

SPATIAL VARIABILITY IN GLOBAL STRUCTURE COLLAPSE: TWO-DECADE COMPARATIVE ANALYSIS OF FATALITIES AND INJURIES

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ABSTRACT: Despite recent advancements, there has not been a drastic reduction in structure collapse across the world. The impacts have been devastating in the last two decades on human life and properties. The study sets out to compare the frequency, fatalities, and related injuries associated with construction collapse from 2005-2024, to examine the spatial variability in structure collapse impacts a comparative analysis of fatalities and injuries during the period. The study adopted a spatial variation analysis to analyze data obtained from 53 countries comprising 216 documented cases of structure collapse, revealing the type of structures that are most vulnerable to collapse among others. While there was a noticeable drop in incidents for injuries from 3757 to 1229 and fatalities from 2344 to 1232 globally, it was observed that few countries experienced an increase within the recent decade compared to the older decade. The findings revealed that buildings and bridges are predominantly involved in collapse within the construction industry. Also, a decrease in bridge collapses in the recent decade when compared to building collapse that continues to rise. The findings provide valuable insights about the geographic trends of the menace to stakeholders for stricter measures and the introduction of technologies for monitoring the collapse effect to reduce the occurrences and its devastation confirming the need for better structure monitoring and enforcement of construction regulations. The findings present detailed information to government agencies, construction organizations, and construction professionals on approaches for mitigating future collapse through an effective regulatory framework and integration of tools and technology for improved structure monitoring.

1. BACKGROUND

Building and infrastructure systems create provisions for safe movement of people and goods between places speeding up urbanization while improving socioeconomic stability (Baiburin 2018, Tan et al. 2020). However, some of these facilities short-lived their service life due to structural failure and collapse incidents truncating socioeconomic stability and thus requiring a lot of money for corrections globally (Baiburin 2018, Tan et al. 2020). According to (Disaster Doc 2021), there have been 181 building collapses in the last five decades from 51 nations, averaging eight collapses and 343 deaths per year i.e., 38 persons die yearly due to structural collapse. The deadliest during this period was Bangladesh, a commercial building 8 story with 1,127 dead occupants and 2,500 injured (ILO 2018), also the recent historic 137-year-old bridge incident in India killed over 100 people with no present data on injured and missing after recently being refurbishment. According to The Guardian 2016, Rena Plaza in Bangladesh was considered to have taken so many lives due to a structural failure that could have been facilitated quicker by high-density population.

It is also necessary to note that there were several people around the building that were included in the casualties also, structure size plays a role in the total count. Despite these post-construction fatalities and injury challenges, the construction industry still has the highest rate of injuries and fatalities during the construction stage when compared to other industries' work stages (Manzoor et al. 2022, Zhou et al. 2015). The collapse of completed facilities during or post-construction requires urgent attention globally and reporting such incidents should attract more emphasis. Construction work process fatalities are alarming even with the steady effort to reduce the causation (Hinze & Teizer 2011, Zhou et al. 2015). This situation put the end users and construction workers at high risk. OSHA (2022) reported that in the USA there were a total of 4,764 worker fatalities across all industries, and construction accounted for 47.4% (1282) of workplace deaths for the calendar year 2020. For the same period, Europe reported 3,355 fatal incidents, with the construction sector accounting for more than a fifth of the fatal accidents (Eurostat 2021). While it is difficult to get accurate data for developing and underdeveloped countries, it can be posited that the percentage of construction-related fatalities could be relatively very high due to the level of disparity towards technology implementation and use among these countries. Therefore, the need to map global fatalities and injuries that arise from construction collapse.

This study does not evaluate any specific cause of collapse incidents or differentiate between new and historical structures but wants to emphasize that construction collapse should receive the attention it dearly deserves due to the death rate, disabilities, and socio-economic displacement. Therefore, this study aims to juxtapose fatalities and injuries over the last two decades through these objectives: 1) compare if there exists a downward trend between the last two decades; 2) identify collapse numbers by countries reporting and incidents per structure; and, 3) compare construction type experiencing the most collapse. Findings from the study should help guide construction stakeholders in aligning priorities for considering structure monitoring to prevent disastrous future collapse. Also, the findings will inform government agencies to improve regulations peculiar to different structures to forestall future collapse. This study relied solely on available and reported data from a limited number of sources and countries. Key structural parameters such as building height, span, age, materials used, size, and impact from natural disasters were not explicitly considered. Future research is encouraged to incorporate these factors.

2. LITERATURE REVIEW

2.1 Construction Collapse

Construction collapse incidents leave a negative effect that cannot be easily forgotten by the surviving victims and families of others who lost lives. They also cause socioeconomic destabilization in the form of loss of properties, jobs, investments, economic waste, injuries, and fatalities (Obodoh et al. 2019, Shao et al. 2022). Collapses are not just sudden incidents but arise from certain unwarranted conditions that could either be manmade or natural, the causation can be immediate or take a while thereby limiting structures from reaching the expected service life (Olubi & Adewolu 2018, Shao et al. 2022). According to (Baiburin 2018, Shao et al. 2022), when construction facilities reach the expected service life socioeconomic stability exists that allows for growth and development of other necessary structures and sectors within any economy. According to (Obodoh et al. 2019, Olubi & Adewolu 2018, Tan et al. 2020), facilities that have short-lived service life due to manmade conditions result from poor workmanship, faulty design, carelessness, ignorance, inexperienced workers, excessive loading, etc., while natural conditions are rainstorm, wind, flooding, earthquakes, etc. Tan et al. (2020), research on bridge collapse and sustainable management found that the life span for most collapsed bridges is between 0 to 10 and 10 to 20 years, while only 2.1% of collapsed bridges have a service life of 50 years and above likewise emphasizing high social resource waste and environmental degradation. Similarly, collapse occurrence was noticed for buildings in Africa, Asia, Europe, and America. Baiburin (2018) and Lekan et al. (2019), found increasing numbers of collapse deaths ranging from four to 42 and injuries of 70 and above between 2012 and 2018. From their findings, the facility composition is historical, new, and during construction facilities, attributing cause to poor design, substandard materials, structural faults, climate conditions, poor construction practices, climate change, faults and deficiencies, etc. Krentowski et al. (2017) and Shao et al. (2022) stated that not all the aforementioned causes impact historical facilities, concluding that the facilities are impacted by increasing climate conditions, negligence, human attacking structures, and other natural disasters. While

these researchers have identified cause, effect, and possible mitigation strategies, it is stated that collapse is not restricted to any particular continent but a global challenge that calls for the implementation of strategies that will make facilities reach and exceed service life expectancy.

In some cases, collapse comes with several liability issues leaving a nation and its affiliates with managing aggressive socioeconomic instability (Baiburin 2018, Tan et al. 2020). These authors concluded that the failure of a structure is caused by the sudden structural inability to hold together the frame, either partially or entirely, which becomes a threat to the occupants and surrounding environment. The alarming rate of short-time and unplanned death data should be investigated in a more dynamic way to handle these prevailing plights. Recently (2021 – 2022), fatalities due to construction collapse are in the high hundreds (Eurostat 2021, OSHA 2022, Disaster Doc 2021). However, there has been no emphasis on mapping the number of fatalities and injuries resulting from post-construction collapses. Therefore, this study is the first to map fatalities and injuries by country from construction collapse using a spatial variation analysis to help stakeholders understand the need to find a better cause for reducing collapse incidences in construction. This alarming occurrence should help direct how decisions are made among stakeholders and end-users within the industry to safeguard assets and individual safety in the future.

2.2 Construction Injuries and Fatalities

Injuries and fatalities in construction are incidents that arise when a structure collapses or when workers fail to follow due process, affected are the workers, nearby access users depending on site location, site visitors, equipment, etc. (Behm 2005, Manzoor et al. 2022). For several decades, these incidents remain a cause for alarm, with construction topping the list when compared to other industries for several decades (Hinze & Teizer 2011, Manzoor et al. 2022). The magnitude of injuries determines a person's state of disability, while some may be able to return to work others are left in critical states requiring life support for the rest of their lives with significant financial losses (Obodoh et al. 2019, Shao et al. 2022). On the other hand, fatalities instantly truncate lives of any age, and vibrant prospects departing earlier than anticipated due to incessant collapse that could be mitigated. To eliminate these issues, post-construction collapse can be mitigated by using automated devices to determine cracks and failure for regular maintenance, prompting the need to withdraw access to infrastructure facilities and building evacuation (Krentowski et al. 2017, Shao et al. 2022, Tan et al. 2020). According to (Manzoor et al. 2022), the process for mitigating and emergency response differs for developing and developed countries. Developed countries are learning very fast from these incidents and creating solutions to help reduce the problem, but the same cannot be said for developing countries which continue to struggle. The type of equipment and tools used at collapse sites help reduce fatality rates, through the support of prompt dispatch emergency teams for rescue operations in developed countries, while developing counterparts struggle without such innovation, which ultimately results in increasing fatality rates (Manzoor et al. 2022, Okorie & Adindu 2020). Injuries and fatalities cripple activities and increase budget spending for individuals, organizations, and nations, the financial burdens are concerns that should help guide how stakeholders perceive the necessity for eliminating post-construction collapse (Baiburin 2018, Manzoor et al. 2022).

2.3 Spatial Variation

Spatial variability is the ability to measure quantity for exhibiting the value of impact across different locations specifically by global mapping (Brown et al. 2020, Li et al. 2018, Zhang et al. 2020). According to Brown et al. (2020), spatial variation provides abundant time series estimates to develop important explicit and dynamic models for proper aggressive management. The method has also been used to successfully map construction delivery challenges for state-funded projects in China to help material procurement logistics helping to eliminate schedule drawbacks (Jiang et al. 2016), it has been used in Nigeria to identify location, collapse facility type, cause, and lives lost (Nicholas et al., 2014). Overall, using spatial variability helps stakeholders to choose where urgent attention is required, setting more strict standards for construction quality evaluation processes, allocation of resources, and emergency response setup and improvement (Zhang et al., 2020).

3. METHODOLOGY

To achieve the objectives of this study, a mixed-method research approach was employed, incorporating both qualitative and quantitative analyses. The methodology comprised two key components: 1) a literature review to examine key themes such as construction collapse, fatalities, and injury concerns, and 2) spatial variation analysis for global mapping and structural collapse ranking using spatial variation. The literature review was conducted using the keywords: “fatalities,” “injuries,” “spatial variation,” “collapse,” and “construction industry.” These terms were used to search reputable academic databases, including Scopus, Web of Science, Google Scholar, ASCE journal and conference proceedings, and Elsevier. Only peer-reviewed publications in English from 2000 to 2022 were included, ensuring the study's alignment with prior methodologies (Che Ibrahim et al. 2022, Nicholas et al. 2014). Data for the analysis was sourced from Wikipedia (2024) and validated using scholarly sources (Fan et al. 2015, Kim et al. 2022, Krentowski et al. 2017, Nicholas et al. 2014, Zhao et al., 2017). While Wikipedia's academic credibility remains debated, studies by Kousha & Thelwall (2017) suggest that Wikipedia is increasingly referenced in scholarly research, particularly in social sciences and humanities, with some citations overlapping with Scopus-indexed content. However, the study acknowledges certain limitations, such as the lack of differentiation between historical and newly constructed buildings, underreporting of collapses, and the absence of data on emergency response effectiveness, survival rates, and equipment used. Future research should address these gaps. Finally, the ranking method used in this study follows the widely accepted approach in construction and safety research, which sums all events to determine the highest severity occurrence (Baiburin 2018, Gürcanli et al. 2015, Sankarasubramaniam et al. 2014). This method enhances comparability and decision-making in identifying the most vulnerable structures and regions.

4. RESULTS

This section seeks to provide a comprehensive global spatial analysis of injuries and fatalities in the construction industry over the past two decades. By examining trends and patterns, this study aims to determine whether there have been significant changes in construction-related incidents.

4.1 Construction collapse injuries analysis a comparative heat map study (2005 – 2024)

The heat map analysis in Figure 1a (2005–2014) and Figure 1b (2015–2024) highlights significant changes in the number of reported injuries due to construction collapses. The highest number of injuries recorded in a single country was 2,500 cases in Bangladesh, accounting for 67% of the total injuries (3,757) reported during the first decade. Other countries with high injury counts included the United States (294, 8%), Vietnam (189, 5%), Poland (170, 4.5%), Canada (149, 4%), India (123, 3.3%), and Pakistan (100, 2.7%). However, in the subsequent decade (2015–2024), a drastic reduction in injuries was observed, with only 394 cases globally, indicating an improvement in construction safety measures and risk management practices (Zhou et al. 2015, Kim et al. 2022). Notably, some countries, such as Bangladesh, Vietnam, and Poland, which previously reported high injury counts, did not report any cases in the second decade. The United States saw a decrease of 183 cases (from 294 to 111), Pakistan recorded 89 fewer injuries (from 100 to 11), and Canada reported 145 fewer cases (from 149 to 4). Similarly, India had only five reported injuries (118 fewer than in the previous decade). There were 206 structures that collapsed during this period and the ratio of injury to structures shows a drop, 2005 – 2014 had 35 injuries per one structure collapse from 108 reported while 2015 – 2024 had 12 per one structure from 98 reported.

Conversely, new countries emerged in the second decade with significant injury reports. Saudi Arabia (394) and Mexico (292) accounted for 32% and 24%, respectively, of the total 1,229 cases reported between 2015 and 2024. New entries in the two-digit category include South Korea (11), Taiwan (14), Belgium (20), Egypt (25), Italy (25), Cambodia (52), Iran (71), and Indonesia (81), while single-digit reports came from France (8), China (5), Thailand (5), and Israel (1). Despite the significant reduction in injury numbers, the spatial distribution of incidents remained relatively unchanged across both decades, suggesting that construction safety risks are still prevalent within the same regions. However, the decline in cases underscores the impact of improved construction practices, stricter regulations, and technological

interventions in mitigating injuries (Fang et al. 2015, Li et al. 2018). Future studies should explore the specific tools, policies, and safety technologies responsible for these improvements.

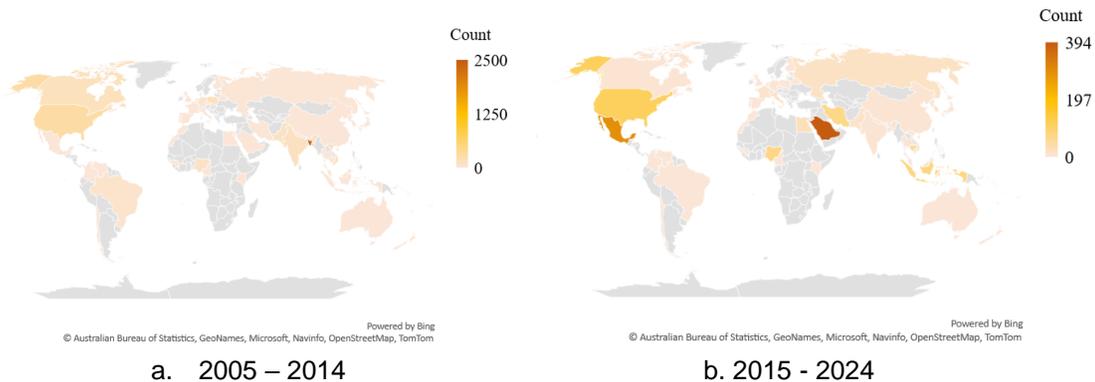


Figure 1: Injuries from construction collapse incidents 2005 – 2024

4.2 Construction collapse fatalities analysis a comparative heat map study (2005 – 2024)

The analysis of fatalities resulting from construction collapses follows a similar trend to injury reports, demonstrating significant reductions over the past two decades. The highest number of fatalities occurred from 2005 to 2014, totaling 1,134 cases (Figure 2a), compared to 200 cases from 2015 to 2024 (Figure 4). This marks a substantial decline in construction-related fatalities, reinforcing the effectiveness of improved safety regulations, construction technologies, and workforce training (Zhou et al. 2015). The country with the highest number of fatalities in the first decade was Bangladesh (1,134), accounting for 48% of the total fatalities (2,344). This was largely attributed to the Rana Plaza collapse, which also contributed significantly to injury statistics in the same period. Other countries reporting high fatality counts in the three-digit range between 2005 and 2014 included India (239), Pakistan (148), Nigeria (143), New Zealand (133), and North Korea (100). In the following decade (2015 – 2024), India saw a decrease of 98 cases (141 fatalities), while Nigeria experienced a slight increase of four cases (147 fatalities). Identifying fatalities per collapse 2015 – 2024 had a reduced number compared to 2005 – 2014, the analysis shows a drop to 12 from 22 for fatalities per structure collapse.

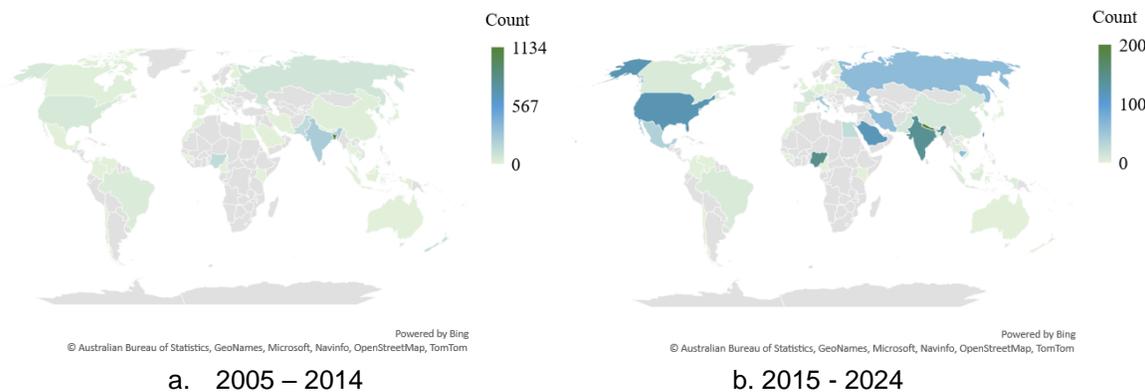


Figure 2: Fatalities from construction collapse incidents 2005 – 2024

New countries reporting fatalities in the three-digit range from 2015 to 2024 (Figure 2b) that were absent in the previous decade include Nepal (200), Taiwan (128), and Saudi Arabia (118). Additionally, the United States reported 122 fatalities, an increase of 73 cases compared to the 49 fatalities reported between 2005 and 2014. Countries with two-digit fatality counts from 2005 to 2014 included Russia (74), Poland (65), Latvia (54), Tasmania (36), Brazil (30), Germany (20), China (12), and South Korea (10). In the 2015 to 2024 decade, the two-digit fatality reports shifted to France (10), South Korea (12), Pakistan (12), Egypt (25), Mexico (36), Italy (46), Iran (62), Russia (62), and Cambodia (64). Of these, only South Korea saw an

increase (+2 cases), while Russia recorded a decrease (-12 cases). A similar spatial variation pattern is observed between Figures 2a and 2b as in Figures 1a and 1b, indicating that while fatality numbers have declined, the geographical distribution of construction collapses remains relatively unchanged. This suggests that systemic construction safety challenges persist in specific regions, emphasizing the need for continued policy enforcement, technological integration, and enhanced safety training programs (Fang et al. 2015, Li et al. 2018). Countries reporting single-digit fatality cases across the two decades include Belgium (five cases in both decades) and Canada (nine cases in the first decade, seven in the second decade). The Czech Republic (four cases), Italy (one case), Netherlands (two cases), Mexico (eight cases), and Japan (nine cases) all reported fatalities in the first decade. Meanwhile, new single-digit entries from 2015 to 2024 included Israel (two cases), Germany (two cases), Thailand (four cases), Indonesia (five cases), Spain (six cases), Brazil (seven cases), and China (nine cases). While the overall decline in fatalities suggests improvements in construction safety, the recurrence of fatalities in specific regions highlights ongoing challenges that must be addressed through more rigorous inspections, enhanced compliance measures, and better training programs for construction workers (Li et al. 2018).

4.3 Post-construction collapse analysis and global reporting trends

The aftermath of construction collapses remains a critical concern, even though the total number of reported incidents has declined over the past two decades. Despite improvements in construction safety measures, several lives were still lost during these events, underscoring the need for continued monitoring, reporting, and intervention strategies (Zhou et al. 2015, Manzoor et al. 2022). Across the 48 countries analyzed, an average of 28 collapses was reported over the study period, with 21 countries recording only a single incident. For countries with multiple incidents, an average of four cases per country was reported for single-digit values (ranging between two and nine collapses). Figure 5 presents the spatial variation mapping of construction collapses recorded during the study period. Countries reporting single-digit construction collapses over the two decades include Australia (2), Belgium (2), Brazil (5), Cambodia (2), Canada (8), Colombia (2), Czech Republic (3), France (3), Germany (9), Indonesia (4), Iran (2), Italy (6), Malaysia (3), Mexico (2), Nepal (2), Netherlands (6), New Zealand (3), Nigeria (9), and Pakistan (5).

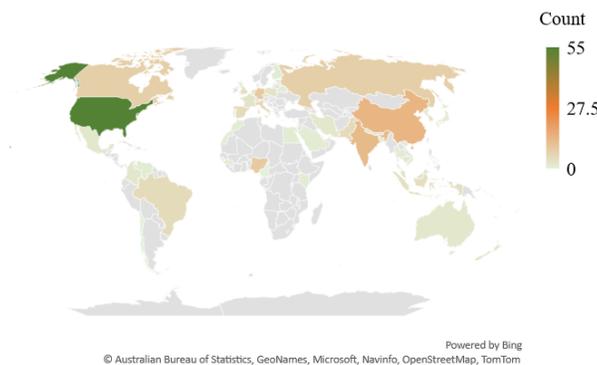


Figure 5: Global heat map construction collapse 2005 – 2024

Among countries with double-digit collapse incidents, the most frequently reported cases occurred in the United States (55), China (14), and India (13). A notable pattern emerges as many of the countries with high collapse reports are developed nations, aligning with the findings of Manzoor et al. (2022) on construction collapse reporting techniques and work process management. This suggests that developed nations may have more robust data collection, transparency, and reporting mechanisms compared to developing and underdeveloped nations, where incidents may go underreported or undocumented. This discrepancy highlights the importance of enhancing global construction safety databases, ensuring that standardized incident reporting frameworks are implemented across all regions. Research has shown that the adoption of digital tools, such as Building Information Modeling (BIM) and real-time monitoring systems, can improve collapse detection and prevention strategies (Lekan et al. 2019). Additionally, international safety regulations must be reinforced to hold construction firms accountable, particularly in regions with historically poor reporting records (Zhou et al. 2015). While a decline in construction

collapses is evident, underreporting remains a major challenge in certain regions. Developed countries tend to report more incidents, which may skew global statistics and create an illusion of lower risks in underreported regions. Strengthening data collection, increasing international collaboration, and enforcing regulatory policies are essential for ensuring a more comprehensive and transparent construction safety landscape worldwide.

4.4 Comparative Analysis Structure Collapse Trends in Construction from 2005 - 2024

To further analyze construction collapses, this study identifies and compares the types of structures that experienced the highest number of incidents over the past two decades. Notably, bridges were the most frequently collapsed structures in both periods, aligning with findings from Tan et al. (2020) on structural vulnerability in civil infrastructure. From 2004 to 2015, there were 26 reported bridge collapses (Figure 6a), whereas the 2015 to 2024 period recorded 14 collapses (Figure 6b). This decline is consistent with the observations of Baiburin (2018) and Lekan et al. (2019), who noted advancements in bridge engineering, maintenance, and structural health monitoring. However, despite this decrease, bridges continue to pose the most significant structural failure risk in construction, emphasizing the need for enhanced design, load assessment, and periodic maintenance strategies (Zhang et al. 2020).

Overhead pedestrian walkways require careful consideration, particularly due to their potentially severe impact on users during a collapse, especially in high-traffic zones. Although only two walkway collapses were reported between 2015 and 2024 (Figure 6b), the consequences of such incidents remain critical. Similarly, wind turbine collapses have declined in the past decade, dropping from seven incidents (2004 – 2015, Figure 6a) to three incidents (2015 – 2024, Figure 6b). This reduction may be attributed to improvements in turbine foundation engineering, structural resilience, and real-time monitoring systems (San et al. 2022). While some structures have shown a decline in collapse frequency, commercial, residential, hospitality, and recreational facilities have maintained consistent collapse rates across both decades. The cumulative number of collapsed buildings in these categories remained at 25 per decade, suggesting that progress in building codes and regulations has not yet significantly reduced structural failures in these sectors. This highlights the need for stricter enforcement of safety standards and enhanced construction oversight during construction and the need to ensure that structures are properly maintained throughout the facility’s life cycle. (de Brito and Silva 2020, Mohamed 2006). Also, building alterations by the owner without considering the initial structural requirements could impact the life cycle and lead to collapse incidents (Nicholas et al., 2014).

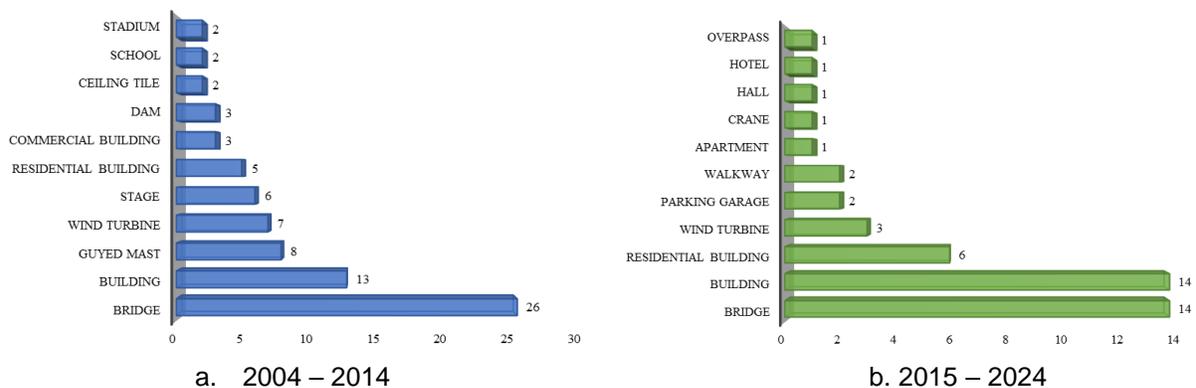


Figure 6: Construction structure Collapse incidents

Another critical issue is tower crane collapses, which have resulted in both fatalities and severe injuries on construction sites (Figure 6b). This suggests ongoing risks related to crane operation, load distribution, and weather-related instability, necessitating improved safety measures, enhanced operator training, and stricter inspection protocols (Tam and Fung 2011). Figures 6 present a ranked order of collapsed structures, displayed in ascending order from bottom to top, for both analyzed periods. This ranking offers a visual representation of the most vulnerable structures, further reinforcing the importance of targeted safety interventions in construction engineering. Despite a general decline in some structural collapses, bridges

remain the most critical area of concern, necessitating ongoing research and investment in structural monitoring and resilience strategies. Additionally, the consistent collapse rates of certain building types suggest that more robust regulatory frameworks and inspection protocols are required. The increase in tower crane collapses also highlights the importance of construction site safety improvements. Addressing these concerns through technological advancements, policy enhancements, and workforce training will be essential to reducing construction-related structural failures in the future.

5. DISCUSSION

This study aligns with the research objective by examining global trends in fatalities and injuries resulting from construction collapses. While there was an overall decline in incidents, individual country-level data revealed significant variations. Notably, some countries, such as Saudi Arabia (394 cases), Mexico (292 cases), Indonesia (81 cases), Iran (71 cases), and Italy (25 cases), emerged as new entries in the dataset, having previously reported no construction-related injuries. Conversely, countries like Canada, India, Pakistan, and Poland exhibited a notable decline, transitioning from triple-digit case reports to single-digit figures over the two decades analyzed. Additionally, several new countries reported construction collapse incidents during 2015 – 2024, despite having no recorded cases from 2005 – 2014. These disparities underscore the evolving nature of construction safety protocols, regulatory enforcement, and technological advancements in different regions (Manzoor et al. 2022).

Only 48 countries out of 195 globally, reported information for the 206 construction collapse incidents documented and analyzed for both decades representing only 25% of the countries. The 2005 – 2014 period accounted for 111 incidents, whereas 95 incidents were reported from 2015 – 2024. Although this global decline appears marginal, country-specific trends varied significantly, with some nations exhibiting sharp reductions while others recorded an increase in reported collapses. The average annual injuries and fatalities across both decades reinforce the downward trend in construction collapse incidents: 2005 – 2014 (average injuries per year 235 and average fatalities per year 102); 2015 – 2024 (average injuries per year 58 and average fatalities per year 51). The decline in reported injuries and fatalities is a positive development, suggesting improvements in construction site safety practices, regulatory oversight, and technological advancements in structural monitoring. However, the study highlights the need for continued efforts to sustain and further reduce these numbers, particularly in high-risk regions.

Interestingly, some countries reported construction collapse incidents without recording any injuries or fatalities. Further investigation is necessary to understand the circumstances surrounding these cases, which could offer valuable insights into best practices for mitigating construction-related calamities. Learning from these low-risk incidents could inform new safety regulations and preventive measures (Behm 2005, Camino Lopez et al. 2008). Both analyzed decades identified bridges as the most frequently collapsed structures, followed by buildings (residential, commercial, and institutional combined) and wind turbines. This finding aligns with prior studies, which have identified design flaws, poor material quality, environmental factors, and inadequate maintenance as key contributors to construction collapses (Elmukashfi et al. 2012, Tan et al. 2020).

6. CONCLUSION, LIMITATIONS, AND FUTURE STUDY

This study highlights global trends using spatial variations to identify construction collapses over the past two decades. While a gradual decline in fatalities and injuries was observed, regional disparities remain significant, with new entries like Saudi Arabia, Mexico, Indonesia, and Iran indicating potential gaps in safety regulations and reporting systems. The dominance of bridge failures across both decades underscores the urgent need for structural integrity assessments and proactive maintenance strategies, aligning with existing literature (Tan et al. 2020). Additionally, the study reveals that some countries reported collapses without casualties, suggesting potential best practices that warrant further investigation. For scientific research, these findings emphasize the need for advanced risk assessment models, AI-driven structural monitoring, and predictive analytics to mitigate collapse risks. The study had limitations by using only data available from literature and other online sources. Therefore, future research should focus on identifying the underlying causes of regional variations and developing evidence-based safety frameworks. For policy

administrators and industry professionals, the results stress the importance of enhanced regulatory enforcement, cross-border knowledge-sharing, and adoption of smart construction technologies. Establishing global databases for construction collapse incidents could further enhance transparency and policy effectiveness, ensuring sustained improvements in construction safety standards worldwide.

Although this study did not delve into the root causes of construction collapses, existing literature provides critical insights into the challenges leading to structural failures. Factors such as poor construction practices, lack of adherence to safety regulations, structural overloading, and extreme weather conditions have been widely acknowledged as primary causes of collapse incidents (Behm 2005, Camino Lopez et al. 2008, Elmukashfi et al. 2012, Manzoor et al. 2022). Future research should focus on: 1. Investigating the resilience factors in countries that reported collapses but no casualties; 2. Analyzing the specific causes behind construction collapses to develop targeted mitigation strategies; and 3. Assessing the role of technological innovations, such as AI-based structural monitoring, in reducing collapses. By addressing these areas, the construction industry can enhance global safety standards, reduce fatalities, and improve infrastructure resilience.

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