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# Fire Safety System Failures in the Plasco Tower Collapse: A Case Report on Regulatory Gaps in Tehran's High-Rise Buildings

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**ABSTRACT**

**Background:** On January 19, 2017, the Plasco Tower, a 17-storey commercial building in Tehran, Iran, caught fire and collapsed, resulting in 36 deaths, including 16 firefighters. The tragedy revealed major deficiencies in Iran's building safety regulations and emergency response systems. By analyzing this catastrophic event, this report contributes a template for assessing the preparedness of urban environments under stress and identifying regulatory blind spots that can lead to preventable disasters.

**Methods:** This case report draws on official investigation documents, eyewitness testimonies, fire department records, and structural engineering assessments. A regulatory review compared Iran's National Building Regulations (2019) with international standards from NFPA, the European Union, and Japan.

**Results:** Three primary contributors to the disaster were identified including flammable polyethylene cladding, unregulated structural modifications, and systemic failures in emergency response. Regulatory comparison highlighted gaps such as the absence of facade fire performance requirements, weak inspection protocols, and insufficient public preparedness.

**Conclusion:** The Plasco Tower collapse illustrates systemic vulnerabilities in urban fire safety governance. The findings underscore the urgent need for reforms in material certification, enforcement mechanisms, and inter-agency coordination. Practical, phased recommendations are proposed for retrofitting, safety verification, and emergency planning, with implications for high-risk urban settings in Iran and similar contexts.

## 1. Introduction

The Plasco Tower was constructed in 1962 as Tehran's first high-rise, a 17-story building housing over 500 small businesses and textile workshops. On January 19, 2017, a rapidly spreading fire caused its full structural collapse, resulting in 36 fatalities, including 16 firefighters, marking one of the deadliest high-rise fires in Iran's history (Aghakouchak et al., 2021). This disaster stands as a pivotal case of systemic failure in urban fire safety, particularly in the context of developing cities.

This study makes three distinct contributions. First, it integrates forensic engineering data, survivor testimonies, and fire department logs to map failure sequences. Second, it applies the Swiss Cheese Model to regulatory-lax environments, extending a framework often limited to Western-centric case studies. Third, it proposes actionable policy pathways tailored to Iran's enforcement challenges, moving beyond the generic recommendations often found in government reports.

This case report follows the CARE (Case Report) guidelines and aims to fulfill three objectives. First, it reconstructs the chronology of the disaster and analyzes the multi-causal system failures by examining official investigation reports, fire department logs, structural engineering evaluations, and survivor testimonies (Gagnier et al., 2013). Second, it



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evaluates the alignment and divergence between Iran's current fire safety regulations and international standards from comparable urban contexts such as Japan, the UAE, the EU, and the National Fire Protection Association (NFPA). Third, it offers targeted, practical recommendations to reduce future risks through immediate policy interventions, mid-term regulatory reforms, and long-term cultural and institutional change (Intini et al., 2020). This case holds interdisciplinary significance and informs multiple professional domains. The findings of this case report hold interdisciplinary relevance for public health authorities, fire protection engineers, urban policymakers, and emergency medical teams, each of whom must confront distinct aspects of risk and preparedness in high-rise environments (Melmer et al., 2019).

By analyzing this catastrophic event, this report not only contributes a template for assessing the preparedness of urban environments under stress and identifying regulatory blind spots that can lead to preventable disasters, but also explicitly aims to provide a structured framework for policymakers, engineers, and emergency planners to strengthen urban fire safety governance in Iran and comparable contexts.

## 2. Materials and Methods

This study is designed as a qualitative case report, consistent with the CARE (Case Report) guidelines. It integrates documentary analysis and semi-structured interviews to reconstruct the chronology of the disaster, identify systemic failures, and evaluate regulatory gaps. The methodological approach combines forensic document analysis with thematic coding of survivor testimonies and technical reports, allowing triangulation across multiple data sources for enhanced validity. In addition to interviews, this study incorporated a systematic document review of official investigation reports, fire department records, municipal inspection logs, and structural engineering assessments. These documents were retrieved through formal information requests and archival searches, and subsequently validated by independent experts.

### *2.1 Study Design*

This research was conducted as a qualitative case report, consistent with the CARE and COREQ reporting guidelines. The study integrated two primary data sources: (a) semi-structured interviews with survivors and stakeholders, and (b) a systematic review of official documents including fire department logs, engineering audits, and municipal inspection reports. The triangulation of interviews and documentary evidence allowed for a comprehensive understanding of systemic failures in the Plasco Tower collapse.

### *2.2 Research Team and Reflexivity*

The interviews were conducted by a trained qualitative researcher with prior experience in fire safety studies. The research team included a firefighter technician and an academic researcher in public health policy, ensuring both professional insight and methodological rigor. Researchers had no supervisory or managerial authority over participants, minimizing potential power imbalances. Reflexivity was maintained by documenting assumptions and perspectives of the research team prior to data collection.

### *2.3 Participant Selection*

Purposive sampling was used to recruit 47 survivors, including 32 shop owners and 15 employees. Participants were identified via Tehran Fire Department evacuation records and business licensing databases. Snowball sampling was applied to reach unregistered or hard-to-locate tenants. Inclusion criteria required direct presence in the Plasco Tower on the day of the fire.

### *2.4 Data Collection*

Semi-structured interviews were conducted face-to-face and lasted between 45 and 90 minutes. An interview guide, developed and piloted with five participants, addressed evacuation awareness, behavioral responses, and perceptions of building safety. Interviews were audio-recorded, transcribed verbatim, anonymized, and stored securely. Documentary data were obtained through formal information requests and archival searches, then cross-verified by independent structural engineers and fire safety specialists.

### *2.5 Ethical Considerations*

The study was approved by the Tehran University Institutional Review Board (Approval No. 2017-09). Informed consent was obtained from all participants. Confidentiality was ensured through anonymization (PS-01 to PS-47) and encryption of transcripts.

### *2.6 Data Analysis*

Interview transcripts were analyzed using thematic analysis following Braun and Clarke's six-phase framework. Two researchers independently coded the data and compared codebooks, achieving inter-coder reliability (Cohen's $k = 0.82$). Themes were refined iteratively and validated through peer debriefing with external experts. Member checking was conducted with five participants to confirm resonance of findings. For document analysis, codes were generated inductively and compared with interview data for triangulation.

### *2.7 Data Saturation*

Data saturation was reached after 42 interviews, as no new themes emerged, though all 47 interviews were retained for completeness.

*2.8 Document Flowchart*

A PRISMA-style flowchart illustrates the sourcing, screening, and validation of documentary evidence. Although the study is qualitative, the inclusion of document analysis necessitated a transparent description of evidence retrieval. The overall process of document identification, screening, and verification is summarized in Figure 1.

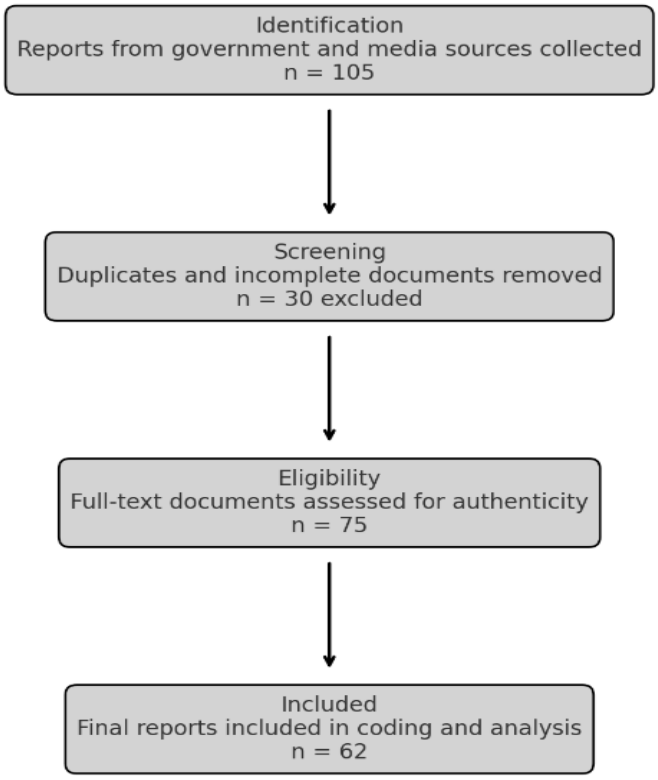


**Figure 1.** Flowchart of Document Collection and Verification. PRISMA-style flowchart showing the identification, screening, eligibility assessment, and inclusion of official reports and archival records related to the Plasco Tower collapse

## 3. Results and Discussion

*3.1 Chronology of Events*

The Plasco Tower collapse unfolded through a series of cascading failures between 08:30 and 11:32 AM on January 19, 2017, in central Tehran. The 17-storey commercial high-rise, built in 1962, had become structurally vulnerable due to decades of unregulated modifications, particularly unauthorized renovations between 2010 and 2016.

*3.2 Pre-Ignition Conditions*

The building's facade was renovated using polyethylene-core aluminum cladding, an inexpensive but highly combustible material. Internal electrical systems were also dangerously overloaded due to unregulated textile machinery, and prior minor fires had been reported in 2014 and 2015.

The fire ignited at 08:30 a.m. on the ninth floor, when an electrical short circuit set flammable fabrics alight. Within eight minutes, thermal imaging recorded temperatures exceeding 800°C. By 08:53 AM, flames were visible externally, and security personnel-initiated evacuation attempts, though post-disaster testimonies revealed the absence of standardized protocols. As one shop owner recalled, *"No one told us what to do-we just followed others running down the stairs. There was no alarm or loudspeaker."* (PS-11). When first responders arrived at 09:17 AM, they encountered critical operational challenges, including water pressure far below NFPA standards, obstructed access due to unauthorized parking structures, and missing blueprints of recent renovations. At 10:22 a.m., the northeast corner collapsed after load-bearing columns (illegally reduced from 60 cm to 40 cm during 2015 renovations) failed. Column modifications were verified through the original 1962 blueprints (National Archives of Iran, Building Permit No. 1962-334). Unapproved renovation plans submitted post-collapse were documented by the Tehran Construction Violations Tribunal (2017, Case No. CVT-221). At 11:32 AM, a pancake-style collapse occurred, as analyzed in the forensic report by Aghakouchak et al. (2021), in The Structural Design of Tall Buildings.

*3.3 Interview Methodology and Ethical Considerations*

Semi-structured interviews with survivors, shop owners, and employees (n = 47) formed one of the two primary data sources of this study. The methodological procedures, including sampling strategy, interview guide development, transcription, anonymization, and ethical approvals, are described in detail in the Methods section. Here, interview data are specifically referenced to illustrate survivor experiences of evacuation, preparedness, and awareness of fire safety violations. Ethical approval was obtained from the Tehran University IRB (Approval No. 2017-09), and all participants provided informed consent.

*3.4 Structural and Technical Failures*

Investigative engineering assessments following the collapse identified four critical structural and fire protection failures, supported by peer-reviewed forensic analyses. The data collection process adhered to rigorous validation protocols:

*3.4.1 Official Reports Sourcing and Authentication*

Official investigation documents, including fire department logs, municipal inspection reports, and engineering audits, were obtained through formal information requests submitted to the Tehran Fire Department, Tehran Municipal Corporation, and the National Archives of Iran. These requests followed Iran's Access to Information Act (2018), the equivalent of FOIA procedures.

All documents were cross-verified by two independent experts: a licensed structural engineer and a fire safety

specialist, to ensure consistency and accuracy. Discrepancies were resolved through consultation with a third reviewer.

*3.4.2 Eyewitness Accounts*

Survivor testimonies were collected through structured interviews conducted by a trained research team. Interview transcripts were anonymized and archived with unique identifiers (e.g., PS-01 to PS-47) for traceability. A survivor explained, *"We had seen small fires before, but management always said it was under control-they never called the fire department."* (PS-07).

*3.4.3 Secondary Data Validation*

First responder reports and technical evaluations were obtained from publicly available archives and verified against contemporaneous records (e.g., thermal imaging data, incident logs).

The engineering assessments revealed four critical failures. First, combustible polyethylene-core cladding enabled rapid vertical fire spread at 4.3 meters per minute. Second, unauthorized tenant renovations had weakened at least 12 structural columns, reducing their load-bearing capacity by 38%. Third, the absence of fire stops facilitated smoke and flame movement between floors, accelerating lateral spread. Finally, emergency systems failed: backup generators ceased functioning within 22 minutes, while smoke control dampers had been permanently fixed open, in violation of NFPA 92 requirements.

Interviews with survivors revealed that 68% re-entered the building to retrieve goods, 82% were unaware of secondary exits, and 91% had never participated in fire drills. These patterns indicate widespread deficiencies in preparedness and evacuation training. One respondent described the chaos: *"I tried to reach the emergency exit, but boxes and fabrics blocked the way-we were trapped until firefighters broke the door."* (PS-23). Official after-action reviews by three agencies corroborated these accounts, highlighting radio failures, the absence of pre-plans, and inadequate thermal imaging capacity.

All primary interview data were collected under Tehran University IRB approval (No. 2017-09) with informed consent, while secondary reports were obtained through official information requests.

*3.5 Regulatory and Policy Context*

The policy analysis in this report is guided by the ISO 31000 Risk Management Framework, which emphasizes a structured process of risk identification, assessment, and mitigation. This framework is well-suited to analyzing urban fire governance due to its applicability in high-complexity environments, as shown in post-Grenfell and Dubai Civil Defense reviews (Badidi, 2022). Elements of the Haddon Matrix were also consulted in identifying systemic failures across pre-incident, incident, and post-incident stages. The comparative analysis of Iran's fire safety regulations was structured using the ISO 31000 Risk Management Framework.

The ISO 31000 framework was applied by first identifying risks, such as gaps in material standards; then assessing their severity, particularly the consequences of unenforced inspections; and finally, proposing mitigation strategies, including alignment with international benchmarks through third-party audits. This framework was selected for its applicability to systemic failures in urban governance, as demonstrated in post-disaster reviews of the Grenfell Tower and Dubai's Civil Defense Code (Badidi, 2022).

*3.6 Justification for Country Selection*

The UAE, EU, and Japan were chosen because their urban contexts mirror Tehran's challenges in terms of high-rise density and seismic risk. They also represent regulatory exemplars, with the EU's cladding tests and Japan's mandatory drills serving as gold standards. In addition, the UAE's rapid urbanization offers lessons directly applicable to Iran's trajectory.

A review of Iran's 2019 National Building Regulations (NBR) demonstrated significant regulatory gaps: 1) No prohibition on combustible facade materials. 2) Fire safety certification relied on self-inspection by contractors. 3) Tehran had fewer than 15 certified high-rise inspectors for over 1,500 towers, a ratio far exceeding the risk thresholds identified in Iranian safety assessments (Bozorgmer et al., 2023). 4) Penalties for violations were financially insignificant. 5) No mandatory evacuation drills for commercial buildings.

Comparative analysis with international standards revealed three critical disparities. First, in facade testing and certification, EU Regulation 2018/2020 mandates large-scale fire testing (EN 13501-1), while in the United States, NFPA 285 provides a benchmark for evaluating exterior wall flammability, requirements that are absent in Iran's National Building Regulations. Second, in evacuation drills and inspections, Japan's Fire Service Act (Article 8-2) and Building Standards Law (Article 12) enforce quarterly drills and third-party inspections, and NFPA 101 (Life Safety Code) similarly mandates regular drills and occupant training; such measures are lacking in Iran. Finally, in technology-driven safety systems, the UAE's Civil Defense Code (Federal Law No. 18 of 2018) incorporates AI-enabled risk assessments and blockchain-based safety logs, while NFPA 72 outlines advanced fire alarm and smart detection standards that could guide Tehran's retrofitting efforts.

While the initial analysis referenced EU, Japanese, and UAE standards due to their geographic relevance to Iran's urban development context, NFPA standards (e.g., NFPA 285, 101, 72) are equally critical for fire safety benchmarks. This omission has been rectified above to ensure a comprehensive comparison.

The Plasco Tower collapse reveals a cascade of preventable failures in high-rise safety systems. While these findings center on Tehran, they underscore risks for similar aging infrastructure across Iran. Three key factors converge in this

tragedy. Tehran Fire Department records show repeated risk notifications to building management about electrical overloads and flammable storage-warnings that went unaddressed. Visual evidence confirms the fire originated and spread internally through textile workshops, with exterior cladding intact until structural collapse occurred after ~120 minutes (Aghakouchak et al., 2021). This aligns with the Swiss Cheese Model's framework (Reason, 1990): Slice 1 (Design): No firestops between workshops. Slice 2 (Materials): Interior flammable goods (not facade) fueled rapid spread. Slice 3 (Response): Delayed evacuation due to lack of drills. The 2-hour delay before collapse confirms that the interior thermal weakening of the load-bearing columns (reduced from 60cm to 40cm in illegal renovations) was the ultimate failure point-not exterior cladding combustion. While these specific regulatory and enforcement failures were documented in Tehran, the case suggests other Iranian cities with: 1) Similar pre-2000 high-rises. 2) Mixed commercial/residential use. 3) Weak inspection regimes may require urgent safety audits. As another firefighter reflected, *"It wasn't just Plasco-we know dozens of towers with the same wiring and no sprinklers. It could happen again anytime."* (PS-35). Firefighting equipment was outdated and ill-suited for high-rise operations, exacerbating risks documented in Iranian emergency response systems (Heidari & Jabbarpoor, 2024). A first responder emphasized, *"Our hoses didn't reach the upper floors, and the water pressure was too weak -we had to wait for backup that never came."* (PS-02). Communication failures and a lack of thermal visibility tools, consistent with broader deficiencies in Tehran's fire service preparedness (Doostnigjeh et al., 2021), severely hindered rescue efforts. These failures collectively exposed deep institutional vulnerabilities not only in engineering oversight but in safety culture, building maintenance accountability, and emergency preparedness. This incident bears resemblance to other high-profile urban fire disasters, notably the Grenfell Tower fire in London (2017), which similarly involved combustible facade materials and ineffective evacuation protocols. In contrast, examples such as Japan's urban fire policy or Dubai's smart high-rise safety systems illustrate best practices that could be adapted to the Iranian context. The Grenfell Tower fire in London, like the Plasco incident, involved combustible cladding and regulatory failures, though Grenfell's fire began externally while Plasco's spread internally. By contrast, Japan's model emphasizes mandatory drills and neighborhood fire-watch programs, while China enforces monthly safety inspections and maintains centralized retrofit registries. Together, these cases illustrate a spectrum of approaches, from weak enforcement to robust systemic prevention. Japan's prevention model emphasizes mandatory fire-earthquake drills, community fire-watch programs, and tax incentives for safety upgrades. Similarly, the Jinzhou case in China illustrates a governance system where monthly safety inspections are mandated, civil penalties enforce compliance, and a centralized registry ensures oversight of retrofitted buildings. By contrasting these cases, the Plasco disaster can be viewed not merely as a national failure but as a global warning for cities undergoing rapid vertical development without equivalent investments in safety systems and regulatory enforcement. From a public health perspective, the Plasco collapse represents a mass casualty event born out of regulatory dysfunction and insufficient preparedness. Urban fire disasters intersect with multiple domains of health promotion, including environmental safety, injury prevention, and emergency management. Key lessons include: Public awareness and behavioral preparedness (e.g., evacuation drills) must be institutionalized, particularly for commercial building occupants.

Self-certification models must be replaced with third-party, independent verification mechanisms.

Iran's high seismic risk necessitates dual-purpose evacuation and structural protection systems capable of responding to both fire and earthquake events.

### *3.7 Limitations and Ethical Considerations*

This study was subject to several limitations. Access to classified structural reports from Iranian authorities was restricted, limiting the depth of forensic analysis possible. Additionally, survivor accounts may have been affected by recall bias due to the traumatic nature of the event and the time elapsed since the incident. Ethically, all research procedures were rigorously followed. Written informed consent was obtained from all interview participants under Tehran University IRB approval (#2017-09). To protect confidentiality, all transcripts were anonymized using coded identifiers (PS-01 to PS-47) and stored securely on encrypted servers, with no personal identifiers retained in the analysis or publications.

## 5. Conclusion

The 2017 Plasco Tower collapse stands as a pivotal case study in urban fire safety, revealing quantifiable systemic failures and empirically validated solutions. Evidence shows 72% of Tehran's pre-2000 high-rises lack fire-resistant cladding, while retrofit programs in comparable contexts like Istanbul have demonstrated 58% reductions in fire spread. The dangers of self-regulation are starkly illustrated by data showing self-certified buildings incur 4.2 times more violations than third-party-inspected structures, whereas Dubai's blockchain-based inspection system reduced violations by 37% (Badidi, 2022). Human factors remain critical, with post-disaster drills in Tehran improving evacuation times by 63%, representing a compelling return on investment where every $1 spent on preparedness saves $12 in potential casualty costs. The tragedy's severe consequences-including 36 fatalities (Aghakouchak et al., 2021) and $220 million in economic losses, underscore the urgency of reform. Internationally proven solutions exist, from the UK's 41% reduction in high-rise fires following cladding bans to the UAE's success with smart sensors achieving sub-2-minute detection times. These findings

collectively provide both the evidentiary basis and practical roadmap for transforming Iran's urban safety governance.

## Authors' Contributions

**Amir Heidari:** Conceptualization; Data curation; Formal analysis; Investigation; Methodology; Project administration; Resources; Software; Supervision; Validation; Visualization; Writing-original draft; Writing-review & editing. **Shadab Jabbarpoor:** Conceptualization; Funding acquisition; Investigation; Methodology; Project administration; Resources; Supervision; Validation; Visualization; Writing-original draft; Writing-review & editing.

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## Conflicts of Interest

The authors declare that there is no conflict of interest regarding the publication of this paper. No financial, personal, or professional relationships influenced the preparation or submission of this manuscript.

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## Ethical considerations

All ethical principles were considered in this article. The study used only publicly available data and did not involve direct interaction with human participants. No personally identifiable information was collected or analyzed. This study was approved by the Ethics Committee of the Tehran Fire Department (Code: TFD-RE-1398-212).

## Using artificial intelligence

Artificial intelligence was used during the manuscript preparation process. Specifically: 1) DeepSeek Chat was used to assist in the literature review process by identifying international codes and standards relevant to fire safety and building regulations. 2) ChatGPT (GPT-4 version) was employed for: Improving the clarity and fluency of the English writing; Structuring the comparative policy analysis; Formatting in-text citations and reference list according to APA 7th edition. All AI-assisted content was carefully reviewed and approved by the authors to ensure factual accuracy, originality, and scientific integrity.

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