Urban and Building Science
https://www.sciltp.com/journals/ubs

Article

Assessment of Public Safety Standards in Commercial High-Rise Buildings of the Central Business District of Peshawar, Pakistan

Muhammad Ibrahim [1,*], Waqas Ahmed Mahar [2,3], Muhammad Jawad Khan [4], Muhammad Jamal Nasir [5] and Aman Ullah [2]

[1] Department of Urban and Regional Planning, University of Peshawar, Peshawar 25000, Pakistan
[2] School of Art, Design, and Architecture, National University of Sciences & Technology (NUST), Islamabad 44000, Pakistan
[3] Sustainable Building Design (SBD) Lab, Department of Urban & Environmental Engineering (UEE), Faculty of Applied Sciences, Université de Liège, 4000 Liège, Belgium
[4] Department of Civil Engineering Technology, University of Technology (UoT) Nowshera, Nowshera 24100, Pakistan
[5] Department of Geography & Geomatics, University of Peshawar, Peshawar 25000, Pakistan
* Correspondence: plnr.ibrahim1@gmail.com

How To Cite: Ibrahim, M.; Mahar, W.A.; Khan, M.J.; et al. Assessment of Public Safety Standards in Commercial High-Rise Buildings of the Central Business District of Peshawar, Pakistan. *Urban and Building Science* **2026**, *2*(2), 3. https://doi.org/10.53941/ubs.2026.100009

Received: 8 December 2025
Revised: 24 February 2026
Accepted: 9 March 2026
Published: 1 April 2026

Abstract: Rapid vertical development in South Asian cities has led to an increase in high-rise buildings, but enforcement of safety regulations has not kept pace with construction. This study evaluates compliance with public safety standards across twenty-three (23) commercial high-rises in Peshawar's Central Business District (CBD). Using a GIS-based Multi-Criteria Decision Analysis (MCDA), the research assesses seven safety parameters, including Emergency Exit, fire extinguishing systems, staircases, elevators, parking, basements, and building structures, in accordance with the Cantonment Board Peshawar (CBP) by-laws. Data collected through field surveys were spatially analysed and categorised into three safety levels, i.e., good, moderate, and poor. Results reveal that only two buildings (8.7 per cent) achieved a "good" safety rating, five (21.7 per cent) a moderate, and sixteen (69.6 per cent) a poor. Key deficiencies included a lack of Fire Extinguishers, locked or missing Emergency Exit, the absence of elevators, and non-compliance with parking and accessibility standards. Spatial analysis indicated that poorly rated buildings were concentrated along Saddar Road, reflecting older, unregulated commercial areas. These findings underscore the importance of strengthening institutional coordination, adopting GIS-based compliance monitoring, and enforcing mandatory periodic safety certifications for commercial high-rises. Beyond technical measures, the study stresses that public safety should be integrated into broader urban resilience and sustainability initiatives. This developed methodological framework can serve as a High-Rise Safety Index for other cities, fostering data-driven governance and safer vertical development nationwide.

Keywords: high-rise buildings; public safety; building codes; GIS; central business district; urban resilience; Peshawar

1. Introduction

The Central Business District (CBD) is the commercial and financial centre of a city, where the offices and shopping malls are located in bulk quantities, with some residential areas as well [1]. It is a very distinct part of a city with the characteristics of the highest land values, high-rise buildings, mainly pedestrian movement, and

automobility [2]. There is a pivotal role of the CBD in large metropolitan cities [3]. It has all the concentration of commercial activities with a high price of land, resulting in high and growing rents [4].

The United States of America (USA) built the first high-rise commercial building, which was used for office purposes [5]. Nowadays, high-rise buildings are primarily designed for commercial use [6]. There is a growing recognition that increasing commercial density in CBDs can bring significant potential benefits to human beings [7]. Therefore, special attention must be given to maximizing the benefits of commercial high-rise buildings. The urbanization of large cities creates a problem of commercial accommodation, and it is inevitable to construct high-rise buildings according to international building codes to enhance their future viability [8].

Pakistan is the third most urbanised country in South Asia [9]. Urbanisation and economic growth are generally considered to be closely related, particularly in a country like Pakistan. Pakistan is rapidly transitioning from horizontal growth to vertical high-rise development. The recent disasters in the country have compelled government officials to adopt safety measures to protect the public. To shift from a responsive to a proactive approach, the Government of Pakistan has developed codes and standards to embrace, promote, and introduce modern technological advancements nationwide. For this purpose, the following building codes have been implemented throughout the country: Building Code of Pakistan-Seismic Provisions 2007; Building Code of Energy Provisions Pakistan-2013; Pakistan Electric and Telecommunication Safety Code (PETSAC) 2014; Building Code of Pakistan Fire Safety Provisions 2016, Energy Conservation Building Code (ECBC) 2023 [10–14].

High-rise buildings are constructed, but safety provisions such as Emergency Exit and proper firefighting systems are rarely followed. There are building regulations covering various safety measures, but neither the development authority nor the builders prioritise them. According to the WHO, fire-related burns cause approximately 120,000–130,000 deaths annually worldwide, with over 90% occurring in low- and middle-income countries [15]. From 2014 to 2024, global age-standardised mortality rates declined by about 25–30%, yet absolute numbers remain high in sub-Saharan Africa and South Asia due to open flames and limited healthcare access [16]. Similarly, Pakistan ranks among the top countries globally for fire-related fatalities, with an estimated 10,000–15,000 deaths annually from around 12,000–15,000 incidents, driven by rapid urbanization and inadequate infrastructure [17,18]. In Pakistan, annual fire incidents cause significant fatalities and property damage exceeding Rs. 1 trillion, with approximately 70% of deaths occurring in existing high-rise commercial buildings due to violations of building codes and the absence of fire safety systems [19,20]. The leading cause of these fatalities is the lack of fire protection and safety measures, including the absence of exits, alarms, or hydrants, exacerbated by poor enforcement and negligence [21,22]. Due to the fire risk in high-rise buildings, providing emergency escape routes is essential for safe evacuation. Fire escape routes in high-rise buildings are vital, given the number of stories and occupants compared to low-rise buildings. Inadequate or missing escape routes can lead to disastrous outcomes during a fire in a commercial high-rise. Evaluating the advantages and disadvantages of high-rise buildings is necessary to identify ways to improve their future safety features. The advantages and disadvantages of high-rise buildings are essential for defining their future characteristics.

Despite extensive international efforts to address high-rise safety and fire control, relatively little empirical research on compliance monitoring in second-tier South Asian cities has been conducted. Most efforts have centred on large cities like Karachi, Dhaka, and Mumbai, with modest but quickly urbanizing ones like Peshawar remaining largely unexplored. This is a restriction on our knowledge of how safety regulations are interpreted and enforced in emerging business hubs. Thus, the present study provides new contributions by assessing the effective enforcement of Pakistan's building codes in Peshawar's Central Business District using a spatially explicit, GIS-based approach.

Research Context and Objectives

The comparative survey of global and regional literature highlights that although high-rise safety assessment has been gaining momentum in major South Asian cities such as Karachi, Dhaka, and Mumbai, there is an extensive gap for large-scale empirical studies grounded in the local contexts of smaller but rapidly expanding urban areas such as Peshawar. Being one of Pakistan's most ancient and economically prosperous cities, the Peshawar Central Business District (CBD) has witnessed rapid vertical growth, with numerous multi-story commercial structures erected over the last two decades. Nevertheless, based on anecdotal data and initial inspections, inconsistencies in compliance with the Cantonment Board Peshawar (CBP) by-laws and overall non-compliance are noted.

The present research thus seeks to comprehensively assess public safety compliance in commercial high-rise structures within Peshawar's CBD using a blend of field-level audits and GIS-enabled multi-criteria analysis. The study has the following objectives:

I. Examining the extent of compliance with current CBP building standards for safety, specifically fire safety, emergency escape, structural accessibility, and service facilities
II. Measuring and mapping the spatial distribution of levels of safety in the study area
III. Identify the weakest points most critical and propose actionable recommendations for enhancing compliance and institutional enforcement.

The originality of this research lies in combining empirical field observations with a spatial decision-support platform to develop a quantifiable, geographically referenced safety index. Unlike previous descriptive code-violation analyses, this enables visualisation of high-risk hotspots and supports data-based urban safety governance. Situating the Peshawar case in broader debates over regional governance and building safety, the paper places local policy reform alongside comparative urban research across developing cities.

2. Literature Review

The rise of high-rise structures has now become a sign of urbanisation across the globe. The structures respond to land shortages in fast-growing cities, but they also bring new governance, safety, and environmental challenges. Around the world, scholars have noted that high-rise development should be matched with robust regulatory systems and compliance systems on safety to shelter city inhabitants [23,24]. In developing nations, the institutions tasked with building controls, however, cannot implement such controls effectively, and hazardous construction activities and high disaster risks follow [25,26].

2.1. Building Codes and Safety Compliance

Building codes are pivotal instruments in ensuring the structural stability, fire safety, and habitable conditions of buildings. Al-Fahad [27] defined building codes as legislated codified standards meant to guarantee public health, safety, and welfare through construction design and material use. Code enforcement is always supplemented with rigorous inspection regimes and liability by law in most advanced countries, effectively reducing fire-related fatalities and building collapses. For instance, Hall [5] clarified that strict adherence to safety regulations on buildings in the United States has lowered fire fatalities and on-site construction accidents in high-rise settings considerably.

Conversely, most developing nations experience weak compliance with building codes due to weak institutional enforcement, limited professional capacity, and a failure of coordination among enforcers. Anees et al. [28] established that, in Pakistan, code violations are common, with escalating environmental hazards and urban expansion, and enforcement is not well coordinated. Likewise, Khan et al. [29] critically analysed Pakistan's Building Code of Fire Safety Provisions (2016) and found that, although the code is comprehensive, its implementation is not correctly monitored, particularly in commercial high-rise buildings.

2.2. High-Rise Buildings in Pakistan

High-rise buildings in Pakistan are generally defined under the Building Code of Pakistan (BCP) 2021 and associated local bylaws as multi-storey structures exceeding 48 feet (approximately 15 m) in height from the crown of the road to the top of the parapet wall, excluding non-structural elements like chimneys or water towers [30]. These are categorized into medium-rise (up to 120 feet), high-rise 1 (up to 200 feet), high-rise 2 (up to 300 feet), and skyscrapers (above 300 feet), with stricter seismic provisions applied to taller structures in zones 3 and 4 as per BCP Seismic Provisions 2007 (updated in BCP 2021), which mandate enhanced ductility detailing, equivalent lateral force analysis, and site-specific hazard assessments for buildings over 10 storeys or 100,000 sq ft to mitigate earthquake risks from Pakistan's high seismicity [11]. Additionally, Civil Aviation Authority (CAA) regulations impose height restrictions within a 15 km radius of airports, requiring no-objection certificates (NOCs) based on obstacle limitation surfaces (OLS) to ensure aviation safety, with maximum limits varying by site (e.g., up to 900 feet above ground level in designated outer horizontal areas near major aerodromes) [31].

In Peshawar, governed by the Peshawar Development Authority (PDA) Building and Zoning Regulations 2020 (aligned with BCP 2021), high-rise buildings follow a similar threshold of over 48 feet but incorporate local zoning for vertical expansion, allowing up to 200 feet in high-rise-1 zones on plots of 4 kanals or larger along 60-foot-wide roads, escalating to 300 feet with CAA/PDA approval for taller structures [32]. Peshawar's seismic zone 2B status (0.16–0.24 g peak ground acceleration) [11] Under BCP, reinforced concrete framing with ductility enhancements is required for buildings exceeding 10 storeys. At the same time, proximity to Bacha Khan International Airport enforces CAA height limits within 15 km, often capping at 450–900 feet in outer sectors to avoid interference with flight paths. These provisions promote safe urbanization amid Peshawar's rapid growth and tectonic vulnerabilities [33].

2.3. Fire Safety and Emergency Preparedness in High-Rises

Fire safety is the most significant concern in high-rise buildings. Worldwide, research indicates that delayed evacuation, blocked staircases, and the lack of suppression systems are the primary reasons for fire-related deaths in urban fires [34,35]. Zhang et al. [26] described how China's rapid urbanisation process engulfed the enforcement of fire safety codes, resulting in recurrent high-rise disasters despite contemporary regulations. In Bangladesh, a study by [36] found that just 30 per cent of Dhaka's commercial buildings had functioning fire safety equipment, and most failed to receive regular inspections. The same patterns are evident in Pakistan's major cities, where ageing infrastructure and weak firefighting capabilities increase exposure [29,37]. Research also identified a lack of emergency preparedness among people in the aftermath of fire disasters. Kobes et al. [34] found that poor signage, obstructed stairways, and a lack of training for occupants reduced the likelihood of orderly evacuation. Effective fire safety management thus includes not just technical equipment but also operational preparedness, practice, drills, and maintenance, which are seldom adopted in South Asian cities.

2.4. Urban Governance and Institutional Enforcement

Urban governance plays a pivotal role in operationalizing safety standards. Beavon [3] contended that urban management institutions need to adapt along with densification, especially at inner city business districts where land use and vertical intensification are more relevant. In Pakistan, building development is governed by several overlapping jurisdictions: municipal corporations, cantonment boards, and provincial, regional, and local development authorities, resulting in accountability gaps. Ali et al. [38] observed that this institutional collapse has led to the uncontrolled commercialization of Peshawar's CBD, inducing large-scale code violations.

This deficit is further aggravated by adverse public perception and an open culture of unregistered construction. Reddy [4] authored the same characteristics in Indian cities, where commercial high-rises were constructed without strict adherence to safety codes, primarily because of cost considerations and the absence of regulation. These regulatory failures directly impact public safety, especially given the lack of regular inspections and occupancy permits.

2.5. Application of GIS and Multi-Criteria Models in Safety Assessment

Over recent years, Geographic Information Systems (GIS) have been key tools in the creation and delineation of urban safety risks. Yeboah [39] illustrated the potential of GIS-based fire response modelling to facilitate the identification of at-risk buildings and emergency service planning. Using Multi-Criteria Decision Analysis (MCDA) within GIS enables researchers to combine multiple parameters, such as building type, accessibility, and safety equipment, into a composite safety measure. Schröter et al. [40] demonstrated that spatial risk modelling enhances evidence-based urban governance by enabling policymakers to target areas of high risk geographically.

Although they are widely used, few studies in Pakistan have employed GIS and MCDA to evaluate compliance with building codes. Past urban safety studies were mainly policy-focused or descriptive, without spatial quantification of risk. The current research bridges this gap by combining field data with GIS-based analysis to develop a spatial safety index for commercial high-rise buildings in Peshawar's CBD. The strategy not only measures compliance but also monitors spatial concentrations of hazard-prone structures and provides an empirically replicable framework for other cities.

2.6. GIS-Based Risk Assessment in Urban Built Environments

Recent advancements in GIS-based spatial multi-criteria analysis (SMCA) have enabled researchers to model urban risk through integrated weighting frameworks, particularly using the Analytical Hierarchy Process (AHP). Studies have applied GIS–AHP approaches to fire risk zoning, disaster vulnerability assessment, and building safety mapping in rapidly urbanizing contexts [41,42]. However, most existing studies focus on hazard exposure or environmental vulnerability rather than regulatory compliance within the commercial high-rise buildings. This gap is particularly apparent in secondary cities of developing countries, where vertical growth often outpaces institutional enforcement capacity.

The literature review identifies three gaps in the research. First, there are very few local empirical studies of safety compliance in secondary cities in Pakistan, such as Peshawar, given their rapid urbanization. Second, field audits and GIS-based analytical models have seldom been used together to assess safety compliance spatially. Third, the governance and institutional determinants of safety code enforcement have not been adequately explored. This research addresses the above lacunae by framing a geospatially linked model to assess compliance

with CBP bylaws, gauge safety levels, and identify policy interventions to enhance public safety in the urban high-rise city context.

3. Materials and Methods

The analytical framework of this study is divided into two parts. The first part involves a comprehensive review of the Peshawar Cantonment Board's existing building bye-laws to identify the relevant building codes for commercial high-rises. A checklist is then developed from the existing byelaws. The second part comprises field observation and physical verification of existing buildings. This methodology is designed to collect data to assess the likelihood of deficiencies and violations, and their impact on the safety, health, and general welfare of users of these commercial high-rise buildings in Peshawar.

3.1. Study Area

Peshawar cantonment commercial area, known as Saddar, is one of the commercial areas that was particularly developed during the colonial period [38]. The commercial agglomeration activities took place due to the recent development and better accessibility of other parts of the city to the CBD in Peshawar [43]. Due to the rapid development of commercial structures, it is the priority area for investment in any business [38]. Commercial activities are taking place along transportation routes/streets. The development direction is proceeding both vertically and horizontally. The CBD spans 13.64 km^2 and primarily caters to the affluent population through modern high-rise commercial buildings. Among these, the Dean Trade Centre stands out, offering offices, a hotel, a marriage hall, and over 500 shops. In contrast to the older city CBD, this is a newly developed commercial hub with a more compact retail centre. Nevertheless, it holds significant appeal due to its upscale shopping options, improved traffic flow, and accessibility. Figure 1 shows the location of the CBD, Peshawar.

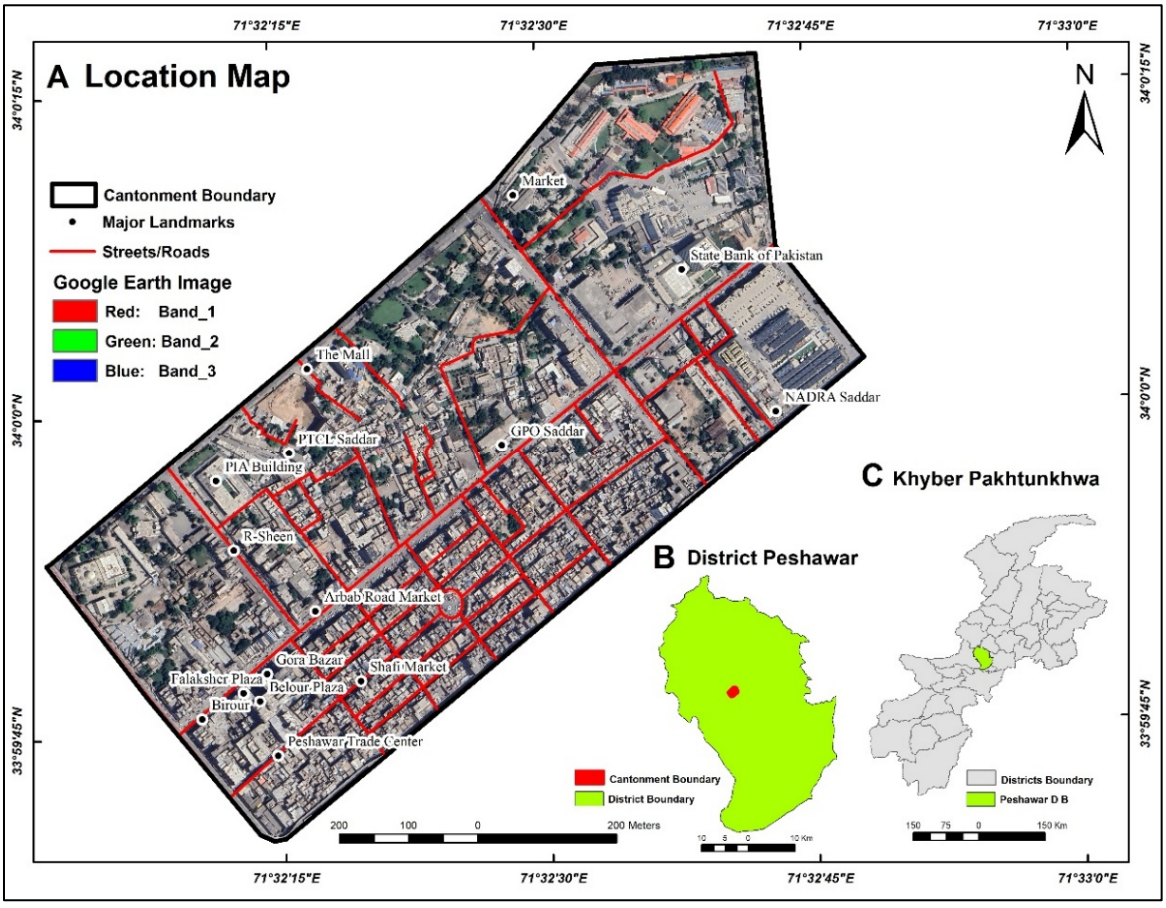

Figure 1. (**A**) Location map of the study area. (**B**) Peshawar district. (**C**) Khyber Pakhtunkhwa province.

3.2. Sample Selection and Coverage

The sampling strategy followed a census-based approach rather than random sampling. According to records obtained from the Cantonment Board Peshawar (CBP) and verified through field reconnaissance and satellite imagery, a total of twenty-three (23) commercial buildings within the defined CBD boundary met the study's inclusion criteria of G+3 or higher. Therefore, the study includes 100 per cent of eligible commercial high-rise buildings located within the CBD study boundary at the time of the survey (2023). No eligible buildings were excluded.

Buildings under active construction, residential-only high-rises, and structures located outside the officially delineated CBD boundary were excluded to maintain consistency with the research objective focused on operational commercial high-rise buildings.

Because the full utilisation of eligible buildings was assessed, the findings reflect the overall safety compliance status of commercial high-rise structures within Peshawar's CBD, rather than a sample-based estimate. All commercial buildings with ground with three stories (G+3) or more were selected for this study. The names and numbers of stories of the chosen buildings are given in Table 1.

Table 1. Commercial high-rise buildings in the study area.

S. No.	Commercial Building	No. of Stories	S. No.	Commercial Buildings	No. of Stories
1	Abbas Center	5	13	Jazz emporium	4
2	Azeem studio	4	14	Jolly Collection	4
3	Bilour Plaza	6	15	Masood Buildings	5
4	Blue Bell	4	16	Place Shop	4
5	Cants Mall	5	17	Qamar Minshan	3
6	Co-operative Bank	4	18	Rashid Plaza	4
7	Deans Trade Centre	6	19	Roshan Plaza	4
8	Feramedo	4	20	Saqib Plaza	4
9	Fit Right	4	21	Splash Plaza	6
10	Falak Sair Plaza	8	22	T.P.H Plaza	4
11	Galleria	3	23	Tasneem Plaza	8
12	Javid Plaza	5	--	--	--

Source: Field Survey, 2023.

3.3. Data Collection

The data used in this study were collected from both primary and secondary sources. Secondary data were obtained from government departments, satellite imagery from Google Earth, and various sources, including books, journals, and online sources. Primary data were collected through a field survey of all selected high-rise buildings. A total of 23 high-rise commercial buildings (Table 1) were studied and compared with the byelaws given in Table 2. The researcher personally visited each building and conducted physical observations using a structured checklist developed explicitly for this study. Descriptive-analytical methods were used to analyze field-collected data. The checklist was developed for these commercial buildings. It was investigated based on the commercial building codes (byelaws) of the cantonment Peshawar, and the provision of parking, elevator facilities, Emergency Exit, and fire extinguisher facilities was checked. The Cantonment Board Peshawar implemented the commercial building byelaws in 2016, pursuant to the powers conferred by Section 186 of the Cantonments Act, 1924 (II of 1924), and exercised by Section 282 of the same Act.

3.4. Safety Provisions for Commercial High-Rise Buildings in CBP Byelaws

This study assessed the safety provisions of commercial high-rise buildings within the study area, focusing on key structural and safety features as outlined in the CBP building byelaws. The evaluation considered the overall building structure and accessibility, including the total number of stories and retail units, to understand vertical expansion, accessibility, and business capacity. The basement characteristics of each building were also examined to determine the presence and functional use of basements, such as for parking or storage, which reflects how space is utilized within commercial premises. In addition, the study assessed safety and emergency features, including the number and condition of staircases, the availability of designated Emergency Exit, and the installation of Fire Extinguishers to evaluate preparedness for emergencies and evacuation efficiency. Finally, tenant-related amenities such as on-site parking and elevator access were reviewed to assess convenience, accessibility, and compliance with relevant safety standards. Table 2 presents the commercial building bye-law standards as outlined in the official CBP document, which served as the benchmark for comparing the existing high-rise buildings in Peshawar's Central Business District.

Table 2. Comparison of studied components with CBP byelaws.

S. No.	Study Items	Standard
1	No. of Storeys and Shops within the building	G+3 floor shall be considered a high-rise. Chapter III Space Requirements and Abutting of Buildings (Section 22-e)
2	Basement and Use of Basement	May be Used for Parking/other Purposes. Chapter IV Parking Requirements (Section 25)
3	No. of Staircases/standard	The riser of the staircase in the commercial building shall not be more than 6 inches, and the tread shall not be less than 10 inches. Chapter IX Lighting and Ventilation (Section 85)
4	Parking Facility	Enough car parking provision for all commercial buildings, residential-"cum"-commercial and high-rise buildings constructed on plots of above 399 square yards and having a frontage of more than 60 feet. Chapter IV Parking Requirements
5	Elevator facility	At least one lift for a building of G+3 is compulsory, and an additional lift shall be required for every additional two floors. Chapter III Space Requirements and Abutting of Buildings
6	Emergency Exit	Fire exit mechanisms for the evacuation of high-rise buildings in accordance with the International Building Code. Chapter X Fire Resistance and Fire Precautions (Section: 87. Fire exit—mechanism)
7	Fire Extinguisher	• Every commercial, multi-story building shall be equipped with a standpipe of 6 to 10 cm diameter. • Automatic sprinkler system • Interior fire alarm system. Chapter X Fire Resistance and Fire Precautions (Section: 88. Stand pipe-equipment's)

Source: CBP, 2016 [44].

3.5. Methodology for Ranking Safety Levels in GIS

This study uses a GIS-based analytical framework to assess and rank the safety levels of 23 commercial high-rise buildings in Peshawar's Central Business District (CBD). This methodology integrates primary survey data, secondary sources, and relevant byelaws from the Cantonment Board Peshawar (CBP) to evaluate public safety compliance and categorize buildings into "Good", "Moderate", and "Poor" safety levels. The following steps outline the methodology for developing and mapping these rankings using ArcMap 10.8.

3.5.1. Data and Parameter Selection

The spatial data was collected using the QGIS survey tool and satellite imagery, in accordance with the CBP's 2016 building byelaws. The parameters were selected for analysis based on their significance in determining public safety in high-rise commercial buildings, i.e., (i) Building structure (number of stories and shops), (ii) Basement availability and use, (iii) Number of staircases, (iv) Availability of Emergency Exit (v) Fire extinguisher installation (vi) Parking availability, (vii) Elevator facility.

3.5.2. Development of Standards-Based Scoring Criteria

All safety requirements were matched against the respective provisions in CBP's commercial building bylaws, and marking was conducted to assess compliance levels. 3 graded an excellent performance, indicating complete compliance with CBP standards, including having multiple Emergency Exit, adequate parking facilities, and properly held Fire Extinguishers. A score of 2 indicated fair compliance with safety measures in place but needing improvement, e.g., fewer than the required number of Emergency Exit. A score of 1 indicated poor compliance, with little or no compliance with safety regulations, e.g., the absence of Emergency Exit or substandard fire safety fittings. The detailed scoring analysis is shown in Table 3.

Table 3. The scoring criteria for each parameter.

Parameter	Good (Score 3)	Moderate (Score 2)	Poor (Score 1)
Stories/Shops	Meets G+3 standard or better	Slightly below G+3	Fails to meet G+3
Basement Use	Parking/compliant storage	Other purposes	Non-compliant storage
Staircases	Meets riser/tread standards	Partially compliant	Non-compliant
Parking Facility	Ample, meets all standards	Limited	None
Elevator Facility	Available	Non-Functional	Not available
Emergency Exit	Exist and Functional	Exist but locked	//
Fire Extinguishers	Full installation, sprinkler, etc.	Partial installation	//

3.5.3. Parameter Weighting for Multi-Criteria Analysis (MCA)

The relative importance of each safety parameter and the corresponding weights assigned using Multi-Criteria Decision Analysis (Table 4). Critical safety features, such as Emergency Exit and fire extinguisher installations, received higher weights due to their essential role in disaster response, while parameters like basement use and parking received lower weights based on their importance [23,24,40]. The weights reflect each feature's criticality, prioritizing those essential for life safety and accessibility.

Table 4. Assigned weights of building safety parameters.

Parameter	Weight	Justification
Emergency Exit	0.25	Critical for evacuations during emergencies; absence poses significant life-safety risks.
Fire Extinguisher Installation	0.20	Essential for controlling small fires, preventing them from escalating and causing harm.
Number of Staircases	0.15	The key to safe evacuation, especially in buildings with multiple stories, is more staircases to increase safety.
Elevator Facility	0.15	Important for accessibility, especially in taller buildings; it helps with daily use and emergencies.
Parking Facility	0.10	Improves convenience and accessibility for tenants and customers but is not as critical for safety.
Building Structure (Stories & Shops)	0.10	Indicates occupancy capacity; affects evacuation needs but is not directly a safety measure.
Basement Availability and Use	0.05	Relevant for space utilization, but has a lower direct impact on public safety.

3.5.4. AHP Implementation Procedure

To enhance methodological rigor, the Analytic Hierarchy Process (AHP) was applied following the standard procedure proposed by Saaty (2008) [45]. A structured pairwise comparison matrix was developed for the seven safety parameters. Each expert independently compared parameters using the 1–9 Saaty scale, where 1 indicates equal importance, and 9 indicates extreme importance of one parameter over another.

Five experts were purposively selected based on professional experience and domain relevance. The panel includes two urban planners with more than five years of experience in development control and building regulation, one structural engineer registered with the Pakistan Engineering Council, one certified fire safety specialist with field inspection experience and one GIS analyst experienced in spatial multi-criteria modelling. All experts had direct familiarity with building compliance standards in Pakistan.

For each expert's pairwise comparison matrix, the Consistency Index (*CI*) and Consistency Ratio (*CR*) were calculated using the following formulas:

$$CI = (\lambda\max - n)/(n - 1)$$

$$CR = CI/RI$$

where λmax denotes the largest eigenvalue of the matrix, n is the number of parameters (n = 7), and *RI* is the Random Index based on the matrix size.

A *CR* value below 0.10 was considered acceptable, as recommended in the literature of AHP. All individual matrices achieved *CR* values below 0.10, confirming logical consistency in judgments. The final weights were derived from the normalized average of the experts' priority vectors.

3.5.5. Calculation of Cumulative Safety Score

For each building, a cumulative safety score was calculated by summing the weighted scores of all parameters: Cumulative Safety Score = ∑ (Parameter Score × Weight).

Thresholds for safety classification were established using the following calculations:

Lower Threshold (Poor to Moderate):

$$1.1 + \frac{2.05}{3} = 1.8$$

Upper Threshold (Moderate to Good):

$$1.1 + 2 \times \frac{2.05}{3} = 2.5$$

The safety level for each building was determined by:

$$= IF(A2 > 2.5, "Good", IF(A2 > 1.8, "Moderate", "Poor"))$$

This cumulative score reflects the overall safety compliance level of each building.

3.5.6. Classification of Safety Levels

Structures were graded into three levels of safety based on their overall scores. Structures with scores of 2.5 or higher were graded as having high or good safety, indicating complete compliance with CBP regulations. Scores between 1.8 and 2.5 were graded as moderate, implying partial compliance with most safety provisions. Structures with grades below 1.8 were classified as poor, implying low safety features and high risks to human life and the environment.

- Rationale for Threshold Selection

The cumulative safety score theoretically ranges from 1 (complete non-compliance) to 3 (full compliance). To classify buildings into three safety categories, the total score range (2 units) was divided into three intervals. While equal-interval classification would produce approximate breakpoints at 1.67 and 2.33, slight adjustments (1.8 and 2.5) were made to ensure clearer differentiation between marginal compliance and substantial compliance levels.

A threshold of 1.8 was selected to ensure that buildings categorised as "moderate" demonstrate compliance in at least half of the weighted critical safety parameters. Similarly, the 2.5 threshold ensures that buildings categorised as "good" achieve strong compliance across nearly all high-weight safety parameters, particularly Emergency Exit and fire safety provisions. This approach avoids classifying marginally compliant buildings as "good".

3.5.7. Sensitivity Analysis of Safety Classification Thresholds

In order to examine the robustness of safety classification, a sensitivity test was conducted by applying alternative threshold values using equal interval classification (1.67 and 2.33). The classification results were compared with the original thresholds (1.8 and 2.5). Under equal interval thresholds, two buildings shifted between "moderate" and "poor" categories, while the number of buildings classified as "good" remained unchanged. The overall pattern of dominant poor safety compliance within the CBD persisted.

This indicates that the general conclusion of widespread safety deficiencies is stable and not highly sensitive to minor variations in threshold selection. Therefore, the adopted classification scheme provides a reliable representation of safety conditions.

3.5.8. GIS Mapping and Visualization

The safety levels were mapped in GIS software, with each building assigned a colour-coded category based on its grade. High-compliance, safe-condition buildings were tagged green and graded "good" for safety. Acceptable but needing improvement were tagged brown and graded "moderate" for safety. Structures with high hazards and urgent need for intervention were marked in red, denoting an area of "poor" safety. The exercise employed in this study is depicted in Figure 2 below.

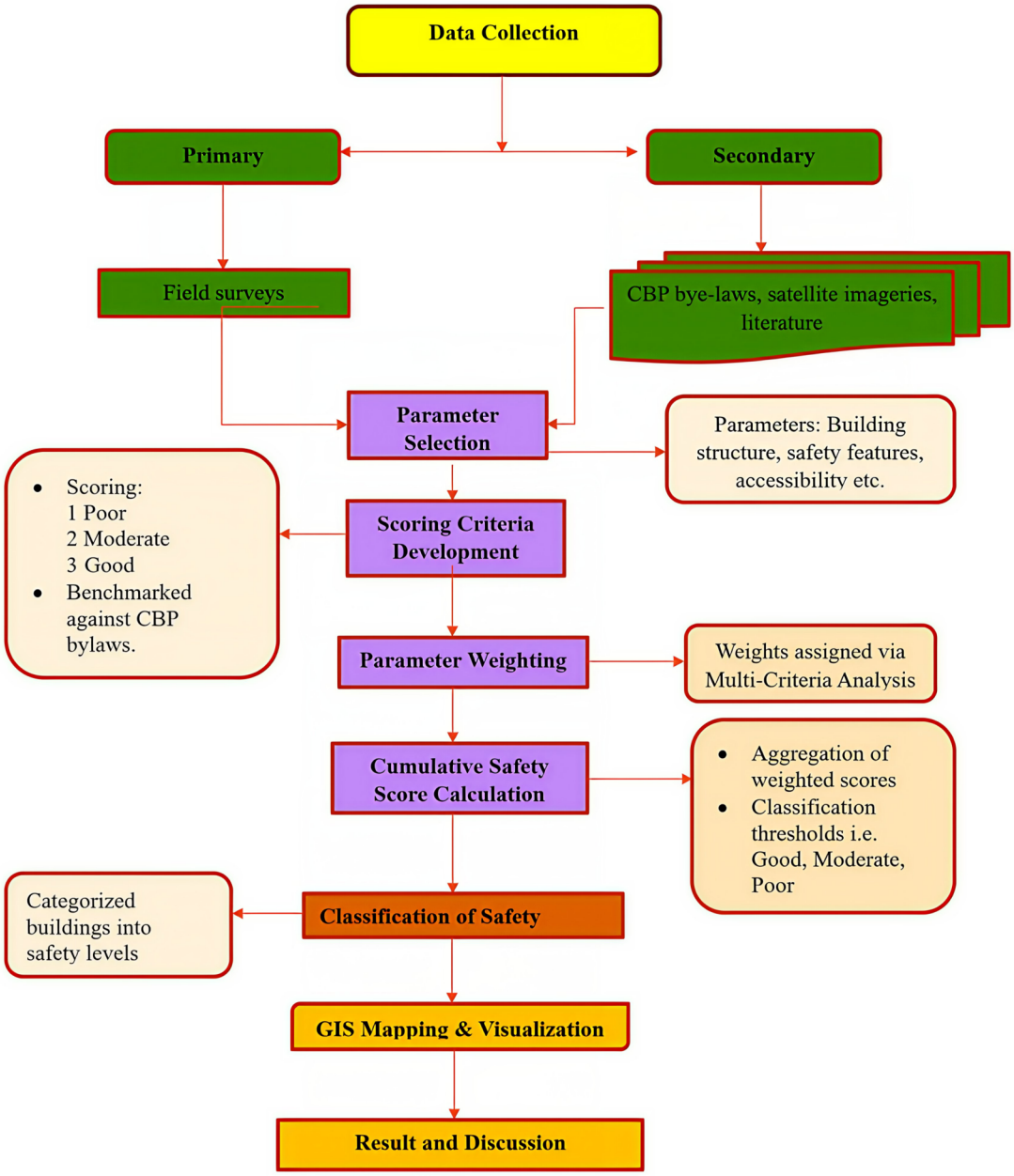

Figure 2. Integrated analytical framework combining field survey, AHP weighting, and spatial multi-criteria analysis.

4. Results and Discussion

The study captures a trend of systemic non-adherence to the Cantonment Board Peshawar (CBP) byelaws. Twenty-three buildings were inspected, among which more than two-thirds scored below 1.8, suggesting serious gaps in emergency preparedness and fire protection. Spatial analysis in GIS also confirms that hazardous buildings are clumped along Saddar Road and its surrounding commercial alleys, suggesting that areas with older buildings have been less regulated. This section covers each parameter in the local context and its corresponding best practices.

4.1. Building Structure and Accessibility

The structural characteristics and accessibility of commercial high-rise buildings in the study area were evaluated using two primary parameters: the number of stories and the number of shops per building. The height of buildings, measured in stories, is an important indicator of vertical expansion and functional capacity. The analysis shows a notable variation in building heights across the Central Business District. Several buildings, including Galleria, Qamar Minshan, Co-operative Bank, and Place Shop, are three stories tall, representing the lower end of high-rise development in the area. A relatively larger proportion of buildings, such as Blue Bell, T.P.H Plaza, Saqib Plaza, Feramedo, Javid Plaza, Roshan Plaza, Rashid Plaza, Jazz Emporium, Jolly Collection, and Azeem Studio, are four stories tall, forming the dominant height category in the CBD.

Buildings such as Masood Buildings, Abbas Centre, Bilour Plaza, Falak Sair Plaza, and Fit Right rise to five stories, reflecting medium-scale vertical expansion. A smaller group of structures, including Splash Plaza, Bilour Plaza, and Dean's Trade Centre, has six stories. In comparison, Tasneem Plaza and T.P.H Plaza exceed seven stories, representing the tallest commercial developments in the study area. The spatial distribution of buildings by height is illustrated in Figure 3, which highlights the concentration of taller structures along major commercial corridors within the CBD. This variation in vertical development indicates differing levels of compliance with planning controls and structural provisions specified in the CBP building bye-laws.

Figure 3. Number of stories of buildings in the CBD, Peshawar.

4.1.1. Number of Shops

To understand the scale and intensity of commercial activity, buildings were also categorized by the number of shops they contained. This parameter provides insight into the economic concentration and functional diversity of high-rise commercial spaces within Peshawar's Central Business District. The analysis shows that a few smaller buildings, such as Blue Bell, Rashid Plaza, Azeem Studio, and Place Shop, contain between two and four shops, reflecting limited commercial operations. Medium-sized structures, including Javid Plaza, Splash Plaza, and Galleria, accommodate between five and ten shops, indicating moderate commercial density.

Larger developments, such as Roshan Plaza, Qamar Minshan, Bilour Plaza, and Falak Sair Plaza, host between 20 and 100 shops, highlighting their role as mid-tier commercial hubs within the CBD. The most extensive concentration of retail units is found in Cants Mall, with approximately 140 shops; Bilour Plaza with 96 shops; and Deans Trade Centre, which contains around 3700 shops—making it the largest commercial complex in the study area. The spatial distribution of these buildings, shown in Figure 4, clearly shows a clustering of high-density retail structures along major commercial corridors, indicating the economic centrality of this urban core.

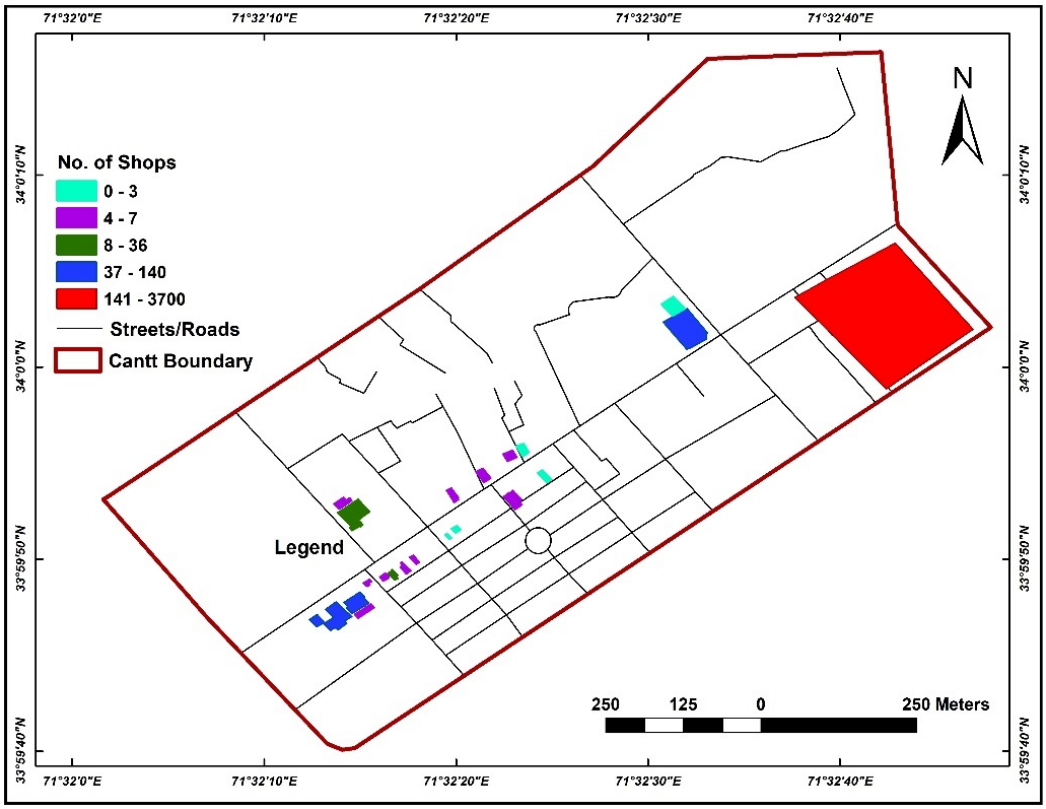

Figure 4. Number of shops within buildings in CBD, Peshawar.

4.1.2. Presence of Basement and Use

Out of twenty-three (23) commercial buildings, only four (4) had basement parking facilities, while the remaining buildings lacked such facilities. Additionally, eight (8) commercial buildings served various purposes, including retail shops, offices, and apartments. Notably, Azeem Studio, Jolly Collection, and Rashid Plaza did not have basements. Detailed information on the basement uses of each building is provided in Table 5. below. Figure 5 shows the spatial distribution of buildings with or without basements.

Table 5. Basement utilization in Central Business District (CBD) high-rise commercial buildings in Peshawar.

S. No.	High-Rise Building	Use of Basement
1	Masood Buildings	Warehouse
2	Saqib Plaza	
3	Cants Mall	Parking
4	Deans Trade Centre	
5	Falaksair Plaza	
6	Tasneem Plaza	
7	Abbas Center	Shops
8	Blue Bell	
9	Co-operative bank	
10	Feramedo	
11	Fit Right	
12	Galleria	
13	Javid Plaza	
14	Jazz Emporium	
15	Place Shop	
16	Splash Plaza	
17	T.P.H Plaza	
18	Bilour Plaza	
19	Qamar Minshan	
20	Roshan Plaza	
21	Azeem Studio	No Basement
22	Jolly Collection	
23	Rashid Plaza	

Source: Field Survey, 2023.

Figure 5. Basement availability in buildings of CBD, Peshawar.

4.2. Safety and Emergency Features

This section analyzes the safety and emergency provisions of the surveyed high-rise commercial buildings, with particular attention to the number of staircases, the availability of Emergency Exit, and the installation of fire extinguishing equipment. The number of staircases varied significantly across the buildings, ranging from one to five. A majority of sixteen buildings, including Blue Bell, T.P.H Plaza, Saqib Plaza, Feramedo, Javid Plaza, Galleria, Roshan Plaza, Rashid Plaza, Qamar Minshan, Co-operative Bank, Jazz Emporium, Jolly Collection, Azeem Studio, Place Shop, Splash Plaza, and Fit Right, had only a single staircase. Four buildings, namely Cants Mall, Tasneem Plaza, Bilour Plaza, and Abbas Centre, were equipped with two staircases, while only one building, the Deans Trade Centre, contained five staircases, representing the highest level of compliance in this category. The predominance of single-staircase buildings highlights a serious safety concern, as multiple staircases are essential for ensuring safe evacuation during emergencies. The analysis of emergency exit availability revealed an even more critical deficiency. Only seven commercial buildings had a dedicated Emergency Exit, whereas sixteen lacked such a provision. The absence of secondary escape routes significantly increases the risk to occupants during fire outbreaks or structural emergencies. These findings indicate widespread disregard for basic safety codes and underscore the urgent need to improve enforcement of building regulations. Table 6 presents the distribution of buildings with and without Emergency Exit. At the same time, Figure 6 illustrates their spatial pattern across the study area, clearly showing the concentration of non-compliant buildings in the CBD core.

Table 6. Emergency exit in high rise buildings.

Emergency Exit Status	Number of Buildings	Percentage	Building Names
Emergency Exit Provided	7	30.4%	Abbas Centre, Cants Mall, Co-operative Bank, Deans Trade Centre, Galleria, Jolly Collection, Saqib Plaza
No Emergency Exit	16	69.6%	Azeem Studio, Bilour Plaza, Blue Bell, Feramedo, Fit Right, Falaksair Plaza, Javid Plaza, Jazz Emporium, Masood Buildings, Place Shop, Qamar Minishan, Rashid Plaza, Roshan Plaza, Splash Plaza, T.P.H Plaza, Tasneem Plaza

Fire Extinguisher Installation

According to Section 87 of the CBP byelaws, high-rise buildings should be equipped with fire exits and comply with international building codes, especially given their high occupancy. Furthermore, Fire Extinguishers

of various types should be strategically placed for enhanced safety. However, findings show that only five (5) buildings are equipped with Fire Extinguishers. In contrast, the remaining buildings lack these essential fire safety mechanisms, constituting a serious violation of CBP byelaws and significantly increasing risk for occupants. The buildings equipped with Fire Extinguishers include Abbas Centre, Cants Mall, Deans Trade Centre, Galleria, and Tasneem Plaza. Seventeen (17) buildings lack Fire Extinguishers, including Azeem Studio, Bilour Plaza, Blue Bell, Co-operative Bank, Feramedo, Fit Right, Falaksair Plaza, Javid Plaza, Jazz Emporium, Jolly Collection, Masood Buildings, Place Shop, Qamar Minshan, Rashid Plaza, Roshan Plaza, Saqib Plaza, Splash Plaza, and T.P.H. Plaza. Figure 7 shows the spatial distribution of buildings with or without Fire Extinguishers installed.

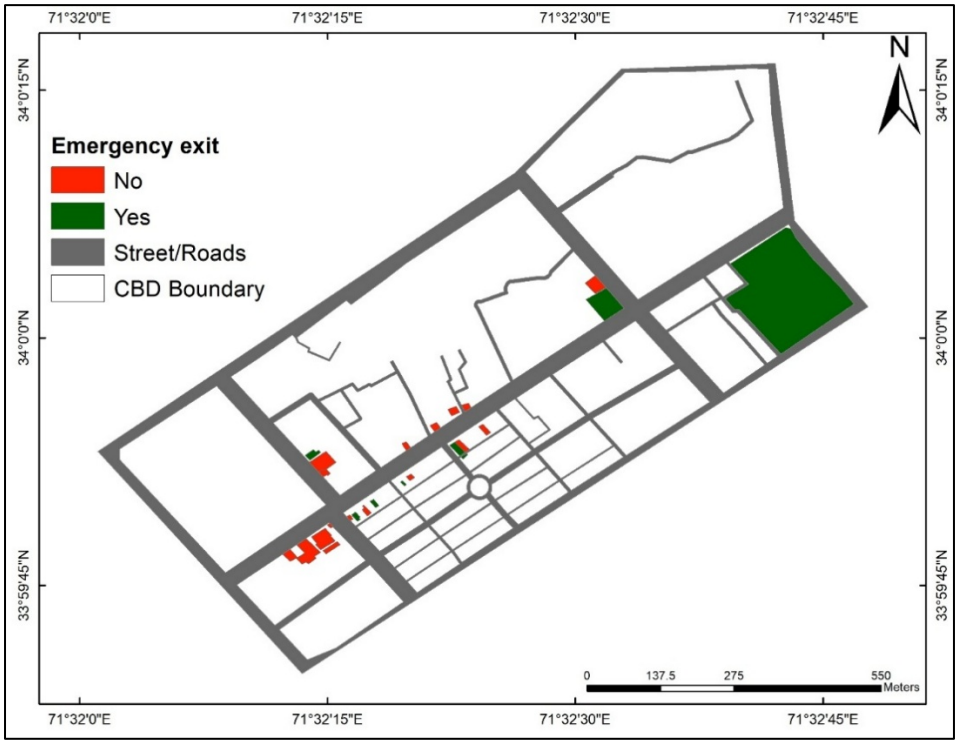

Figure 6. Availability of emergency exit in CBD, Peshawar.

Figure 7. Provision of fire extinguisher within buildings in CBD, Peshawar.

4.3. Amenities and Tenant Considerations

This section discusses the availability of essential amenities, specifically parking facilities for tenants and visitors in high-rise commercial buildings.

4.3.1. Parking Availability

Parking facilities are crucial for tenants' and visitors' convenience in commercial buildings. The analysis reveals that parking is available only in a limited number of buildings, leaving many high-rise buildings without dedicated parking. Eight (8) buildings are equipped with parking facilities, including Cants Mall, Tasneem Plaza, Falak Sair Plaza, Abbas Centre, Bilour Plaza, and Deans Trade Centre. Fifteen (15) buildings lack parking facilities. These buildings include Blue Bell, T.P.H Plaza, Saqib Plaza, Feramedo, Javid Plaza, Roshan Plaza, Rashid Plaza, Qamar Minshan, Co-operative Bank, Jazz Emporium, Jolly Collection, Azeem Studio, Galleria, Place Shop, and Splash Plaza. Figure 8 shows the spatial distribution of buildings with on-site parking.

Figure 8. Parking availability in the buildings of the CBD of Peshawar.

4.3.2. Elevator Facility

The analysis highlights a concerning issue in these buildings. Of the total buildings considered, only 4 provide parking facilities, while the rest lack this provision. This presents significant challenges for customers, especially during peak hours, as they struggle to find parking spaces for their vehicles. The situation is particularly difficult for those who drive to these shopping buildings, as they must invest considerable time and effort searching for suitable parking spots before they can commence shopping. According to the Cantonment Board Peshawar (CBP) By-laws, it is mandatory for a building with (G+3) floors to have at least one elevator, with an additional elevator required for every additional two floors. However, the study discovered that sixteen (16) commercial buildings had more than three (3) stories and no elevator facilities, indicating non-compliance with CBP By-laws standards. Among these, two (2) commercial buildings had one (1) elevator, four (4) had two (2) elevators, and one (1) had five (5) elevators installed. The detailed analysis is shown in Table 7.

Table 7. Commercial high-rise with elevator facility.

No. of Elevators	No. of Buildings	Percentage
0	16	70
1	2	9
2	4	17
5	1	4
Total	**23**	**100**

Source: Field Survey, 2023.

The elevators are an essential amenity in high-rise buildings, particularly for ease of access and tenant convenience. The analysis below details the distribution of elevator installations across the commercial buildings studied. Sixteen (16) buildings lack elevator facilities, limiting accessibility for tenants and visitors. These buildings include Azeem Studio, Blue Bell, Co-operative Bank, Feramedo, Fit Right, Galleria, Javid Plaza, Jazz Emporium, Jolly Collection, Masood Buildings, Place Shop, Qamar Minshan, Rashid Plaza, Roshan Plaza, Splash Plaza, and T.P.H. Plaza. Two (2) buildings, Abbas Center and Saqib Plaza, have one elevator installed, providing limited vertical access for occupants. Four (4) buildings, including Bilour Plaza, Cants Mall, Falaksair Plaza, and Tasneem Plaza, are equipped with two elevators each, enhancing accessibility for higher floors. Deans Trade Centre stands out with five (5) elevators, offering substantial vertical access capacity to support the building's higher occupancy.

4.4. Safety Level of High-Rise Buildings

The safety level was measured based on the scores of each building and the weight parameters. The score for each building was categorized as 3 for full provision, 2 for partial provision, and 1 for no provision for each safety parameter. These scores were then multiplied by the assigned weights for each parameter to obtain the cumulative score for each building. The safety level was then determined based on three categories, i.e., Good, Moderate, and Poor. The detailed analysis is shown in Table 8.

Table 8. The detailed analysis of commercial buildings in CBD, Peshawar.

S. No.	Name	No. of Stories	Elevator Facility	Emergency Exit	Fire Extinguishers	Own Parking	Basement	Use of Basement	No. of Staircase	Cumulative Safety Score	Safety Level
1	Abbas Plaza	3	2	3	3	1	2	1	1	2.35	Moderate
2	Azeem	2	1	1	1	1	1	1	1	1.15	Poor
3	Bilour Plaza	3	3	1	1	1	2	1	2	1.75	Poor
4	Bluebell	2	1	1	1	1	2	1	1	1.2	Poor
5	Cantt Mall	3	3	3	3	3	3	3	2	3	Good
6	Co operative	2	1	3	1	1	2	1	1	1.7	Poor
7	Deans Trade Centre	3	3	3	3	3	3	3	3	3.15	Good
10	Falak Sair	3	3	1	1	3	3	3	1	1.95	Moderate
8	Feramedo	2	1	1	1	1	2	1	1	1.2	Poor
9	Fit Right	2	1	1	1	1	2	1	1	1.2	Poor
11	Galleria	1	1	3	3	1	2	1	1	2	Moderate
12	Javed Plaza	3	1	1	1	1	2	1	1	1.3	Poor
13	Jazz Emporium	2	1	1	1	1	2	1	1	1.2	Poor
14	Jolly	2	1	3	1	1	1	1	1	1.65	Poor
15	Masood Building	3	1	1	1	1	2	1	1	1.3	Poor
16	Place shop	2	1	1	1	1	2	1	1	1.2	Poor
17	Qamar Minshan	1	1	1	1	1	2	1	1	1.1	Poor
18	Rashid Plaza	2	1	1	1	1	2	1	1	1.2	Poor
19	Roshan	2	1	1	1	1	2	1	1	1.2	Poor
20	Saqib Plaza	2	2	3	1	1	2	1	1	1.85	Moderate
21	Splash	3	1	1	1	1	2	1	1	1.3	Poor
22	Tasneem Plaza	3	2	1	3	3	3	3	1	2.2	Moderate
23	TPH	2	1	1	1	1	2	1	1	1.2	Poor

Source: Field Survey, 2023.

Table 8 indicates that the Deans Trade Centre and Cantt Mall have a cumulative score of 3 or above, which categorizes these two commercial buildings as having a good level of safety and byelaws that meet the safety parameters described in the cantonment byelaws. Similarly, a cumulative score of 1.8 to 2.9 is a commercial moderate public safety level for a commercial building. Based on this, five (5) buildings are declared to have

moderate safety standards. The rest of the sixteen (16) buildings have the lower cumulative score, where the value of each building is below 1.8 and declared as a poor public safety standard. The spatial join tool of the GIS was utilized to join Table 8 with the spatial database of the commercial high-rise buildings to depict the three categories, i.e., good, moderate, and poor, on the map. Figure 9 illustrates the overall public safety level, and Figure 10 shows the spatial distribution of buildings that have public safety standard provisions.

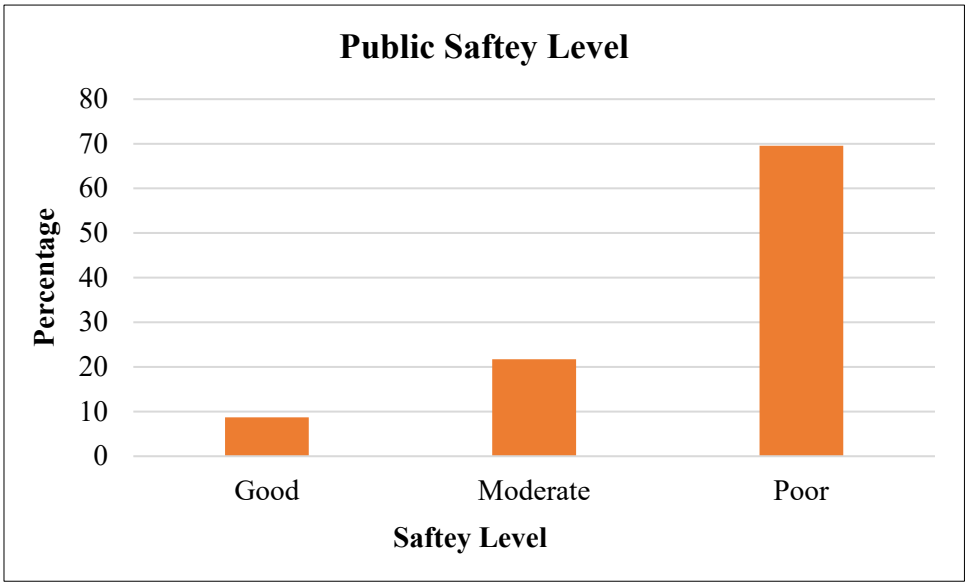

Figure 9. Public safety level in high-rise buildings in CBD, Peshawar.

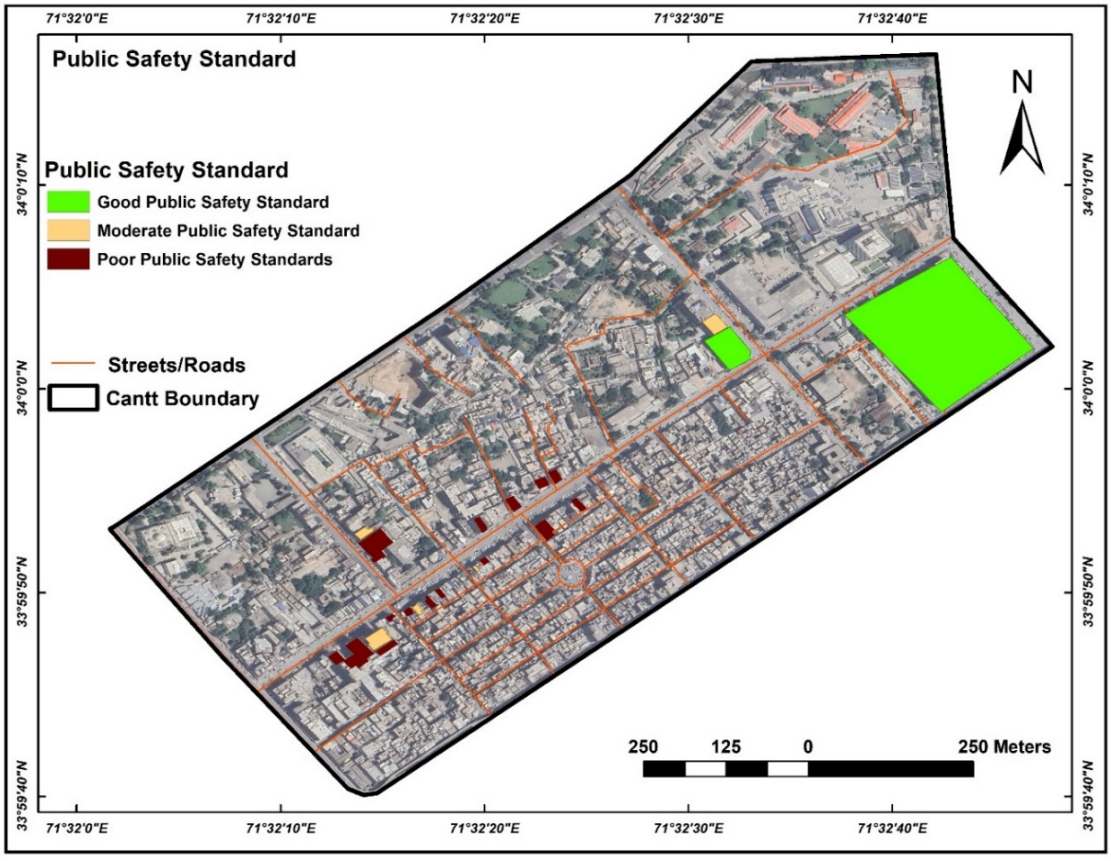

Figure 10. Overall public safety standard of buildings in CBD, Peshawar.

Compared with studies from other South Asian cities, the findings reveal similar institutional weaknesses. For example, Khan et al. [29] reported only 25 percent compliance with fire-safety provisions in Karachi's high-rises, while [36] found 30 percent in Dhaka. Peshawar's compliance rate of less than 10 percent for fully equipped

buildings is therefore among the lowest in the region. Lack of compulsory inspection regimes, non-existence of digital building registries, and inadequate planning authority-emergency service coordination seem to be the primary reasons. Addressing these governance deficits is no less important than technical retrofitting for improving public safety outcomes. The study found extensive violations of public safety codes in Peshawar CBD high-rises, resulting from poor enforcement of building ordinances. These are the result of poor planning and manifest in many forms. Unplanned commercial high-rises disrupt the visual balance of the city skyline and further strain existing utility services, such as water, gas, and power. Traffic and parking deficiencies are even more severe, causing greater woes for locals and visitors alike. The smaller structures in the area are affected by insufficient light and air, and fire safety risks still dominate most business complexes. Additionally, adequate lifts limit everyday mobility within the buildings, and the lack of parking space contributes to overall strain on the urban environment. All of these demonstrate the need for stronger enforcement of building codes and better city planning in the region.

5. Discussion

The findings reveal a structural governance gap rather than isolated technical deficiencies. While rapid vertical growth has transformed the CBD of Peshawar, regulatory oversight has not evolved at the same pace. The predominance of poor safety classifications indicates that compliance failures are systemic and institutional rather than incidental. The rapid commercialisation of Peshawar CBD has incentivised the proliferation of multi-level buildings, but enforcement of construction bylaws has lagged. As documented by [29], the lack of effective enforcement mechanisms and institutional overlapping responsibilities is a typical challenge for Pakistan's urban management. The experience documented in this study corroborates the notion that fear is systemic, not singular. This is what [3] referred to as the "urban intensification paradox", wherein economic densification exceeds institutional ability to manage it.

In the field surveys, it was determined that only four commercial high-rise buildings have provided dedicated parking. The lack of off-street parking generates significant congestion, obstructs emergency vehicle access, and heightens pedestrian risks (Figure 11). Similar patterns have been observed in other South Asian cities, where dense commercial districts prioritise rentable floor space over service facilities [36]. The absence of structured parking also signals weak coordination between urban transport planning and building control agencies. Addressing this issue requires integrated land-use and mobility planning rather than isolated enforcement actions.

Figure 11. Illegal roadside parking was observed along the main Saddar road, Central Business District (CBD), Peshawar. Photograph taken during field survey in July 2023 (Source: Authors' field survey).

The CBP by-laws require at least one elevator in buildings with three or more stories, with additional lifts for every two extra floors. Yet sixteen buildings (approximately 70 percent) lacked operational elevators. The absence of lifts severely limits accessibility for elderly and disabled users, contradicting both local standards and the UN Convention on the Rights of Persons with Disabilities. Even in buildings with elevators, they are often locked for private use by shop owners, reflecting poor regulatory oversight. These findings align with [8], who emphasize

that accessibility is central to the social sustainability of vertical development. Fire safety represents the most critical weakness. Only seven buildings had functional Emergency Exit, while most relied on a single staircase that often served both as entry and escape route. Locked or obstructed exits were common, echoing findings by [26] in China and [36] in Bangladesh, where similar patterns of neglect contributed to severe fire incidents. Such deficiencies indicate that compliance monitoring occurs primarily at the construction approval stage rather than during occupancy. Routine post-construction inspections are essential to ensure continued adherence to safety codes. Only five buildings (21.7 percent) had Fire Extinguishers or sprinklers installed. This gap not only violates CBP regulations but also exposes occupants to life-threatening risks. Fire incidents in Pakistani cities frequently result in heavy casualties due to inadequate suppression systems [29]. The absence of simple safety measures such as extinguishers or alarms highlights a culture of reactive rather than preventive management. Introducing annual safety certification could ensure that such critical equipment remains functional. Field observations showed that many commercial buildings originally designed as single-story shops have been vertically extended into three or four stories without formal approval. These extensions ignore load-bearing capacities and violate open space (COS) and floor area ratio (FAR) standards. Unregulated vertical conversions mirror the "informal densification" trend reported in Karachi and Dhaka, where commercial demand drives unsafe alterations to existing buildings [46]. Such unauthorised modifications increase structural vulnerability, compromise ventilation and lighting, and strain utilities. The absence of provisions for persons with disabilities is another major concern. None of the surveyed buildings had ramped access or holding bars as required under national accessibility standards. This omission reflects the broader neglect of universal design in Pakistani urban development, where economic priorities overshadow inclusivity. Making high-rises accessible is not only a legal obligation but also a moral and developmental imperative consistent with Sustainable Development Goal 11, which calls for "inclusive, safe, resilient, and sustainable cities". Similarly, compared with other South Asian cities, Peshawar's compliance rate is among the lowest. Karachi reports roughly 25 per cent compliance [29], while Dhaka's rate stands near 30 per cent [36]. Peshawar's figure, under 10 per cent for fully equipped buildings, shows that smaller urban centres face more acute enforcement challenges due to weaker institutions and resource constraints. This situation calls for targeted interventions that balance economic growth with public safety. Urban resilience frameworks emphasise that safety in high-rise settings is not just a regulatory issue but a component of disaster risk reduction [40]. By failing to implement bylaws, cities inadvertently increase exposure to hazards. Strengthening inspection systems, mandating retrofits, and linking compliance to occupancy permits can mitigate these risks.

The study contributes theoretically to debates on urban governance in rapidly verticalizing cities by demonstrating that vertical densification without regulatory capacity produces what may be termed "compliance asymmetry." Economic growth and built-form transformation advance faster than institutional enforcement mechanisms. The development of GIS-based safety index offers a replicable decision-support tool that operationalises regulatory compliance into measurable spatial risk categories.

This demonstrates that vertical development without adequate regulation compromises both safety and livability. Ensuring compliance with building codes should therefore be integrated into sustainable urban development strategies. Safety provisions such as fire systems, Emergency Exit, and accessible design must be treated as essential urban infrastructure rather than optional features. Policymakers should view these measures as investments that protect human capital and sustain economic productivity in high-density urban cores.

6. Future Research and Policy Implications

6.1. Study Limitations

This study is geographically limited to the Central Business District (CBD) of Peshawar and therefore does not represent safety conditions in other urban centres. The analysis focuses exclusively on operational commercial buildings of G+3 and above, excluding residential and mixed-use high-rise structures. The safety index is based on observable compliance indicators rather than structural engineering audits or fire simulation modelling. Although AHP consistency testing was performed, weight assignment involves expert judgment and may contain subjective elements. Lastly, the assessment reflects conditions during the 2023 survey period and does not account for temporal variations.

6.2. Future Research Direction

Future studies should expand the GIS-based safety index to residential high-rise structures and conduct comparative analyses across multiple Pakistani cities. Longitudinal assessments would help evaluate whether regulatory reforms improve compliance over time. Integration with structural engineering inspections and fire risk simulation models could enhance the robustness of the framework. In addition, incorporating remote sensing or

LiDAR-based building characterisation will improve spatial accuracy. From a research perspective, future studies could expand this framework in three important ways. First, the GIS-based multi-criteria model can be refined into a High-Rise Safety Index (HRSI) that quantifies risk on a citywide or national scale. Such an index could incorporate additional parameters such as building age, occupancy load, maintenance history, and proximity to emergency services. Second, incorporating temporal data through satellite imagery and change detection would allow researchers to monitor the evolution of compliance levels over time, identifying emerging hotspots of unsafe construction. Third, future work should include comparative case studies across multiple Pakistani cities, such as Karachi, Lahore, and Islamabad, to understand how differences in enforcement capacity, land value, and governance structures shape compliance behavior.

6.3. Policy Implications

From a policy standpoint, the results call for a digital transformation of building safety management. The development of a GIS-linked inspection database by local authorities would enable real-time monitoring of compliance with bylaws. Building control authorities should also adopt a mandatory periodic certification system that requires commercial high-rises to renew their safety every three to five years. Such certifications should include structural integrity assessments, fire system testing, and accessibility audits. Additionally, introducing publicly accessible safety ratings, similar to restaurant hygiene scores, would create transparency and encourage voluntary compliance among building owners. Capacity-building programs for inspectors, architects, and developers are equally essential to ensure that by-laws are properly understood and implemented. Integrating these policy measures into broader urban resilience and disaster risk reduction frameworks would align Pakistan's urban governance with international standards, such as the Sendai Framework for Disaster Risk Reduction (2015–2030) and UN Sustainable Development Goal 11 (Sustainable Cities and Communities). Ultimately, this study demonstrates the potential for data-driven urban management tools to enhance safety and accountability in Pakistan's rapidly verticalizing cities. Future research that builds on this framework can help create safer, more resilient, and more inclusive urban environments across the country.

7. Conclusions

This study assessed public safety compliance in 23 commercial high-rise buildings in Peshawar's Central Business District (CBD). By integrating field-based data collection with GIS-based multi-criteria analysis, it quantified the degree of adherence to the Cantonment Board Peshawar (CBP) by-laws across key parameters, including fire safety, Emergency Exit, structural accessibility, elevator facilities, and parking provision. The results show that only two buildings (8.7 per cent) met good safety standards, five (21.7 per cent) achieved moderate compliance, and sixteen (69.6 per cent) were categorized as poor. These findings confirm a significant enforcement and monitoring gap in the implementation of safety codes within one of Peshawar's most densely built commercial zones. The analysis reveals that deficiencies are not limited to technical or structural shortcomings but stem from more profound institutional weaknesses, including inadequate inspections, lack of awareness among property owners, and limited coordination between building control authorities and emergency management departments. Fire safety violations and the absence of accessible escape routes represent the most critical risks, while poor elevator provision and insufficient parking highlight issues of accessibility and urban functionality. These findings underscore that urban safety is an integral part of sustainable development and cannot be ensured solely through bylaws. Effective enforcement mechanisms, regular monitoring, and transparent accountability systems are necessary to implement safety regulations. Enhancing inter-agency coordination, investing in digital compliance databases, and strengthening the technical capacity of inspection authorities will be essential steps toward safer vertical development.

Moreover, the study highlights that the current model of vertical growth in Pakistan is evolving faster than the institutional capacity to manage it. If left unchecked, this pattern could amplify risks to life, property, and economic stability in Central Business Districts. Therefore, enforcing building codes and retrofitting existing structures should be treated as part of a broader urban resilience agenda, consistent with global frameworks such as the Sendai Framework for Disaster Risk Reduction (2015–2030) and Sustainable Development Goal 11 on inclusive, safe, and resilient cities.

Overall, this research contributes a replicable spatial methodology for evaluating building safety compliance and provides an empirical foundation for policy reform in Pakistan's urban centers. The evidence from Peshawar demonstrates that improving public safety in high-rise environments requires not only technical compliance but also institutional accountability, community awareness, and a commitment to resilience-oriented urban governance.

Author Contributions

M.I.: conceptualization, methodology, investigation, data curation, formal analysis, visualization, writing—original draft preparation; M.J.K.: methodology, investigation, data curation, validation, visualization, writing—original draft preparation; W.A.M.: writing—review and editing; M.J.N.: writing—review and editing; A.U.: writing—review and editing. All authors have read and agreed to the published version of the manuscript.

Funding

This research received no external funding.

Institutional Review Board Statement

Not applicable.

Informed Consent Statement

Not applicable.

Data Availability Statement

The datasets generated and analyzed during the study are available from the corresponding author upon reasonable request.

Acknowledgments

The authors thank the institutions that supported this study, including the Cantonment Board Peshawar (CBP), the United States Geological Survey (USGS), the Tehsil Municipal Administration (TMA), and the City Government.

Conflicts of Interest

The authors declare no conflict of interest.

Use of AI and AI-Assisted Technologies

No AI tools were utilized for this paper.

References

1. Emtehani, M.R.; Nagendra, H.N.; Rafiee, N. Changing Scenario of CBD: A Case Study of Shiraz City in Iran. *Int. J. Environ. Sci.* **2012**, *1*, 173–177.
2. Murphy, R.E.; Vance, J.E., Jr. A comparative study of nine central business districts. *Econ. Geogr.* **1954**, *30*, 301–336.
3. Beavon, K.S.O. The role of transport in the rise and decline of the Johannesburg CBD, 1886–2001. In Proceedings of the 20th Annual South African Transport Conference, Pretoria, South Africa, 16–20 July 2001.
4. Reddy, K.N. *Urban Redevelopment: A Study of High-Rise Buildings*; Concept Publishing Company: New Delhi, India, 1996.
5. Hall, J.R. *High-Rise Building Fires*; The Association: Quincy, MA, USA, 2000.
6. Foroughi, R.; Mostavi, E.; Asadi, S. Determining the optimum geometrical design parameters of windows in commercial buildings: Comparison between humid subtropical and humid continental climate zones in the United States. *J. Archit. Eng.* **2018**, *24*, 04018026.
7. Smith, W.S. Mass transport for high-rise high-density living. *J. Transp. Eng.* **1984**, *110*, 521–535.
8. Al-Kodmany, K.; Ali, M.M. Skyscrapers and placemaking: Supporting local culture and identity. *Archnet-IJAR* **2012**, *6*, 43.
9. UN ESCAP. *The State of Asian and Pacific Cities 2015: Urban Transformations Shifting from Quantity to Quality*; United Nations: Bangkok, Thailand, 2015.
10. Pakistan Engineering Council. Pakistan Electric and Telecommunication Safety Code (PETSAC-2014). Available online: https://www.pec.org.pk/wp-content/uploads/2021/05/Pakistan-Electric-Telecommunication-Safety-Code-PETSAC-2014.pdf (accessed on 14 November 2025).
11. PEC. Building Code of Pakistan: Seismic Provisions—2007. Pakistan Engineering Council. Available online: http://www.ndma.gov.pk/storage/publications/July2024/c4N0IE4vVWQCa073QB1i.pdf (accessed on 20 November 2025).
12. Pakistan Engineering Council. Building Code of Pakistan: Energy Provisions. 2013. Available online: https://www.pec.org.pk/downloads-documents/building-code-of-pakistan/ (accessed on 28 October 2025).

13. Pakistan Engineering Council. Building Code of Pakistan: Fire Safety Provisions—2016. Available online: https://www.pec.org.pk/wp-content/uploads/2021/05/Building-Code-of-Pakistan-Fire-Safety-Provisions-2016.pdf (accessed on 30 October 2025).
14. National Energy Efficiency and Conservation Authority (NEECA). *Energy Conservation Building Code (ECBC-2023)*; NEECA: Islamabad, Pakistan, 2023.
15. WHO. WHO Mortality Database: Interactive Platform Visualizing Mortality Data. World Health Organization. Available online: https://platform.who.int/mortality/themes/theme-details/topics/indicator-groups/indicator-group-details/MDB/fires (accessed on 11 November 2025).
16. IHME. Global Burden of Disease Collaborative Network. Global Burden of Disease Study 2021. Institute for Health Metrics and Evaluation. Available online: https://ghdx.healthdata.org/gbd-2021 (accessed on 11 November 2025).
17. Fire Protection Association of Pakistan (FPAP). Violation of Building Codes, no Safety Kits: Over 12,000–15,000 Die in Fire Incidents Annually: Experts. Business Recorder, 2025. Available online: https://www.brecorder.com/news/40274722 (accessed on 13 November 2025).
18. Barry, F. 1 Dead as Fire at Karachi Building Brought under Control: Rescue 1122. Dawn, 2024. Available online: https://www.dawn.com/news/1858347 (accessed on 25 October 2025).
19. Nasir, G.; Asghar, W.; Anwar, S. Analyzing the Causes of Fire Accidents and Prevention Strategies in Pakistan: Exploring Mitigation Measures. *Sustain. Bus. Soc. Emerg. Econ.* **2025**, *7*, 145–158.
20. Chakor Ventures. Fire Protection Systems in Pakistan. 8 November 2022. Available online: https://chakorventures.com/fire-protection-systems-in-pakistan-have-improved/ (accessed on 26 October 2025).
21. Masood Rafi, M.; Wasiuddin, S.; Hameed Siddiqui, S. Assessment of fire hazard in Pakistan. *Disaster Prev. Manag.* **2012**, *21*, 71–84.
22. International Labour Organization (ILO). Pakistani Factory Fire Highlights Lack of Workplace Safety Measures, Says ILO. Available online: https://www.ilo.org/resource/news/pakistani-factory-fire-highlights-lack-workplace-safety-measures-says-ilo (accessed on 1 Novermber 2025).
23. Foroughi, R.; Asadi, S.; Khazaeli, S. On the optimization of energy efficient fenestration for small commercial buildings in the United States. *J. Clean. Prod.* **2021**, *283*, 124604.
24. Chen, X. *Enhancing Public Facility Planning with Sustainable Development Viewpoints: A Case Study in the City of Tracy, California*; Cornell University: Ithaca, NY, USA, 2023.
25. Alianto, B.; Nasruddin; Nugroho, Y.S. Numerical Study on the Effect of Single and Multi-injection Pressurized Fan in Enclosed Stairwell of High-Rise Building. In *Sustainable Architecture and Building Environment*; Springer: Berlin/Heidelberg, Germany, 2021; pp. 99–105.
26. Zhang, Y.; Yan, D.; Hu, S.; Guo, S. Modelling of energy consumption and carbon emission from the building construction sector in China, a process-based LCA approach. *Energy Policy* **2019**, *134*, 110949.
27. Al-Fahad, J.Y. Reform of Building Codes, Regulations, Administration and Enforcement in Kuwait: Within the Legal, Administrative, Technical and Social Framework. Ph.D. Thesis, Loughborough University, Loughborough, UK, 2012.
28. Anees, M.; Yan, W. An Overview about the Challenges of Urban Expansion on Environmental Health in Pakistan. *J. Energy Environ. Policy Options* **2019**, *2*, 64–71.
29. Khan, A.F.; Ahmad, I. A critical analysis of building codes of Pakistan; fire safety provision 2016. In *5th World Congress on Disaster Management: Volume I.*; Routledge: Abingdon, UK, 2022; pp. 138–144.
30. Pakistan Engineering Council. Building Code of Pakistan 2021 (BCP-2021). Available online: https://www.pec.org.pk/thinktank/building-code-of-pakistan-thinktank/ (accessed on 1 Novermber 2025).
31. Civil Aviation Authority. No Objection Certificate (NOC) for Height Clearance. CAA Notice, 2019. Available online: https://www.zameen.com/news/important-notice-for-developers-from-caa.html (accessed on 2 Novermber 2025).
32. Peshawar Development Authority. Building and Zoning Regulations 2020. 2020. Available online: https://rda.gop.pk/wp-content/uploads/2024/01/RDA_Building&Zoning_Regulations2020.pdf (accessed on 2 Novermber 2025).
33. The Express Tribune. Building By-Laws Raise Height Limit. 2020. Available online: https://tribune.com.pk/story/2256368/building-by-laws-raise-height-limit (accessed on 3 Novermber 2025).
34. Kobes, M.; Post, J.; Helsloot, I.; Vries, B.D. Fire risk of high-rise buildings based on human behavior in fires. In Proceedings of the Conference Proceedings FSHB 2008, Bucharest, Romania, 7–9 May 2008; pp. 7–9.
35. Nakagawa, T. Staircase Design of High-rise Buildings Preparing against Fire. In Proceedings of the TRIZCON2001: The 3rd Annual AI TRIZ Conference, Woodland Hills, CA, USA, 25–27 March 2001; pp. 25–27.
36. Rahman, M.M.; et al. Does building development in Dhaka comply with land use zoning? An analysis using nighttime light and digital building heights. *Sustain. Sci.* **2021**, *16*, 1323–1340.
37. Naz, N. Proliferation of the tallest building syndrome: From global to local. *Pak. J. Eng. Appl. Sci.* **2007**, *1*, 84–103.
38. Ali, A.; Malik, S.M.; Jan, M.A. Delimitation of the Central Business District Peshawar (Pakistan). *Glob. Soc. Sci. Rev.* **2018**, *3*, 193–213.

39. Yeboah, G. First Responders' Emergency Response Time Analysis: City of Saskatoon Case Study. Master's Thesis, University of Saskatchewan, Saskatoon, SK, Canada, 2017.
40. Schröter, K.; Schweizer, P.-J.; Gräler, B.; et al. Invited perspectives: Fostering interoperability of data, models, communication and governance for disaster resilience through transdisciplinary knowledge co-production. *Nat. Hazards Earth Syst. Sci. Discuss.* **2025**, *25*, 3055–3073.
41. Goswami, S.; Kolte, R.; Kumar, A.; Pipralia, S. Prioritizing fire risk factors in historic urban cores of India: An analytic hierarchy process approach. *Int. J. Disaster Resil. Built Environ.* **2025**, *16*, 474–493.
42. Mendizabal, S. Modeling urban fire risk using the AHP-GIS method and sensitivity analysis: A case study in the City of Santa Fe, Argentina. *Cybergeo: Eur. J. Geogr.* **2025**. https://doi.org/10.4000/14khq.
43. Aman, M.; Waheed, A.; Naeem, M.A.; Shah, S.A.A. Implementing the living streets concept by transforming streets in the central business district of Peshawar, Pakistan. *Urbani Izziv* **2019**, *30*, 75–86.
44. Cantonment Board Peshawar. Cantonment Board Peshawar (Building) Bye-Laws, 2016; 2016. Available online: http://peshawar.cantonment.gov.pk/en/laws/building-bye-laws (accessed on 5 Novermber 2025).
45. Saaty, T.L. Decision making with the analytic hierarchy process. *Int. J. Serv. Sci.* **2008**, *1*, 83–98.
46. Danish; Baloch, M.A. Dynamic linkages between road transport energy consumption, economic growth, and environmental quality: Evidence from Pakistan. *Environ. Sci. Pollut. Res.* **2018**, *25*, 7541–7552.