Improving the Process of Accident Analysis Using HumanFactor Analysis and Classification System (HFACS) Framework in Construction

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ABSTRACT

Accidents in the construction industry remain a significant concern, demanding a comprehensive and systematic approach to their analysis and prevention. This study proposes an innovative method to improve the process of accident analysis in construction by using the Human Factor Analysis and Classification System (HFACS) framework. HFACS, originally developed in aviation, has proven effective in identifying and categorizing human errors contributing to accidents. This research adapts HFACS to the construction context, aiming to provide a complete understanding of the human factors influencing accidents on construction sites. The adapted HFACS framework will serve as a structured tool for analyzing these factors, encompassing organizational, supervisor, and individual levels. The findings are expected to contribute valuable insights into the root causes of accidents, allowing for the development of targeted mediations and preventive measures. The significance of this study lies in the potential to enhance safety practices and minimize accidents in the construction industry. By applying the HFACS framework, construction companies and stakeholders can gain a deeper understanding of the underlying causes of accidents and take proactive steps to mitigate risks. By using the HFACS framework, accident analysis in construction can be improved by systematically identifying and categorizing human errors that contribute to accidents. This systematic approach will help in the development of effective strategies to prevent similar accidents from occurring in the future. This literature review aims to explore previous studies that have utilized the HFACS framework in various industries, such as aviation, maritime, and rail, to improve safety and reduce human errors.

Key Words: Accident Analysis, HFACS, HFACS Framework, Safety Management, Human Factors.

INTRODUCTION

Accident analysis in construction is a critical process aimed at unravelling thecomplex web of factors that contribute to workplace incidents, with the overarching goal of enhancing safety and preventing future accidents. The construction industry,described by its dynamic and risky nature, requires an assessment of accidents that stretches out past causes. In order to develop a safety framework, it is essential to comprehend the interaction of human factors, organizational influences, and systemicconditions. As development projects keep on advancing in intricacy and scale, so do the difficulties related with keeping a protected workplace.

Construction Safety Challenges

The construction industry is a crucial component of global infrastructure development because of its dynamic nature and diverse operations. Nonetheless, close by its undeniable contributions, the industry is plagued by complex safety challenges that request pressing consideration. The inherent nature of construction work, characterized by heavy machinery, elevated structures, intricate processes, anda diverse workforce, creates an environment where accidents and injuries are an ever-present risk.

Significance Of Accident Analysis

Accurate and thorough accident examination holds principal importance related security, filling in as a key part for the counteraction of future incidents and the constant improvement of working environment conditions. The primary target ofaccident analysis is to uncover the main root causes and contributing variables behindoccurrences, giving a far-reaching understanding. Accident analysis's function as a proactive risk mitigation measure is its greatest significance.

Current Challenges of Accident Analysis in Construction Industry

The realm of accident analysis in the construction industry confronts several challenges that impede the development of effective safety strategies and hinder the prevention of recurrent incidents. These challenges reflect the complex and dynamicnature

of construction work, demanding a nuanced approach to overcome existing limitations. One major challenge lies in the often-narrow-minded focus on immediate causes of accidents. Traditional accident analysis methodologies frequently prioritize identifying the direct triggers of incidents without delving into deeper systemic and underlying factors. This limited scope hampers the ability to implement comprehensive preventive measures, as it fails to address the root causes that may be rooted in organizational culture, communication breakdowns, or inadequate training.

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Overview Of HFACS in Construction

The Human Factors Analysis and Classification System (HFACS) emerges asa potent and comprehensive framework that has the potential to transform construction accident analysis. Initially developed for aviation, HFACS has proven its adaptability to various domains, including construction, where the intricate interplay of human factors significantly influences safety outcomes. At its core, HFACS offers a systematic approach to understanding accidents, transcending the traditional focus on immediate causes to delve into the deeper layers of human error and organizational influences. The ability of HFACS to examine factors across these interconnected levels topresent a holistic view of accidents is what sets it apart. Thusly, it offers a more nuanced comprehension of the human factors engaged with mishaps, encouraging a shift from simple fault attribution to the distinguishing proof of foundational issues and regions for development.

Overview Of HFACS Framework in Construction

The HFACS framework, initially created in the aviation industry, has been effectively adjusted for different high-risk spaces, including development. It recognizes inert and dynamic distresses at the hierarchical, administrative, andindividual levels, offering an efficient method for breaking down mishaps past superficial causes. By sorting variables like preconditions for hazardous demonstrations, dangerous oversight, and hierarchical impacts, HFACS allows a careful assessment of the perplexing communications that contribute to accidents. The Human Factor Analysis and Classification System (HFACS) framework stands as a robust and systematic tool for enhancing accident analysis in the construction industry. Originally developed for aviation, HFACS has evolved into a versatile and widely applicable model that recognizes the multifaceted nature of human errors and organizational failures contributing to accidents. In the context of construction, HFACS serves as a comprehensive lens through which to scrutinize accidents, extending the analysis beyond immediate causes to uncover deeper humanfactors and latent conditions.

LITERATURE REVIEW

The global construction sector faces high rates of occupational accidents and diseases. Fatal accidents, especially falling from height (41.6%), highlight challenges in safety culture despite regulations [1]. Rainstorm induces safety hazards in large-scale, prolonged, and intricate deep excavation projects. A system dynamics model, analyzing key safety factors, was developed and validated through empirical analysis, offering valuable safety insights [2]. Analyzing accident data, it proposes automated measures, highlighting a 30% reduction in road worker fatalities by automating road traffic in work zones [3]. National occupational safety initiatives often reactively address issues, lacking substantial improvement. By employing machine learning to predict and understand construction workers' fatality risk, emphasizing crucial national factors. Results inform a practical framework for policymakers [4]. Understanding construction accidents is crucial for preventing them. At most of the cases accident causation models STAMP, Accimap, HFACS, 2-4 model for construction accidents, recommending the 2-4 model for future analyses [5]. Expert system aids in operation guidance by identifying and resolving issues. Challenges include insufficient

knowledge, inapplicable resolutions, and information overload. A novel knowledge database construction method integrates HAZOP and accident analyses to enhance system effectiveness [6]. Shield machine operation (SMO) errors in tunnelling accidents, adapting TRACEr with hierarchical task analysis. The adapted TRACEr identifies and analyzes fine-grained SMO errors, proposing mitigation strategies for the construction industry [7]. About 60% of electrical fatalities happen in construction, particularly in the electrical sector. Reducing such fatalities eliminates most incidents [8]. Utilizing the C5.0 decision tree algorithm, analyzes Social Security Institution data to identify key factors influencing construction accidents. Findings highlight unsafe conditions, accident type, and activity as crucial, aiding in prevention and mitigation strategies. This model achieved a 70.26% accuracy rate [9]. Employing discrete event simulation to quantify safety risk impacts on project cost and explores correlations with worker age. Results emphasize preventing harm for safer workplaces [10]. Safety concerns and the volume of RMAA works have surged. E&M works are hazardous, yet limited research exists. This study develops a BN model, revealing safety factors' interrelationships and proposing effective safety strategies [11]. Construction accidents result from complex concrete composition, construction process shortcomings, equipment issues, and more [12]. In recent years, civil construction has grown significantly, posing a demand for Occupational Health and Safety (OHS). Companies aimed to identify and analyze incidents, revealing a need for improved OHS training and communication for accident prevention and management [13]. According to Australian construction investigations, finding a limited focus on human error and a need for a broader, systems theory-based approach for improved analysis and prevention [14]. The 2012 report from the Iranian Social Security Organization highlighted the construction industry's highest work-related accidents. Addressing factors in this sector, they focus on managerial elements, utilizing fault tree analysis for risk assessment with gray numbers [15]. Labour Inspectorate's investigation on occupational accidents (2007-2009) on Dutch showed 5.2k victims, 15% being foreign nationals. This paper explores if they face higher risk, citing data analysis and sector disparities [16]. Constructing tall buildings in urban areas demands increased use of tower cranes. Installation and dismantling are essential but risky tasks, causing accidents, delays, and fatalities. Factors influencing safety were investigated, revealing key issues for regulatory and practical improvements [17]. By applying safety system engineering, using

fault tree analysis and analytic hierarchy process, to identify, analyze, and prevent collapse accidents in construction by addressing key risk factors through proactive measures [18]. The construction industry is perilous, with fatal work injuries nearly three times the average. Prior studies focused on systemic accident analysis but overlooked upstream factors. This study develops and validates a contributing factor classification framework for construction safety, involving federal inspectors and practitioners [19]. Post-1970, construction safety improved under the Occupational Safety and Health Act. Contractors, responding to legislation, initiated safety programs. Recent research evaluates safety program elements, identifying management support and subcontractor selection as most effective [20]. Cranes, especially complex tower cranes, are critical to construction site safety. The Dutch Safety Board analyzed a 2008 tower crane collapse, revealing design flaws, highlighting the need for better safety measures considering human factors in construction and inspection processes [21]. A computer-aided amusement equipment security analysis system, combining HAZOP analysis and statistical data. It integrates tools like C#, SQL Server for comprehensive safety assessment, management, and improvement of recreational facilities [22]. Construction processes evolve through technological innovations. The findings are applicable beyond construction, spanning organizational factors, ethnography, innovations, and knowledge management [23]. High-fall accidents, widespread in construction industry, account for 60% of total incidents. Human factors are key, with insufficient training and equipment defects contributing to 80% of accidents [24]. Barriers to HFACS adoption and proposes solutions to overcome these challenges, emphasizing the need for organizational commitment and training to successfully integrate HFACS into accident analysis processes [25]. A contributing factor classification framework for construction safety,involving federal inspectors and practitioners. The difference is significant, particularly in the manufacturing, construction, trade, and transportation sectors [26]. The Human Factor Analysis and Classification System (HFACS) framework has emerged as a powerful tool to dissect incidents comprehensively. demonstrated its efficacy, showcasing HFACS' ability to identify latent and active factors contributing to accidents, providing a foundation for targeted interventions [27]. By identifying latent conditions and active failures, HFACS facilitates a proactive approach to safety management, ultimately contributing to a culture of continuous improvement and accident prevention [28]. the application of HFACS to

enhance the depth and accuracy of accident investigations in the construction industry and concluded with how accidents in construction are often multifaceted, involving intricate interactions of human factors [29]. The role of HFACS in pre-emptive identification of potential human factors, facilitating a proactive safety culture in the construction industry. Accident analysis should extend beyond a reactive approach and HFACS serves as a proactive tool [30].

DATA TEXT ANALYSIS

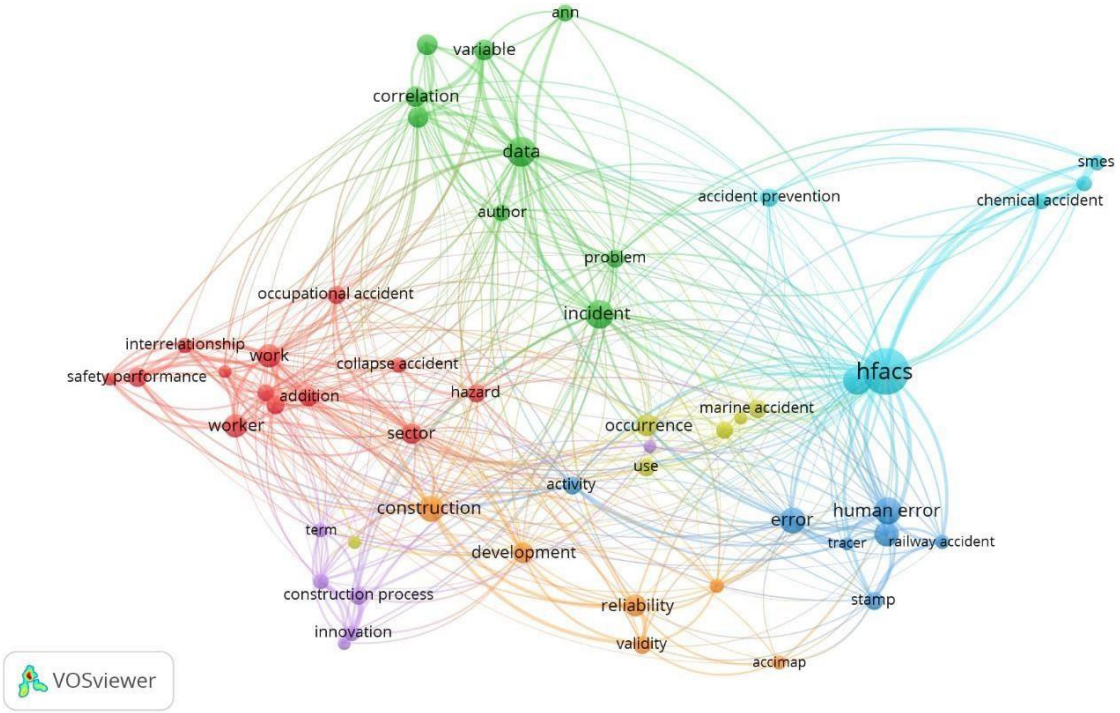
This data text analysis explores the topic of "Improving the Process of Accident Analysis Using Human Factor Analysis and Classification System (HFACS) Framework in Construction." The study focuses on leveraging the HFACS framework to enhance accident analysis in the construction industry by systematically categorizing human factors contributing to accidents. To gain insights from existing literature, a Visualizing Output of Science (VOS) Viewer analysis was conducted.

The analysis involved the extraction and examination of relevant texts from scholarly articles, conference papers, and research publications related to accident analysis, HFACS, and construction safety. The aim was to identify key themes, influential authors, and the interconnectedness of concepts.

The VOS Viewer analysis revealed significant clusters representing themes such as "Construction Safety," "Accident Analysis," and "HFACS Framework." The visualization highlighted influential authors and their collaborations, providing a comprehensive overview of the research landscape.

Co-occurrence networks demonstrated the interconnectedness of key terms, emphasizing the relationships between human factors and construction accidents.

This data text analysis using VOS Viewer offer a clear understanding of thekey themes, influential authors, and relationships between concepts, providing a foundation for further exploration and development of strategies to enhance safety practices in the construction industry. This study serves as a roadmap for researchers, practitioners, and policymakers seeking to advance the understanding



of human factors in construction accidents and improve safety outcomes.

Fig – 1 Data Text Analysis

CONCLUSION

In conclusion, the integration of the Human Factor Analysis and Classification System (HFACS) framework into accident analysis processes in the construction industry emerges as a pivotal stride towards enhancing safety outcomes. This literature review underscores the efficacy of HFACS in comprehensively dissecting human errors and organizational factors contributing to accidents. By adopting a systematic approach, HFACS facilitates a nuanced understanding of the root causes, enabling proactive preventive measures. As construction safety remains a paramount concern, the implementation of HFACS holds significant promise in cultivating a safety culture that

prioritizes human factors, fostering continual improvement in accident analysis methodologies and, consequently, augmenting overall safety performance within the construction sector.

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