Safety First! Evaluating the Association of Inspections on Incidents in the Construction Industry Using Data Analytics

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Introduction

- The construction industry is known for its high-risk dynamic environment and has the highest fatality rates compared to other sectors like oil and gas [1].
- In Canada, it was responsible for over 18.4% of fatalities and over 8.18% of lost time claims in 2022 [2].
- Safety issues continue to persist due to inadequate safety inspections, incomplete safety planning, and poor hazard identification performance [3].
- This study investigates the association between incidents and the pre-job safety inspection (PSI) with the use of data analytics and literature review to provide recommendations to mitigate incidents and enhance risk and safety management in the construction industry.

Research Questions:

- What is the distribution of different incident types?
- Does the PSI completion affect incident classification in the construction industry?
- Does the PSI completion affect the different types of incidents in the construction industry?

Methodology

- This research study used 113,551 incident reports of multiple construction projects from January 1999 to December 2022.
- The columns analyzed are the incident ID, incident classification, incident type, and PSI completion.
- Incident classifications: Class A has the potential to cause permanent disability and fatality, Class B has moderate incidents and Class C has minor incidents.
- Data preprocessing was done to ensure accuracy:
  - 3,351 duplicates were deleted.
  - Columns that were not used for the study were dropped.
  - 16 incident types were narrowed down to 6.
- Overall, 110,200 incident reports were analyzed for this study.
- The Chi-square test was conducted on the variables of questions two and three to determine if there is an association between their variables.
- A literature review was performed to identify recommendations for improving safety and risk management in the workplace.
- All the analysis mentioned in this research was done using Python programming language coding version 3.12.4 through the Anaconda environment.

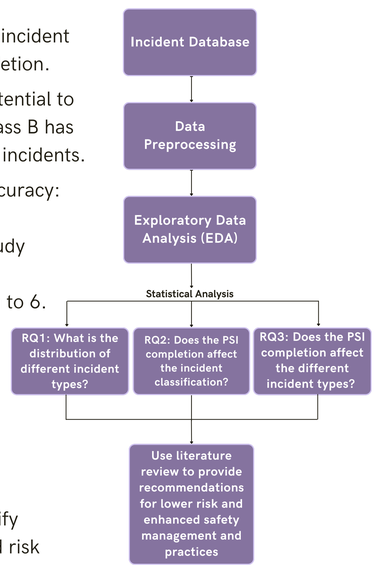

Figure 1: Research methodology used in the study

Results and Discussion

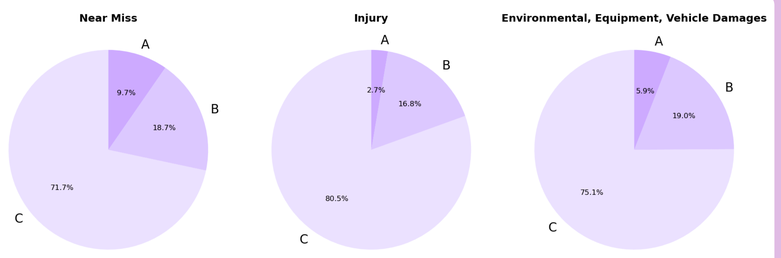

Figure 2: Incident Types and their Classification Distribution

- In Figure 2, Class A, near misses had the highest percentage of incidents accounting for around 9.7% of incidents.
- For Class B, environmental, equipment, and vehicle damages had the highest percentage with around 19.0%
- In Class C, injuries represented the highest percentage with approximately 80.5%

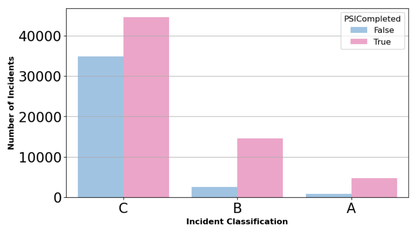

Figure 3: Incident Classification based on PSI Completion

- The Chi-square test between PSI completion and incident classification revealed a significant association since the p-value was less than 0.05 (p-value of 0.0)
- Class C incidents account for around 76% of the incidents in the database and Class A incidents around 6%.
- Results indicate that completed PSIs have higher counts of incidents highlighting the need for more robust and improved safety inspections

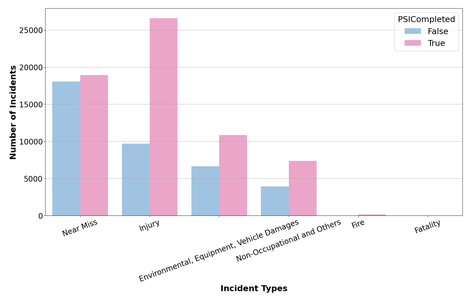

Figure 4: Incident Types based on PSI Completion

- A similar analysis was done between PSI completion and incident types which also showed a significant association (p-value of 0.0).
- The increase in injury reports from when it was not completed to when the PSI was completed is approximately 174%.
- High near-miss reports (36.9%) reveal the frequent exposure to potential hazards, emphasizing underlying safety issues, while also reflecting a proactive safety culture and effective documentation.

Conclusion

- In conclusion, in the analyzed 110,200 incident reports, near misses had the highest percentage of Class A incidents (9.7%), for Class B, environmental, equipment, and vehicle damages were the most frequent (19.0%), and for Class C injuries were the most common (80.5%).
- With the use of the Chi-square test, a significant association between PSI completion and incident types and severity was found (p-value of 0.0) which underscores the role of safety inspections in enhancing safety and risk management.
- Multiple studies indicate that safety inspections or observations - including site auditing, formal safety inspections, and behaviour observation, provide moderately strong evidence of reduced injuries [4].
  - With the use of visualization technologies such as Building Information Modeling (BIM), Virtual Reality (VR), and Augmented Reality (AR), hazard identification and site awareness can be improved [3].
  - Body sensors offer more personalized safety and risk monitoring by monitoring real-time physiological health to help prevent incidents like near misses and injuries [5]. With this technology, hazards can be detected early before incidents occur.
  - Also, organizations can reduce incidents and injuries by engaging in "safety voice" which involves sharing safety concerns with upper management without the fear of punishment [6].
  - Other ways to improve safety is by promoting a stronger safety culture [7], enhancing equipment design [8], and regular equipment auditing.

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