Evaluating Fire Risk Levels in Storage Facilities: A Semi-Quantitative Approach for the Sri Lankan Context

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Abstract

The rapid proliferation of storage and warehouse facilities in Sri Lanka has introduced escalating fire safety challenges due to increasing operational complexity and insufficient regulatory compliance. A series of severe fire incidents, both locally and internationally, has underscored the vulnerability of such facilities to catastrophic loss of life, property, and environmental damage. This study aims to evaluate the prevailing fire risk levels in Sri Lankan warehouses and develop an improved assessment framework to enhance regulatory and practical fire safety performance. A semi-quantitative, checklist-based fire risk assessment tool was developed and applied to ten warehouse facilities. The tool, validated through more than fifty prior case studies, integrates the Relative Importance Index (RII) with additional technical and managerial fire risk attributes not addressed in the CIDA fire regulations. Structured around twelve critical fire risk factors across five domains: means of escape, structural fire protection, detection systems, suppression systems, and fire safety management, the model introduces a systematic scoring framework to quantify compliance levels. The findings indicate critically low compliance, with adherence to key fire safety measures averaging below 25%. Active fire protection systems performed the poorest (18%), while passive systems exhibited a 40% deviation from required standards. Compliance with CIDA regulations averaged 30%, compared to 45% for British and international benchmarks. None of the facilities achieved a "low risk" classification; 30% were identified as high risk and 70% as moderate risk. The study highlights the urgent necessity for regulatory reform, strengthened enforcement, and targeted investment in comprehensive fire safety management within Sri Lanka's warehouse sector

Keywords: *Fire Risk Assessment, Warehouse Fire Safety, Semi-Quantitative Evaluation, Building Fire Regulations, Sri Lanka*

1. Introduction

Over the past two decades, the scale and complexity of building fire hazards have increased noticeably, with warehouse fires emerging as a critical global concern [1] [2]. Despite the existence of comprehensive fire regulations and codes of practice, catastrophic warehouse fires continue to occur, resulting in severe economic losses, operational disruptions, environmental degradation, and loss of life. The expansion of large-scale industrial and logistics developments has further intensified the risk, as modern warehouse facilities frequently extend over tens of thousands of square meters [3]. Global fire statistics indicate that incidents in such logistics centers have quadrupled over the past decade [4] [5]. The persistence of major fire events despite the presence of regulations underscores ongoing weaknesses in both global and national fire protection practices.

Several catastrophic incidents illustrate the magnitude of this problem. The 2015 Tianjin port warehouse explosion in China resulted in 173 fatalities and extensive material losses, emphasizing the urgency of effective fire protection in large storage facilities. Similarly, in 2022, a container warehouse fire near a southeastern Bangladeshi port caused at least 49 deaths, including nine firefighters, and injured over 100 people [6]. Other notable cases include the Jingdong warehouse fire in China (2016), Amazon's BHX1 logistics facility fire in the United Kingdom (2017), the Japanese transport logistics warehouse fire (2018), and the Amazon logistics center fire in the United States (2020). Between 2003 and 2006, U.S. fire departments responded to an average of 1,350 warehouse structure fires annually, resulting in five civilian deaths, 21 injuries, and approximately USD 124 million in property losses. The 2015 General Electric warehouse fire in Louisville, Kentucky, caused USD 110 million in damage, while the 2020 Amazon logistics center fire in Alabama led to losses exceeding USD 500 million[4]. Similar trends have been observed elsewhere, with Dubai reporting a 22% increase in warehouse fires between 2009 and 2010 [7].

Although Sri Lanka has not experienced warehouse fires of comparable scale, several significant incidents have occurred locally. Fires at the Bata warehouse in Ratmalana (2004), the Sri Lanka Ports Authority facility (2013), and a textile warehouse in Lansiyahena highlight growing national vulnerability (Nadarajah et al., 2024). More recently, a five-story retail apparel store in Colombo caught fire, injuring 23 people, six critically [8]. These incidents reveal that, while Sri Lanka's regulatory framework for fire safety is extensive, its enforcement remains inadequate, especially in large and densely stocked warehouses where abundant combustible materials and limited compartmentation enable rapid fire to spread [9].

Noncompliance with fire safety standards remains a key factor contributing to warehouse fire incidents. Common deficiencies include deviations from approved building plans, inadequate active and passive fire protection systems, poor maintenance of fire protection systems, and limited regulatory oversight. Against this backdrop, the present study aims to assess fire risk levels in Sri Lankan storage buildings and analyze the implications of noncompliance with national fire codes. The findings are expected to raise awareness among warehouse stakeholders, inform policymakers of regulatory and monitoring gaps, and promote timely revisions to national fire safety standards. Overall, the study underscores that many storage facilities in Sri Lanka fail to fully comply with prescribed fire regulations, creating a significant gap between actual fire safety conditions and the standards required by law and regulations. Addressing this gap is essential to safeguard human life and property while ensuring the resilience of supply chains vital to industrial, commercial, and economic development.

Figure 1. The spatial layout and storage arrangements within large warehouses in Sri Lanka

Source: FT.lk article and Access Engineering PLC webpage

1.2 Key challenges

One key challenge is the lack of systematic design guidelines tailored for the unique fire risks associated with warehouse facilities [3]. The push for economic efficiency often leads to taller storage configurations and reduced open spaces, with storage heights frequently exceeding 12 meters, and in some cases reaching up to 30 meters with automated systems [7]. This significantly increases the fire load and risk profile. In the Sri Lankan context, many warehouse facilities lack even the minimum fire safety requirements. In some cases, fire protection systems receive minimal attention, often due to the low occupancy levels typically associated with such buildings. This underscores the urgent need for robust, context-specific fire safety strategies, especially in low- and middle-income countries where warehouse fires often lead to complete structural loss and high casualty rates (Bošković et al., 2023).

The ignition of warehouse fires was most commonly the result of electrical distribution (14 %) and intentional arson. In many cases, warehouses are completely destroyed by fire due to high fuel loads and the failure of fire protection systems. Notably, 38% of warehouse fires occurred in facilities equipped with fire protection systems; however, these systems often failed to perform effectively due to malfunctions or poor maintenance, contributing to the severity of the losses [10]. Automatic sprinkler systems serve as the primary fire protection method for warehouse and storage facilities [7]. Additionally, fire compartmentation helps restrict the spread of fire, containing damage to a limited area [11]. However, it has been observed that most warehouse buildings in Sri Lanka do not comply with these requirements, even when mandated by regulations.

1.3 Enhancement of fire safety measures in warehouse buildings

Building fire safety regulations play a critical role in determining a structure's overall fire resilience. Prescriptive code requirements are generally considered sufficient to ensure regulatory compliance, under the assumption that fire hazards are effectively managed when standard provisions are met [12] [13]. These prescriptive approaches rely on a combination of active and passive fire protection systems (Kodur, Kumar, and Rafi, 2020), requiring the installation of all protective measures specified in relevant codes and standards [14]. In Sri Lanka, the Construction Industry Development Authority (CIDA, 2018) has published prescriptive fire regulations, and their implementation is typically straightforward [15]. However, studies have revealed that several Sri Lankan buildings were constructed without adequate active or passive fire protection systems, resulting in significant deviations from standard requirements. The increasing frequency of fire incidents suggests inadequate fire safety planning, while weak enforcement and insufficient monitoring mechanisms further contribute to poor compliance[16].

Fire development is a complex process influenced by the characteristics and configuration of the fuel load [17]. Many Sri Lankan warehouses are highly vulnerable to fire due to insufficient fire protection measures, highlighting the need for a comprehensive fire safety strategy. A key concern is that many organizations aim only to satisfy the minimum fire safety requirements stipulated by codes, largely due to the financial burden associated with installing and maintaining full systems [18]. Modern logistics warehouses often fail to meet even basic code requirements for fire protection [5]. According to Nadarajah et al. (2024), critical issues include the absence, inadequacy, or poor maintenance of fire detection and suppression systems, unsuitable storage configurations, large facility footprints, and the flammable nature of stored materials. Although CIDA guidelines specify sprinkler, hose reel, hydrant, and detection system standards, many warehouses remain noncompliant. Fire experts interviewed during the study agreed that fire safety standards in Sri Lankan warehouses are considerably below acceptable international levels [9].

A recurring issue is cost-cutting through the partial implementation of fire protection systems (FPS), where devices are installed according to maximum allowable service areas rather than actual risk requirements. This practice contradicts code provisions and can reduce FPS functionality by 40–65%, significantly compromising safety [14].In a fire event, this reduction in system effectiveness can lead to property losses two to three times greater than would occur under fully compliant conditions [10].

Enhancing warehouse fire safety, therefore, requires a multifaceted approach encompassing strict regulatory enforcement, improved system design, greater awareness, and the integration of modern technologies Bošković et al., 2023). For a facility's fire protection system to function effectively, it must incorporate all essential components and devices to ensure full operational capacity. Ultimately, a holistic fire safety strategy must also account for the time-dependent dynamics of fire growth and suppression, particularly in large or tall buildings[19].

1.4 Barriers to the effective application of fire safety regulations and standards

In many developing countries, it is challenging to comply with fire safety regulations due to a lack of resources, insufficient regulatory frameworks, and a lack of enforcement mechanisms[20]. Despite the introduction of fire regulations, their effective implementation is often important [21]. Municipal fire departments, as the Authority Having Jurisdiction (AHJ), are responsible for enforcing applicable fire codes to reduce the risk of structure fires [20]. Fire regulations enforcement in Sri Lanka is hindered by a range of systemic issues, beginning with the outdated

Factories Ordinance No. 45 of 1942, which lacks provisions for modern construction practices and technologies. This legislative gap undermines effective regulation and fails to address current fire safety needs [22]. Furthermore, the Construction Industry Development Authority (CIDA), which is tasked with overseeing construction standards, plays a limited role in enforcing fire safety regulations. Other key stakeholders, including trade associations and educational institutions, also have minimal involvement, resulting in fragmented enforcement[23]. Compounding the issue, many buildings lack adequate fire safety management systems, leading to poor maintenance, the absence of responsible personnel, and unauthorized alterations to safety features. These deficiencies significantly weaken the effectiveness of fire protection measures. Additionally, broader governance challenges such as slow judicial processes and limited administrative capacity, further delay the implementation and enforcement of safety standards.

1.5 The role of fire risk assessment in warehouse fire management

A warehouse fire risk assessment plays a crucial role in ensuring that all fire prevention measures, safety procedures, and protective systems are properly implemented and functioning [2]. Such assessments have both theoretical and practical significance in preventing warehouse fires [24]. These approaches help pinpoint the most critical causes of fire within a building, allowing control measures to be implemented based on their relative importance [25]. They facilitate the comparison of various fire protection strategies and help quantify how each measure contributes to reducing overall fire risk [26]. As such, fire risk analysis is considered a fundamental component of comprehensive fire risk management(Xin and Huang, 2014; Danzi, Fiorentini, and Marmo, 2021). However, current methods for assessing fire safety in logistics warehouses remain limited and underdeveloped. It is often argued that prescriptive design regulations implicitly reflect society's expectations for acceptable safety levels and, therefore, serve as a benchmark for what constitutes "adequate safety" [28]. The concept of fire risk assessment has gained wide acceptance as a cost-effective tool for prioritizing and screening fire risks. It offers valuable insights into potential hazards and vulnerabilities [29]. Accordingly, facility managers, including those overseeing their properties, must conduct regular fire risk assessments to address emerging hazards. These hazards may arise from changes in user behavior, workplace design, or operational practices, and proactive fire risk assessment is essential for effective fire prevention [30].

1.6 Rationale for the development of the novel tool

Risk assessment and management techniques are among the most effective tools for identifying, prioritizing, and mitigating fire hazards[31]. However, in Sri Lanka, the lack of comprehensive failure data and reliable fire incident records poses a major obstacle to performing robust quantitative fire risk assessments [32]. Many existing assessment methods are also resource-intensive, requiring extensive data and specialized expertise, which can make them costly and time-consuming[33] . Qualitative methods, such as checklist-based assessments, remain widely used for evaluating compliance with fire safety codes and standards. Checklists have long been recognized in fire safety engineering as effective tools for hazard identification, ensuring compliance with prescriptive codes, and simplifying risk evaluations, especially for users without specialized expertise [13][14].

However, these tools have several limitations. They typically assign equal weight to all factors, regardless of their relative risk, and often overlook critical variables such as building design criteria and the maintenance and management of fire safety systems. Additionally, checklists frequently lack intermediate scoring or guidance, making it difficult for assessors to determine whether a specific condition fully meets compliance requirements. To address the limitations of traditional fire risk assessment methods, a semi-quantitative, checklist-based tool was developed by the author, designed to accommodate all 54 building categories in Sri Lanka. Unlike traditional checklists, which often assign equal weight to all risk factors, potentially obscuring the true impact of serious non-compliance, the newly developed tool integrates a more refined risk evaluation approach. The Relative Importance Index (RII) method was used to evaluate and rank risk attributes. Based on the author's original research, the Relative Importance Index (RII) was used to evaluate the identified 12 critical fire risk factors specific to the Sri Lankan setting. These factors are mapped across the building lifecycle design, construction, and maintenance, highlighting that fire risks vary in both severity and influence depending on their context. The above research identified the top three contributors to elevated fire risk in the Sri Lankan context as: Flawed building design, Approval of non-compliant or unsuitable building plans, and Inadequate maintenance of fire safety systems [34].

2. Methodology

2.1 Tool architecture and working process

Figure 1 illustrates the operational flow of the semi-quantitative Fire Risk Assessment Tool. The tool is structured around three core modules: Database, Interface, and User Interaction, which together enable a systematic, evidence-based assessment of fire safety compliance[35].

Module 1: Database (Knowledge Foundation)

The database module compiles regulatory requirements, standards, and expert knowledge essential for accurate fire risk evaluation. It draws on several key data sources, including the CIDA Fire Regulations Database, Sri Lanka's national fire safety standards, and the overarching regulatory framework applicable to all buildings across the country. Where the CIDA fire regulations fall short, British Standards, which the CIDA regulations are largely based on, are used to fill the gaps. In addition, the database has been expanded to incorporate common fire safety practices from the industry, which play a vital role in the fire risk assessment process. A key enhancement is the inclusion of fire safety management standards, such as fire safety management in BS 9999, which are not addressed by the CIDA regulations or most other prescriptive codes. Finally, the module integrates insights from expert interviews to guide the prioritization of 12 critical risk factors relevant to the current fire safety landscape in Sri Lanka. Based on the above data, a total of 221 fire risk assessment attributes were identified under 12 critical risk factors. Each attribute was then weighted using the Relative Importance Index (RII) to reflect its significance in terms of fire risk.

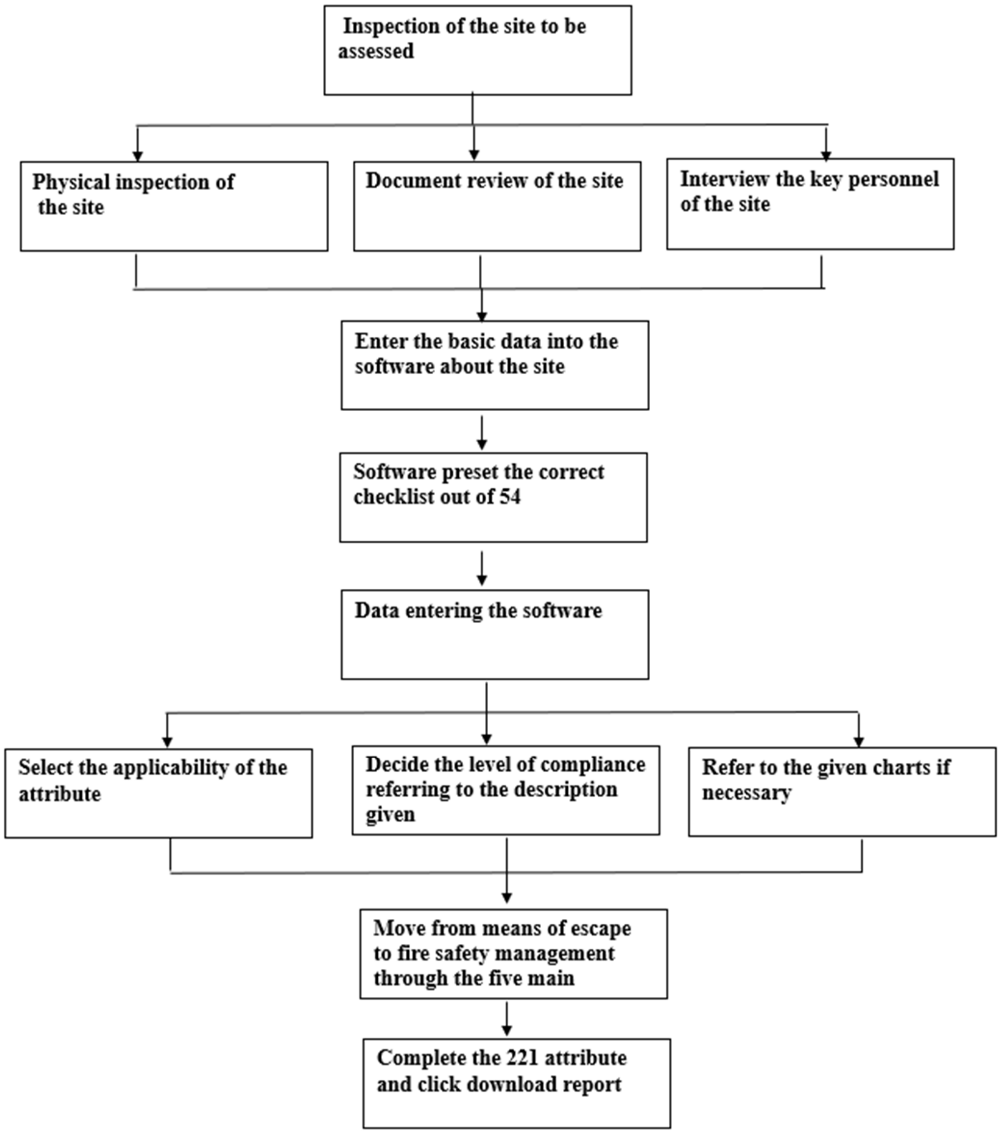

Figure 2: Operational flow of the semi-quantitative Fire Risk Assessment Tool

Source: Own elaboration

Module 2: Interface (Operational Platform)

The interface module serves as the bridge between the knowledge base and the user interface. It incorporates the following components:

The system includes 54 custom checklists, each tailored to one of Sri Lanka's officially recognized building categories, defined by height and purpose group classifications. An automated checklist selector then assigns the appropriate checklist based on the initial building inputs provided by the user. The software also incorporates built-in RII weightings for each attribute, ensuring that the evaluation reflects the significance of fire risk rather than merely the number of compliance measures.

Module 3: User Interaction (Assessment Engine)

The final module facilitates the user-driven assessment process by guiding users through a structured series of steps. First, users input essential building information such as the name, type, height, and occupancy purpose. Next, they indicate whether each attribute applies to the building. For each applicable attribute, users then select a compliance level 0%, 25%, 50%, or 75%, with the help of descriptive guidance. Finally, the software applies embedded RII logic to calculate a weighted compliance score, compares it against the theoretical maximum, and determines the compliance gap as a percentage.

2.2 Attribute structure and weighting logic

The tool also incorporates additional standards from British and European fire codes to enhance the framework established by CIDA. The 221 assessment attributes are organized into five key domains: Means of Escape, Structural Fire Protection, Fire Detection Systems, Fire Protection Systems, and Fire Safety Management. If an item is not applicable, users can select "Not Applicable," and the software will automatically exclude it from scoring. By default, all attributes are marked as "Applicable," requiring users to provide just two inputs per item: applicability and the selected compliance level. After that, each checklist item is evaluated using a four-tier compliance scale (0%, 25%, 50%, 75%), with clear and user-friendly guidance provided to support even non-specialist assessors. The tool then calculates a theoretical maximum score under ideal conditions and compares it to the actual score derived from user input, producing a semi-quantitative fire risk profile that highlights both compliance strengths and areas needing improvement.

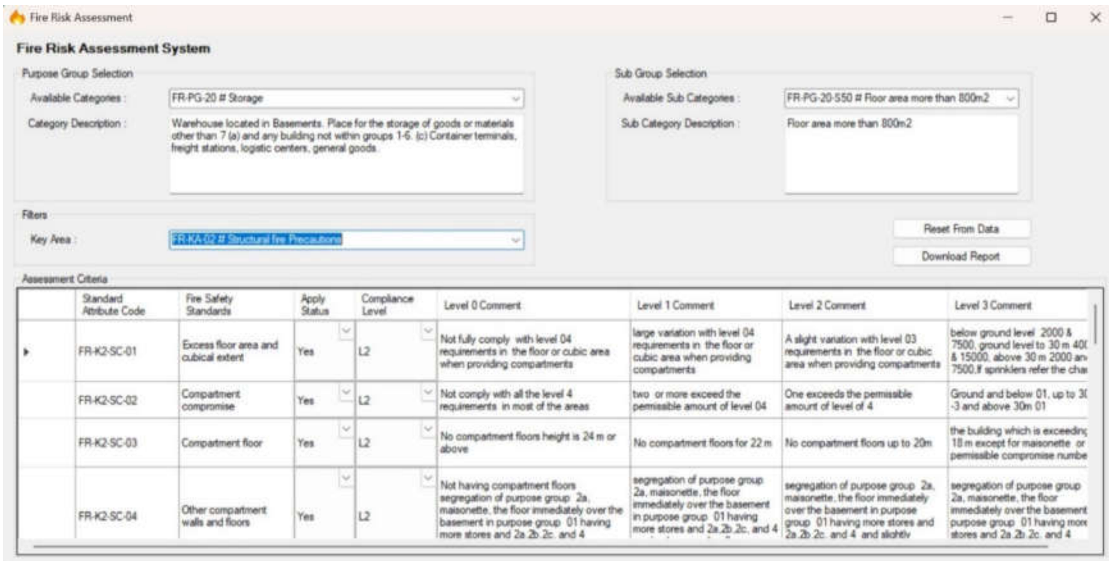

Figure 3: Scoring system and differentiating the weight of each attribute

Source: Own elaboration

This weighting system ensures that deficiencies in high-risk areas contribute more substantially to the overall fire risk rating.

2.3 Report generation and summary output

Upon completion, the software generates a structured compliance and risk profile that includes a fire risk rating categorized from "Very High" to "Very Low," a compliance percentage breakdown across key fire safety domains, and visual representations such as bar and pie charts illustrating compliance by theme and risk type. It also provides a detailed list of major and minor deviations that require corrective action. The output is designed to support audit readiness, facilitate policy compliance reviews, and enable risk-informed decision-making by building owners, fire officers, and regulatory authorities

2.4 Output visualization and summary tools

The final output is a comprehensive, visual, and actionable report that includes domain-specific graphs and compliance charts, a color-coded overall risk rating, a summary of compliance percentages, and a prioritized list of deviations.

Table 1: Description of the results generated by the software

Description of the results & details of the final report	Fire Safety level as a percentage	Visualization Method
Fire Safety level due to compliance percentage with the means of escape	%	Bar chart
Fire Safety level due to compliance percentage with structural fire precautions	%	Bar chart
Fire Safety level due to the Compliance percentage with fire detection and alarm systems	%	Bar chart
Fire Safety level due to compliance percentage with fire extinguishers and fixed fire protection systems	%	Bar chart
Fire Safety level due to compliance percentage with the fire Safety management system	%	Bar chart
Fire Safety level due to compliance percentage with the active fire protection system	%	Pie chart
Fire Safety level due to the Compliance percentage with the Passive fire protection system	%	Pie chart
Fire Safety level due to Compliance percentage with local standards	%	Pie chart
Fire Safety level due to the Compliance percentage with British and best industrial practices	%	Pie chart
Fire Risk Level	Marks and level of risk	Risk Level Chart

List of Major Deviations		List
List of minor deviations		List

Source: Own elaboration

2.5 Case study application to real-world storage buildings

A total of ten storage and warehouse facilities were selected as case studies to demonstrate the practical application of the Fire Risk Assessment Tool. These facilities represent a diverse cross-section of the warehousing sector in Sri Lanka, encompassing variations in stored materials, operational scale, and organizational type. The selection aimed to capture a wide range of fire risk factors relevant to different industry contexts. The selected facilities are illustrated in Table 3.

Table 2: Details of the selected case studies

Number	Company	Nature of the Warehouse	Floor area of the warehouse
1	A	Confectionery items	3500
2	B	Cereals	4500
3	C	Garments	2800
4	D	Textile raw material	5000
5	E	Fast-moving goods manufacturing storage	9300
6	F	Foods	2200
7	G	Tea storage	2800
8	H	Stationaries	4200
9	I	Packing materials	3100
10	J	Multi items	2400

Source: Own elaboration

2.6 Methodology adopted for the case study

Before assessing the risk levels of the selected buildings, a thorough review was conducted of all 221 attributes included in the fire risk assessment tool. This initial step helped in gaining a comprehensive understanding of each attribute. Subsequently, each building was inspected in detail to evaluate compliance with these attributes. Physical measurements and architectural drawings were used to assess key parameters such as staircase width, travel distances, floor heights, locations of hose reels, fire hydrant systems, and fire detection coverage.

To assess the compliance of management systems, service records, and checklists were reviewed. Additionally, interviews were conducted with relevant personnel, including fire team members, emergency response team members, safety officers, and maintenance staff. These interactions provided valuable data and helped validate the findings. Photographic evidence was also collected to document non-compliances and to capture the condition of fire protection equipment, emergency exit doors, and exit pathways.

After gathering all the required data, it was systematically entered into the risk assessment software. Upon launching the software, the user is guided through a set of instructions and prompted to input basic information, such as the company name, address, building height, and purpose group. The software then presents the main checklist, organized under five key categories. Each attribute was reviewed individually, and the compliance level, ranging from Level 0 (L0) to Level 3 (L3), was determined based on inspection findings, documented evidence, and the descriptions provided in the software. Each attribute is weighted based on its Relative Importance Index (RII), which is embedded in the tool. Upon completion of all 221 attributes, the software automatically generates a detailed results sheet that summarizes the overall fire risk assessment outcomes.

3 Results and discussion

Following the analysis of fire risk levels in the ten selected case study warehouse buildings, the results are as follows.

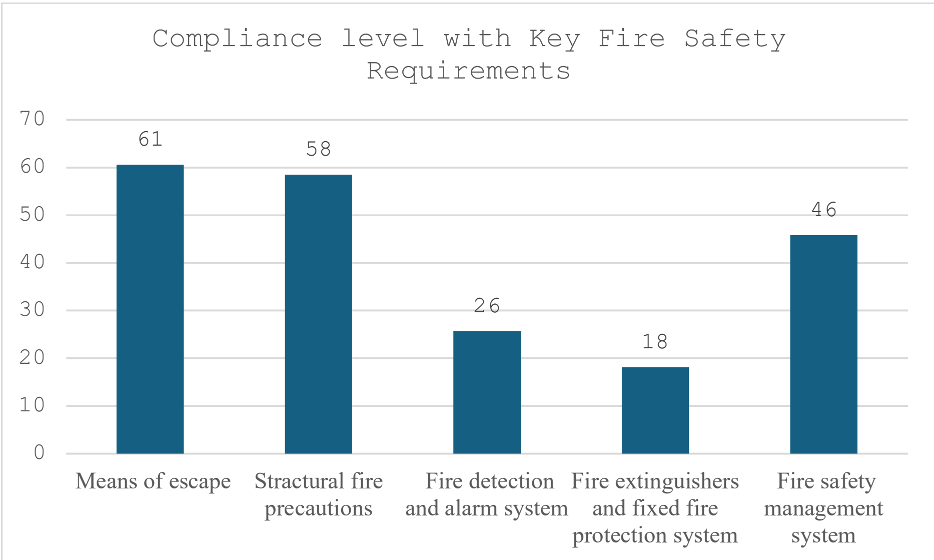

Figure 4: Compliance levels with key fire safety requirements

Source: Own elaboration

The analysis clearly indicates that the majority of storage and warehouse buildings in Sri Lanka fall significantly short of meeting standard fire safety requirements. Notably, compliance with fire detection systems, portable fire extinguishers, and fixed fire protection systems, such as hose reels, hydrants, and sprinklers, is below 25%. The lowest levels of compliance were observed in relation to fire extinguishers and fixed protection systems (18%), despite the high fire load and the potentially catastrophic consequences for life and property. These findings are consistent with those reported by [9], who noted that fire protection in Sri Lankan warehouse facilities is critically lacking, with experts unanimously agreeing on the widespread non-compliance with basic fire regulations. The author's professional observations during site inspections further support these conclusions and served as the foundation for initiating this research. Previous studies conducted by the author also identified two primary contributors to elevated fire risk: the design of non-compliant building plans and the approval of such plans by regulatory authorities. These issues are reaffirmed by the above research findings.

According to CIDA fire regulations, storage buildings with a habitable floor area exceeding 800 square meters must be equipped with hose reels and hydrant systems. In addition, the same standards emphasize that fire sprinkler systems are also required, based on the outcomes of a risk assessment, when the floor area exceeds the above threshold. However, substantial evidence shows that most Sri Lankan storage facilities do not comply with these requirements. These components are vital to firefighting infrastructure, ensuring dependable access to water during emergencies [36]. Consequently, when a fire reaches a stage beyond the control of portable extinguishers, the absence of fixed suppression systems poses a severe threat to both occupants and property. Several safety barriers, such as fire detection, fire suppression, fire containment, fire isolation, and evacuation, can be implemented to reduce the damage caused by storage fires. If the fire suppression system operates effectively, the fire can be extinguished in its early stages. However, if suppression fails and the fire progresses, the level of safety will then rely heavily on the effectiveness of fire containment measures. In such cases, proper containment can limit damage, allowing the warehouse to sustain only minor losses and recover after the fire is extinguished [37]. Unfortunately, many storage facilities in Sri Lanka are non-compliant with horizontal compartmentation requirements, particularly when floor areas exceed the limits specified in local fire safety regulations.

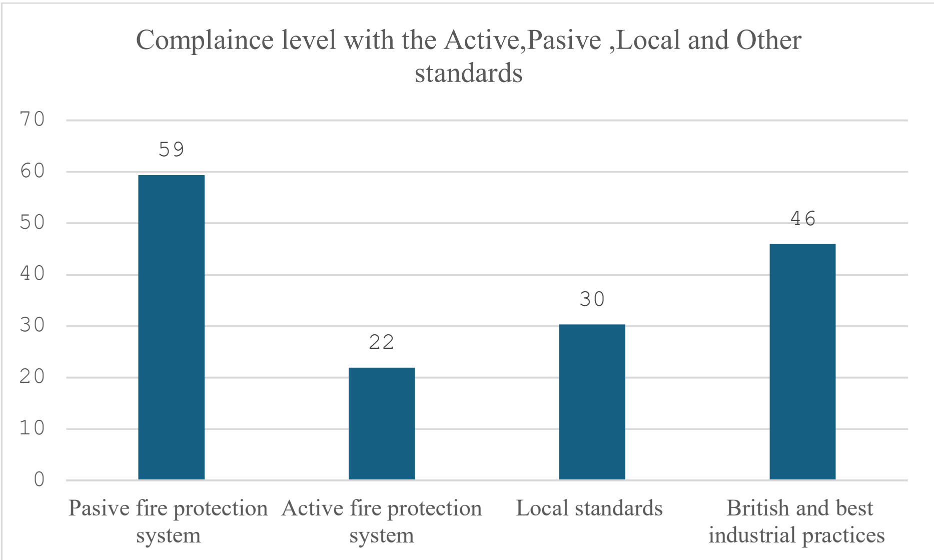

Figure 5: Compliance levels with active, passive, local, British, and best industrial practices

Source: Own elaboration

In addition to the previously discussed findings, the analysis indicates that most storage buildings in Sri Lanka show higher compliance with passive fire protection systems compared to active fire protection systems. Large warehouses are typically constructed using solid walls or load-bearing structures made of concrete or steel beams. Due to operational needs and security considerations, openings such as windows and doors are minimal, and party walls are usually built with solid masonry. As a result, many structural fire safety elements are inherently addressed during construction to meet functional and security requirements.

However, despite these inherent advantages, there remains a 40% gap in compliance with standard passive fire protection requirements. More concerning is the overall compliance with the CIDA fire regulations, which stands at only 30%, revealing a 70% shortfall, less than half of what is required.

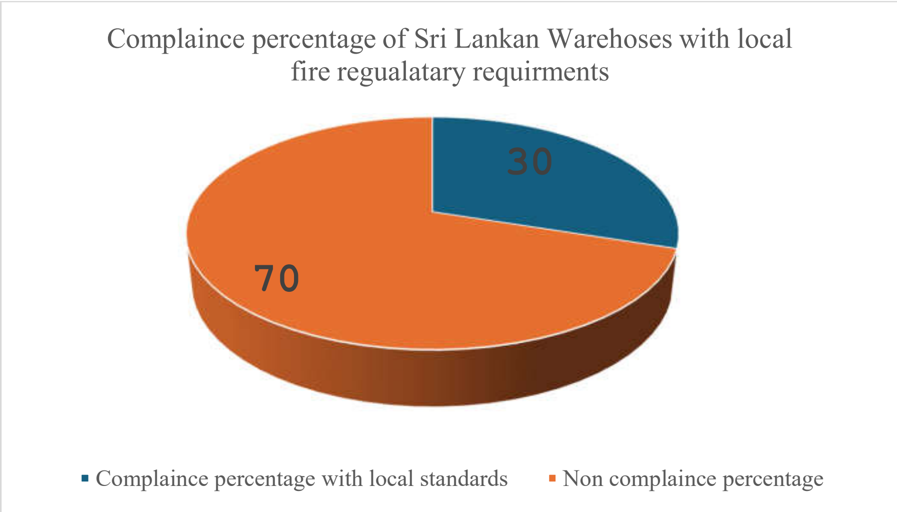

Figure 6: Compliance level with local fire safety standards

Source: Own elaboration

This significant deficiency highlights a serious fire safety concern that warrants immediate attention from the relevant authorities. Furthermore, the analysis shows a 45% compliance rate with British standards and recognized best industry practices. This relatively higher figure is attributed to the implementation of service, maintenance, and management practices that do not require substantial financial investment but are not adequately addressed by local regulations. These findings suggest that while Sri Lankan storage facilities may partially meet passive protection standards by default, there is a critical need for enhanced regulatory enforcement and investment in both active fire protection and fire safety management systems to ensure comprehensive safety.

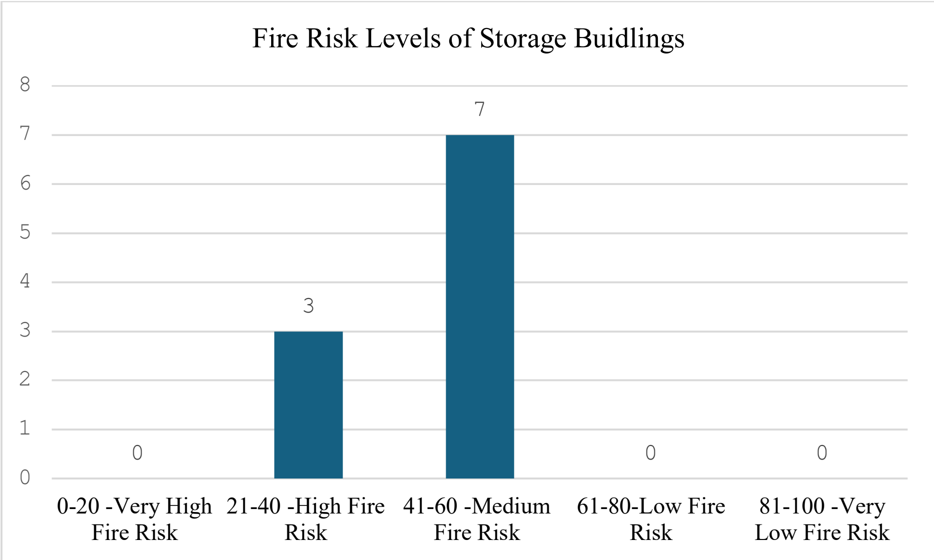

Figure 7: Fire risk level of storage buildings

Source: Own elaboration

An analysis of the fire risk levels in the ten selected buildings revealed that none of the storage facilities fell into the "low" or "very low" fire risk categories, indicating widespread non-compliance with both local fire regulations and internationally recognized standards such as British standards and best industry practices. In addition to the above, it was found that out of the above sample, 30% of store buildings are high risk, and 70 % of store building fire risk levels fall into the moderate risk level. The literature review revealed that the key fire safety issues in warehouse and storage buildings in Sri Lanka include the absence of fire protection systems, malfunctioning or poorly maintained fire protection systems, and a lack of essential structural fire protection measures such as compartmentation. However, the developed tool enables users to easily assess compliance and risk levels related to active, passive, and structural fire protection systems, as well as their management practices. By identifying these gaps, building owners can take prompt corrective actions to reduce fire risks. This directly addresses the research problem and supports the validity of other findings related to fire safety in Sri Lankan buildings

4. Conclusion

Storage and warehouse facilities are expanding rapidly in both scale and complexity worldwide, including in Sri Lanka, resulting in significantly heightened fire risks. A series of severe fire incidents, both locally and internationally, has underscored the dangers these facilities pose to human life, infrastructure, and the environment. Research and field observations consistently show that many storage buildings in Sri Lanka fall short of meeting critical fire safety requirements when measured against local regulations, British standards, and international best practices.

To address these gaps, a semi-quantitative, checklist-based fire risk assessment tool was developed and applied to ten warehouse facilities in Sri Lanka. The tool, validated through more than 50 prior case studies, integrates the Relative Importance Index (RII) along with additional technical and managerial fire risk attributes that are not covered by the CIDA fire regulations. It introduces a systematic scoring framework to measure compliance levels and is applicable to all 54 building categories. The assessment is structured around 12 critical fire risk factors identified through the author's previous research, encompassing five key fire safety domains: means of escape, structural fire protection, detection systems, suppression systems, and fire safety management.

Findings revealed critically low levels of compliance with key fire safety systems, including detection mechanisms, extinguishers, hose reels, and hydrants, with overall adherence below 25%. Active fire protection measures showed the weakest performance 18%, despite the high fire loads typical of such facilities. The study also confirmed that poorly designed buildings and the regulatory approval of non-compliant plans significantly contribute to elevated fire risk. While passive fire safety elements, such as fire-resistant structures, demonstrated slightly better adherence, they still showed a 40% shortfall from required standards. Compliance with national CIDA fire safety regulations averaged only 30%, while British and industry best practices fared marginally better at 45%, largely due to routine, low-cost maintenance practices not covered under local codes. None of the assessed buildings achieved a "low risk" status; instead, 30% were classified as high risk, and 70% as moderate risk. These results confirm prior findings and underscore the urgent need for regulatory reform, enhanced enforcement, and targeted investments in active fire protection and comprehensive fire safety management within Sri Lanka's warehouse sector.

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