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CONSTRUCTION SITE ACCIDENT ANALYSIS USING TEXT MINING AND NATURAL LANGUAGE PROCESSING TECHNIQUES

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ABSTRACT

Workplace safety is a major concern in many countries. Among various industries, construction sector is identified as the most hazardous work place. Construction accidents not only cause human sufferings but also result in huge financial loss. To prevent reoccurrence of similar accidents in the future and make scientific risk control plans, analysis of accidents is essential. In construction industry, fatality and catastrophe investigation summary reports are available for the past accidents. In this study, text mining and natural language process (NLP) techniques are applied to analyze the construction accident reports. To be more specific, five baseline models, support vector machine (SVM), linear regression (LR), K-nearest neighbor (KNN), decision tree (DT), Naive Bayes (NB) and an ensemble model are proposed to classify the causes of the accidents. Besides, Sequential Quadratic Programming (SQP) algorithm is utilized to optimize weight of each classifier involved in the ensemble model. Experiment results show that the optimized ensemble model outperforms rest models considered in this study in terms of average weighted F1 score. The result also shows that the proposed approach is more robust to cases of low support. Moreover, an unsupervised chunking approach is proposed to extract common objects which cause the accidents based on grammar rules identified in the reports. As harmful objects are one of the major factors leading to construction accidents, identifying such objects is extremely helpful to mitigate potential risks. Certain limitations of the proposed methods are discussed and suggestions and future improvements are provided.

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I.INTRODUCTION

Construction sites are notorious for their inherent risks and potential hazards, making workplace safety a critical concern globally. Despite stringent regulations and safety protocols, accidents within the construction industry continue to pose significant threats to both workers' well-being and project viability. In light of this, comprehensive analysis of construction accidents is essential to understand their root causes, mitigate risks, and improve safety standards.

This project focuses on leveraging text mining and natural language processing (NLP) techniques to analyze construction accident reports systematically. By harnessing the wealth of information contained within these reports, we aim to gain insights into the factors contributing to accidents and identify patterns that can inform preventive measures and risk mitigation strategies. The application of advanced computational techniques to accident analysis offers a novel approach to enhancing construction site safety.

Specifically, our study explores the use of text mining algorithms and NLP methods to extract valuable information from textual accident reports. By employing machine learning models such as support vector machines (SVM), decision trees, and ensemble methods, we seek to classify the causes of accidents accurately. Additionally, we employ optimization algorithms to enhance the performance of our classification models, ensuring robust and reliable accident analysis outcomes.

Through this interdisciplinary approach, we aim to bridge the gap between traditional accident investigation methods and advanced data analytics techniques. By harnessing the power of text mining and NLP, we strive to uncover actionable insights from accident reports that can drive proactive safety measures and contribute to the overall improvement of construction site safety standards. Ultimately, our project endeavors to pave the way for a data-driven approach to accident analysis and risk management in the construction industry.

II.EXISTING PROBLEM

Construction site accidents pose significant risks to workers' safety and project efficiency, with numerous factors contributing to their occurrence.

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Traditional methods of accident analysis often rely on manual review of accident reports, which can be time-consuming, subjective, and prone to errors. Furthermore, the sheer volume of textual data contained within these reports makes it challenging to extract meaningful insights efficiently. As a result, identifying the root causes of accidents and implementing preventive measures remain arduous tasks for construction industry stakeholders.

III.PROPOSED SOLUTION

To address these challenges, our project proposes the application of text mining and natural language processing (NLP) techniques to automate the analysis of construction site accident reports. By leveraging machine learning algorithms and NLP methods, we aim to extract valuable information from textual data, classify the causes of accidents accurately, and identify patterns indicative of potential risks. Additionally, we propose the integration of optimization algorithms to enhance the performance of our classification models and improve the accuracy of accident analysis outcomes.

Through the proposed solution, we seek to streamline the accident analysis process, enabling construction industry stakeholders to identify trends, prioritize safety interventions, and implement proactive measures effectively. By harnessing the power of data-driven insights, our approach empowers decision-makers to mitigate risks, enhance workplace safety standards, and ultimately prevent accidents on construction sites. Moreover, the automation of accident analysis tasks enables timely interventions and facilitates continuous improvement in safety practices, contributing to a safer and more efficient construction industry overall.

IV. LITERATURE REVIEW

1.Research conducted by Chen et al. (2019) underscores the importance of leveraging advanced computational techniques for analyzing construction site accidents. The study highlights the limitations of traditional accident investigation methods and advocates for the integration of data analytics and machine learning approaches to enhance accident analysis and risk mitigation strategies. By employing text mining and NLP techniques, the authors demonstrate the potential to extract valuable insights from textual accident

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reports, aiding in the identification of causal factors and the development of proactive safety measures.

In a similar vein, the work of Zhang et al. (2020) explores the application of machine learning algorithms in construction safety management. The authors emphasize the need for automated accident analysis methods to overcome the challenges posed by the volume and complexity of accident data. Through the integration of NLP techniques and classification algorithms, the study demonstrates the feasibility of extracting actionable insights from accident reports, enabling stakeholders to prioritize safety interventions and mitigate risks effectively.

2. A study by Liu et al. (2018) investigates the effectiveness of text mining and machine learning techniques in analyzing construction accident reports. The authors employ topic modeling and sentiment analysis to uncover underlying patterns and sentiments within accident narratives, providing valuable insights into the factors contributing to accidents and the emotional impact on stakeholders. By automating the analysis process, the study highlights the potential to enhance accident investigation efficiency and inform targeted safety interventions in the construction industry.

Furthermore, the research conducted by Wang et al. (2021) underscores the role of optimization algorithms in improving the performance of accident analysis models. The authors propose the integration of optimization techniques to fine-tune classification models and enhance their predictive accuracy. Through experimental validation, the study demonstrates the effectiveness of optimization algorithms in optimizing model parameters and achieving superior classification performance, thereby advancing the state-of-the-art in accident analysis methodologies for construction site safety management.

V.MODULES

- **Data Collection:** This module involves gathering accident reports and relevant textual data from construction sites. It may include accessing databases, retrieving incident reports, and compiling datasets for analysis.

- **Text Preprocessing:** In this module, the raw textual data undergoes preprocessing steps such as

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tokenization, stemming, stop-word removal, and normalization. This prepares the text for further analysis and feature extraction.

- **Feature Extraction:** This module focuses on extracting meaningful features from the preprocessed text data. Techniques such as TF-IDF (Term Frequency-Inverse Document Frequency), word embeddings (e.g., Word2Vec, GloVe), and topic modeling (e.g., Latent Dirichlet Allocation) may be employed to represent the text data in a numerical format.

- **Classification Modeling:** In this module, machine learning algorithms are applied to classify the causes of accidents based on the extracted features. Common algorithms include support vector machines (SVM), decision trees, Naive Bayes, and ensemble methods. Each algorithm may be implemented as a separate module or component within this module.

- **Optimization:** This module involves optimizing the parameters of the classification models to improve their performance. Techniques such as grid search, random search, and Bayesian optimization may be utilized to fine-tune the models and enhance their predictive accuracy.

- **Evaluation:** This module focuses on evaluating the performance of the classification models. Metrics such as accuracy, precision, recall, F1-score, and confusion matrix may be computed to assess the models' effectiveness in classifying accident causes.

- **Visualization and Interpretation:** This module involves visualizing the results of the accident analysis process and interpreting the findings. Techniques such as word clouds, bar charts, and heatmaps may be employed to visualize the most frequent accident causes and patterns identified in the data.

VI.CONCLUSION

In conclusion, the project on "Construction Site Accident Analysis Using Text Mining and Natural Language Processing Techniques" represents a significant step forward in improving workplace safety within the

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construction industry. By leveraging advanced computational methods, including text mining and natural language processing, we have demonstrated the potential to extract valuable insights from textual accident reports and classify the causes of accidents effectively. Through the development and implementation of machine learning algorithms, we have automated the accident analysis process, enabling stakeholders to identify patterns, prioritize safety interventions, and mitigate risks proactively.

Our findings underscore the importance of integrating data analytics techniques into accident investigation practices, moving beyond traditional manual review methods. By harnessing the power of text mining and NLP, we have enhanced the efficiency and accuracy of accident analysis, enabling timely interventions and continuous improvement in safety standards. The optimization of classification models further improves the reliability of accident analysis outcomes, facilitating informed decision-making and risk management strategies.

Overall, this project contributes to the advancement of safety practices within the construction industry, offering a data-driven approach to accident analysis and risk mitigation. By leveraging technology and computational methods, we empower stakeholders to create safer work environments, prevent accidents, and protect the well-being of workers. Moving forward, continued research and innovation in this area will be essential to further enhance workplace safety and reduce the incidence of construction site accidents.

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