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STATISTICAL ANALYSIS OF OCCUPATIONAL FATAL ACCIDENTS FOR RISK ASSESSMENT

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ABSTRACT

According to Malaysia's Department of Occupational Safety and Health (DOSH), workplace accidents have increased dramatically as the country's economy has grown rapidly. The purpose of this study is to identify the trends that lead to fatal workplace accidents in Malaysia. This study investigated 505 fatal accident instances from fifteen industries, using both qualitative and quantitative methodologies. The DOSH discovered and reported these

fatalities (2010-2020). Data was organized and coded, then analyzed using Spearman's rank order correlation, frequency analysis, Eta squared, Cramer's V, and Chi-square. Moreover, neurolinguistic programming was used to generate the word cloud and sentiment analysis. Furthermore, light gradient-boosting machine learning was used to better understand the causes of fatalities. The outcomes indicated that fatal falls from heights were the leading cause of fatal accidents (32%). General laborers were the most susceptible to fatal accidents (60%). Contract workers were more likely to die in construction accidents (64%). The findings of this study gave useful insights into workplace fatal accident trends and preventive measures throughout sectors.

Keywords: Risk Assessment, Prevention Management, Machine Learning, Neuro-Linguistic Programming, Mixed-Method Analysis.

INTRODUCTION

According to the Malaysian DOSH's annual reports, there has been a significant increase in accident cases over the last ten years (2010-2020). The lowest number of occupational accidents was 2429 in 2011, while the greatest number was 7981 in 2019 (DOSH, 2021). According to the Occupational Safety and Health Act of 1994 (514), employers are required to disclose workplace injuries. The DOSH examines incidents recorded by companies to discover the root causes under the same Act of 1994 (Act 514) (DOSH, 2004). There has been a significant rise in the frequency of accidents between 2011 and 2020, necessitating quick response (Figure 1).

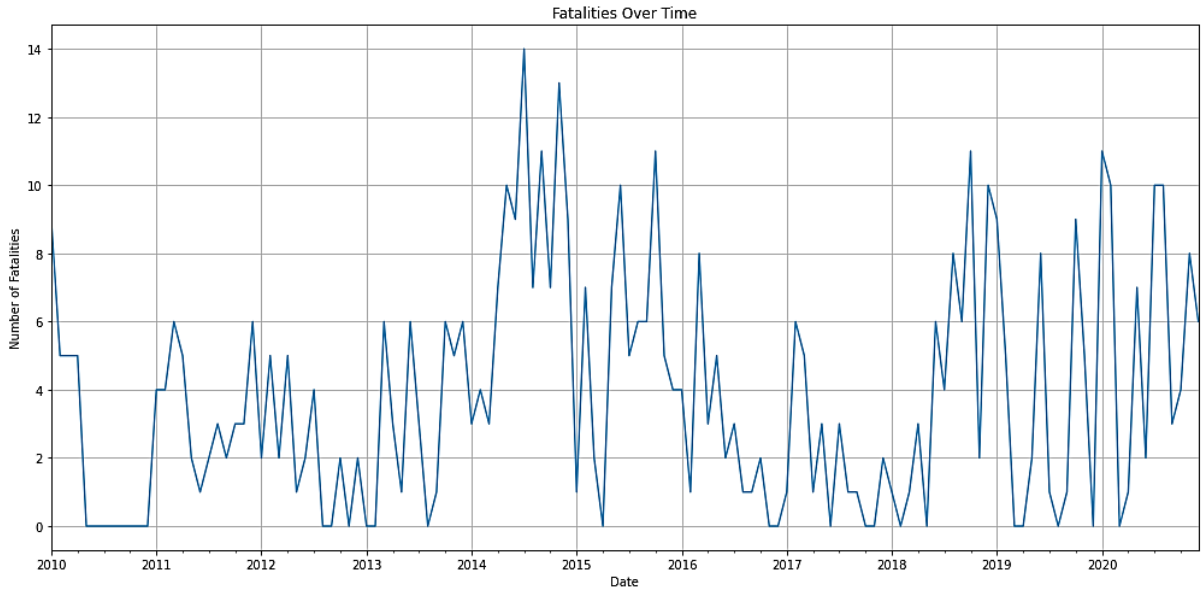


Figure 1. DOSH investigated accident cases from 2011 to 2020 (DOSH, 2021).

It is essential to interpret and utilize this data for informed policy-making and targeted interventions to enhance occupational health and safety across various sectors. Understanding the distribution of accidents allows for the development and implementation of sector-specific safety measures, training programs, and regulations to mitigate risks and safeguard the well-being of the workforce in Malaysia. The provided source offers a valuable resource for stakeholders and policymakers in their efforts to create safer working environments and reduce occupational accidents. Understanding the distribution of accidents allows for the development and implementation of sector-specific safety measures, training programs, and regulations to mitigate risks and safeguard the well-being of the workforce in Malaysia. The provided source offers a valuable resource for stakeholders and policymakers in their efforts to create safer working environments and reduce occupational accidents. This study examines the patterns behind fatal accidents in Malaysia by conducting a statistical analysis of fatal accident cases collected from DOSH concerning several factors such as the industry, the activity, and the type of accidents involved. This study aims to identify the trends behind fatal accidents across sectors, uncover fatal accident patterns, and determine the relationship between different factors that directly affect fatal accidents.

LITERATURE REVIEW

Several investigations have attempted to address one issue at a time, with some researchers focusing on behavioral subjects and others on determining the contributing variables to a certain accident type. Several studies have focused on uncovering the causes or factors of Malaysian workplace accidents. Most of them either looked at one sector, investigated a specific accident or outcome, or focused on a specific target population. Zermane et al. investigated the factors contributing to fatal falls from heights (Zermane et al., 2020), whereas, Abas et al. (A. B. L. Abas et al., 2013) focused on work-related injuries among non-governmental workers in all private sectors. Zerguine et al. (Zerguine et al., 2018) investigated work-related injuries among foreign workers in the construction industry. Marhani et al. measured the perceptions of the Occupational Health and Safety Assessment Series (OHSAS) in the Malaysian workplace (Marhani et al., 2013). Said et al. (Said et al., 2012) analyzed occupational accidents in the manufacturing industry and determined that the behavioral characteristics of individuals significantly affect accident rates. Ismail (A. R. I. Ismail, 2015) found that unsafe behavior and lack of safety awareness are serious issues within Malaysia's mining and quarrying industry. The author found that struck by accidents, poor housekeeping, and the lack of proper maintenance eventually led to vehicle failure. Abas et al. (A. B. L. Abas

et al., 2013) found that non-governmental workers are affected more by more fatal accidents in the agriculture sector than in the construction sector. However, road accidents were the leading cause for non-governmental workers (Sinanaj & Bexheti, 2023).

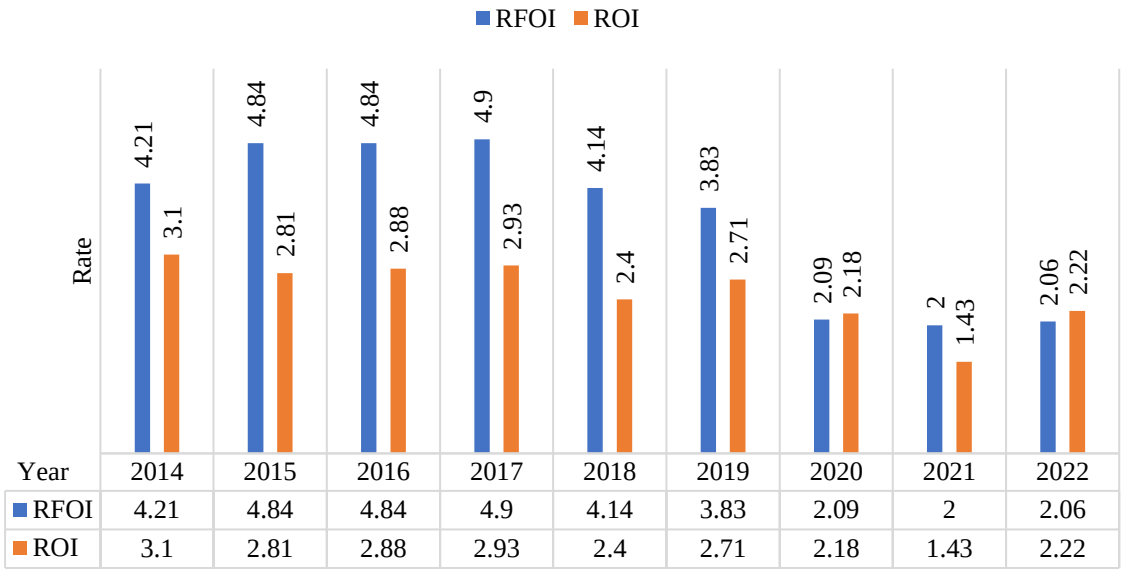
Other studies focused on a particular sector, such as Ayob et al. (Ayob et al., 2018), Chong and Low, (Chong & Low, 2014). Hamid et al., (Hamid et al., 2019), Mohammad and Hadikusumo (Mohammad & Hadikusumo, 2017); and Zermane et al. (Zermane et al., 2020, 2022, 2023) concentrated on the construction sector. Very little study has been conducted on fatal industrial accidents in Malaysia. Zin and Ismail (Zin & Ismail, 2012) studied the behavioral characteristics linked with safety culture in the construction industry (F. Ismail et al., 2012). We polled 117 construction workers listed with the Construction Industry Development Board (CIDB). The authors discovered that management commitment was the most important factor influencing workers' safety habits. However, management strategies and procedures were not the same thing; regardless of how much managers believed in and held high expectations for their commitment to safety, their activities revealed the reverse. The study conducted by Ismail et al. (F. Ismail et al., 2012) did not directly contribute to the prevention of fatal accidents; nonetheless, the findings will shed light on what is going on within construction company management. Zakaria et al. concentrated on individual factors and how they interact with job characteristics. The findings revealed that stress is one of the major causes of workplace accidents, followed by dangerous behavior and a lack of training.

Furthermore, the authors did not focus on occupational accidents, whether fatal or nonfatal; in contrast, Zakaria et al. (Zakaria et al., 2012) took a proactive strategy to prevent human error in Malaysia's oil and gas business. Zin and Ismail (Zin & Ismail, 2012) investigated the behavioral factors associated with safety culture within the construction industry (F. Ismail et al., 2012). Surveyed 117 construction workers registered under the Construction Industry Development Board (CIDB). The authors found that management commitment was the most crucial aspect regarding workers' safety behaviors. However, management beliefs and practices were two different things; no matter how much management put belief and high expectations of their commitment to safety, their practices reflected the opposite. Ismail et al. (F. Ismail et al., 2012) study did not directly help prevent fatal accidents; however, the outcome will help shine the light on what is happening within the management of construction companies. Furthermore, they are linked to avoiding mishaps by concentrating the sample size on high management inside the organization. Hamid et al. (Hamid et al., 2019) researched the causes of fatal accidents in the construction industry. However, researchers, like Ayob et al. (Ayob et al., 2018), concentrated on fatal incidents in the construction industry.

Zermane et al. examined the elements that contributed to 206 fatal falls from height accidents in Malaysia and the United States. Furthermore, administrative and organizational factors, such as management's commitment to safety and the absence of work-at-height training and timelines, were important. Advancing, Zermane et al. (Zermane et al., 2022) carried out a risk assessment to discover the reasons for deadly falls from height accidents. Mohammed and Ishak investigated fatal and non-fatal incidents in the Malaysian construction industry. The researchers observed that fatal accidents have a greater impact on the construction business than nonfatal accidents. The results, however, are consistent with what Ayob et al. discovered in 2018. Ayob et al. (Ayob et al., 2018), similar to Mohammed and Ishak, investigated a fatal accident in the construction business (Mohammed & Ishak, 2013). To conclude, most research that tackled the fatal accidents gap focused on the construction sector since it is the highest contributor to fatal accidents; however, for Malaysians, the manufacturing and the agriculture sectors contribute significantly to fatal accident cases besides the construction sector, according to DOSH (DOSH, 2021). Statistical analysis of fatalities data can uncover helpful information related to a specific accident case which can help determine trends and evaluations of fatalities.

MATERIALS AND METHODS

This study collected data from Malaysia's DOSH public database (DOSH, 2021). The data covered 2010 to 2020, including 505 fatal accidents. The presented data illustrates the annual rates of occupational injuries and fatal occupational injuries per 100,000 workers in Malaysia from 2014 to 2022. The rate of occupational injuries has demonstrated a fluctuating trend during this period, starting at 3.1 in 2014, reaching its lowest point at 1.43 in 2021, and subsequently rising to 2.22 in 2022. This trend indicates a general decrease in the rate of occupational injuries over the years, with a notable reduction in 2021, followed by a slight increase in 2022. Similarly, the rate of fatal occupational injuries per 100,000 workers exhibits variations over the same timeframe. Starting at 4.21 in 2014, the rate initially increases in 2015 and 2016, levels off in 2017, and then experiences a downward trend until 2020. The rate of fatal occupational injuries per 100,000 workers drops to its lowest point at 2.09 in 2020, followed by a slight increase to 2.06 in 2022. Recorded statistics about DOSH-investigated accident cases from 2014 to 2022 are displayed in Figure 2.



Year	2014	2015	2016	2017	2018	2019	2020	2021	2022
RFOI	4.21	4.84	4.84	4.9	4.14	3.83	2.09	2	2.06
ROI	3.1	2.81	2.88	2.93	2.4	2.71	2.18	1.43	2.22

Figure 2. DOSH investigated accident cases (DOSH, 2021).

Legend: RFOI: Rate of Fatal Occupational Injuries, ROI: Rate of Occupational Injuries.

Table 1 provides a thorough summary of occupational accidents broken down by sector. The total number of recorded accidents stands at 6,951, with incidents resulting in Non-Permanent Disability (NPD) numbering 6,575, Permanent Disability (PD) totaling 235, and fatalities resulting in death amounting to 141. The manufacturing sector has the highest accident rate, followed by agriculture, forestry, and fishing. The construction industry reports a considerable number of accidents resulting in permanent disability (eight instances) and fatalities (45 cases). The Finance, Insurance, Real Estate, and Business Services sectors also demonstrate a considerable number of accidents, recording 584 incidents, with 15 resulting in Permanent Disability (PD) and 15 in fatalities.

Table 1. Occupational accident statistics by sector from January to October 2023.

Sector	NPD	PD	Death	Total
Agriculture, Forestry and Fishery	1,020	25	19	1,064
Construction	106	8	45	159
Finance, Insurance, Real Estate and Business Services	554	15	15	584
Hotel and Restaurant	176	0	0	176
Manufacturing	3,961	175	45	4,181
Mining and Quarrying	23	1	4	28
Public Services and Statutory Authorities	117	2	0	119
Transport, Storage and Communication	326	7	9	342

Utilities (Electricity, Gas, Water and Sanitary Service)	147	0	4	151
Wholesale and Retail Trade	145	2	0	147
Total	6,575	235	141	6,951

Legend: PD: Permanent Disability, NPD: Non-Permanent Disability.

Source: International Policy and Research Development Division, DOSH, Ministry of Human Resources, https://www.dosh.gov.my/index.php/statistic-v/occupational-accident-statistics/occupational-accident-statistic-2023.

The data is based on several categories including, Date, title, location, summary case, and focus of Investigation. The key factors used in this study were obtained from the data, such as the year, the location, and the industry (Table 2).

Table 2. Example of published workplace fatal accident cases by DOSH

Date	Title Case	Location	Summary Case
12/12/2020	Deadly workers buried in landslides	Construction, Pahang	A foreign worker died after being buried in a landslide while the victim was monitoring welding work in a pipe.
18/12/2020	A self-employed person was found drowned	Agriculture, Kedah	A self-employed man was found drowned while lying in a rice field

The data collected from DOSH was not standardized due to its descriptive nature and multiple errors in data entry into the database. As a result, it was important to normalize and extract relevant information for data analysis. Relevant data was extracted from the summary and incorporated into the research's variables. Table 3 depicts the method of eliminating details from the data in Table 2. Data extraction proceeded in the following manner: the date column was separated into five additional sections (year, weekday, month, day, and week).

Table 3. Example of the interpretation of keywords in the case reports.

Original form	**Keyword**	**Information**
18/12/2020	18/12/2020	Year + Month + Day + weekday + Week of year
A **foreign worker** died after being **buried** in a **landslide** while the victim was monitoring **welding work in a pipe**.	foreign worker	Nationality: Foreigner
A **foreign worker** died after being **buried** in a **landslide** while the victim was monitoring **welding** work in a pipe.	welding	Activity: Welder
A self-employed man was found **drowned** while lying in a rice field	Self-employed	Employment Status: Self-employed
A **self-employed** person was found **drowned**	drowned	Type of Accident: Drown
Agriculture, Kedah	Agriculture, Kedah	Industry + Location

The dataset was analyzed using eleven criteria, including employment status, nationality, accident type, and so on. Each element has qualities that characterize it (Table 4).

Table 4. List of factors and categories extracted from the case reports.

Factors	**Values**
Day	Days of month
Month	January, February, March, April, May, June, July, August, September, October, November, December
Weekday	Monday, Tuesday, Wednesday, Thursday, Friday, Saturday, Sunday
Year	2010, 2011, 2012, 2013, 2014, 2015, 2016, 2017, 2018, 2019, 2020
Activity	Farmer, General Worker, Welder, Driver, Carpenter, Mechanic, Supervisor, Electrician, Operator, Roofer, Manager, Safety Personnel, Technician, Scaffolder, Other
Employment status	Self-employed, Contract
Industry	Agriculture, Construction, Education, Food and beverages, Forestry, Hotel and Tourism, Manufacturing, Mining, Port, Public Road,

	Quarry, Railways, Residential area, Retail, Storage area, Transportation, Waste treatment, and Undefined industries were marked as other
Location	All 16 Malaysian States, undefined states were marked as other
Nationality	Local, Foreigner
No. of Victims	1, 2, 3, 4, 5, and 6
Type of Accident	Drown, Buried, struck by, Fall, caught in between, Burn, Road accident, Electrocution, Explosion, Asphyxiation, Crushed by, Other.

Following data arrangement, data were coded and exported to Python 3.9. A test for normality was used to evaluate whether the numerical data was normal. Frequency analysis was used to investigate workplace fatal incidents including several causes. In addition, the Mann-Whitney U test and Kruskal Wallis tests were used to determine the relationship between polytomous (nominal) and numerical variables (kind of accidents and number of casualties) (Abd Rahman et al., 2022). Finally, Chi-square, Cramer's V, and Phi were employed to assess the association between the categorical variables (industry and activity) (Chi et al., 2005). When the Cramer's V coefficient for two variables ($P<0.05$) reaches 0.1, it indicates a significant relationship (Shao et al., 2019). Each accident's cause is described in the description column. The authors used this crucial data with Neuro-linguistic programming (NLP) methodology to develop new features.

The authors created a custom stopwords list by analyzing the articles in the 'Summary Case' and 'Focus of investigation' columns, which supplemented the default stopwords in Wordcloud. The authors developed a pre-processing function that simplifies the normally difficult NLP pre-processing pipeline by reducing the case, tokenizing, lemmatizing, and stemming text before processing. After normalizing a word, stemming eliminates any frequently used prefixes or suffixes, leaving only the term's basic form. Several inflected terms derived from the root word "die" are used similarly in this form of healthcare discourse, such as "suffering" and "died". After the overview of the case was standardized, a simple feature selection or symptom tokenization was carried out. Each token may then be utilized to generate a symptom sparse matrix by reversing the frequency of documents containing that token (Chintalapudi et al., 2021). The present research employed sentiment analysis of the summary case and the investigation's emphasis to estimate the severity of the accident cases. Whether a favorable or negative attitude might reflect the gravity of the catastrophe. A score of 0 indicates

neutral mood, whereas numbers more than -0.05 and 0.05 indicate negative and positive sentiment, respectively. The gradient-boosting system supports several interpretable techniques with tree-based learning algorithms, generating precise and quick results. It can process large datasets, uses little memory, and optimizes through parallel and GPU-based learning (Agarwal & Das, 2020).

RESULTS

The primary focus of the frequency analysis was the statistical description of workplace fatal accidents with the different factors of the study. The greatest proportion of fatal workplace accidents in the last 10 years was observed in 2014 and 2020. Around a fifth of all incidents of the accident were reported in 2014 (19%), which is double the normal annual accident number; there was a reduction in the total amount of accidents following that, but it began to rise again about 2018, reaching 14% in 2020. In 2018, there was a dramatic spike in fatal accidents, with the number of accidents nearly doubling from 5 to 10% in the course of a year. Moreover, the accident data are contradictory; for instance, in 2010, (5%) fatal accidents were recorded; the next year, the numbers nearly quadrupled; and then a progressively frightening pattern began from 2011 to 2015, with 13% accidents. The two months with the most serious incidents were February and October, accounting for 10% of all documented accidents. Aside from April, the next months had comparable accident statistics, ranging from 7 to 9%. The two days with the most serious accidents were Friday and Monday. Other days of the week saw comparable accident rates, which varied between 13 to 14%. Wednesday had the lowest number of accidents (n=51, 10%) (Figure 3).

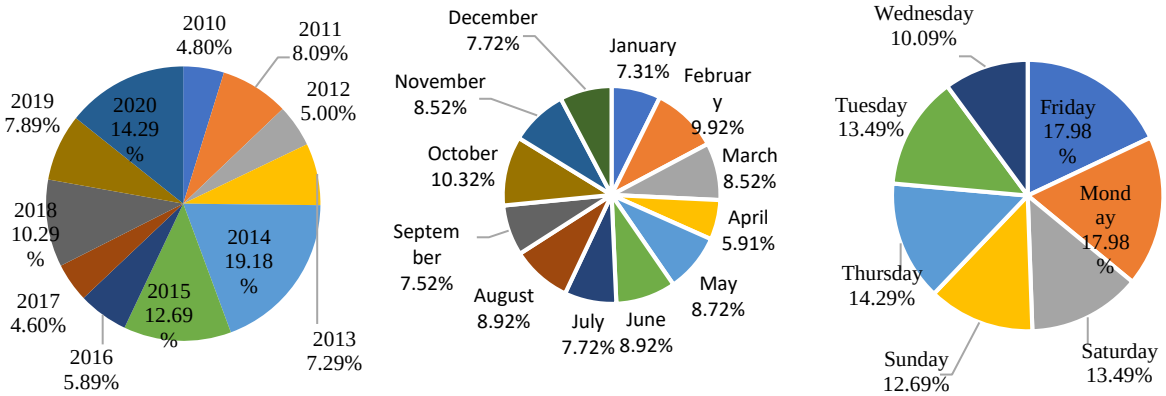


Figure 3. Frequency of fatal accident factors by Year, Month, and Day.

The construction companies had the largest number of fatal accidents (42%), of any sector. The construction industry had twice as many fatal accidents as the manufacturing sector (20%), which placed second among all industries. Over the past decade, deadly falls from

heights have been the main cause of fatal industrial accidents (32%). Nevertheless, this was not the case; victims of accidents were not given proper attention, which increased the death toll. Crushed by, stuck in between, and electrocuted were responsible for 12, 11, and 6% of all fatal incidents, respectively. The remaining causes had lower accident rates, ranging from 1% in 10 years to 3% (Figure 4).

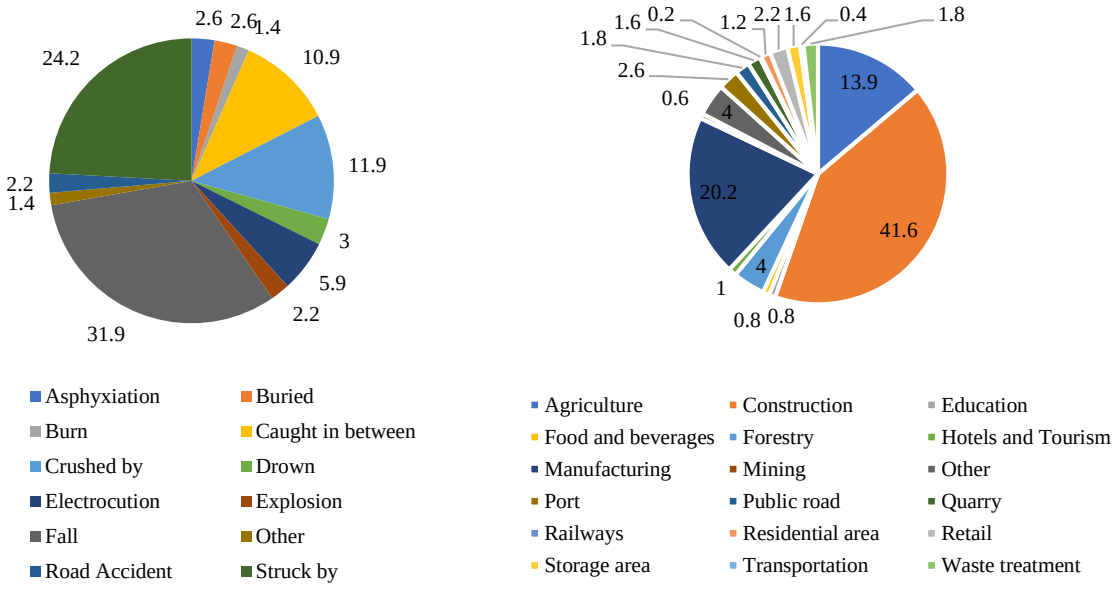


Figure 4. Fatalities by Type of Accident and Sector.

Figure 5 displays the frequency of fatalities by Industry and Type of Accidents. The graph indicates that falls from heights are the leading cause of occupational accidents in Malaysia especially in the construction sector.

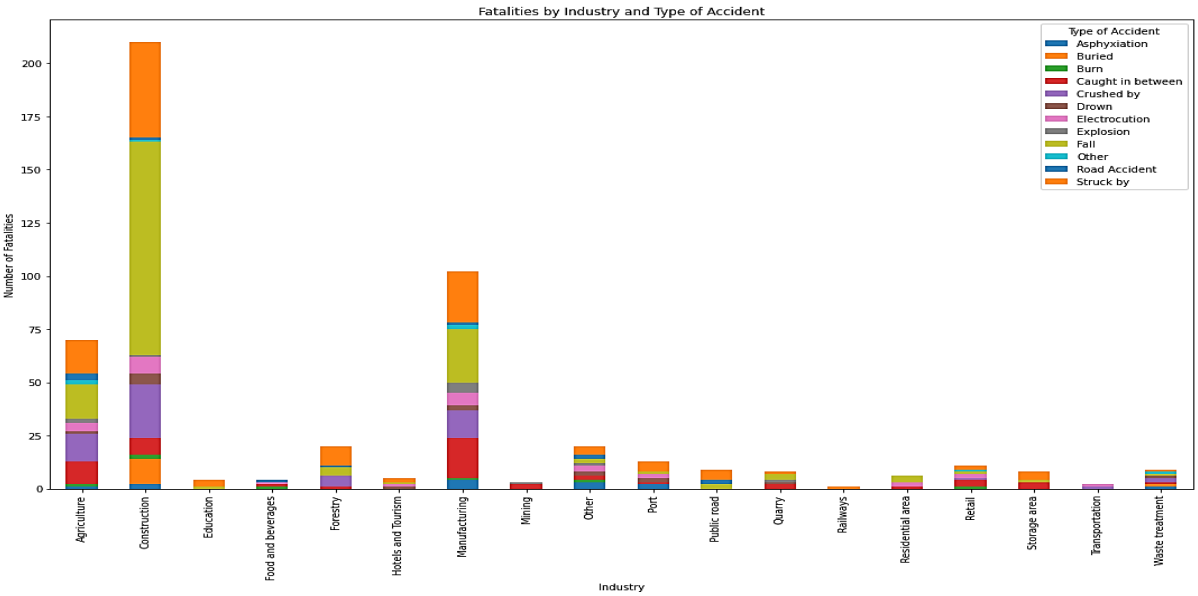


Figure 5. Fatalities by Industry and Type of Accident.

Johor had the largest number of accidents (27% of all incidents). Penang and Sarawak had the second-greatest accident rate (13% apiece). Kuala Lumpur, Putrajaya, and Selangor, their neighboring capitals, are likely to see more development initiatives than other regions (Bujang et al., 2006). Nevertheless, accidents in those areas were significantly lower than in municipalities a thousand kilometers away; this can be attributed to the location of the DOSH main office; the closer the main office, the more DOSH audits occur, and the opposite is true; the further one is from the DOSH main office, the more accidents occur. Putrajaya (where DOSH's main office is located) is the state with the fewest fatal accidents recorded. At the same period, Perak, Sabah, and Kedah saw increased accident rates. General workers were the most vulnerable to fatal accidents with a rate of 60% (Figure 6).

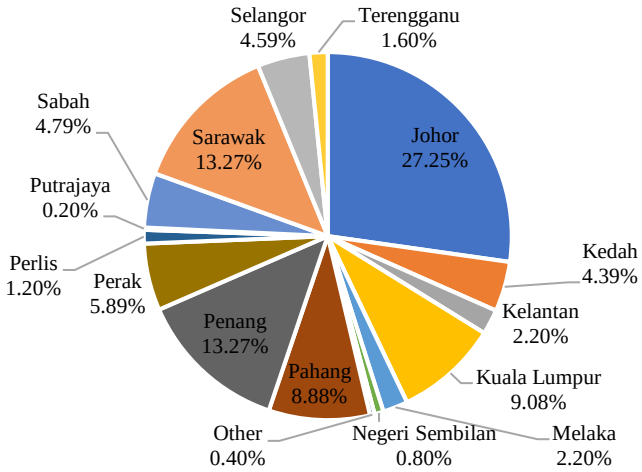


Figure 6. Workplace accidents by Location.

Farmers and Drivers were the second-highest categories vulnerable to deadly accidents (10 and 9%), respectively. Road accidents were not included in this analysis unless the worker was at his workplace or on the way to it; with that in mind, the number of accidents recorded by drivers was the third most recorded accident (9%) of all accident cases. Other categories, such as electricians and operators, registered moderate numbers with (4%) and (6%), respectively. Contract workers are more susceptible to fatal accidents than self-employed workers (64%) (Figure 7).

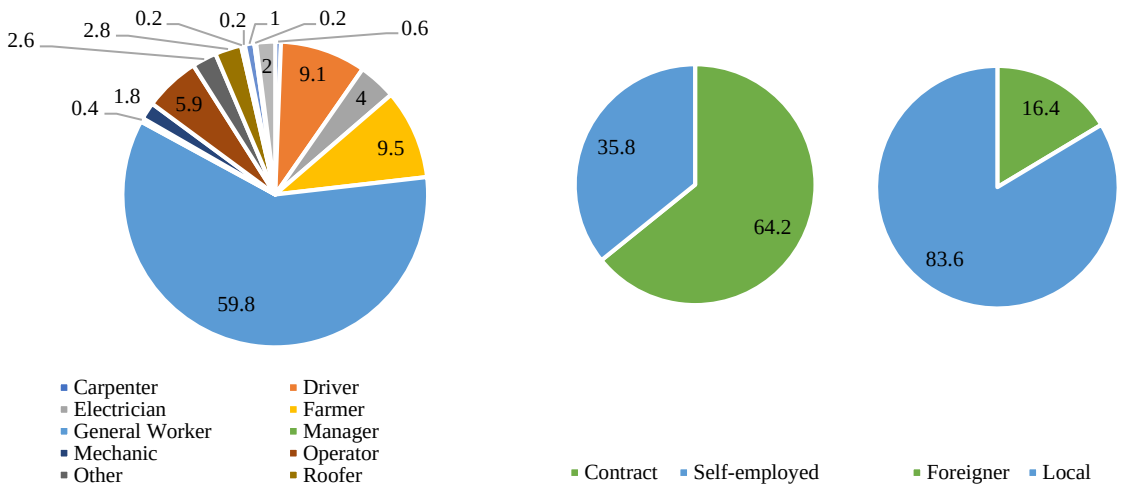


Figure 7. Fatalities by Activity, Type of Worker Contract, and Nationality.

The Spearman correlation analysis (Table 5) revealed no significant association between the number of victims and the dates of the accidents, regardless of whether the dates were analyzed by days, months, weeks, or years as displayed in Table 8. This analysis shows that the correlations between the number of victims and the time-related variables (year, day, week of the year) are very weak and not statistically significant. This indicates that the number of victims in fatal workplace accidents does not have a discernible pattern or association with the specific dates of the accidents.

Table 5. Spearman rank-order correlation coefficient between ordinal columns.

	No of Victims		**Year**		**Day**		**Week of Year**	
	R_s	P-value	R_s	P-value	R_s	P-value	R_s	P-value
No of Victims	1.000		-0.032	0.467	0.049	0.270	-0.006	0.902
Year	-0.032	0.467	1.000		0.008	0.859	0.066	0.140
Day	0.049	0.270	0.008	0.859	1.000		0.040	0.364
Week of Year	-0.006	0.902	0.066	0.140	0.040	0.364	1.000	

Note: *P<0.05, **P<0.01

The Mann-Whitney U test was conducted to evaluate the impact of the number of victims, the year of the accident, the day of the accident, and the week of the year on nationality and employment status (Table 6). The analysis found a significant association only between the week of the year and nationality (*P=0.040*). This analysis indicates that while most factors

showed no significant association with either nationality or employment status, the week of the year was significantly associated with nationality, suggesting that the timing of the accidents within the year might influence the nationality of the victims.

Table 6. Effect of the relevant factors on nationality and employment status.

Relevant factors	**Mann Whitney U test**	
	Nationality	**Employment status**
No of Victims	0.932	0.058
Day	0.586	0.396
Week of year	0.040*	0.628
Year	0.834	0.576

Note: *P<0.05, **P<0.01

The Kruskal-Walli's test was employed to assess the impact of the year, day, week of the year, and the number of victims on the types of accidents, weekday, industry, location, and activity of the workers. The results revealed that the number of victims significantly affects the location of the accident (*p=0.005*) and the types of accidents (*p=0.000*). Additionally, the year of the accident significantly influences the type of accident (*p=0.038*), the industry (*p=0.024*), the location of the accident (*p=0.000*), and the activity performed at the time of the fatality (*p=0.001*). These findings indicate that both the number of victims and the year of the accident have significant effects on various factors related to workplace fatalities. Specifically, the number of victims impacts the location and types of accidents, while the year influences the type of accident, industry, location, and activity being performed at the time of the accident (Table 7).

Table 7. Effect of the relevant factors.

Relevant factors	**Kruskal Wallis test**				
	Types of accidents	**Weekday**	**Industry**	**Location**	**Activity**
No of Victims	0.000**	0.659	0.085	0.005**	0.611
Year	0.038*	0.342	0.024*	0.000**	0.001**
Day	0.073	0.533	0.696	0.167	0.213
Week of year	0.623	0.216	0.444	0.294	0.211

Note: *P<0.05, **P<0.01

In this study, a contingency table was used, and correlation coefficients were measured with 95% confidence intervals, as shown in Table 8. Cramer's V correlation coefficient was chosen to measure the correlation between variables with more than "2 x n" categories. Other

than weekdays, most variables exhibit moderate to strong correlations. The activity of the worker significantly impacts factors such as employment status (*p=0.000*), type of accident (*p=0.000*), and nationality (*p=0.033*). This analysis indicates that worker activity has a strong correlation with employment status, type of accident, and nationality. These significant associations underscore the impact of worker activity on various other factors, highlighting the interconnected nature of workplace accident variables.

Table 8. Contingency table for correlation coefficients between factors.

Dependent variable	**Independent variable**	**X^2**	**df.**	**Sig.**	**Phi**	**Cramer's V**
Activity	Employment status	186.773	14	0.000**	2.726	0.585
	Nationality	25.166	14	0.033*	0.032	0.148
	Weekday	106.132	84	0.052	0.0518	0.085
	Types of accidents	417.604	154	0.000**	3.447	0.220
	Industry	700.793	238	0.000**	3.885	0.259
	Location	291.216	210	0.000**	0.000	0.108
Industry	Employment status	248.417	17	0.000**	4.392	0.677
	Activity	700.793	238	0.000**	3.885	0.259
	Types of accidents	319.453	187	0.000**	5.409	0.155
	Location	410.427	255	0.000**	2.250	0.145
	Nationality	25.700	154	0.080	0.080	0.131
	Weekday	123.529	102	0.072	0.072	0.084
Employment status	Nationality	7.933	1	0.005**	0.004	
	Industry	248.417	17	0.000**	4.392	
	Location	55.899	15	0.000**	1.260	
	Activity	186.773	14	0.000**	2.726	
	Types of accidents	30.900	11	0.001**	0.001	
	Weekday	5.401	6	0.493	0.493	
Nationality	Industry	25.700	17	0.080	0.080	
	Location	26.182	15	0.036*	0.036	
	Employment status	7.933	1	0.005**	0.004	

	Activity	25.166	14	0.033*	0.032	
	Types of accidents	16.989	11	0.108	0.108	
	Weekday	3.007	6	0.808	0.807	

Note: *P<0.05, **P<0.01

The industry recorded a strong correlation with the Employment status (*p=0.000*), the Activity (*p=0.000*), the Types of accidents (*p=0.033*), and the Location (*p=0.000*). Cramer's V shows a strong correlation between all the categorical variables. All variables have no association with the weekdays; hence, weekdays have no impact on fatal accidents. Furthermore, nationality does not impact the Type of accidents ($X^2=16.989$, *p=0.108*), weekdays ($X^2=3.007$, *p=0.808*), and the industry ($X^2=25.700$, *p=0.080*). Adhikary et al. (Adhikary, 2019) found that workers' nationality and location have a strong association per this study's findings ($X^2=26.182$, *p=0.036*). The nationality of workers recorded an association with workers' Activity ($X^2=25.166$, *p=0.033*). Zerguine et al. found an association between workers' nationality and their Activity (Zerguine et al., 2018). Although this study recognizes the enjoyable and novel aspect of word clouds (or tag clouds) for graphically representing text data, the authors assert that these visual tools can also serve as valuable evaluation instruments. Word clouds offer researchers a quick and straightforward method to create visual representations of words that illustrate accident reports. The presence or absence of specific words and phrases can reveal textual patterns, aiding investigators in identifying the root cause of an accident (Zermane et al., 2023).

The three most frequently mentioned words in accident case descriptions are "died," "fell," and "victim." This highlights that fall from heights are the primary cause of occupational accidents in Malaysia, not limited to the construction industry, as noted by Ayob et al, Hamid et al., and Zermane et al. (Ayob et al., 2018; Hamid et al., 2019; Zermane et al., 2020, 2022). Regarding the focus of investigations, the most common terms are "procedure," "fail," and "work," indicating a lack of safe operating procedures in Malaysian workplaces. Another cause of occupational accidents is the failure to conduct Hazard Identification, Risk Assessment, and Risk Control (HIRARC), a mandatory risk assessment by DOSH. The words "supervise" and "provide" suggest that management often fails to supervise workers adequately, and provide a site safety supervisor, necessary training, and personal protective equipment, as indicated by Zermane et al. (Zermane et al., 2022).

An average score of -0.632 for the summary cases indicates that most fatalities were severe, as reported by site investigators. However, DOSH investigators recorded a lower

average score of -0.242, likely due to the site investigators being present at the scene of the accident, while DOSH investigators typically arrived days later. In terms of individual sentiment scores, 487 accident cases had negative sentiments, indicating high severity with an average score of -0.657. In contrast, five accident cases had positive sentiments, suggesting lower severity with an average score of 0.127. Additionally, 13 accident cases received a neutral score of 0. Regarding the investigation focus, 347 accident cases had a negative sentiment with an average score of -0.418, reflecting that DOSH investigators found these fatalities severe. Meanwhile, 60 accident cases had a neutral sentiment, and 98 cases had a positive sentiment with an average score of 0.231, indicating lower severity.

The foundation of this feature set is the Bag-of-Words (BoW) approach, which assigns Term Frequency-Inverse Document Frequency (TF-IDF) values to each word in the dataset (excluding unique words). These TF-IDF vectors are then used as features in a classification system. This method is based on the idea that certain words appear with different frequencies depending on whether they are used in positive or negative contexts. The strategy enhances the readability and understanding of the prediction process for each data point by making the various partition criteria and leaf values accessible to the user.

DISCUSSION

A fifth of all accident cases were recorded in 2014 (19%), which is double the normal yearly accident number; following that, the number of accidents decreased but then began to rise again around 2018, until 2020, when it recorded 14% of all accident cases. The 2014 high accident number might be attributed to Malaysia's GDP growth in 2014 compared to prior years (Azer et al., 2016). Malaysian businesses are obligated to notify work-related injuries to DOSH (DOSH, 2004); yet, in 2017, there were only 5 percent of incidents, which is a low average relative to others, indicating DOSH efforts. DOSH rules and regulations are extensive and inclusive of all safety management systems, and they adhere to OHSAS 18001; yet, fatal accidents continue to be a major concern in Malaysian workplaces. DOSH strict audits are advised to enforce safety requirements in various workplaces. Regular training sessions and activities coordinated by DOSH can assist raise safety awareness among decision-makers, perhaps introducing a good safety culture in the workplace. It is only logical to assume that both months (October and November) are part of Malaysia's rainy season, which includes severe thunderstorms, wet days, and sometimes flooding (Tsang et al., 2017). The large frequency of accidents might be ascribed to unpredictable weather conditions. They labor outside in the hot heat or in the thunderstorms that accompany Malaysia's tropical weather

(Varghese, 2018, p. 20). Fatima et al. (Fatima et al., 2021) addressed in depth the link between high heat and work-related injuries. The Malaysian weather is hot all year, and heat strokes are common among natives. April saw the lowest number of accidents (6%) in ten years. April saw the fewest incidents due to Malaysia's consistent weather conditions, which marked the start of the dry season there.

Friday and Monday (18%) accounted for 91 of the accidents observed during the past ten years. Amiri et al.'s (Amiri et al., 2014) investigation discovered that accident numbers declined on the last day of the business week, contradicting the findings of this study. However, Amiri et al. (Amiri et al., 2014) performed their study in Iranian workplaces, which might reflect differences in working customs. On the other hand, both Amiri et al. (Amiri et al., 2014) and Shao et al. (Shao et al., 2019) found the same result on Monday. Camino López et al. (Camino López et al., 2008) proposed that accidents that occur on weekends may not be reported until Monday; the idea works both ways. Whether employers will wait until the beginning of the week (Monday) to report the accident, or whether DOSH officials will not investigate until Monday. Camino López et al. coined the term "Monday effect" to describe when employers fail to report an accident until the next working day for insurance considerations (Camino López et al., 2008). The same principle applies to Fridays; DOSH officials may set a Friday deadline, and the accumulating accident reports will not be investigated until then.

Because of the ever-changing nature of the construction business and the huge number of workers present at any given moment, it is difficult to develop a universally applicable preventative solution; construction activities and procedures differ from place to place (Zerguine et al., 2016). According to Zid et al., the construction sector is the largest contributor to the Malaysian economy, but it also has the greatest rate of fatal accidents. Zid et al. identified a substantial link between the Malaysian construction sector and the Malaysian economy (Zid et al., 2020). agricultural was the third leading cause of fatal accidents (14%), according to Abas et al. (A. B. L. Abas et al., 2013), who discovered that agriculture had more work-related injuries than construction or manufacturing. Nevertheless, most incidents were not deadly, but they did result in permanent or non-permanent disability for the worker (DOSH, 2021). The rest of the industries had much fewer fatal accidents than the three stated above; this might be attributed to the low-risk activities performed in these sectors (Zakaria et al., 2012). Another element that contributes to workplace accidents is regional differences in levels of development, workforce quality, the efficiency of occupational safety and health legislation, the diversity of job functions, and the complexity of working circumstances. They assumed

that all of the respondents in this study were foreign workers and that foreign workers account for 69% of the total workforce in Malaysia's construction industry (Zerguine et al., 2017). Zerguine et al. concluded that foreign workers who suffered work-related injuries recorded no association with the dates of the accidents (Zerguine et al., 2018).

Over the past decade, fatal falls from heights have been the leading cause of fatal workplace accidents (32%). Previous research in Hong Kong (Chi et al., 2014), the United States (Dong et al., 2014), and China (Shao et al., 2019), all found similar results. Furthermore, Zermane et al. (Zermane et al., 2022, 2023) investigated the factors that led to deadly falls from heights in Malaysia's construction sector and discovered that human and management variables were the primary causes of these sorts of accidents. Struck came in second place after falls from heights, with 122 (24%) occurrences. Abas et al. emphasized the significance of struck-object incidents, concluding that 66% of all struck-by accidents might be prevented via safety training and education (A. B. L. Abas et al., 2013). Employees who neglect to report incidents may do so for a variety of reasons. Some probable factors include workers accepting and believing that injuries are a part of their trade since they occur frequently and are of low severity, as well as the fear of losing their jobs or harming their reputation (Zerguine et al., 2018). Johor had the greatest number of accidents (27% of all incidents), which might be attributed to economic development (Khanam & Noor, 2014). Abas et al. (N. H. Abas et al., 2020) found a modest link between safety staff perception and documented accident causes in the Johor region.

The absence of safety awareness and perception among safety staff indicates a substantial gap in safety knowledge and practice in Malaysian workplaces. Vinodkumar and Bhasi (Vinodkumar & Bhasi, 2010) emphasized the significance of safety knowledge inside the organization; safety motivation and training are vital in promoting a positive safety culture. Zermane et al. underlined the size of the states where the majority of incidents occurred; however, this may not apply in all circumstances (Zermane et al., 2020). When comparing the size of Penang and Sarawak, Sarawak is 124 times larger than Penang; nevertheless, when it comes to population, both states have more than one million people (Booth et al., 2021). Nadhim et al. (Nadhim et al., 2016) found a link between employee characteristics and deadly falls from heights; individual factors included a lack of skills, knowledge, and training, misjudgment, and inexperience. General workers' lack of technical skills and experience exposes them to potentially deadly incidents (Zermane et al., 2022).

General laborers were the most vulnerable to fatal accidents, followed by farmers and drivers. According to Corrigan et al. (Corrigan et al., 2018), the safety culture of an

organization may significantly boost employee satisfaction and help prevent undesirable events; nevertheless, this was not the case in the Malaysian work environment, where contract workers had more accidents than self-employed employees. Furthermore, contract workers are typically linked with huge organizations with significantly more employees than self-employed people. To help minimize such deadly incidents, it is recommended that effective communication, resource management, and supervision be prioritized. It may be beneficial to develop a training and oversight certification program, encourage customers of small projects to verify contractors' conformance records and tackle these problems explicitly in small workplaces (Wong et al., 2016). Self-employed workers accounted for 36% of all fatal accidents compared to contract workers. This high figure is cause for worry because self-employed people are typically found in start-ups, small and medium-sized enterprises (SMEs), and family businesses with fewer employees than large corporations. Compared to their wage-and-salary contemporaries, who frequently get safety protection equipment from their employers, self-employed employees may have fewer resources to dedicate to safety teaching and equipment (Dong et al., 2014). Moreover, organizational preventive measures were suggested, such as improving the organizational culture within these industries.

The risk of injury understating may increase since there are typically no witnesses to provide details of the incident, and medical examiners may fail to identify all work-related fatalities. Despite its limitations, this study explicitly supports the DOSH's vital measures to avoid deaths in Malaysia. Companies should have a documented protection program that specifies the type of safety equipment that will be utilized for specific jobs. Furthermore, ensure that personnel receive proper training in preventing fatal injuries and that safety management systems and standards are enforced across the firm. Furthermore, improvements in design and engineering may be made to eliminate risks, and multi-employer sites might implement site-wide policies to boost risk communication and major alterations to tools and work techniques (Dong et al., 2014). Numerous preventative activities are recommended, beginning with the introduction of training programs specifically designed for small contractor supervisors and managers to improve their safety management and supervisory skills. Daily safety awareness exercises can be completed before beginning work. For specialized high-risk tasks, the industry may build standard technical and management processes; these procedures may subsequently be pushed among small contractors, who often lack strong technical and administrative capabilities (Wong et al., 2016).

CONCLUSION

This study examined 505 fatal workplace accidents across Malaysian states from 2010 to 2020 to identify patterns in these fatalities. The findings revealed distinct trends in Malaysian workplace deaths. Predictably, the construction industry had the highest number of fatalities, followed by the manufacturing sector. Falls from heights were the leading cause of fatal accidents, accounting for nearly one-third of all fatalities. Johor recorded the most fatalities among all states. General workers were the most at risk, and contract workers had higher fatality rates than self-employed workers. The date of the accident did not influence the number of casualties; each incident appeared random. However, there was a moderate association between the number of victims and factors such as the cause of death, location, and industry. Additionally, accident dates moderately correlated with accident locations and weakly with other variables. A strong correlation was found between the activity, industry, employment status, nationality of workers, causes of death, and accident locations. Identifying fatal accident patterns can help in preventing such incidents. DOSH can enhance standard working procedures for fatal accidents, with a particular focus on general workers as a vulnerable group, aiming to improve their awareness and working conditions. Most fatalities in agriculture involved self-employed farmers, suggesting the need for DOSH to establish self-regulation norms to prevent accidents in this sector. Given that construction is the most hazardous industry in Malaysia with the highest fatalities, DOSH should prioritize resources to regulate the construction industry more effectively (Ayob et al., 2018; Carrier, 2023; Hamid et al., 2019).

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