et al., 2019). The article (Szóstak, 2019) presents the results of a statistical analysis covering 630 accidents at work that took place in Poland in 2008-2017 in selected voivodeships. For this action to be effective, it is necessary to know those areas, where there are the most accidents and where they are associated with the most serious consequences, to know the mechanisms of these accidents and their real consequences. The author stated that staff training should be conducted taking into account the needs of each group of employees. Moreover, particular attention should be paid to the group of employees with no or little work experience (up to 1 year). All activities carried out by the employer to ensure health and safety of working conditions are related to accident prevention (Dyreborg, 2022).

First, the concept of an accident at work needs to be identified. The accident at work is considered to be a sudden event which occurred in connection with work caused by an external causes, causing injury or death. Lack of person injury (i.e. no damage to human body tissues or organs due to an external factor) indicates, that an event qualifies as a potentially accidental event (Journal of Laws, 2002). There is lack of obligation to record and analyze information on

potentially accidental events in accordance with applicable law. However, many enterprises that have implemented an occupational health and safety management systems consistently maintain such a register. Nevertheless, it is important, that the analysis of accidents at work was realized in a detailed and reliable manner to implement appropriate corrective actions (Szóstak, 2019; Vasconcelos et al., 2015).

In case of an accident at work, the employer is obliged, among others, to (Polish Labor Code, 1974; Rączkowski, 2009):

- taking actions to eliminate or reduce the hazards,
- providing first aid to victims,
- determining the circumstances and causes of the accident (appointment of an accident team),
- measures to prevent similar accidents at work in the future,
- prepare and archive of an accident documentation (accident report or accident card, statistical card),
- keeping a register of accidents at work.

The established accident team determines the circumstances and causes of an accident, inspects the place of an accident, technical condition of machinery and other technical devices, and protective devices, as well as evaluates the conditions of work and other circumstances that could have had a significant impact on the occurrence of the event.

Analyzing the circumstances of an accident, the accident team should take into consideration (Polish Labor Code, 1974):

- activities which the injured performed or activities belonged to his duties,
- what machines (devices) he operated, which substances or agents he worked with,
- whether he used the required personal protective equipment and other protections,
- whether the protections were functional and properly selected for the duties performed,
- whether the injured respect the health and safety regulations and rules, had appropriate qualifications to perform the work,
- whether the injured had up-to-date training, medical examination and whether he was familiar with the occupational risk at the workplace as well as occupational health and safety instructions, operation of the machine.

After determining the circumstances and causes of the accident, no later than within 14 days from the date of obtaining a notice of the accident, the team draws up the protocol establishing the circumstances and causes of an accident at work. In this report the team performs legal classification of the accident, specifies preventive measures, and verifies the occupational risk assessment at the workstation in which the accident occurred.

Accident report relating to fatal, serious and collective accidents shall be forwarded without delay by the employer to the competent Labor Inspector (Kaźmierczak, 2017).

Based on the approved accident report, the employer is obliged to prepare a statistical card of accident at work. The statistical card for accident at work was introduced by the regulation of the Minister of Economy and Labor of 8 December 2004 concerning the statistical card for accident at work. This regulation has been in force since January 2005. The supplemented accident card at work includes the data of: employer, at which the accident at work occurred, injured person, the consequences of the accident, its course and circumstances, as well as the causes of the accident. The causes of accidents in the statistical accident card are defined as any deficiencies and irregularities that directly or indirectly contributed to the accident. They are closely related to the employee' activities, material (technical) agents, general organization of work and the workstation equipment.

The statistical accident card classifies the accident causes as follows (Węgrzyn, 2017):

1. incorrect condition of the material agent (19 subcategories),
2. incorrect general organization of work (15 subcategories),
3. incorrect organization of the workplace (7 subcategories),
4. lack of material agent or incorrect its use by employee (9 subcategories),
5. not using protective equipment by employees (4 subcategories),
6. incorrect arbitrary behavior of an employee (8 subcategories),
7. psychophysical state of the employee does not ensure safety performance of the work (6 subcategories),
8. improper employee behavior (9 subcategories),
9. other reason.

It should be noted, that most of these 9 categories relate to various types of incorrectly performed actions by the employee, which affect the recording of the causes of accident and the results of statistical analysis.

Currently in Poland, due to the pandemic and the planned adoption of remote work on a permanent basis, additional information will be introduced in the Labor Code and for the purposes of national statistics. It will concern the injured person's work in a remote form. This is to obtain data on possible accidents that have occurred in connection with the performance of work organized in a remote form.

The current statistical card is based on the methodology and model of an accident at work developed by the EU Statistical Office (Eurostat) in the framework of the European Statistics on Accidents at Work (ESAW) project. The ESAW project was launched in 1990, and the ESAW methodology was published by Eurostat in 2001. Member states of the European Union provide data on accidents at work to Eurostat. In connection with the Eurostat system application, a new classification has been made in the statistical cards, including occupations, citizenship, employment status, causes and sources of the accident. Unification of the system allows for comparative analysis of data from Poland and other EU countries (Obolewicz, 2011).

The statistical accident model based on ESAW methodology distinguishes three phases: pre-accident, accident and post-accident (Bojanowski, 2005; Pietrzak, 2007; Eurostat, 2013).

In a pre-accident phase, the employee is taken into account in his broadly understood work environment. The working environment should be understood not only as the place where the victim was at the time of the accident, but also as elements related to the organization of the injured person's work. It should also be noted that all elements of the pre-accident phase are not related to the accident and should be considered as such (Eurostat, 2013).

Accident phase – means the last event that led to the accident. The accident situation is a deviation, non-compliance with the accepted standard. The element associated with deviation is the material agent that caused or was associated with the work process. In the accident phase, it is also important to identify the event that led to the injury.

Post-accident is the last stage in which information is collected regarding: the type of body injured, the number of days unable to work, material losses.

Figure 1 presents the diagram of the statistical accident model based on the ESAW methodology.

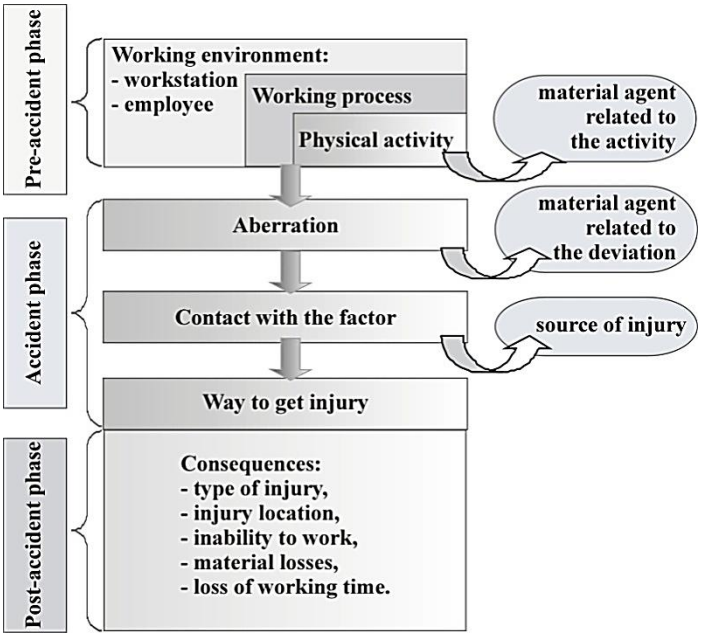

Figure 1. Statistical model of an accident at work based on the ESAW methodology.

Source: Rączkowski B. (2009). OHS in practice. XII edition. Gdansk: Human Resources Consulting and Improvement Center.

As a part of the ESAW project, Eurostat records: fatal accidents at work and accidents at work that result in more than 3 days of absence from work. Moreover, the following variables are taken into account in the ESAW methodology (Eurostat, 2013):

- information about the accident and injured (the economic activity of the employer; occupation of the victim, employment status of the victim; age, sex, and nationality of the victim; geographical location of the accident, the date and time of the accident, size of the enterprise; the working environment, the workstation and the working process),

- information on how the accident occurred, in what circumstances, and how the injuries arose (the specific physical activity at the time of the accident, deviation from normal practice, way in which the injury was incurred, details about associated material agents – there are three variables on material agents: material agent associated to the specific physical activity, material agent associated to the deviation, material agent associated to the contact – mode of injury),
- information on the nature and seriousness of the injuries, the consequences of the accident (the part of body injured, the type of injury, the number of days lost).

The use of statistics for accident at work allows to evaluate the safety state in an enterprise. The statistics also allows to formulate various factors that can be used to evaluate accident rates, workstations with a special risk of accident, realization of various comparative analyzes in the area of investigation of accident situations, and corrective actions towards hazards reduction.

The work describes the principles and practical application of ESAW in a manufacturing company on the example of three workplaces: warehouseman, machine operator and transport worker. The analysis of the work accidents and the victims covers the years 2019 to 2021.

2. Methodology

Based on the model presented in Figure 1, statistical analysis of accidents at work in the selected manufacturing enterprise from automotive industry was presented. Steel car parts are manufactured in the company. The plant consists of: a warehouse, a press shop, a paint shop, a welding shop, assembly and an office part. The enterprise attaches a great importance to the occupational health and safety and keeps a high level of safety culture among employees. It is important for them to be aware of the hazards at the workstations. Due to the nature of the industry, the production in this plant lasts for twenty-four hours a day, seven days a week. Stopping and restarting a production come with enormous costs that no company can afford. Every employee has the required qualifications necessary to work at the workstations. The employee is trained in occupational health and safety before being allowed to work and undergoes periodic training in this area. All new employees undergo general training before being allowed to work. On the other hand, before the work at a given workstation, toolbox talks carried out. Each of the machines/devices in the plant has a technical documentation. The devices meet the requirements of the occupational health and safety, and ergonomics. Their arrangement ensures convenient passageways, free access to them and access to emergency exits. Each device is marked accordingly. Near the machine there is also a manual and a description of personal protective equipment that should be used before starting the work.

The analysis of accident at work includes three workplaces: warehouseman, machine operator, transport worker. In the ESAW methodology, the term workstation is precisely defined. This is the place/workplace occupied by the victim at the time of the accident. Therefore, the work can be permanent or occasional. The term 'usual workstations' should be understood in a restrictive way, always inside the premises of a normal local work unit. It can be a permanent workplace in a workshop, shop, office, etc. (Eurostat, 2013). Another aspect that needs to be defined is the working process. By definition, the working process is actually the main type of work or possibly the tasks that the victim was performing at the time of the accident. Therefore, it must contain a proper description of the type of work and its broadly understood task that the victim was performing at the time of the accident. It should be noted that the work process does not have to be related to the physical activity performed by the injured employee (Eurostat, 2013). According to the ESAW methodology, the working process should be coded according to a two-digit classification (Table 1).

Table 1.
Examples of codes in classification of working process by ESAW methodology

Working process	
Code	**Description**
00	Lack of information
10	All types of manufacturing, production, processing
11	Production, manufacturing process
12	All types of storing
19	Others
20	All types of excavation, construction, repair, demolition
21	Excavation
22	Building of new construction
23	Civil engineering, infrastructures, roads, bridges, etc.
24	Repairing, extending, remodeling of all types of buildings
25	Demolition of all types of constructions
29	Others

Source: European Statistics on Accidents at Work (ESAW). Summary methodology. Eurostat European Commission, 2013.

In order to identify the activity during which the accident occurred, it is important to analyze the ordinary working day of the victim. In the analyzed case, at the warehouseman workstation the following activities are carried out:

- unloading and loading material,
- issuing and receiving materials,
- supply control,
- warehouse operation, computer operation, record keeping,
- handling of transport devices,
- manual transport,
- use of chemical substances,
- cleaning the warehouse.

Warehouseman performs a work 8 hours a day. It is, above all, work in a standing position that requires considerable physical exertion.

The activities performed at machine operator workstation include:

- service of machines, tools, including hand tools,
- handling of transport equipment and transport of parts,
- set of process parameters,
- production of components,
- process control,
- cleaning job,
- keeping records and computer skills,
- use of chemical substances,
- personnel management.

The work at the machine operator lasts for 8 hours a day. It is primarily work in a standing position, which requires considerable physical effort.

Activities carried out at the transport workstation are following:

- repair of machines, devices and production stands,
- connection of machines, equipment modifications, retooling and setting machines and production stations,
- operating machines, devices and hand tools, power tools,
- welding works, works at heights,
- manual transport,
- servicing of in-house transport equipment with a mechanical drive,
- use of chemical substances,
- record-keeping and maintenance of computer,
- clearing job,
- personnel management.

The transport worker works 8 hours a day, usually in a standing position. These works require considerable physical exertion.

According to the ESAW methodology, the so-called specific physical activity at the time of the accident are specified. In other words, how the incident differed from normal practice, the exact manner in which the injury occurred, and details of any material factors involved (Eurostat, 2013).

The scope of the research, based on the statistical ESAW model, was narrowed to the following categories of analysis of the statistical accident card:

- the type of injury and the part of body injured,
- the physical activity at the time of the accident,
- an event that is a deviation from normal practice (state),
- causes of the accident.

The results of the analysis should provide the basis for the enterprise to implement additional corrective actions. The analyzed enterprise performs the 5 Why analysis after each accident. Such an analysis allows to notice additional causes of an accident that were not taken into consideration during the post-accident procedure.

The next phase according to the ESAW methodology is the accident phase (Figure 1). In this section, materials agent related to the deviation are specified. There are three variables that provide information about the material factors involved in an accident (Eurostat, 2013):

- the 'material agent' associated to the 'specific physical activity',
- the 'material agent' associated to the 'deviation',
- the 'material agent' associated to the 'contact – mode of injury'.

In practice, usually all three types of agents can be differ significantly. There are also cases identical or significantly related to each other. In some cases there is no 'material agent' to be recorded or encoded. According to the ESAW methodology, if several 'material agents' are revealed with a (last) 'deviation', the last 'material agent' involved, i.e. effective at the time of contact causing the damage, should be recorded (Eurostat, 2013). The last group – material agent associated to the contact with the tool, object or instrument with which the victim of the incident came into contact. It can be both physical and psychological. This is the main 'material agent' associated with the injury. If there are several 'significant agents' associated with the injury, the 'significant agent' with the most severe injury should be recorded (Eurostat, 2013).

The last phase of the ESAW statistical model is the post-accident phase. It covers the scope and type of consequences of the analyzed accident at work.

3. Results and Discussion

3.1. Analysis of accidents at work at the selected workplaces

The first analyzed group of the accidents at work, from the statistical card, is the type of injury with its location. For the analyzed case (analyzed workplaces) the injury codes are summarized in Table 1. Analyzing the Table 2, it can be concluded that the most repeated are the following types of injuries:

- wounds and superficial injuries (code 010),
- bone fractures (code 020),
- dislocations, sprains and strains (code 030).

However, it should be noted that there is a significant difference in the number of these types of injuries. Most accidents, which resulted in wounds or superficial injuries were reported. The reason for this type of injury may result from the employees' contact with devices or tools

that may cause this type of injury or wound, e.g. contact with knife used to open the box with parts. In addition, some machine have sharp components. If the employee does not keep enough concentration, this can cause injury.

Table 2.
Injury codes according to the statistical card

Code	Type of injury	A year of accidents			TOTAL
		2019	2020	2021	
000	Unknown or unspecified	1	0	0	1
010	Wounds and superficial injuries	8	3	2	13
020	Bone fractures	1	2	1	4
030	Dislocations, sprains and strains	1	2	1	4
040	Traumatic amputations (loss of body parts)	1	1	0	2
070	Poisonings, and infections	0	0	1	1
	TOTAL	12	8	5	25

Source: European Statistics on Accidents at Work (ESAW). Summary methodology. Eurostat European Commission, 2013.

The next step of the ESAW analysis was to determine the location of the type of injury (the part of body injured). In the analyzed enterprise collected data are presented in Table 3. The codes for the location of injuries by individual body parts, developed according to the statistical accident card were presented in Table 4.

The analyzed data presented in Tables 3 and 4, and in Figure 2 show that the injuries are often located in the area of upper extremities – hand (code 53), especially of fingers (code 54).

Table 3.
The results in the placement of trauma in the 2019-2021

Location of the injury	Year of accidents		
	2019	2020	2021
Head/face	2		1
Lower extremities	1		1
Upper extremities	9	8	3

Table 4.
Injury location codes for individual body parts

Code	Location of the injury	Code	Location of the injury
12	Facial area	54	Finger(s)
19	Head	58	Upper extremities, multiple sites affected
30	Back, including the spine	59	Upper extremities, other parts not mentioned above
52	Arm, including elbow	63	Ankle joint
53	Hand	64	Foot

Source: European Statistics on Accidents at Work (ESAW). Summary methodology. Eurostat European Commission, 2013.

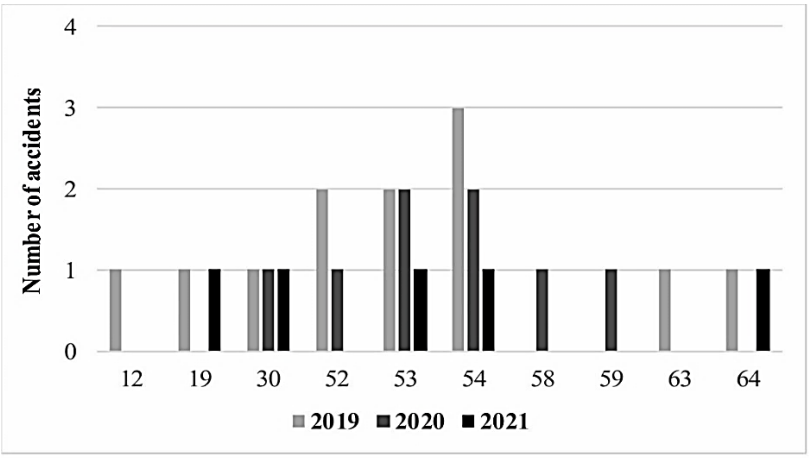

Figure 2. Location of the injuries for individual body parts in the years 2019-2021.

Finger injuries are a result of the production process, which mainly consists of manual work using machines, tools or manual means of transport. Injuries of arm, including elbow (code 52) usually occur at warehouse position like back injuries, including the spine (code 30). Work at the warehouse workstation mainly consists of loading, unloading materials or manual transport actions. The job specifications at this position increase a probability of such injuries. But this is not the only position with those identified hazards. Machine operators also have similar accidents, but with a reduced frequency.

Analyzing the collected data, it can be concluded that foot injuries usually occur during manual transport works. Transport of parties from one position to another is an example of such injuries. Traumatic amputation is connected with a machine operator and this accident was classified as a serious accident.

3.1.1. The activities performed by the victims at the time of the accident

For a better understanding of the course of the accident, according to ESAW model, the focus on the activities performed by the injured at the time of the accident was made. Explanations of the codes from the statistical card for these activities are presented in Table 5.

Table 5.
Type of physical activities performed by the injured at the time of the accident

Code	Type of activities	Code	Type of activities
12	Feeding the machine, unloading the machine: supplying/ receiving materials, semi-finished products, products, etc.	**51**	Carrying vertically – lifting, raising, lowering an object
13	Monitoring the machine, operating or driving the machine	**52**	Carrying horizontally – pulling, pushing, rolling (an object)
31	Driving a means of transport or operating machines and other self-propelled mobile devices	**53**	Transporting a load – carried by a person
41	Manually taking hold of, grasping, seizing, holding, placing – on a horizontal level	**61**	Walking, running, going up, going down, etc.
42	Tying, binding, tearing off, undoing, squeezing, unscrewing, screwing, turning	**65**	Getting up, pitting down
45	Opening or closing the box, package, etc.		

Source: European Statistics on Accidents at Work (ESAW). Summary methodology. Eurostat European Commission, 2013.

The activities performed by the workers (numerically presented) in the years 2019-2021 are presented in Figure 3. It can be stated that the workers at the time of the accident generally supplied or received material or component used in the production process from each other (code 12). These workers were usually machine operators. They constitute 80% of the injured belonging to the group of 12. The reason for the fall of the production part may be the lack of sufficient knowledge about the transport of such parts. This is confirmed by the fact that 4 injured workers have a small seniority in the company (up to half a year). They do not yet have sufficient skills and experience. The company should focus more on training new machine operators or, if possible, limit the work at the workstations where many activities are related to the transport of the parts.

The next, most often repeated actions that occurred at the time of the accident were those related to a vertical or horizontal transport (codes 51 and 52). The warehousemen and machine operators are injured from these groups. But more accidents were noted at the warehouse workstation. In the both positions, the workers are involved in transport. The main causes of the accidents are rush and insufficient focus on the action being performed. Moreover, the company imposes increasingly higher production standards, which means that workers do not comply with the proper transport requirements. They do not transport the one part, as is in the instruction, but they transport two parts at the same time, which speeds up the task, but it is the cause of the accident.

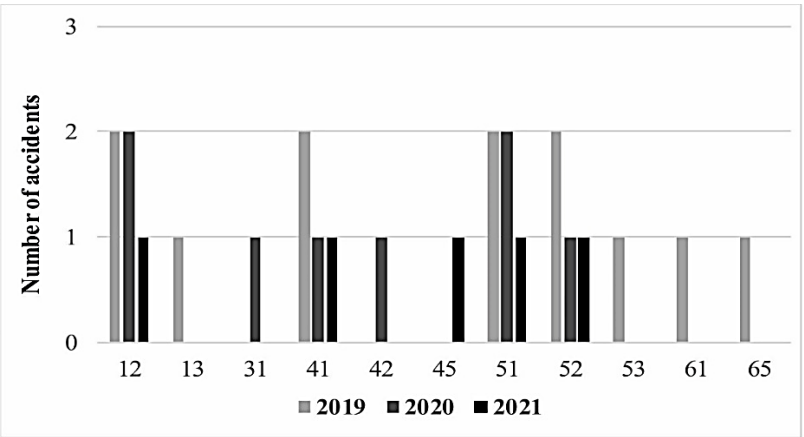

Figure 3. The activities performed by the victim at the time of the accident in the years 2019-2021.

The activities performed during the accident, classified with code of 41 (manually taking hold of, grasping, seizing, holding, placing – on a horizontal level), are related to the injured who worked as the machine operators.

The workers employed at transport workstation represent a smaller part of the analyzed research group. During the analysis, it was found out, that they performed the activities of 13 – monitoring the machine, operating or driving the machine, and 42 – tying, binding, tearing off, undoing, squeezing, unscrewing, screwing, turning, etc. Based on the above data, it was stated that the activities performed at the time of the accidents coincide with the job specifications in the analyzed manufacturing enterprise.

3.1.2. An incident that is a deviation from normal practice

Deviation should be interpreted, according to ESAW model, as an incident that causes the disturbance of the normal course of the work process, which results in an accident. In many cases, such an incident is not connected with the activity which was performed by the injured at the time of the accident. The reason for choosing this group for analysis was to check where in the system there is a nonconformity that causes the accidents. Removal of such 'deviations' from the normal practice may in the future reduce the number of accidents or at least decrease the severity of the accidents.

The selected codes with their explanation concerning incidents that are deviation from the normal practice are presented in Table 6.

The analysis of incidents with deviation from the normal state can be constricted (Figure 4). For many accident events, lack of information about these events (00) or the incident is not specified in the accident statistical card (49).

In addition, a major proportion of incidents is associated with:

- the loss of control of object (44),
- the loss of control of machine (41),
- the loss of control of means of transport (42).

Table 6.
Incident codes that are deviation from normal practice according to the statistical card

Code	Code explanation	Code	Code explanation
00	No information	**49**	Other, unspecified deviations in the group (loss of control of machine)
33	Slip, fall, collapse of material agent – from above (falling on the victim)	**61**	Walking on a sharp object
35	Slip, fall, collapse of material agent – on the same level	**64**	Uncoordinated movements, spurious or untimely actions
41	Loss of control (total or partial) – of machine (including unwanted start-up) or of the material being worked by the machine	**69**	Other, unspecified deviations in the group of body movement without any physical stress
42	Loss of control (total or partial) – of means of transport or handling equipment (motorised or not)	**71**	Lifting
44	Loss of control (total or partial) – of object (being carried, moved, handled, etc.)	**72**	Pushing, pulling

Source: European Statistics on Accidents at Work (ESAW). Summary methodology. Eurostat European Commission, 2013.

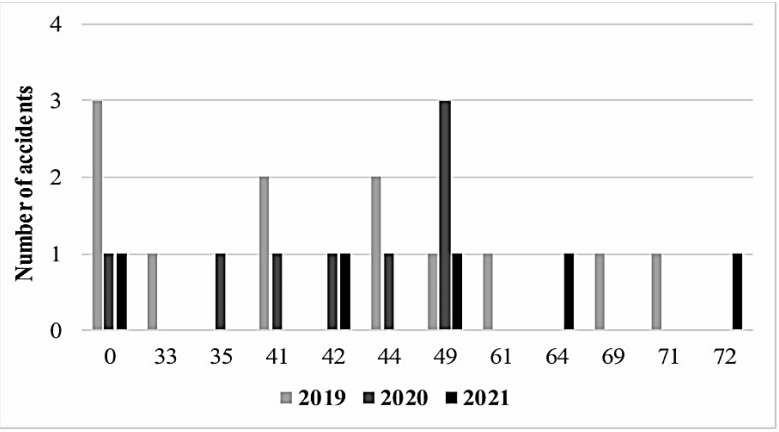

Figure 4. The incident that is a deviation from normal practice in the years 2019-2021.

The monotype of the work decreases the concentration on the actions performed, what can increase the probability of losing control of object, machine. Therefore, it is important that employees rotate to another operations or a machine from time to time. This allows to overcome the routine and also engages employees to work. Thanks to rotation, employees are trained to perform many operations, which make them more flexible. Change of position also allows to meet other employees, and it is easier to work as a team.

As a result of the analysis, it was observed that the loss of control of machine (code 41) is associated with the workers employed in the company over 5 years. Their mistakes could be due to the long working time at one workstation which caused they were too confident in their skills.

3.1.3. Event causing injury

An injury event describes the way in which the injured worker has suffered an injury. The results of these investigations may be the basis for implementation of a new, additional corrective actions in the enterprise that were not previously considered. Table 7 summarizes the selected codes classifying events that are deviations from the state with their explanation.

Table 7.
Codes for the events caused an injury according to the statistical card

Code	Event causing injury	Code	Event causing injury
31	Vertical motion, crash on or against (resulting from a fall)	**51**	Contact with sharp material agent (knife, blade, etc.)
32	Horizontal motion, crash on or against	**61**	Trapped, crushed- in
39	Other, unspecified contact in the group of horizontal or vertical impact with or against a stationary object (the victim is in motion)	**62**	Trapped, crushed- under
42	Struck – by falling object	**63**	Trapped, crushed-between
44	Struck – by rotating, moving, transported object, including vehicles	**64**	Limb, hand or finger torn or cut off
45	Collision with an object, including vehicles – collision with a person (the victim is moving)	**71**	Physical stress – on the musculoskeletal system
49	Other, unspecified contact in the group of struck by object in motion, collision with		

Source: European Statistics on Accidents at Work (ESAW). Summary methodology. Eurostat European Commission, 2013.

According to data presented in Figure 5, in the analyzed enterprise in 2019, 33% of all accidents were caused by a contact with sharp material agent, e.g. knife (code 51).

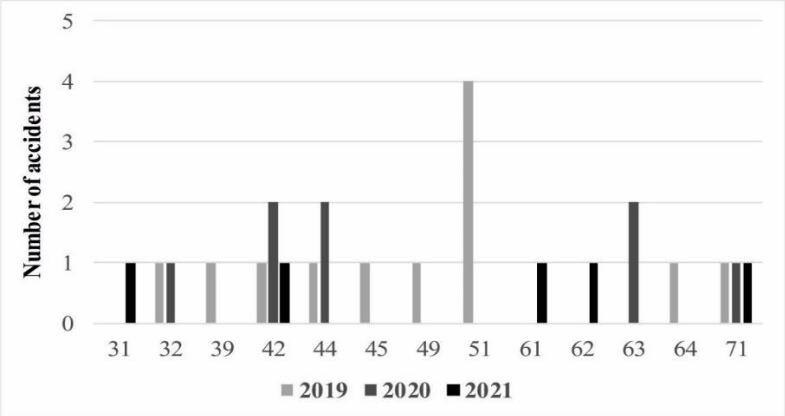

Figure 5. Codes for the events causing injuries according to the statistical card in the years 2019-2021.

This group of injured workers have been working in the company for over 5 years. The workers, probably, did not keep their concentration. They performed this activity routinely, ignoring the hazard. After the implementation of 'safety knives' and training of employees, similar events did not occur in other years.

At the turn of 2019/2021, there was often accidents in which workers were injured as a result of being struck – by falling object (code 42) or by rotating, moving, transported object, including vehicles (code 44). In both cases, the events concerned the transport of production parts. The high number of similar accidents means that employees have limited awareness about the hazard or they do not respect the health and safety rules. Another reason may be the lack or unclear instructions for transport works. If an employee does not have sufficient knowledge and skills, he is more exposed to an accident.

In 2020, two accidents indicated as being trapped or crushed between a given factor (code 63), resulting in a finger injury were observed. In the both cases, the employees did not work in the company for one year. This may suggest that they did not have sufficient skills to operate the machine. The musculoskeletal load (code 71) causing the injury is repeated at least once each year.

3.1.4. Causes of the accidents

Definition of the causes of accidents at work can be present as all deficiencies or irregularities that directly or indirectly contributed to the occurrence of an accident at work, taking into account material agents, work organization and workspace (Eurostat, 2013). The analysis of this category of the statistical card is one of the most important part of the investigations. The analysis results will allow to introduce corrective actions that can eliminate the repeated causes of accidents at work. It also creates a chance that a similar situation will not occur in the future. In the statistical accident card can be selected more than one cause of an accident.

Selected codes of the causes of accidents at work with their explanation at the turn of 2019/2021 were collected in Table 8.

Table 8.
Codes of the causes of accidents at work according to the statistical accident card

Code	Code explanation	2019	2020	2021	Total
059	Other, unspecified material defects	1			**1**
061	Overexploitation of material agent		1		**1**
101	Inappropriate division of work or task layout		1		**1**
119	Other, unspecified irregularities related to the overall organization of work	1			**1**
123	Improper distribution and storage of work instruments (raw materials, intermediate products, products, etc.)	1	1	1	**3**
139	Other, unspecified irregularities of workstations organization	1			**1**
147	Inadequate fit, mounting, hanging		1		**1**
225	Insufficient focus on the realized action	3	1	2	**6**
226	Surprise by an unexpected event	3	2	1	**6**
227	Improper pace of work	2	1	1	**4**

Source: Pietrzak, (2007). *Analysis of accidents for prevention needs*. Warsaw: National Labour Inspectorate.

The results from Table 7 show, that a frequent causes of the accidents at work are:

- insufficient focus on the realized action (code 225),
- surprise by an unexpected event (code 226),
- improper pace of work (code 227).

From the above analysis, it can be concluded that the main cause of the accidents at work is due to the mistakes done by the employee. According to data from the Polish Central Statistical Office (CSO) about the causes of accidents at work in 2020, 60.8% of accidents were caused by an inappropriate employee behavior. This indicates that a similar problem exists in many other companies. The machine is not responsible for an accident but the employee.

The results presented in Table 7 also indicate that the cause of the accidents often was the improper distribution and storage of work instruments (code 123). This information should be a clue for the company that a reorganization of the workstations is necessary.

4. Preventive and corrective actions

In the analyzed enterprise the number of accidents at work in 2020 and 2021 is successively reduced (Table 2). This is because of the preventive and corrective actions undertaken by the management of the enterprise by the end of 2019. In addition to initial and periodic trainings, the health and safety department started organizing ‘shoptalks’ about OHS. Important safety information was given on the bulletin board. Weekly audits carried out by the health and safety department allowed to check all areas in terms of safety and employees’ knowledge on the

hazards occurring at workstations. If in a given area there is low risk awareness, then supervisor is obliged to conduct an additional training for employees. Top management also realized its own audit based on a prepared check-list. Such audits are a good example for employees and show that management is also involved in building a safety culture. The employees are kept informed about new hazards in this way. Moreover 5S principles were implemented at the workstations at the beginning of the year 2020. The 5S program is a collection of methods and techniques that are developed to keep a well-organized, clean and safe workstation (Veres et al., 2018; Costa et al., 2018). The motto of the method is 'a place for everything and everything in its place'. The 5S method owes its name to five successive steps leading to a correctly organized workstation, when each of these five stages start with 'S': sort, set in order, shine, standardize, and sustain. A lack of order at the workstations made the employees work more difficult what led to mistakes. That is why trainings in the scope of the 5S method were introduced for employees and managerial staff. The management also implemented a suggestion submission program. Each employee can submit its suggestion, e.g. on safety. Once a month, the commission which was appointed checks the suggestions and selects the best individual or group change proposal. The awarded person or group of employees receive a cash prize, that contributes to raising awareness and care for the occupational safety state in the company.

5. Conclusions

In this work the statistical analysis of accidents at work according to the ESAW methodology in the selected automotive enterprise was presented. In particular:

- collected data providing reliable information on working conditions at workplaces, like: warehouseman, machine operator and transport worker;
- defined areas which were characterized by the highest number of accidents at work – that was manual transport work, including vertical or horizontal transport. This applied to the positions of warehousemen and machine operators. The accidents often were associated with the improper distribution and storage of work instruments;
- identified areas where accidents at work were associated with the most serious health consequences for employees – it can be concluded that foot injuries usually occurred during manual transport works. The most serious accident was traumatic amputation and it was connected with a machine operator;
- specified, that probable causes and mechanisms of identified accidents at work were the mistakes done by the employee. The monotype of the work decreases the concentration and then workers loss of control of machines. That is mechanism for workers employed in the company over 5 years.

All the actions carried out enabled the selection of effective tools and corrective, and preventive actions adequate to the current working conditions.

Summarizing, statistical data on accidents at work are one of the basic sources of information on working conditions used to develop policies in the field of occupational safety both in Poland and at the European Union level.

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