Uncovering the Root Causes of Factory Accidents: A Quantitative Content Analysis of Workplace Safety Compliance Reports

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The garment industry is one of the largest contributors to the global economy, but it also has a long history of labor exploitation and unsafe working conditions (Alamgir & Banerjee, 2019; Martinez, 2018). The tragedies at Triangle Shirtwaist Company and Rana Plaza highlighted the human cost of exploitative labor practices and the importance of worker safety and labor rights in the garment industry (Ansary & Barua, 2015; Behrens, 1983). Bangladesh has always been plagued by a multitude of accidents in its workplaces, resulting in a high number of fatalities and injuries among its workers (Mizanuzzaman, 2016). According to the Bangladesh Occupational Safety, Health and Environment Foundation(2022), 853 people died, and 236 were seriously injured in industrial accidents in 2021 alone, and over 18,000 people have died in such accidents since 2005 (Saad, 2022). Bangladesh's Ready-Made Garment (RMG) sector is particularly affected, with building collapses and fire incidents being the most common types of accidents. The Rana Plaza building collapse, which killed 1134 people, and the Tazreen Fashion factory fire, which killed 112 people, are two of the deadliest industrial accidents in the RMG sector's history (Faisol & Rezoana, 2015). However, the aftermath of these accidents led to significant national and international commitments to improve workplace safety in garment factories.

The Accord on Fire and Building Safety in Bangladesh, a legally binding safety framework, was established after the Rana Plaza building collapse tragedy to provide a secure working environment for millions of Bangladeshi garment workers (Accord, 2013). It has nearly 200 partner signatories, including global unions, Bangladeshi trade union federations, and brands from over 20 countries, who oversee fire and structural inspections, remediation, and training. The Accord has been highly successful in overseeing numerous safety improvements and providing a secure workplace (Clean Clothes Campaign, 2021), however, the country's track record in worker safety has remained poor, indicating a need for further improvements and stronger enforcement of labor laws and safety regulations. Very recently, on June 4th 2022, a fire at a container depot in Chittagong killed 49 people and injured more than 150 people (The Associated Press, 2022). Unsafe working conditions and lax enforcement of safety standards have been identified as the main reasons for industrial accidents in Bangladesh. Lack of fire safety measures such as segregation of flammable materials, clear demarcation of assembly areas, and maintenance of fire-escape routes often results in factory fires (Wadud & Huda, 2017). Moreover, substandard construction materials, illegal constructions, and violations of the building design are also contributing factors (Faisol & Rezoana, 2015).

This study is grounded on the theories of accident causation, particularly the human factor model (Ferrell, 1997). According to this model, accidents are caused by an individual's fault due to overload, incompatibility, and improper activities (DeCamp & Herskovitz, 2015). Petersen (1984) expanded this model and added ergonomic traps, decision to err, and system failures. The Petersen model suggests that a comprehensive approach to accident prevention is required, which includes the identification and mitigation of all the risk elements, including human faults, environmental flaws, and system failures. The content analysis approach was used to analyze the Corrective Action Plans (CAPs) of 518 factories, which were part of the Accord certification process. The CAPs were proposed by safety inspectors and executed by the factories to meet safety standards. The data available on each CAP reports were analyzed for this study and coded using Petersen's (1984) framework. Any coding discrepancies were resolved through discussion. To analyze the data, descriptive statistics were run to determine frequencies and the Spearman correlation test was performed to determine the correlations between different safety flaws reported in the CAP reports.

The study identified three themes in structural issues: system failures (N=1070), human faults (N=648), and environmental flaws (N=618). System failures had five sub-themes, including difference between drawing & building (N=352, 68%), concrete strength (N=306, 59.1%), and non-engineered structure (N=182, 35.1%). Human faults had five sub-themes, including cracks (N=308, 59.5%), and exposed reinforcement (N=181, 34.9%). Environmental flaws had three sub-themes, including high loading (N=348, 67.2%) and improper documentation (N=65, 12.5%).

Under the system failures theme, *Non Engineered Structure* had a significant, large negative correlation with the *Difference between Drawing & Building*, $r(518) = -.508$, $R^2 = .26$, and $p < .001$ (Cohen, 1988), a significant, medium positive correlation with *Undocumented Extension/ Design*, $r(518) = .405$, $R^2 = .16$, and $p < .001$ (Cohen, 1988), a significant, medium negative correlation with *Concrete Strength*, $r(518) = -.383$, $R^2 = .15$, and $p < .001$ (Cohen, 1988), and a significant, small negative correlation with *Slender Columns*, $r(518) = -.158$, $R^2 = .02$, and $p < .001$ (Cohen, 1988). Under the human faults theme, *Cracks* had a significant, small positive correlation with *Beams*, $r(518) = .175$, $R^2 = .03$, and $p < .001$ (Cohen, 1988), a significant, large positive correlation with *Exposed Reinforcement*, $r(518) = .580$, $R^2 = .34$, and $p < .001$ (Cohen, 1988), a significant, small positive correlation with *Unprotected columns for vehicle impact*, $r(518) = .224$, $R^2 = .05$, and $p < .001$ (Cohen, 1988), and a significant, small positive correlation with *Sensitivity of cantilever*, $r(518) = .224$, $R^2 = .05$, and $p < .001$ (Cohen, 1988). Moreover, Beams had a significant, small positive correlation with Exposed Reinforcement, $r(518) = .196$, $R^2 = .04$, and $p < .001$ (Cohen, 1988), and a significant, large positive correlation with Unprotected columns for vehicle impact, $r(518) = .642$, $R^2 = .41$, and $p < .001$ (Cohen, 1988). Under the environmental flaws theme, *High loading* had a significant, small negative correlation with *Improper Documentation*, $r(518) = -.343$, $R^2 = .12$, and $p < .001$ (Cohen, 1988).

The results suggest that certain safety flaws related to system failures, human faults, and environmental flaws are significantly correlated with each other in the context of building safety. For example, non-engineered structures are negatively correlated with the difference between drawing and building, undocumented extension/design, concrete strength, and slender columns.

Meanwhile, undocumented extension/design showed mixed correlations with non-engineered structures and slender columns. Regarding human faults, cracks are positively correlated with beams, exposed reinforcement, unprotected columns for vehicle impact, and sensitivity of cantilever. Beams are positively correlated with unprotected columns for vehicle impact and exposed reinforcement, while exposed reinforcement is positively correlated with unprotected columns for vehicle impact and negatively correlated with sensitivity of cantilever. Moreover, high loading is negatively correlated with improper Documentation, indicating that inadequate Documentation can lead to buildings being subjected to higher loads than intended. By understanding the correlations between safety flaws, factory owners can make more informed decisions to avoid multiple safety flaws occurring simultaneously. The results can also raise awareness among stakeholders, including factory owners, buyers, and workers, about the importance of addressing safety flaws related to system failures, human faults, and environmental factors.

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