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Fire safety Codes-Evolution and Significance, a case of Global Perspective

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Abstract:

The development of modern fire protection codes results from responding to catastrophic fires rather than anticipating such fires. Fire safety regulations are essential for ensuring the security and integrity of all sorts of buildings. These regulations establish minimum standards to protect the people within a building and the structure itself from harm. The codes are the living documents continuously evolving and modified according to the adaptation and response of people, their knowledge, technologies, and trends, the greatest threat to fire disaster management. Traditionally, incidents that have occurred within buildings and resulted in many incidents have directly influenced the current code standards. Many changes which could make to building & fire safety codes are a direct reaction to tragic events. The evolution of fire safety codes over some time and test technologies have significantly improved in ensuring fire safety; through the existing regulations. Fire safety still faces new challenges as the buildings go high rise with the latest technologies and new building materials used for construction.

Key Words: Fire codes, origin, performance-based, traditional, disaster management.

Introduction:

The development of fire protection codes can be traced back to Rome in 64 A.D. when it first used building materials. The first fire protection code is known to man. Currently, firefighters employ sophisticated technologies which greatly enhance fire disaster management. Reports of investigations are similar between the Triangle Shirtwaist Factory fire of 1911 and the Station Nightclub fire of 2003; business owners largely ignore essential fire protection and building codes. Additionally, the investigators report that disaster response time has gradually reduced due to the improvements made to the fire alarm system. Despite such development's reduction in response time, noncompliance with fire protection codes hinders the effective management of fire disasters. Although fire management has improved tremendously, new challenges continue to face fire disaster management. Such challenges include fires started by non-traditional causes such as terror attacks such the 9/11. Requires fire disaster managers to evaluate the effectiveness of existing fire protection codes continuously.

Fire disasters have led to some of the most horrific property damage and loss of human life. Recurrent fire disasters have led to gradual changes, amendments, and improvements in fire protection codes. However, these incremental changes have yet to lead to the achievement of success in the management of fire disasters. About the findings in this research paper, the following hypothesis seems relevant: despite the gradual improvements made to fire protection codes, noncompliance and the challenge of the dynamic nature of fire disasters continue to hinder the attainment of successful fire disaster management practices. This hypothesis raises questions about why successful fire disaster management is still determined. It is imperative to evaluate the circumstances that have led to the evolution of fire protection codes [2].

Fire protection and building codes

The management of fire disasters evolved from rudimentary methods in ancient Europe to sophisticated methods employed today in the direction of fire disasters. Such gradual development results from the evolution of complex life and property safety codes. Generally, developed life safety codes to minimize or eliminate the loss of human life and property damage in case of a major fire outbreak. Traditional fire protection codes mainly addressed various issues concerning managing fire disasters. Such problems range from the ability of materials used in construction to withstand and prevent the spreading of fire and adequate means of exit to the use of fire protection tools like smoke detectors and alarms. Additionally, the evolution of fire protection codes incorporates proper planning procedures and tenancy elements.

These allow quick evacuation of people in fire emergencies case. While the development of detection and prevention methods and rapid response systems help minimize the effects of fire, disaster managers emphasize absolute compliance with existing fire protection codes. In this regard, compliance with fire protection codes dramatically relies on the latest technological advancements combined with historic codes. Aimed at improving disaster management practices. It is imperative to state that with time, NFPA has successfully separated building codes from fire protection codes, which combine to ensure improved efficiency in managing fire disasters. While NFPA building codes aim to enhance the building architecture to avert a major fire disaster, fire protection codes aim to strengthen early warning, response, fire detection, and prevention preventing the fire from spreading and evacuating victims (Alderson, Artim, and Allen 1, 2).

The origin of fire protection code and building regulation

Even though there is little documented evidence on the origin of modern fire protection codes, NFPA codes trace their or19th-century Europe. Evidence indicates that using the earliest fire known in 64 AD, Rome, after the great Roman fire, gutted Rome and left a trail of devastating effects on human life and property. As a result, Emperor Nero instructed the Roman architects to develop building regulations, mainly focused on building materials. As a result, Romans used fireproof materials for buildings. Used fireproof materials to rebuild Rome. It is the first recorded case of applying scientific principles to enhancing building safety. The fact that there is no previous mention of building and fire protection codes implies that before 64 A.D., there was no effort to manage fire disasters professionally.

There are no records of any improvements in fire protection codes between 64 A.D. and the 17th century. Primarily attributed to the fall of the Roman Empire. It wasn't until the renaissance that made any significant improvement. Existing records show consistency with these assertions since it was after the great London fire that advances in fire prevention standards developed in 64 AD Rome. In 1666, the Great London Fire gutted London destroying more than 80 % of the City and resulting in massive loss of life. In response to the fire, architects in London adopted the standards developed in 64 AD Rome, with minor improvements. Other than building the outer walls with fire-resistant materials such as bricks and stones, they used fireproof materials for house partitions.

Indicates that houses in 17th century England had an improved ability to withstand fire than those built in 64 AD Rome. Additionally, the Great London fire spurred the development of fire suppression techniques. As such, hand-pumper fire apparatus, the first fire prevention equipment to use water, was developed. Hand-pumper fire apparatus was a heavy hand-drawn water carrier that sprayed water over a fire, thus extinguishing it. Therefore, before the industrial revolution, the only recorded use of fire prevention codes involved the usage of fire-resistant building materials combined with the help of hand-pumper fire apparatus.

May trace back to the beginning of an industrial revolution in 18th-century England. Numerous industrial fires gutted most of London's new industries, necessitating the fire norms. Records indicate that concrete, steel, and hardened rock were the primary building materials to avert the loss of lives and property. Besides strengthening buildings, engineers combined these three materials at the time and provided English engineers with suitable solutions to prevent rampant industrial fires. Additionally, the first public fire department to enhance fire protection codes' effectiveness in 18th century England and the installation of underground water mains and ready-to-use fire hydrants.

Moreover, between the 18th century and early 19th century, fire protection codes mainly focused on specific buildings and the contents therein. This new approach was necessitated by numerous industries, each having unique industrial processes and materials under storage. This approach, however, gained prominence in the later stages of the 19th century after the outbreak of numerous fires within London's paper and textile industries. Due to poor storage of paper and lint debris and waste, disaster managers faced a new challenge not possible to manage using fire protection methods existing at the time. As such, engineers developed the first ever recorded fixed fire suppression system. Involved in the use of manually operated water pipes. However, the hazard posed to firefighters using manually operated water pipes gave rise to the idea of automatic water sprinklers. When it comes to fire safety, this is undoubtedly one of the best inventions ever made by engineers. [2]

Performance-based codes

The focus on performance-based codes is not recent in many countries, including the U.S. There have been performance-based regulations in several countries for many years. It began with British [3], Japan [4], and Australia in the 1980s and gained worldwide attention through the Warren center report [5] to maximize the design flexibilities in the building code. The United States and Sweden can be called pioneers in providing performance-based approaches to structure and design analysis.

The focus of the study is the regulation, analysis, and design methodologies related to fire safety. Narrowed down the survey to 13 nations (United States, Spain, Poland, Norway, New Zealand, Netherlands, Japan, Great Britain, (Wales, England,), France, Finland, Canada, and Australia) and the two organizations (ISO "international organization for standardization" and the international council for building research and documentation (CIB) utilizing or creating codes based on performance, technical tools, processes for designing fire-safe structures with a regulatory framework. This study aims to outline the advancements made in research over the last 30 years concerning legislation analysis and design techniques connected to fire safety.

Chronological overview

A historical context for applying performance-based regulation to building fire safety has been available for some time. There has been a rise in curiosity about the consequence of the availability of more progressive and performance-based building fire laws in many nations. Due to the magnitude and pace, this document claims to need to be completed or comprehensive. The purpose of this document is to acknowledge the efforts of fire safety design through performance-based codes. To give readers the concept of a global fire protection trend to sensitize buildings' awareness and fire safety. It provides the existing current steps to follow. Similarly, it should not assume that the methodologies referred to are more important and the others are not significant.

In the 1970s, the conforms with code method of analyzing and creating fire regulations gave way to a more systematic approach. The visionaries and the engineers can see the building and the fire as the essential system component by designing components individually without regard to the system's potential. There could be areas for improvement in the system.

Table 1. Events Influencing the Development of Performance-Based Codes and Fire Safety Design Approaches in Chronological Order.

Year	Development and Country
1971	The United States Government Services Administration (GSA) is hosting a global summit on fire safety in tall structures. (U.S. [)6,7]
1972	Appendix D, Guide for Objective- Oriented Method to Building Fire Safety, is now available online as part of the GSA's Building Safety Criteria. (U.S.) [8]
1973	A Technical Board on Systems Theories for Fire Protection was formed by the NFPA

	(National Fire Protection Agency). (U.S.) [9]
1974	Fitzgerald et al. begin the development of the Anatomy of Building Fire safety (U.S.) [10]
1975	National Academy of Science publishes "Program for Developing and Implementing a New Approach to Designing for Fire Safety in Buildings" (U.S.) [11]
1976	Harmathy publishes "Design Approach to Fire Safety in Buildings" (Canada) [12]
1979	Seminal research undertaken by Vaughan Beck into risk assessment modeling (Australia) [13]
1979	Kobayashi publishes "A Methodology for Evaluating Fire/Life Safety Planning of Tall Buildings" (Japan) [14]
1980	SFPE (Society of Fire Protection Engineers) Symposium on Systems Methodologies as well as some Applications (U.S.) [15]
1980	SFPE/ NBS (National Bureau of Standards) Workshop on Engineering Applications of Fire Technology (U.S.) [16]
1981	NFPA Technical Committee on Safety to Life publishes the Fire Safety Evaluation System for Health Care Facilities (U.S.) [17]
1982-87	Developing a Fire Safety Design Method is a project taken on by the Ministry of Construction. (Japan) [2]
1985	In an industry-first, performance-based Building, Regulations are released to the public. (U.K.) [1]
1986	SFPE sponsors symposium on "Quantitative Methods for Life Safety Analysis" (U.S.) [1]
1986	NFPRF (National Fire Protection Research Foundation) and NBS (National Bureau of Standards) undertake the National Fire Risk Assessment Project (U.S.) [19]
1987	Beck collaborates with NRCC (National Research Council Canada) on fire risk assessment modeling (Australia along with Canada) [20,21]
1987	SFPE sponsors symposium on "Techniques of Quantitative Fire Hazard Analysis" (U.S.) [22]
1988	SFPE Handbook of Fire Protection Engineering is published (U.S.) [23]
1989	The Warren Centre for Advanced Engineering has released a paper detailing the results of its Fire Safety and Engineering initiative (Australia) [3]
1990	BRRTF (Building Regulations Review Task Force) designed and launched NBFSSC (National Building Fire Safety System Code) (Australia) [2]
1990	A subgroup within ISO is formed to address how might apply fire safety norms (International) [25]
1991	This 21st Century Conference on Fire Safety Design is co-sponsored by WPI (Worcester Polytechnic Institute), NSF (National Science Foundation), SFPE (Society of Fire Protection Engineers) (U.S.) [26]
1991-93	Custer and Meacham devel f course on the performance-based design of fire detection systems for the SFPE (U.S.)
1992	The performance-based New Zealand Building Code (and regulations) go into effect (New Zealand) [28]

1992	The Fire Administration Authorization Act of 1992 (Federal Fire Safety Act) goes into effect (U.S.) [29]
1992	Based on their work developing the FIVE (Fire-Induced Vulnerability Evaluation) techniques, EPRI (Electric Power Research Institute) has released a document titled Methods of Quantitative Fire Hazard Analysis. (U.S.) [30]
1992-93	Draft British Standard Code of Practice for the Application of Fire Safety Engineering Principles to Fire Safety in Buildings developed (U.K.) [31]
1993	The International Council for Building Research and Documentation (CIB) establishes a team to work on performance-based codes (TG11) (International) [32]
1994	Subcommittees on Engineer in evaluating building fire safety and computer fire model assessment have been formed as part of CIB Working Commission 14: Fire (Wl4) (International) [3]
1994	Inclusion of Performance standards in new Swedish construction laws introduced by the Board of Building, Housing, and Planning (Sweden) [34]
1994	The Fire Engineering Design Guide published (New Zealand)3[5] 1994
	The Fire Code Reform Centre Ltd (FCRC) established (Australia) [36]
1994-95	Custer and Meacham develop a course for SFPE on performance-based design for fire protection engineers (U.S.) [37]
1995	ABCB (Australian Building Codes Board) drafts the Performance Building Code of Australia (Australia) [8]
1995	CCBFC) introduces a plan for converting building code from prescriptive to objective-based (Canada) [39]
1995	The Nordic Committee on Building Regulations publishes *Performance Requirements for the Fire Safety* and *Technical Guidance to verify with calculation* [40]
1995	The FCRC publishes interim Fire Engineering Guidelines (Australia} [41]
1995	The NFPA publishes concept for the transition of NFPA codes and standards from prescriptive to performance-based (U.S.) [42]
1995	The Ministry of Construction undertakes a new project for performance-based building code (Japan) [43]
1995	SFPE started an initiative to establish a national standard for performance-based fire safety design in the U.S. (U.S.) [44]

Fires in History that Influenced Building and Fire Codes [1]

Table:2- Fires in History that Influenced Building and Fire Codes [1]

Sl. No	Fire Accident	Impact	Changes in codes
1.	Date: December 30, 1903; Place: The Iroquois Theatre Fire Chicago, Illinois –	**602 deaths**	• limitations on capacity • enhanced means of escape • marks indicating the way to the exits • continuously lit exit signs • battery backup for exit signs and another emergency lighting • Enhancements to egress systems, such as the development of panic bars,
2.	Date: March 25, 1911; Place: Triangle Shirtwaist Fire New York, New York –	**500 deaths**	**Prompted the creation of NFPA's Committee on Safety to Life which laid the groundwork for NFPA 101** • Fire escapes must adhere to stricter regulations and higher building requirements. • The requirement of fire drill by law. • Sprinkler systems Enhanced capabilities for egress from high-rise buildings.
3.	Place: Cocoanut Grove Fire Boston, Massachusetts – Date: November 28, 1942;	**492 deaths**	• Make rotating doors with collapsible panels standard, or install a conventional outswing door nearby. • Limits on the combustibility of building materials • Restriction on the combustibility of home furnishings and decor • Emergency lighting
4.	Place: Our Lady of the Angels School Fire Chicago Date: December 1, 1958	**93 deaths**	• All schools must have working fire alarms • Sprinklers that turn on automatically • Automatic, outward-opening, self-closing exit doors • Closed stairwells in the event of a fire • Egress window height restrictions • The distinction between flammable areas and grades for fire proneness • Purpose-built emergency lights

5.	Place: Grand Hotel & Casino Date: Las Vegas, Nevada – November 21, 1980; MGM	**85 deaths**	• Sprinkler systems required by law for any structures above a specific size or floor count • Detectors for smoke in rooms and lifts • emergency exit maps in the guest rooms. • In the prevention of the spread of smoke, they adopted Safety measures.

Global overview

Fire safety standards usually minimize the response to the fireplace of products and materials utilized in unique living environments, including home dwellings, family systems, furnishings and electronics, homes, and extraordinary shipping modes. Globally, fireplace safety requirements cognizance on stopping the initiation of fireplaces through establishing overall performance-based norms which, if adhered to, will enhance the fire protection of materials and merchandise. The illustrations of the declining death trends indicate the fire safety standards. The fact, though, is that globally there are many contrasting standards internationally for just about every scenario. within the constructing and creation region, for example, the diversity of methods and codes has created uncertainty and confusion within the trying out and approval of production methods, products, and operation of buildings.

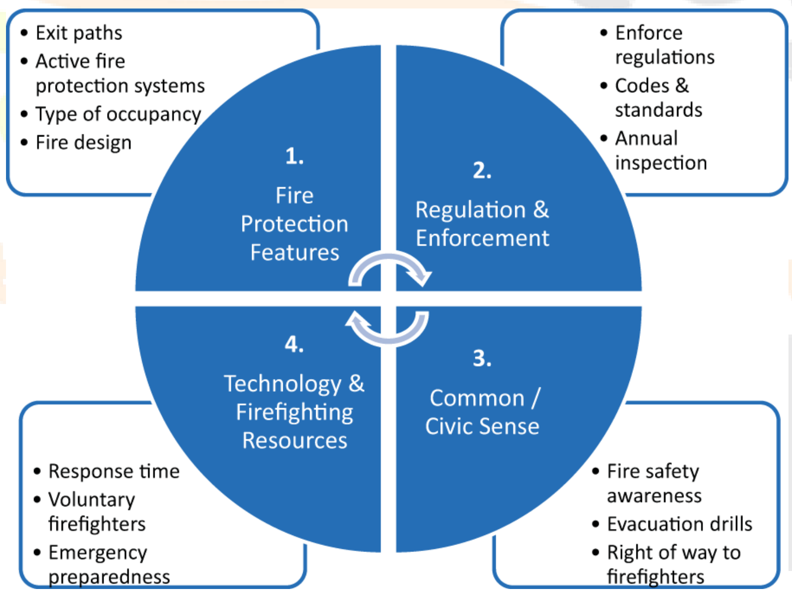

Figure-1 "Fire threat in buildings: analysis, valuation, and approaches for improving.

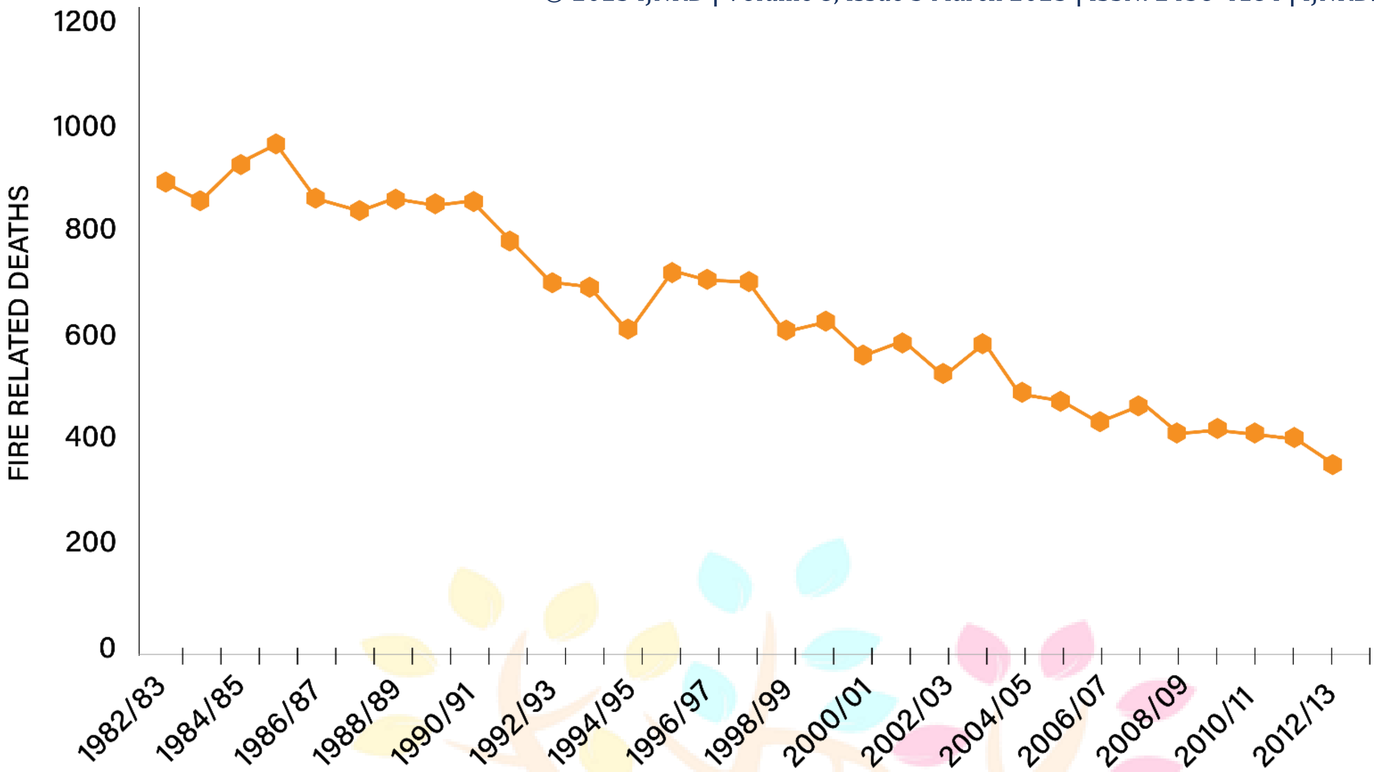

Figure:2 Trends in fire deaths in the USA 2002 – 2011

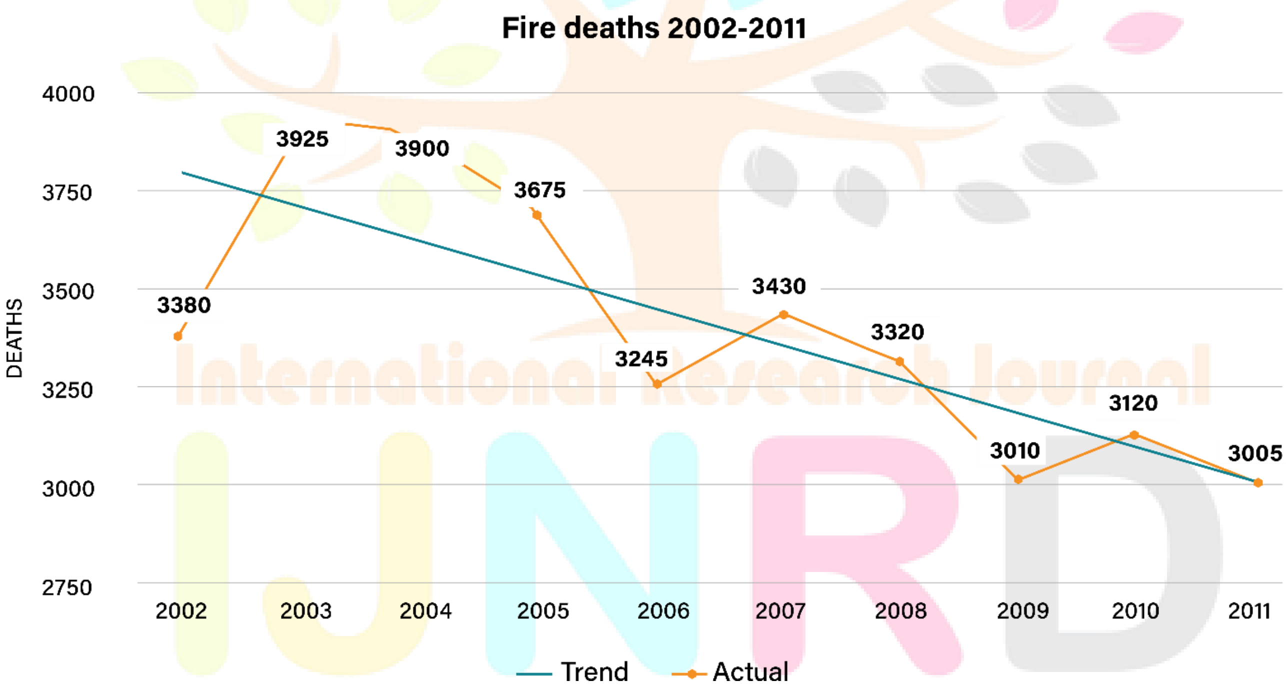

Figure:3 Fatalities from fires, Great Britain, 1982/83-2012

Conclusion

However, the elusive success in managing fire disasters should take into account improvements made to fire protection codes. Valuable enhancements to traditional fire protection methods result in sophisticated fire protection codes. Success in fire management, though, seems elusive owing to factors like noncompliance, the complexity issue, and the changing nature of fire disasters. The growth of fire protection rules, as well as the usage of recent technology, have made a substantial improvement in putting out big fires. However, it must address the disaster manager's challenges through existing codes. Such challenges include the threat of terrorism and fires that might start due to such causes as terror attacks.

Additionally, each fire occurs under unique conditions and thus needs unique solutions to combat. The uniqueness of the fire makes the development of new fire protection codes before a fire breaks out a near impossibility. Consequently, managing fire catastrophes is an ongoing process that has yet to have any definitive answers.

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