ANALYSIS OF THE ACCIDENTS RATE CHANGES IN INDUSTRY SECTORS USING THE METHODOLOGY OF RANKING

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Abstract:

The accident rate is a key indicator of work safety performance in particular sectors of industry in Poland. The proposed methodology for ranking respective sections of the Polish Classification of Activities (PKD) sections is applied to assess changes in accident rates in Poland before the COVID-19 epidemic, during the state of epidemic and immediately after that period. The analysis uses data for the years 2018–2024 furnished by Statistics Poland (GUS), covering three periods: before the epidemic (2018–2019), during the state of epidemic (2020–2022) and in the period that followed (2023–2024). All accident rate indicators recalled in the study are expressed per 1,000 workers, including the total number of injured persons, the number of fatalities and those injured in severe accidents, and the number of days of work incapacity. Finally, an all-embracing accident rate was calculated and a ranking of PKD sections was compiled, enabling a comparison of risk levels and their changes over time. The results indicate a varied risk profile across the analyzed sectors. The most significant decrease in the total accident rate was found for the 'Agriculture, forestry, hunting and fishing' section, whilst the largest increase is reported in the 'Mining and quarrying' sector. However, the increase reported in the mining sector should be interpreted in the context of major mining accidents that occurred in 2022, which clearly indicates that the observed changes cannot be directly attributed to the COVID-19 epidemic. In several sectors, including Water supply; wastewater and waste management; and Land reclamation, a growing trend in the total accident rate was observed throughout the entire period, with this sector demonstrating the highest rate of increase. A comparative study of changes in the total accident rate over the analysed periods does not indicate the impact of the COVID-19 epidemic on accident rates in the Polish industry.

Nevertheless, the analysis fully attested to the adequacy of the proposed methodology for assessing changes in risk levels at various stages of business operations. The ranking method can become a useful tool for cross-sector comparisons, for monitoring changes in risk levels over time, and for identifying sectors that require an in-depth analysis of root causes of accidents and targeted preventive measures.

Keywords: workplace safety, accident rate, Covid-19 epidemic, rankings

1. Introduction

1.1. Accidents at work in Poland

In the Polish legal system an accident at work is defined as a sudden, work-related event arising out of an external factor and resulting in an injury or death, The full legal definition is provided in the Act of 30th October 2002 on social insurance in respect of accidents at work and occupational diseases (Journal of Laws of 2002, No199, item 1673, as amended). Furthermore, an accident at work is recognised as an incident that occurred, *inter alia*, whilst an employee is engaged in occupational duties, when following instructions from their superiors, while performing tasks for the employer, even without being expressly directed to do so, and whilst the employee remains available for work-related duties, e.g. on the way to and from the workplace. Thus formulated definition provides the legal framework for recognising incidents as accidents at work. In regard to their consequences, accidents are categorised as fatal (whereby death should occur within 6 months from the incident), severe accidents (resulting in major injuries or producing ill health effects) and group accidents (involving at least 2 persons injured).

Consequently, the relevant regulation specifies the post-accident procedure for employers to follow (Journal of Laws 2009, No. 105, item 870) obligating them to, inter alia, to produce the accident statistics report once the post-accident investigation has been concluded. Data provided in the accident statistics reports are collected, statistically-treated and published by the Statistics Poland (GUS). These data include the type of business activity, the age and gender of those injured, their occupation, length of service, the circumstances and root causes of the accident, and the nature of the injury. Statistics Poland (GUS) provides the indicators relating to frequency and severity of accidents, enabling cross-comparisons between sectors and provinces (voivodeships) (GUS, 2025).

The workplace accident statistics are used to identify the root causes of incidents, implement appropriate preventive measures and assess their effectiveness, and to monitor changes in accident rates over time. The analysis of GUS statistics of workplace accidents brings to light the impacts of other circumstances, such as the COVID-19 epidemic, on workplace safety performance, and that is the subject of the present study.

1.2. The impacts of the COVID-19 epidemic on work safety performance

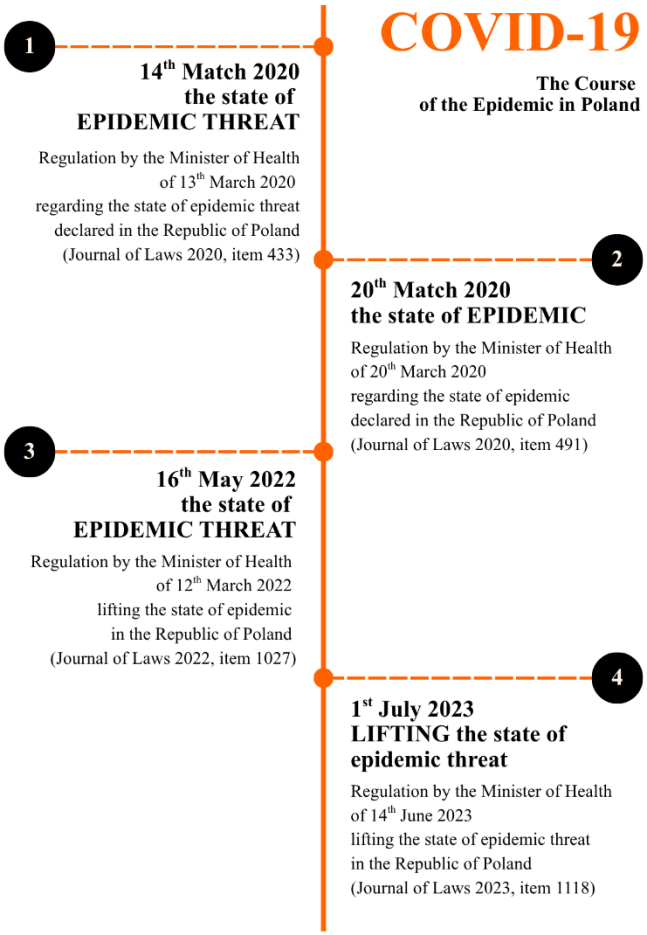

Fig. 1. Government regulations having relevance to the Covid-19 epidemic threat and epidemic conditions
Source: compiled by the Authors

The outbreak of the COVID-19 pandemic led to certain restrictions being imposed by the government to contain the SARS-CoV-2 virus and to respond to emerging crisis situations, pursuant to the Act of 2 March 2020 on special measures regarding the prevention, counteraction and containing of COVID-19 and other infectious diseases (Journal of Laws 2020, item 374, as amended). Dedicated legal instruments were provided accordingly, enabling state authorities, employers and other stakeholders to take actions and put in place appropriate preventive measures to contain the virus. Article 3 of the aforementioned act made provisions for employers admitting remote work.

Restrictions were imposed in the form government regulations, in consideration of the current epidemic conditions or epidemic threat (see Fig. 1), and of the Covid incidence rates.

In the first stage, the state of epidemic threat was declared, effective from 14 March 2020 (Journal of Laws 2020, item 433). Accordingly, business operations were restricted and bans were imposed regarding:

- restaurants, catering establishments (excluding the sale of takeaway and delivery meals), bars and cafés,
- the organisation, promotion or management of events,

- creative activities related to collective forms of culture and entertainment,
- sport, entertainment and recreation activities,
- cinemas, film clubs and the screening of films or recordings in other venues,
- tourist accommodation facilities, health resorts and short-stay accommodation,
- casinos,
- the operation of libraries, archives, museums and other institutions of culture.

The operations of catering and entertainment businesses were restricted, and the ban was imposed on retail trade in premises larger than 2,000 m² selling textiles, clothing, furniture, lighting equipment, audio-visual equipment, household appliances, stationery and books. In the context of healthcare services provided via ICT systems, the service users were given an option to submit data via this channel. The restrictions covered the functioning of public administration and organizational units performing public duties whose operations were limited exclusively to tasks necessary for providing assistance to citizens; moreover these duties had to be pursued without providing services to members of the public. A ban was introduced on organising public gatherings of more than 50 people. The border traffic was suspended or restricted; in particular, rail travel was suspended, and the entry into the territory of the Republic of Poland was restricted. All these measures were intended to minimize the spread of the SARS-CoV-2 virus.

As the threat grew more serious, the state of epidemic was declared in Poland on 20 March 2020 (Journal of Laws 2020, item 491). In terms of work organization, the restrictions resulting from the state of epidemic threat have been maintained. In addition, a ban was imposed on the retail sale of food, cosmetics, cleaning products, medicines, newspapers, building materials, pet supplies and fuel in retail shops larger than 2,000 m². The provision of rehabilitation services under Social Insurance Institution (ZUS) contracts was prohibited, and independent public healthcare facilities did not provide healthcare services to patients. During the state of epidemic, additional restrictions were introduced with the aim of minimizing the number of infections and limiting the spread of the virus (Journal of Laws 2020, item 566). In terms of work organization, hairdressing and beauty salons, tattoo and piercing studios, and facilities related to physical fitness (including gyms and fitness clubs) were closed, and so were hotels. The number of people allowed in retail shops was limited. Excluding staff members, a maximum of three people were permitted per one checkout point at a time, and between 10.00 and 12.00, entry was restricted to people aged 65 and more. In addition, these premises were required to provide customers and staff with protective equipment in the form of disposable gloves and hand sanitizer, as well as to implement a procedure for disinfecting the workstations after each customer. Furthermore, the workspace area had to be reorganized, in line with the requirement to maintain a 1.5-metre distance between workstations. With regard to post offices, apart from staff members, a maximum of two people were permitted inside at a time. In addition, restrictions were imposed on the movements of people, subject to social distancing

protocols (a distance of at least 2 meters was required), which affected staff mobility. The use of public transport was allowed in limited capacity (with no more than 50% of seats occupied).

The Regulation declaring the state of epidemic (Journal of Laws 2020, item 491) was further amended (Journal of Laws 2021, item 2398) to incorporate a requirement to have protective vaccinations, effective from 23 December 2021, whereby medical professionals and staff members working in pharmacies as well as students studying medical subjects were subject to the emergency vaccination protocols.

As the number of Covid infections decreased, the restrictions were being gradually lifted in early 2022. First, the state of epidemic was lifted, replaced by the state of epidemic threat on 16 May 2022, whilst the emergency vaccination protocols remained in force. On 1 July 2023, the state of epidemic threat was lifted, thereby removing all existing restrictions (Journal of Laws 2023, item 1118).

The outbreak of the COVID-19 pandemic in Poland required the government to implement extraordinary measures to limit the spread of the SARS-CoV-2 virus. Obviously, these measures had an impact on work processes across various sectors of industry, particularly in regard to prohibition or restriction of certain activities (including the closure of premises and limits on the number of visitors), interfering with the normal work procedures and the way services were provided (including the option of remote working, disinfection procedures, social distancing orders and a ban on the sale of certain protective equipment), and impacting on workers' mobility (restrictions on people mobility and transport services, and the quarantine orders).

2. Materials and Methods

2.1. Accidents rate statistics (2018-2024) based on Statistics Poland (GUS) data

Among the main indicators of workplace safety performance in industry is the accident rate. The accident rate analysis used the workplace accident statistics from 2018 to 2024 provided by the Statistics Poland (GUS) (GUS, 2018, 2019, 2020, 2021, 2022, 2023, 2024). This seven -year period was selected as complete datasets were readily available from Statistics Poland. This timeframe covers the two- year period before the COVID-19 epidemic (2018 - 2019), the period when the epidemic emergency regulations were in operation in Poland (2020–2022), and the two -year period immediately after the epidemic (2023 - 2024).

The use of single-factor indicators, such as the frequency or severity of accidents, will not highlight all aspects of safety performance. A more comprehensive analysis is merited to take into account all consequences of accidents and to capture the variability of indicator values over

time. Thus, a dedicated methodology was developed to rank PKD sections in regard to accident rate levels. The accident rate statistics uses data obtained for 1,000 workers, including:

- the total number of employees injured in accidents at work;
- the number of fatalities;
- the number of serious injuries in accidents at work;
- the number of days away from work among those injured in accidents at work.

In regard to availability of data for the selected period, the following sections of business activities were considered in the study:

- Agriculture, forestry, hunting and fishing (Section A);
- Mining and Quarrying (Section B);
- Manufacturing (Section C);
- Electricity, gas, steam, hot water manufacturing and supply (Section D);
- Water supply, sewerage, waste management and remediation activities (Section E);
- Construction (Section F);
- Wholesale and retail trade, repair of motor vehicles (Section G);
- Transportation and storage (section H);
- Accommodation and food service activities (Section I);
- Information and Communication (Section J);
- Financial and insurance activities (Section K);
- Real estate activities (Section L);
- Professional, scientific and technical activities (Section M);
- Administrative and support service activities (Section N);
- Public administration and defence, compulsory social security (Section O);
- Education (Section P);
- Human health and social work activities (Section Q);
- Arts, entertainment and recreation (Section R);
- Other service activities (Section S).

2.2. Methodology of PKD (Polish Classification of Activities) section ranking

In order to identify high-risk sections, relevant weights were assigned to the averaged accident rates derived for each section, equivalent to that section's contribution to each category of indicators, i.e. the total number of people injured in accidents, the number of fatalities, the number of serious accidents, and the number of days away from work measured per 1000

employees. The formulas yielding the relative contribution of each section (i.e. respective weights), are given as:

$$\boldsymbol{Uo_k = \frac{Wo_k}{\sum_{i=1}^{n} Wo_k}} \quad (1)$$

where:

Uo_k – the proportion of accident rate Wo_k for section 'k' relative to all sections analysed (the total number of people injured in accidents at work per 1,000 employees);

$$\boldsymbol{U\acute{s}_k = \frac{W\acute{s}_k}{\sum_{i=1}^{n} W\acute{s}_k}} \quad (2)$$

where:

$U\acute{s}_k$ –the proportion of the accident rate $W\acute{s}_k$ for section 'k' relative to all analysed sections (the number of fatalities in workplace accidents per 1,000 employees);

$$\boldsymbol{Uc_k = \frac{Wc_k}{\sum_{i=1}^{n} Wc_k}} \quad (3)$$

where:

Uc_k –the proportion of the accident rate Wc_k for section 'k' relative to all analysed sections (the number of serious injuries in workplace accidents per 1,000 employees);

$$\boldsymbol{Udn_k = \frac{Wdn_k}{\sum_{i=1}^{n} Wdn_k}} \quad (4)$$

where:

Udn_k –the proportion of the accident rate Wdn_k for section 'k' relative to all analysed sections (the number of days away from work per 1,000 employees);

It is assumed that respective contributions (i.e. weights assigned to particular sections) in each category should merge finally yielding the contribution of the given section to the overall result.

$$\boldsymbol{Su_k = Uo_k + U\acute{s}_k + Uc_k + Udn_k} \quad (5)$$

Su_k- sum total of accident rate indicators for the given section 'k'

Based on the sum total value of accident rate indicators for the given section Suk, the percentage fraction that this section represents relative to all analysed sections is derived by the formula:

$$\boldsymbol{\frac{Su_k}{\sum_{i=1}^{n} Su_k} * 100\%} \quad (6)$$

Obviously, the higher value of this indicator represents the greater risk of an accident at work in that section.

3. Results and Discussion

3.1. Ranking of PKD (Polish Classification of Activities) sections

Based on the proposed methodology, the sections are duly ranked, revealing those at particular risk of work-related accidents. To highlight the impacts of the COVID-19 epidemic on risk levels at work, the results are broken down into three distinct periods: before the epidemic (2018 and 2019), during the state of epidemic (2020–2022) and immediately afterwards (2023–2024). In consideration of data availability, the analysis had to be simplified, leaving out the exact dates when the respective states of emergency were declared. The results are collated in Table 1.

3.2. The impacts of Covid-19 epidemic

The accident statistics were analysed using the proposed methodology and PKD sections were ranked accordingly on the basis of accident rate values. The results expressed as percentage fractions are given in Fig. 2.

The results lead us to the following conclusions:

- The most significant decrease in the total accident rate (by 6.5 per cent) following the outbreak of the pandemic is reported in the 'Agriculture, forestry, hunting and fishing' sector
- During the state of epidemic, the largest increase (approx. 3%) in the total accident rate compared with the pre- and post-epidemic periods is reported in the 'Mining and quarrying' sector. However, this increase can be attributed to two major accidents that occurred in 2022 in the 'Pniówek' coal mine in the wake of a methane explosion and fire (16 fatalities, 7 serious injuries, 25 people with work incapacity) and in the 'Borynia-Zofiówka' mining company, caused by a rock burst and methane release (10 fatalities) (State Mining Authority Report WUG, 2025). It appears, therefore, that the rise in the accident rate was not directly associated with the COVID-19 epidemic.
- A growing trend in the overall accident rate was observed throughout the entire analysed period in the following sectors: 'Water supply; sewerage and waste management; remediation', 'Transport and warehousing', 'Healthcare and social work', 'Wholesale and retail trade; repair of motor vehicles', 'Real estate activities', 'Accommodation and food service activities', 'Other service activities'

In regard to the Water supply; sewerage and waste management; remediation' section, the accident rate increase was found to be most significant in the analysed period. Further analysis is merited to identify the root causes of accidents and to verify the adequacy of preventive and control measures that were adopted. In regard to the Water supply; sewerage and waste management; remediation' section, the accident rate increase was found to be most significant in the analysed period. Further analysis is merited to identify the root causes of accidents and to verify the adequacy of preventive and control measures that were adopted.

Table. 1. Accident rate statistics in Poland over the years 2018-2024 (broken down into specified time periods)

No.	CLASSIFICATION OF ACTIVITY	Before the epidemic (2018-2019)		During the state of epidemic (2020-2022)		After the epidemic (2023-2024)	
		Su_k	%	Su_k	%	Su_k	%
1	Mining and Quarrying	0,81	20,3%	0,93	23,4%	0,83	20,7%
2	Water supply, sewerage, waste management and remediation activities	0,47	11,6%	0,55	13,6%	0,58	14,4%
3	Agriculture, forestry, hunting and fishing	0,59	14,8%	0,33	8,3%	0,33	8,2%
4	Manufacturing	0,31	7,8%	0,32	8,1%	0,30	7,5%
5	Construction	0,29	7,2%	0,32	7,9%	0,28	7,1%
6	Transportation and storage	0,26	6,4%	0,26	6,6%	0,27	6,8%
7	Electricity, gas, steam, hot water manufacturing and supply	0,21	5,2%	0,29	7,2%	0,25	6,2%
8	Administrative and support service activities	0,19	4,7%	0,17	4,3%	0,20	5,1%
9	Human health and social work activities	0,16	4,0%	0,16	4,0%	0,17	4,3%
10	Arts, entertainment and recreation	0,12	3,0%	0,11	2,7%	0,14	3,6%
11	Wholesale and retail trade, repair of motor vehicles	0,11	2,7%	0,12	3,0%	0,13	3,2%
12	Real estate activities	0,10	2,4%	0,10	2,6%	0,11	2,8%
13	Public administration and defence, compulsory social security	0,09	2,3%	0,08	2,0%	0,07	1,8%
14	Accommodation and food service activities	0,07	1,8%	0,08	1,9%	0,10	2,5%
15	Education	0,07	1,8%	0,06	1,6%	0,09	2,2%
16	Other service activities	0,04	1,0%	0,04	1,1%	0,05	1,4%
17	Financial and insurance activities	0,06	1,4%	0,02	0,6%	0,05	1,2%
18	Professional, scientific and technical activities	0,04	1,0%	0,03	0,7%	0,03	0,8%
19	Information and Communication	0,02	0,6%	0,02	0,5%	0,01	0,3%

Source: compiled by the Authors

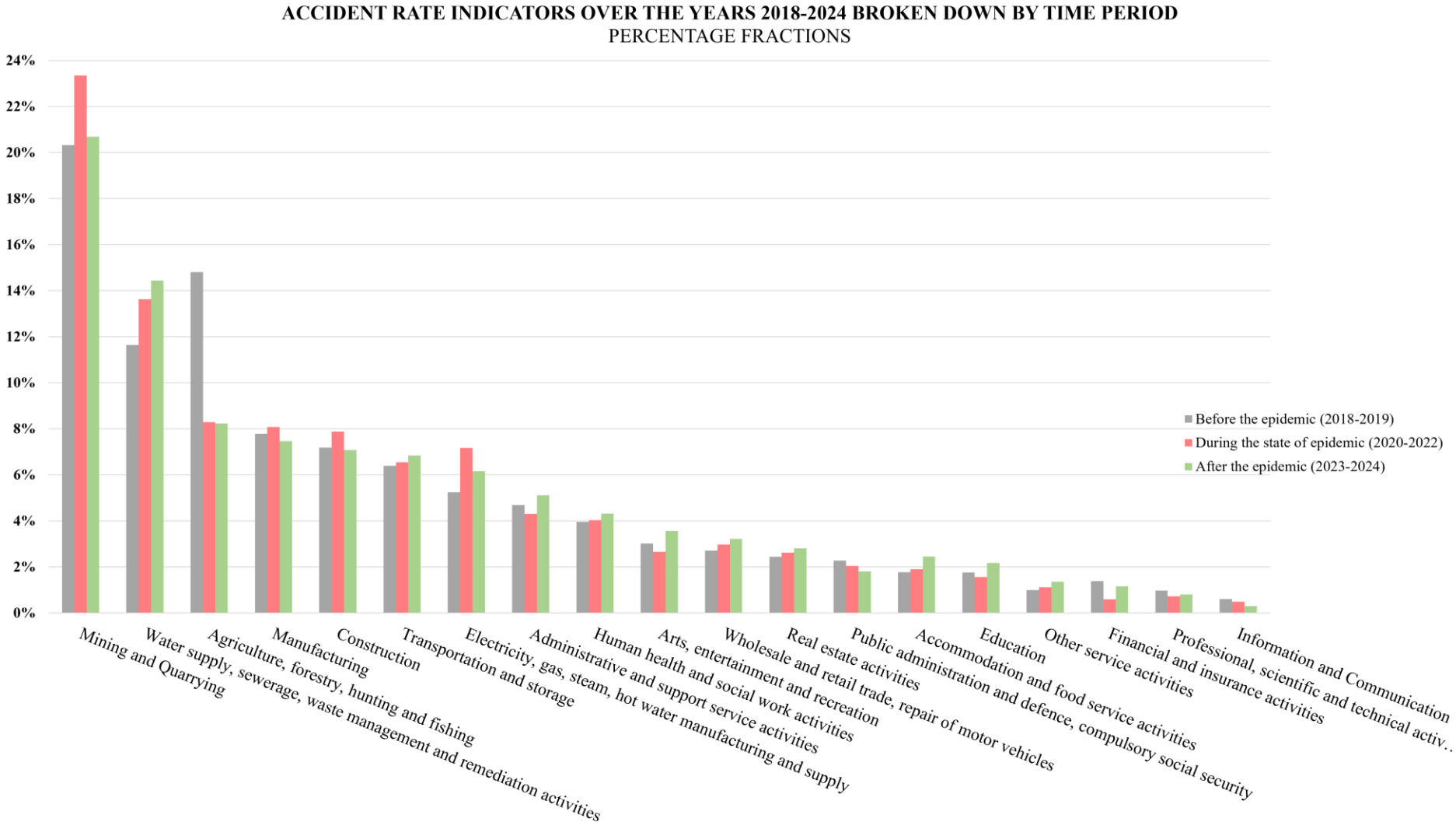

Fig. 2. Accident rate statistics: percentage of accident rate indicators over the years 2018-2024 (broken down by time period)
Source: compiled by the Authors

4. Conclussion

The proposed methodology of ranking the Polish Classification of Activities (PKD) sections in regard to accident rate statistics brings to light the impacts of the COVID-19 epidemic, taking into account the frequency of accidents and their consequences.

A comparative summary of total accident rates over time reveals the impacts of the Covid-19 epidemic on accident rates in the Polish industry. The actual risk profile varies across sectors. The largest decrease in the total accident rate during the epidemic is noted in the 'Agriculture, forestry, hunting and fishing' section, whilst the largest increase is reported in the 'Mining and quarrying' section. Sectors were identified with an increase in the total accident rate throughout the entire analyzed period. Of particular significance is the 'Water supply; sewerage and waste management' section, demonstrating the highest rates of increase of the indicator value. For that reason, this section should merit further research to identify the root causes of workplace accidents and to assess the effectiveness of adopted preventive measures.

The results confirmed the adequacy of the proposed methodology used for analyzing changes in risk levels in various periods of business activity. The resulting ranking provides the framework not only for cross-sector comparisons, but also for monitoring changes in risk levels over time.

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