Using statistical analysis and literature review to identify temporal patterns of incident occurrence and trades in the construction industry

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Introduction

Background

- The construction industry has a high number of fatalities and injuries when compared to other industries, such as oil and gas [1,2].
- In Canada, the construction industry is responsible for over 19.6% of workplace fatalities and over 10% of lost-time claims [3].
- There is a lack of comprehensive analysis, and limited research has been done to understand how incidents vary across different trades and periods of time [4].
- This study aims to provide recommendations for an improved safety management plan by reducing incident rates in the construction industry using statistical analysis and literature review.

Research Gap

- How do times of year, week, and day affect incident occurrence in the construction industry?
- How does trade or division of work affect incident occurrence in the construction industry?

Methodology

Statistical Analysis

- This study analyzed 3,222 incident reports of a construction project from January to December 2020.
- The incident dataset contained reports with information about the date, time, incident severity, and the division of work involved in the incident.
- Several data pre-processing steps were conducted before analyzing the data (Figure 1):
  - Incident records were organized chronologically for clarity.
  - Duplicate and incomplete entries were identified and eliminated since the data would be repetitive or incomplete.
  - This eliminated 171 entries from the dataset.
- Excel functions were then used to identify how many incidents occurred in specific trades and at specific times.
  - Times of day were rounded to the closest hour.
- The data was normalized by dividing the number of incidents by the work hours to determine the rate.
- The trades and periods of time were then graphed alongside the number of incidents to identify any patterns.
- The results of this study were then compared with the literature review to validate the findings of the study.

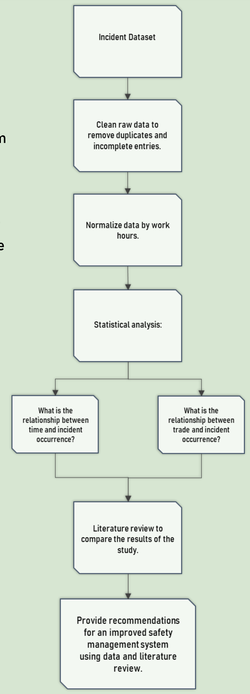

Figure 1: Research methodology adopted in this study.

Results

Statistical Results

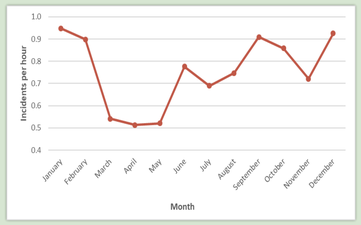

Figure 2: The incident rate normalized by work hours during each month.

Incident Rate By Month (Figure 2)

- The most incidents per hour occurred in the winter months, with the highest rates in January and December, likely due to risker weather conditions.
- The third highest incident rate was in September, likely due to a higher volume of workers or work being done.
- Low incident rates are observed in March through May, likely impacted by the large scale shutdown of many industries in March 2020 due to COVID-19.

Incident Rate by Day of Week (Figure 3)

- The highest incident rate was observed on Wednesday, likely due to the fatigue from the previous workdays which may have decreased awareness of safety risks.
- Sunday had the lowest incident rate; however, when disregarding the weekends, Friday had the lowest incident rate, most likely due to a decreased amount of work being done.

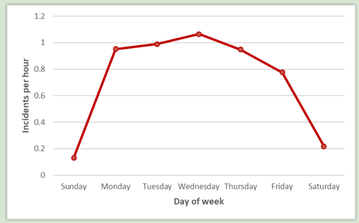

Figure 3: The incident rate normalized by work hours during each day of the week.

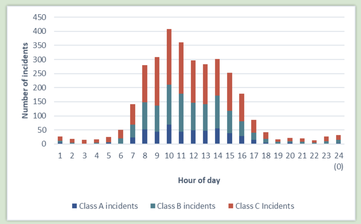

Figure 4: The total number of incidents in each class during each day of the week.

Number of Incidents by Hours (Figure 4)

- The most total, Class A, Class B, and Class C incidents occurred at approximately 10:00, most likely due to a greater amount of work being done.
- The least total incidents and Class C incidents occurred at 22:00, likely due to less work being done.
- The least Class B incidents occurred at 3:00.
- Several hours of the day (2:00, 3:00, 4:00, 22:00, and 23:00) reported no Class A incidents.

Number of Incidents by Division of Work (Figure 5)

- The most total, Class A, Class B, and Class C incidents were in the sitework division, accounting for over 39.7% of incidents, likely due to a large number of workers and a large variety of work being done.
- The second highest numbers of total, Class A, and Class B incidents occurred in the concrete division, making up 14.4% of total incidents.
- The most Class C incidents occurred in the metals division, totaling 12.2% of overall incidents.

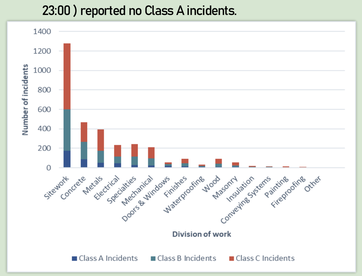

Figure 5: The total number of incidents in each class in each division of work.

Literary Results

- The results of this study are in line with a study conducted in the United States construction industry [4], which found the following similarities:
  - The study found that the number of incidents peaked in the summer months (June through August), although it is likely that due to the hours worked, the winter months may have had a higher rate of incidents per hour.
  - Since Canada and the United States have similar seasons, the general weather patterns and work hours during each month are similar as well.
  - The study also found that the highest number of incidents occurred at 10:00, and on Wednesdays.
- In addition, another study analyzing incident occurrence in China [5], found similar patterns in time, with the most incidents occurring at 10:00 and 15:00.

Conclusion

Recommendations for Improving Safety

- By identifying which times and trades have a higher risk of incidents, increasing safety awareness within a worker community can help identify premature incidents and lower the number of incidents, and by providing thorough and accessible training, we can increase this awareness.
- Focusing on increasing inspection frequency and safety awareness training specifically during the winter is especially important, as incidents are more likely to occur during this time.
- Since most incidents occurred in the sitework division, it is important that every worker is able to properly recognize and identify hazards, reducing selective attention and inattention [6].
  - In the future, we can use technologies like building information modeling (BIM) [7] or sensor-based safety management systems [8], to make it easier to identify and record safety risks, as well as monitor worker safety.
  - By embracing these technologies, we can make it easier for workers to identify leading indicators and prevent incident occurrence.
- By making construction safety training more accessible and worker friendly through the integration of new technologies such as BIM, we can increase the number of people on site who are able to identify a hazard and control it, before it occurs [9]. When workers are aware of the times and trades that have the highest risk of incident occurrence, they may be more aware of hazards.

Acknowledgements & Literature Cited

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