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Comparative Analysis of Fire Safety Regulations in Hospitality Design: National and International

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Abstract - This study compares fire safety regulations in hospitality design focusing on India and Japan. It aims to evaluate regulatory frameworks, enforcement, and their impact on fire safety outcomes. The research reviews national fire safety codes and means of egress requirements using fire case studies. It examines the causes of high fire casualties in Indian hotels compared with Japan's stringent regulations. Findings highlight poor compliance, staff training gaps, and enforcement failures in India, contrasting with Japan's effective practices. The study recommends best practice improvements, bridging operational and regulatory gaps to enhance fire safety.

Key Words: Fire safety, Hospitality design, Hotel fire, Evacuation, Means of egress

1.INTRODUCTION

The hospitality sector is an important part of the global economy, accommodating millions of guests annually across diverse venues such as hotels, restaurants, and event spaces. These environments are complex, characterized by high occupant density and varied functional areas, which collectively elevate their vulnerability to fire hazards. Globally, hotel fires number between 4,000 and 8,000 annually, resulting in approximately 5,000 to 10,000 deaths and various injuries, highlighting the essential need for specialized fire safety strategies tailored to these unique environments. [1] Fire incidents in hospitality settings range from minor occurrences to catastrophic events, often exacerbated by guests' unfamiliarity with building layouts, leading to evacuation challenges during emergencies. Globally, hotel fires result in significant casualties and property damage.

This study intends to compare fire safety regulations in hospitality design between India and Japan, assessing the effectiveness of regulatory systems, enforcement methods, and their real-world impact on fire safety outcomes. By investigating the high incidence of fire-related casualties in Indian hotels through national code reviews and case studies, and contrasting these findings with Japan's stringent regulatory practices and outcomes, the research seeks to identify best practices and areas for improvement. This analysis is intended to provide valuable information for enhancing fire safety protocols and contribute to the development of safer hospitality environments worldwide.

2. LITERATURE STUDY

Fires in hotels are often caused by a range of factors, including kitchen fires originating from unattended cooking, overloaded electrical systems, and combustibles near heat sources, and the presence of combustibles near heat-generating equipment. Other common sources include open flames from candles, smoking materials like cigarettes and lighters, and the use of flammable liquids and aerosols. [2]

Fire prevention strategies aim to decrease the probability of fire outbreaks through proactive maintenance and safety measures, categorized into active and passive protection systems, each essential for overall fire safety management. Passive Fire Protection Systems includes structural and architectural measures designed to resist fire spread and maintain building integrity. They ensure that critical evacuation routes, such as staircases and corridors, remain safe and accessible during a fire. Following the building codes and standards is important to ensure the implementation of these measures. [3]

Effective fire safety planning in hotels integrates fire detection and suppression with architectural and operational strategies to ensure safe evacuations. Critical elements include well-marked, accessible evacuation routes that accommodate all occupants, including those unfamiliar with the facility or with mobility impairments. Passive fire protection should be incorporated during building design phases to enhance safety. Regular staff training and emergency drills are essential for coordinated evacuations.

Evacuation is the organized movement of individuals from hazardous areas to safe locations during emergencies to reduce injuries and fatalities. Effective evacuation planning ensures secure, uninterrupted pathways from any building location to a designated safe area. Such pathways align with daily movement flows, are always prepared for immediate evacuation, connect to multiple exits and public thoroughfares, and resist fire and smoke. They must have

adequate capacity, multiple routes for redundancy, freedom from obstructions, and be appropriate for all occupants.

The means of egress is an uninterrupted route that enables occupants to safely exit a building to a public area or safe location. The means of egress comprises three components: exit access (paths from rooms to exits, including corridors and aisles), exit (protected segments like stairways and external doors), and exit discharge (routes leading occupants safely out of the building to public ways). It is important to provide multiple evacuation routes to ensure safety. [4]

This study adopts the prescriptive codes for means of egress from the fire safety regulations of India and Japan as the basis for comparison. The national codes of both countries specify the technical requirements related to building exits, exit passages, and other egress components.

Table -1: Fire safety regulations used in this study

Country	Name of the fire safety regulations
India	National building code 2016
Japan	Building standard law
	Fire service act

National Building Code (NBC) of India Part 4 provides comprehensive guidelines for fire prevention, fire protection, and life safety in building design and construction. Japan's Building Standard Law sets comprehensive minimum standards for building construction, including fire safety, structural integrity, and sanitation. The BSL emphasizes structural and procedural fire safety measures such as evacuation routes, smoke exhaust, emergency lighting, and designated assembly points. [5]

Table 2 presents a comparison of fire safety requirements concerning means of egress in India and Japan, focusing on aspects such as the number of exits, maximum travel distance, exit width, length of dead-end corridors, staircase width, and exit discharge.

Table -2: Comparative analysis of fire safety regulations

	India	Japan
Floor exits	Minimum two staircases for buildings above 15 m; exits to be remote and accessible; one external staircase mandatory for >24 m height	2 exits for each floor > 100 m^2 floor area
Maximum travel distance (to Exit)	Max 30 m (un sprinklered) or 45 m (sprinklered) in hotels	30 m to nearest stairs; shorter if not sprinklered for 14th floor or less 20-40m for 15th floor or higher.
Exit width	1.5m	Min.900mm
Dead-end corridor	15m	10m
Corridor Width	1.5m	1.2m
Width of escape staircase	2.5m	1.4m
With of exit discharge	15	Effective width-1.5m

3. METHODOLOGY

The comparative analysis of fire safety regulations of two countries involves the quantitative approaches to achieve the intended results. The research includes the comparison of the fire safety regulation of the two countries that is India and Japan. Initially, data collection involves a comprehensive literature review utilizing various research papers, articles, and journals. Further, the detailed study of the regulatory framework and codes such as national building codes 2016 and building standard law and fire service act, of the countries is studied. The international country for comparative analysis was selected based on the hotels having less fire incidents in Asia region. Assessment of relevant case studies using fire safety audits, articles, journals and reports. The assessment includes relevant case studies through fire safety audits, articles, journals, and reports. The analysis aims to identify the differences and similarities in standards. Finally, conclusions are made based on the analysis.

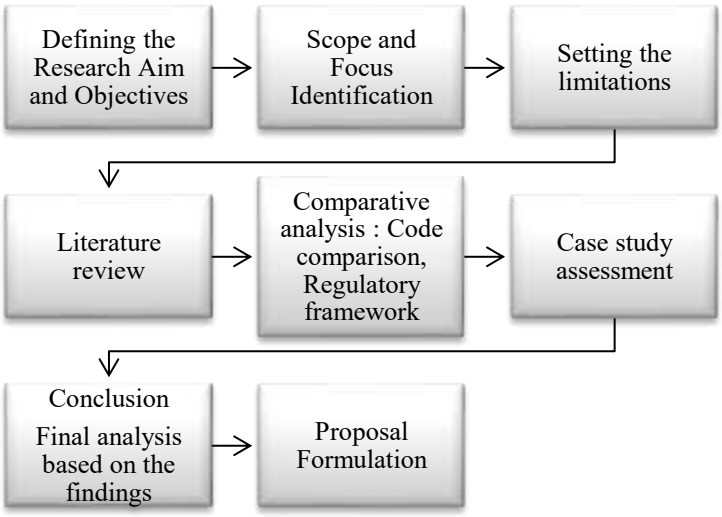

Fig -1: Methodology of the study
Source: author

4. CASE STUDIES

Case studies are an effective method for examination, the implantation of fire safety regulations, exposing both the strengths and weaknesses encountered by various countries in practice.

1. Case study: 1 The Levana Suite Hotel, Lucknow

Name of the project: The Levana Suite Hotel

Location: Madan Mohan Malviya Marg, Hazrat Ganj

Date: September 5, 2022

No. Of deaths and injuries: Four people died on the spot and more than a dozen people were injured.

Major Reasons for Fire Casualties and deaths:

a. Non-availability of Legally Required Frontage: Required six-meter clearance around hotels for fire tender movement was not maintained, hampering firefighting efforts and delaying fire control.

b. Inadequate Fire Safety Arrangements in Kitchen: Mandatory water hydrants and fire extinguishers were missing in the kitchen, which was the ignition point of the fire.

c. Use of an Old Building Improperly Converted into a Hotel: The hotel operated from a converted residential building without proper map approval or adherence to hotel-specific safety norms; modifications were made without official permissions.

d. Absence of Exhaust Fans: Lack of exhaust fans prevented smoke ventilation, contributing to suffocation and increasing fatalities.

e. No Fire Escape Provision: The hotel lacked emergency exits or fire escapes; iron grills and glass walls obstructed evacuation and firefighting access, causing prolonged rescue efforts.

f. Illegal Electrical Connections: The fire originated from an electrical short circuit; expired No Objection Certificate (NOC), no periodic inspections, and faulty wiring increased fire risk.

g. Conditional Fire Department NOC: The hotel ran on a conditional Fire Department NOC with non-functional firefighting equipment, non-maintained alarms, and sprinklers which failed during the fire, exacerbating casualties. [6]

Conclusion

Adequate fire safety laws exist but enforcement is hampered by significant compliance gaps among officials; therefore, increased public oversight, regular inspections, and stricter enforcement on property owners are essential to ensure adherence to regulations and improve fire safety outcomes.

2. Case study: 2 Hotel Arpit palace, Central Delhi

Name of the Project: Hotel Arpit palace

Location: Karol Bagh, Central Delhi

Date: Karol Bagh, Central Delhi

No. of deaths and injuries: 17 people died

The main reasons for the fire and deaths were:

a. Staff Negligence: Staff did not notice the fire in a timely manner and failed to alert the fire department. Due to inadequate training and malfunctioning of equipment, attempts of using firefighting systems were failed, and electrical safety checks were overlooked.

b. Extensive Wooden Interiors: Wood paneling on walls and floors results in the rapid spread of the fire, blocking exits and trapping

guests. Many fatalities occurred due to smoke and heat exposure.

c. Obstructed Emergency Exits and Poor Stair Design: The emergency exit was blocked by storage, lacked clear signage, and stairs were too narrow for effective evacuation, leaving guests unaware of escape routes.

d. Locked Windows: Windows were shut for winter and could not be opened quickly, preventing guests from escaping or accessing help once corridors were impassable.

e. Unsafe Kitchen Layout: The kitchen, located on the terrace, contained LPG cylinders and flammable materials, intensifying the speed and danger of the fire's spread.

f. Conclusion

g. Key actions to enhance hotel fire safety include enforcing stricter compliance through regular inspections, providing comprehensive staff training on, maintaining clear and unobstructed emergency exits, these measures significantly control the risks and protect lives. [7]

3. Case study: 3 Tenzankaku hotel Shira Hama hot-spring resort

Name of the Project: Shira Hama hot-spring resort

Location: Japan

Date: Shira Hama hot-spring resort

No. of deaths and injuries: no deaths and injuries

The key factors that contributed to successful evacuation:

a. Automatic Fire Alarm System Efficiency: Even with the building's complex layout, the automatic fire alarm system successfully pinpointed the fire's location early. This early identification enabled quicker emergency response actions.

b. Prompt Reporting by Employees: Some employees reacted swiftly by reporting the fire promptly. Their quick action heightened occupant awareness, allowing most people to become aware of the danger early on and prepare for evacuation.

c. Sufficient Staff to Guide Occupants: The balance between the number of guests and staff helped in effective evacuation. Staff were able to lead and assist guests efficiently, ensuring orderly and timely movement toward safety.

d. Fire Doors Limiting Smoke Spread: Fire doors closed automatically to compartmentalize the fire and prevent smoke from filling corridors. This containment preserved the corridors as safe passageways for safe egress until everyone evacuated.

e. Early Fire Perception: The combination of detection systems and human vigilance led to early fire perception, limiting casualties by facilitating timely evacuation and intervention. [8]

Conclusion

Key recommended hotel fire safety actions include rigorous enforcement of regulations through regular inspections and penalties, comprehensive and ongoing staff training on fire response, clear marking and unobstruction of emergency exits and evacuation routes, and routine maintenance and testing of fire detection along with suppression systems, collectively reducing risk and ensuring guests safety.

4. Case study: 4 B016 Hotel New Japan

Name of the Project: Hotel New Japan

Location: New Japan

Date: February 8, 1982

No. of deaths and injuries: 33 deaths and 34 injuries.

Key Causes of Fatalities:

a. The building's corridor layout formed a trident shape, making the staircase locations unclear, which obstructed and confused occupants during evacuation.

b. Many guests, including a significant number of foreigners, were unfamiliar with the building's internal configuration, complicating their ability to find evacuation routes.

c. The shafts within the building lacked proper partitioning, allowing smoke to spread rapidly and enabling the fire to quickly propagate to upper floors.

d. The absence of a sprinkler system allowed the fire to expand unchecked, worsening the situation.

e. Fire-retardant partitioning throughout the building was incomplete, reducing compartmentalization effectiveness.

f. Combustible materials were extensively used in internal construction across rooms, corridors, and foundations, increasing fire load.

g. Thermal fuses of fire prevention doors designed to close during fire scenarios had melted, but the doors remained open, enabling free fire and smoke spread. [9]

Conclusion

Key failures in hotel fire safety include poor staff awareness and training, lack of clear notification and extinguishing protocols, absence of essential systems like sprinklers, use of non-fire-resistant materials, neglected system inspections, improper fire door management, and inadequate emergency communication, especially for foreign guests, all of which significantly increase fire risks and compromise guests safety.

5. ANALYSIS

The comparative analysis of fire safety regulations in hospitality design between India and Japan reveals notable differences in outcomes related to fire incidents in hotels. In India, a certain number of deaths and injuries in hotel fires incidents is due to non-compliance with national and local fire safety norms, absence of clear evacuation signage and plans, insufficient staff training, and irregular government inspections. In contrast, Japan experiences fewer casualties in hotel fires is due to stricter enforcement of fire safety regulations, comprehensive staff training, and clearly marked emergency exits. This difference underscores the impact of regulatory compliance, effective enforcement, and preparedness on fire safety performance in hospitality settings.

6. CONCLUSION

This study conducted a detailed comparative analysis of fire safety regulations in hospitality design between India and Japan, focusing on the effectiveness of regulatory frameworks, enforcement, and practical outcomes. The findings reveal significant challenges within India's hospitality sector, where hotels frequently fail to comply with national and local fire safety standards. Identified issues include a lack of proper staff training, blocked and poorly maintained escape routes, regulatory and enforcement failures, and overall poor emergency preparedness. Moreover, negligence by hotel management and oversight authorities like government departments and fire safety officials—worsen these risk factors, leading to devastating fire incidents and loss of life. In contrast, Japan's well-enforced codes, comprehensive staff training programs, and strict adherence to evacuation protocols have resulted in significantly fewer fire casualties. This difference underscores that robust fire safety regulations alone are insufficient; their rigorous implementation and proactive enforcement are crucial to safeguarding lives in hospitality contexts.

The practical takeaways of this study emphasize the need for hospitality designs to align with key elements of the National Building Code (NBC) of India 2016, particularly Part 4 focused on fire and life safety. This includes requirements for buildings like hotels to have a minimum of two staircases each with widths not less than 1.2 to ensure efficient evacuation. The maximum travel distance to a protected exit is limited to 30 meters in unsprinklered buildings, extendable to 45 meters in sprinklered ones. Dead-end corridors should not exceed 15 meters to avoid trapping occupants, and corridors must be at least 1.5 meters wide to accommodate safe flow. Staircases must be protected and fire-resistant to maintain safe evacuation routes during fire incidents. Clear and unobstructed evacuation routes, avoidance of dead-end corridors. These requirements are important for developing safe hospitality environments but must be paired with ongoing fire safety training, rigorous inspection regimes, and management accountability to fully mitigate risks.

This research concentrates on fire safety regulations related to architectural design and means of egress in India and Japan, and did not explore regulations applicable to other building types, conduct experimental fire simulations, or analyze a broader range of international standards. Future research could broaden the scope to include comparative studies across more diverse geopolitical contexts, assess the impact of emerging technologies such as smart fire detection systems, and assess behavioral factors influencing fire safety compliance in hospitality operations.

Therefore, considering the complex nature of fire safety in hospitality design calls for well-organized regulations, steadfast enforcement, continual staff training, and a strong safety-first culture. Closing the gap between regulatory intent and real-world practice is critical, and only through efforts from all the stakeholders can reduce fire-related damages and casualties. This study provides useful insights for architects, hotel managers, and

policymakers aimed at improving fire safety standards within the hospitality.

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