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OVERVIEW OF ACCIDENTS AT WORK IN BRAZILIAN CIVIL CONSTRUCTION: ANALYSIS OF INDICATORS AND STATISTICS

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ABSTRACT

Civil construction employs millions of professionals and moves a significant part of the economy. However, it still records numbers of accidents, high indicators of the number of daysof absence and lethality rate. Therefore, it is important to understand the behavior of accidents at work to identify as the most critical classes and to take actions to improve statistics. This study analyzed the statistics of occupational accidents in construction in the 2009-2018 decade, explaining as the main causes of the variations in the number of accidents, in addition to analyzing thoroughly how statistics and indicators in the 2016-2018 three-year period, listing the behavior of the sector's subdivisions within the number of accidents matrix and identifying a lethality rate and the impact of priority classes. From the study of the decade, there was a strong relationship between the number of accidents, the number of people in the sector and the economic moment, with no clear improvement in worker health and safety. Based on the analysis of the triennium, it was found that only 4 classes (construction of buildings, works for the generation and distribution of electricity and for telecommunications, incorporation of real estate projects and construction of highways and railways) accounted for more than 60% of accidents, highlighting the importance of being effectively monitored.

KEYWORDS: Occupational accident. Construction. Statistics. Indicators

1. INTRODUCTION

All types of work have risks associated with their execution, but with the development of productive systems, especially with the emergence of factories and the inclusion of steam engines during the Industrial Revolution in the 18th century, there was an increase in the

risks to which workers were exposed. This led to the creation of the first regulations related to the health and safety of workers (COELHO, 2016). Globally, the concern for preventing workplace accidents led to the establishment of the International Labour Organization (ILO) in 1919, which is responsible for creating and enforcing international labor standards and providing statistics on accidents (ILO, 2020).

The construction industry is one of the sectors with the highest risk of serious accidents worldwide (KINES et al., 2010). In economically advanced countries, the probability of construction workers suffering fatal accidents is three to four times higher than in other industries, while in less developed countries, the rate is three to six times higher (ILO, 2014). Therefore, workplace safety remains one of the biggest challenges in this sector (GAO, GONZALEZ, YIU, 2020; LEE et al., 2020).

In Brazil, the concern for worker safety increased with the approval of the Consolidation of Labour Laws (CLT) in 1943, through Decree-Law No. 5452, which addresses safety and occupational health in Chapter V (COELHO, 2016). This chapter was amended in 1977 by Law No. 6514, which resulted in the approval of Regulatory Standards (NRs) related to safety and occupational health in 1978 through Ordinance No. 3214. Nevertheless, Brazil still has much to improve in terms of worker health and safety, as a new workplace accident occurs every 49 seconds, and a death is recorded every 3 hours and 43 minutes (SMARTLAB, 2020).

The National Social Security Institute (INSS) has spent over 98 billion Brazilian reais on leave due to work-related accidents since 2012, equivalent to an average of 11 million reais per year (SMARTLAB, 2020). Among all sectors considered in the count of these accidents, the construction industry accounts for a significant portion, ranking as the 6th sector that caused the most accidents, with 5.13% of the total, estimated from raw data from the Statistical Yearbook of Work Accidents (AEAT) 2018, trailing only behind the following sectors: Manufacturing Industries; Trade, Repair of Motor Vehicles and Motorcycles; Human Health and Social Services; Transportation, Warehousing, and Postal Services; Administrative and Support Services (BRASIL, 2018).

The construction industry remains a sector with a high accident rate (ANDERSEN et al., 2018; LIANG, LEUNG, AHMED, 2020), and the severity, in many cases, leads to worker fatalities, contributing to the high fatality rate.

In 2018, the total fatality rate of workplace accidents in Brazil, estimated from AEAT 2018 data, was 3.52 deaths per thousand accidents, with the construction industry ranking as the second sector with the highest fatality rate that year, at 8.88 deaths per thousand accidents, only behind the agriculture sector (9.51). This data highlights the importance of analyzing and understanding accident trends in this sector over the years (BRASIL, 2018). The AEAT, published since 2000, was created to assist in the dissemination of statistical information about workplace accidents, enabling the monitoring of fluctuations and historical trends, supporting not only national but also municipal-level planning of economic activities based on accidents and their aspects such as incidence, fatality, and quantity (BRASIL, 2016). While statistical yearbooks are important tools, they cover all sectors of the Brazilian economy and provide only raw data for all classes, necessitating a more detailed analysis of the sector of interest, given the high number of accidents and the elevated fatality rate of the sector compared to national averages, as well as the lack of studies in the literature that conduct this type of investigation.

In light of the above, the objective of this study is to analyze the number of workplace accidents in the Brazilian construction industry between 2009 and 2018, considering their different types, and to conduct a more in-depth analysis of the last three years, exploring the classes that make up the accidents as well as their indicators, with the aim of contributing to preventive decision-making against accidents.

2. METHODOLOGY

2.1 ANALYSIS OF ACCIDENT STATISTICS IN THE DECADE 2009-2018

For the analysis of the accident panorama related to construction, the last ten Statistical Yearbooks of Work Accidents (AEAT) from 2009 to 2018, made available by the Special Secretariat for Social Security and Labor (SEPT), were gathered. It is worth noting that the annual AEAT also includes updated data from the two previous years, and the most recent data were used for this research (BRASIL, 2018). In each AEAT report, data related to classes related to construction were selected and are presented in Table 1. For each class, information regarding the quantity of typical accidents with Work Accident Report (CAT), commuting accidents with CAT, occupational diseases with CAT, and accidents without CAT were gathered for the reference years. Typical accidents are linked to the characteristics of the professional activity performed, commuting accidents result from the journey between the workplace and the insured person's residence, and occupational diseases can be defined as those triggered or acquired as a result of the special conditions in which work is performed or directly related to it (BRASIL, 2018).

The annual data on workplace accidents, related to the aforementioned classifications, are recorded through CAT submitted by companies and registered by the National Social Security Institute (INSS), whether or not there is a work leave. However, CAT is not always issued, and accidents without CAT may occur. This type of accident is identified through possible connections such as technical connection due to disease equated to a workplace accident, epidemiological and social security technical connection, and technical work/professional connection (BRASIL, 2018). After separation, the data were organized in a table format, summarizing the quantity of accidents from 2009 to 2018 and their composition.

Based on the statistics of workplace accidents over the last decade, an analysis of the year-to-year trend in the number of accidents was conducted. Subsequently, for a more detailed study of workplace accidents, an analysis of the indicators for the years 2016, 2017, and 2018 was carried out by class, as presented in section 2.2. The selection of this period was justified because it represents the most recent published data, and a smaller sample space allows for a more detailed analysis of the data presented.

2.2 DETAILED ANALYSIS OF ACCIDENT STATISTICS AND INDICATORS, TRIENNIAL 2016-2018

The analysis focused on the statistics of the number of accidents, class by class in the construction industry, for the last three years. However, it was noticed that out of the 21 classes present, there were 9 classes that, when summed up, represented approximately 85% of the total accidents year by year. Therefore, the analysis was directed towards this group,

which is identified in bold in Table 1, and analysis of the other classes occurred on an as-needed basis. It is worth noting that the National Classification of Economic Activities (CNAE) is composed of 21 sections, consisting of 86 divisions that branch out into various classes. Construction is one of these sections, represented by the letter "F," and it is composed of divisions 41, 42, and 43: construction of buildings, infrastructure works, and specialized services for construction, respectively (IBGE, 2020).

Table 1 - Classes of economic activities related to construction

41.10-7 Real Estate Development
41.20-4 Building Construction
42.11-1 Highway and Railway Construction
42.12-0 Construction of Specialized Civil Engineering Works
42.13-8 Urbanization Works - Streets, Squares, and Sidewalks
42.21-9 Construction of Power and Telecommunications Infrastructure
42.22-7 Construction of Water Supply and Sewage Systems and Related Structures
42.23-5 Construction of Pipelines, Except for Water and Sewage
42.91-0 Port, Maritime, and River Works
42.92-8 Assembly of Industrial Facilities and Metal Structures
42.99-5 Civil Engineering Works, Not Elsewhere Classified
43.11-8 Demolition and Site Preparation
43.12-6 Drilling and Boring
43.13-4 Earthmoving Works
43.19-3 Site Preparation Services, Not Elsewhere Classified
43.21-5 Electrical Installations
43.22-3 Hydraulic, Ventilation, and Refrigeration Systems Installations
43.29-1 Building Installation Works, Not Elsewhere Classified
43.30-4 Finishing Works
43.91-6 Foundation Works
43.99-1 Specialized Construction Services, Not Elsewhere Classified

Source: CONCLA (Adapted).

Once the scope was defined, the data was filtered and compared class by class over the mentioned three-year period, with the data presented in accordance with the numerical order of the 9 pre-listed classes. The accident rates analyzed for the triennium were: incidence rate and fatality rate. The incidence rate of occupational accidents is represented by the ratio, times 1,000, between the number of new cases of occupational accidents registered and not registered, and the average annual number of employment relationships. This ratio constitutes a more comprehensive and synthesized expression of risk, symbolizing the relationship between the work circumstances and the average number of workers subject to

those conditions (BRASIL, 2018). The fatality rate is calculated as the ratio, times 1,000, of the number of deaths resulting from occupational accidents to the number of registered and unregistered occupational accidents. This ratio expresses the possibility of the accident resulting in the death of the injured worker and can be used as an indicator of the severity of the accident (BRASIL, 2018). The process of acquiring and organizing this data followed the same protocol as the data presented in the previous section.

3. RESULTS AND DISCUSSION

Workplace accidents generate significant losses for the INSS (National Institute of Social Security). From 2012 to 2018 alone, R$ 26,235,501,489 were spent on benefits resulting from new concessions (SMARTLAB, 2020). These accidents also cause both physical and psychological human suffering. Therefore, the analysis of accidents is essential to prevent the recurrence of similar problems and to control the risks in this sector (HOLA, 2017; VASCONCELOS, 2015; ZHANG, 2019).

3.1 WORKPLACE ACCIDENTS FOR THE DECADE 2009-2018

Between the years 2012 and 2018, there were 4,503,631 reported workplace accidents, of which 104,646 were attributed to the building construction class, making it the fourth sector with the highest number of CAT (Work Accident Notification) reports during this period. Additionally, during this period, 16,455 accidents resulted in fatalities in Brazil (SMARTLAB, 2020).

The construction industry is one of the sectors with a significant contribution to the Brazilian economy. Its Gross Value Added at basic prices (GVA at basic prices) has substantial contributions to the Gross Domestic Product at market prices (GDP at market prices). In 2010, the construction industry represented 6.3% of the total Brazilian GVA at basic prices, whereas in 2017, this figure was 4.3% (CBIC, 2019). Besides being a sector with significant economic participation, the construction industry also has a high incidence of workplace accidents. A summary of the number of accidents over the last decade is presented in Table 2.

Table 2 - Overview of workplace accidents for the decade 2009-2018

Year	Work sickness with CAT	Typical witg CAT	Route with CAT	Without CAT	**Total**
2009	1.111	35.265	5.042	14.252	55.670
2010	1.052	36.611	5.660	12.597	55.920
2011	931	39.282	6.335	13.867	60.415
2012	794	41.748	6.759	14.860	64.161
2013	800	40.694	7.324	13.590	62.408
2014	681	39.520	7.486	2.975	50.662
2015	567	32.118	5.962	6.729	45.376
2016	431	25.622	5.346	5.760	37.159

2017	346	20.895	4.399	4.684	30.324
2018	295	21.032	4.423	3.862	29.612

Source: BRASIL 2009-2018 (Adapted).

Based on the data from Table 2, it can be observed that the main cause of accidents is typical accidents with CAT, and there was an increase in the total number of accidents between 2009 and 2012, reaching a peak of 64,161 accidents. However, there was a sharp drop in the total number of accidents in the year 2014, followed by successive declines from 2015 to 2018. For a better visualization of the contribution of each type of accident with CAT, as well as accidents without CAT, Figure 1 was constructed.

It can be noted that the primary cause of the drop in the number of accidents in 2014 was accidents without CAT, which decreased from 13,590 in 2013 to 2,975 in 2014. This drop can be related to the launch of the National Strategy for Reducing Workplace Accidents 2015-2016, which aimed to expand actions by the Ministry of Labor and Employment (MTE), with the goal of reducing occupational diseases and accidents (BRASIL, 2015). After the campaign was launched, between January and March, 26,378 fiscal actions were carried out, with 16,545 notifications, resulting in sanctions against 25,902 companies and the suspension or closure of 1,108 construction sites (JUNIOR, 2015). These actions may have had an impact on the number of accidents in 2014 and subsequent years, even though it was instituted in 2015, as the AEAT 2014 reported 12,254 accidents without CAT for the year 2014, while the AEAT 2016 updated the accidents for 2014 to 2,975, a value considered in this study.

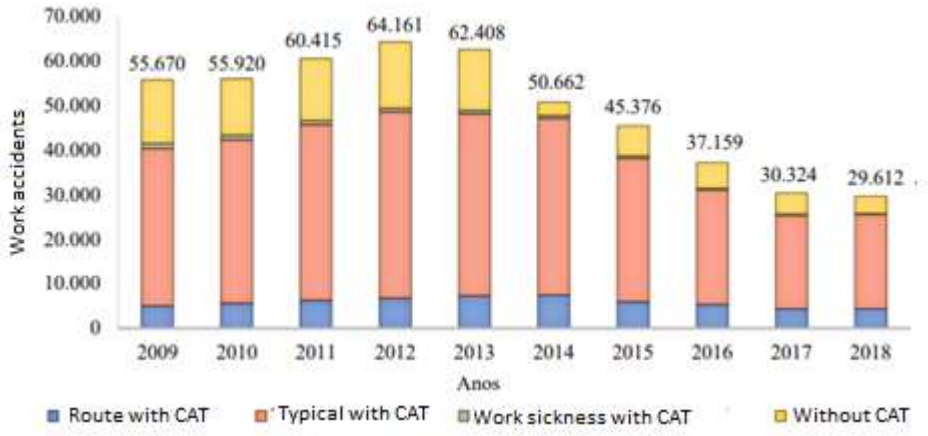

Figure 1 – Statistics on occupational acidentes for the decade 2009-2018

Source: BRASIL 2009-2018 (Adapted).

Another factor that should be related to the trend in the number of workplace accidents during the period 2009-2018 is the country's economy. In 2009, the economy felt the impact of the international crisis but showed a strong recovery in 2010, with a 7.5% growth in GDP at market prices (CBIC, 2019). In the following years, the economy experienced a period of deceleration, which was mitigated to some extent by government interventions, such as the conclusion of the Growth Acceleration Program (PAC) 1 and the implementation of

PAC 2. However, by 2015, the economy had contracted by 3.5% (MATTOS, 2015; CBIC, 2019).

Since the construction industry is directly linked to the country's economy, it is expected that the number of people involved in this sector will vary according to its performance, and as a consequence, the number of accidents as well. Thus, it is possible to draw a parallel between the number of people involved in construction and the number of accidents in the decade 2009-2018. To do this, you can compare the annual number of accidents in AEAT with the Annual Survey of the Construction Industry (PAIC) year by year, as presented in Figure 2. Through this comparison, you can see a similarity between the trend in the number of accidents and the number of people working in the sector in most years. For example, in 2012, there was a 6.3% increase in the number of people employed in construction, and the number of accidents increased in proportion (6.2%).

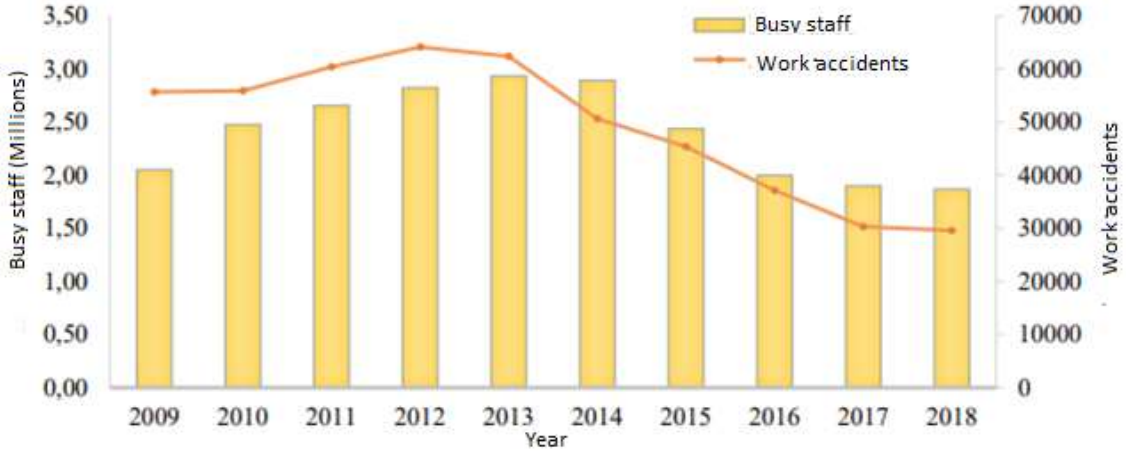

Figure 2 – Comparison between the number of acidentes and the number of people working annually

Source: IBGE 2009-2018 (Adapted).

Thus, the growth in the number of accidents between 2009 and 2013 can be attributed to the annual increase in the number of people working in the construction sector as a result of the growth in construction-related activities, driven by government measures such as the investment of 278.2 billion Brazilian reais in the "Minha Casa Minha Vida" program, a part of PAC 2 (CUT, 2010). During this period, the construction industry showed a growth rate of 7% in 2009, reaching its highest value of 13.1% in 2010 and experiencing a growth rate of 4.5% in 2013.

In the period from 2014 to 2019, the total number of accidents gradually decreased. This decline can be attributed to the launch of the National Strategy for Reducing Workplace Accidents 2015-2016, as mentioned earlier, and the year-on-year reduction in the number of people working in the sector due to its deceleration during this period. The construction sector faced successive annual contractions, with a 10% reduction in GVA at basic prices in 2016 and a 9.2% reduction in 2017 (BRASIL, 2015a). Thus, it can be observed that there has been a reduction in the overall number of accidents in recent years. However, this does not necessarily mean that this sector has become safer.

3.2 Workplace Accidents And Detailed Indices For The Triennial Period 2016-2018

According to AEAT 2017, there were 585,626 workplace accidents in Brazil in 2016. From the primary data in this annual report, it can be inferred that 37,159 accidents are related to the construction sector, representing 6.35% of the total accidents that year. In 2018, there were 576,951 accidents, of which the construction sector was responsible for 29,612 (5.13%) (BRASIL, 2018; BRASIL, 2017). The number of accidents in the triennium 2016-2018 is depicted in Figure 3, where the data is presented according to the classes of economic activities related to construction, with emphasis on the nine classes that contributed the most to the annual number of accidents.

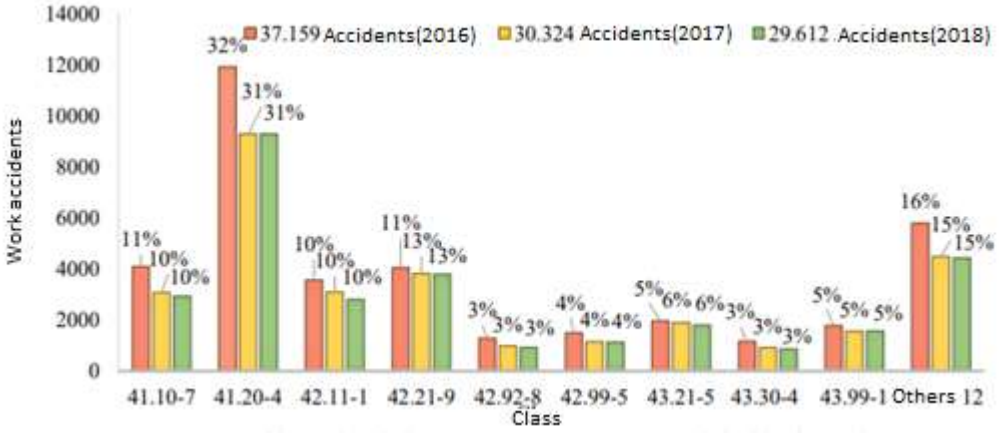

Figure 3 – Occupational accidents by class and their percentage of annual incidence

Source: BRASIL 2016-2018 (Adapted).

From Figure 3, it can be observed that the class 41.20-4, "Building Construction," was the major contributor to the number of accidents in the construction sector. It accounted for 11,917 accidents in 2016, 32% of the total that year, 9,292 accidents in 2017 (31%), and 9,291 accidents in 2018 (31%). Despite a decrease of 2,626 accidents from 2016 to 2017, the annual percentage participation of this class remained relatively unchanged. This pattern repeats for the other classes, indicating that the reduction in the number of accidents from 37,159 in 2016 to 30,324 in 2017 occurred proportionally among the classes.

Other classes that had a significant impact on the number of accidents in the 2016-2018 triennium included: Class 42.21-9, "Works for the Generation and Distribution of Electric Power and Telecommunications," with 4,052 accidents in 2016, 3,827 accidents in 2017, and 3,799 accidents in 2018. Class 41.10-7, "Real Estate Development," with 4,096 accidents in 2016, 3,082 accidents in 2017, and 2,947 accidents in 2018. Class 42.11-1, "Highway and Railway Construction," with 3,570 accidents in 2016, 3,102 accidents in 2017, and 2,815 accidents in 2018.

These four sectors, when combined, represented more than 60% of the annual construction accidents and therefore deserve greater attention. The complete values of each class's contributions to the annual number of accidents in the construction industry are expressed in Table 3.

The overall trend in the total number of accidents during this period followed a relationship with the number of people working in construction, as shown in Figure 2. In 2016, there was an 18.1% decrease in the number of accidents compared to the previous year, which was close to the decrease in the number of employed individuals, which was 18.0%. In 2018, there was a slight reduction in the number of accidents, by 2.3%. This period also saw the smallest decrease in the number of people working in construction, with a 1.7% decrease, the lowest value since 2014 (BELANDI, 2020?). Thus, it can be observed that there was no single class responsible for the decrease in the number of accidents during this period. The variation in the total number of accidents behaved very similarly to the number of people employed, and the contribution of each class remained almost unchanged between the years.

Table 3 – Statistics and indicators of construction acidentes in the triennium 2016, 2017, 2018

Year	Class	Nº of acidentes	Incidence*	Lethality rate **
2016	41.10-7	4.096	**22,32**	6,84
2017	41.10-7	3.082	**20,55**	5,52
2018	41.10-7	2.947	**21,05**	5,09
2016	41.20-4	11.917	14,22	6,80
2017	41.20-4	9.292	13,48	6,78
2018	41.20-4	9.291	14,21	8,40
2016	42.11-1	3.570	**23,77**	**7,00**
2017	42.11-1	3.102	**22,50**	**12,25**
2018	42.11-1	2.815	**23,42**	**15,63**
2016	42.21-9	4.052	**23,57**	**8,14**
2017	42.21-9	3.827	**22,85**	**11,24**
2018	42.21-9	3.799	**22,00**	**8,69**
2016	42.92-8	1.291	14,38	6,20
2017	42.92-8	986	13,10	9,13
2018	42.92-8	929	12,85	6,46
2016	42.99-5	1.502	17,55	7,99
2017	42.99-5	1.156	15,55	6,92
2018	42.99-5	1.149	17,46	9,57
2016	43.21-5	1.971	13,43	11,16
2017	43.21-5	1.905	13,50	8,40
2018	43.21-5	1.805	12,33	7,76
2016	43.30-4	1.170	8,55	8,55
2017	43.30-4	923	8,29	6,50
2018	43.30-4	869	8,39	3,45
2016	43.99-1	1.794	12,60	**11,15**

2017	43.99-1	1.559	13,08	**7,70**
2018	43.99-1	1.571	12,43	**14,00**

*per 1.000 links, **per 1.000 accidents

Source: BRASIL 2016-2018 (Adapted).

The construction industry not only has a significant number of accidents but also experiences more severe accidents. In 2016, according to raw data from AEAT 2018 tables, 284 deaths were recorded, accounting for 12.41% of the total Brazilian deaths due to accidents, with a fatality rate of approximately 7.26, roughly twice the Brazilian average. In 2018, there were 263 deaths in construction with a fatality rate of 8.8 (BRAZIL, 2018). Therefore, it is important to understand which sections and classes have a greater impact on the total number of accidents to pay more attention to the most critical classes in order to improve the situation of accidents in Brazil. Table 3 presents the scenario of accident statistics and indicators from 2016 to 2018.

According to Table 3, the three classes with the highest incidence of accidents in the analyzed triennial period were class 42.11-1 - Road and Railway Construction - reaching a rate of 23.77 per 1,000 affiliations in 2016, with a total of 3,570 accidents, followed by class 42.21-9 - Works for Power Generation and Distribution and Telecommunications - with an incidence of 23.57 in 2016 and 4,052 accidents, and class 41.10-7 - Real Estate Development - reaching values of 22.32 in 2016 with 4,096 accidents that year. Building construction, class 41.20-4, had the highest number of accidents, reaching 11,917 in 2016, but its incidence was 14.2 that year, lower than some classes due to a higher number of affiliations. The average Brazilian incidence in 2016 was 14.26 (BRAZIL, 2017). The other classes not shown in Table 2 do not have incidence values higher than those mentioned above. Based on the incidence of the number of accidents, comparisons can be made between classes to understand which ones deserve more attention, such as the three mentioned above.

The three classes with the highest fatality rates in the last triennium were class 42.11-1 - Road and Railway Construction - with a maximum value of 15.63 deaths per thousand accidents in 2018 and an average annual death rate of 35, followed by class 43.99-1 - Specialized Services for Construction Not Previously Specified - with a fatality rate of 14 in 2018 and an annual average of 18 deaths, and class 42.21-9 - Works for Power Generation and Distribution and Telecommunications - with a maximum fatality rate of 11.24 in 2017 and an average of 36 deaths annually. It is worth noting that the class with the highest average annual deaths was class 41.20-4, building construction, with an average of 74 deaths in the 2016-2018 triennium, but its fatality rate is lower due to the higher number of accidents in this class (BRAZIL, 2018).

Another point worth mentioning is that the highest fatality rates are not among the 9 classes presented in Table 3, as the fatality rate is the result of the ratio, times a thousand, between the number of deaths and the number of accidents. There are classes that have a less significant number of deaths but also have a reduced number of accidents, resulting in higher ratios, such as class 43.11-8, demolition and site preparation, which recorded 2 deaths in 2017 out of a total of 41 accidents, resulting in a fatality rate of 48.78 (BRAZIL, 2018). Therefore, a careful analysis of fatality should be conducted, not only considering its absolute value.

4. CONCLUSIONS

The number of workplace accidents is closely linked to the quantity of workers involved in construction and the country's economy, as the number of accidents has followed similar annual variations to the number of people employed in the sector, with the number of employed individuals influenced by the economic period. Therefore, the idea that the construction sector has been experiencing a decrease in the number of annual accidents should be reconsidered because even though there may have been an improvement in accident prevention, its primary cause is still related to the number of workers involved.

It can also be inferred that the classes that make up the largest sources of annual accidents in construction were: 41.10-7 - Real Estate Development; 41.20-4 - Building Construction; 42.11-1 - Road and Railway Construction; 42.21-9 - Works for Power Generation and Distribution and Telecommunications; and 43.99-1 - Specialized Services for Construction Not Previously Specified, as these classes showed the highest number of accidents, the highest incidence rate, and a high fatality rate.

With the most critical classes identified, measures need to be taken to mitigate the number of accidents and their severity. For example, rigorous enforcement of the use of personal and collective protective equipment, adherence to the guidelines of Regulatory Norm 18, which deals with safety and health conditions in the construction industry, and the implementation of accident prevention strategies such as training, seminars, and meetings with workers. The informality and underreporting in the sector also need to be taken into account for a more accurate analysis of the problem since these are prominent characteristics of the construction industry, which could be a potential topic for future studies.

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