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Fire Safety Risk Assessment of Workplace Facilities: A Case Study

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Workplace facilities are organizational capital assets, which entail high risks of fire occurrences. The fire risks increase based on occupants' behaviors, lack of awareness and poor workspaces safety management. Thus, fire safety risk assessment is vital to raise awareness about workplace fire-safety culture, and to train employees on effective fire response requirements and methods. The literature lacks studies focusing on managing fire safety at the workplace, and limiting occupants dispossessed behaviors. This research presents a case study, which demonstrates the utilization of risk assessment for fire safety prevention in a workplace facility. Relevant literature is synthesized for identifying causes of fire, various propagation hazards, control measures to develop a risk assessment tool based on fire codes. The codes were analyzed by describing the requirements for fire safety precautionary measures, followed by an exemplary assessment. This research aims to provide professional practice and knowledge on the fire risk assessment methodology, serving safety professionals, and facilities managers. It serves to raise awareness on the causes of fire, consequences of fire events, and mitigation strategies in workplace facilities, for the purpose of protecting users' lives and business properties against fires.

Keywords: codes of practice and standards, safety, workplace, fire, risk assesment, facilities

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INTRODUCTION

Office Workplace

An office building is a form of construction, which provides a workplace for conducting business activities, such as administration, consulting services and client-related services (Aronoff and Kaplan, 1995). As in any built-environment, fires could occur in office properties, due to several causes (McDermott et al., 2010; Campbell, 2013; Shang et al., 2013). The ramifications of fire occurrence in office properties could be catastrophic, in several dimensions. Fire events have destructive effects on business organizations. Fires could result in serious damages to property, and loss of valuable assets, documents, and data (Sun and Luo, 2014). These consequences cause organizations to lose productive time for business operations, and hence incur financial losses. Fires also have destructive effects on the organizational staff, fire fighters and the public, due to the injuries and fatalities that could happen (Hall, 2014). Thus, facilities managers of office properties should be prepared to conduct regular fire risk assessments, to identify the continually emerging hazards, due to users' activities, design and operation of the workplace, and to safeguard against fire occurrence. The term hazard is used to describe any source or condition that would result in potential harm to people or properties (Furness and Muckett, 2007). Fire risk assessment procedures comprise the

systematic and regular identification of the available fire hazards that could harm the users of office properties, and devising means to reduce these hazards, to save lives and businesses (Home Office, 2006; London Fire Brigade, 2020). These procedures would ultimately result in reducing the probability of fire occurrence and guarding against its consequences (Sun and Luo, 2014). Watts and Hall (2016) defined risk assessment as "the process of establishing information regarding acceptable levels of a risk and/or levels of risk for an individual, group, society, or the environment". They have discussed the lack of availability of a universal approach for fire risk assessment, as the relativity of compromises and complexity of the processes differ in acceptance by its users.

Behavioral-Based Fire Safety for the Workplace

Behavioral-based safety (BBS) is the process of building a strong collaboration among the workplace users, in an attempt to raise awareness and behavioral capacity upon fire safety. **Figure 1** presents the strategies and consequences to be considered for behavioral based fire safety practices. It is focusing on workplace users' actions and behaviors. There have been different approaches undertaking the fire risk assessment of buildings. Within literature, several examples have been presented as research case studies. Brzezińska and Bryant (2020) conducted research utilizing fire strategy risk index to benchmark key performance objectives. The significant considerations for fire risk strategy assessment covered in their study comprised of control of ignition sources, combustibles, compartmentation, smoke control, detection and suppression systems, field service intervention and firefighting. Danzi et al. (2021) proposed a different fire safety assessment approach that is inclusive of occupants' behaviors, a methodology named fire risk assessment method for enterprises. The proposed method is less time consuming than computational fluid dynamics approaches. Koutsomarkos et al. (2021) discussed the need for simplicity of fire risk indexing, where more complex approaches are deemed less transparent, and non-feasible for its users. Therefore, it is imperative to comprehend the various causes of fire, types of combustibles in office properties. Following a synthesis of the reviewed literature the authors identified three main research questions, as an objective of this study:

RQ1) How did the literature discuss behavioral fire safety practices in the context of workplace facilities?

RQ2) What are the fire protection and prevention measures, in the codes, that must be considered in office facilities?

RQ3) How to inspect and assess the behavioral fire safety in workplace office facilities?

Thus, this study aims to develop a risk assessment tool for assessing the compliance level for providing and maintaining compulsory fire protection and prevention requirements in office properties, for the purpose of mitigating fire occurrence. The study also presents a case study to assess the provision and maintenance of fire safety requirements, utilizing the developed risk assessment tool. This paper is of significant value to design professionals, real estate developers and owners, and facilities managers, through raising awareness about the causes of fire, consequences of fire events, and mitigation strategies in office properties. This research provides a comprehensive checklist for conducting periodic fire risk assessments of office buildings.

RESEARCH METHODOLOGY

This research comprised of a systematic set of activities. These activities conducted to accomplish the objectives of this research:

- Synthesizing the relevant published literature in the domain of fire safety in office properties, to identify the various types of combustible contents and causes of fire, and the set of factors that render office properties as a high risk facilities in fire events (Greenwald, 1991; Home Office, 2006; Hassanain, 2008; Thauvoye et al., 2008; Zalok et al., 2008; McDermott et al., 2010; Kuligowski and Hoskins, 2011; Campbell, 2013; Shang et al., 2013; Khorasani et al., 2014; Sun and Luo, 2014; The Building Regulation, 2019; London Fire Brigade, 2020).
- Analyzing the fire codes to describe the pertinent requirements for fire safety precautionary measures, for office properties (International Fire Code, 2018; National Fire Protection Association 10, 2018; National Fire Protection Association 13, 2019; National Fire Protection Association 70, 2020; National Fire Protection Association 72, 2019; National Fire Protection Association 78, 2020; National Fire Protection Association 92, 2018; National Fire Protection Association 101, 2021).
- Developing a fire code-risk assessment tool to assess the compliance level for providing and maintaining fire safety code requirements in office properties, for the purpose of mitigating fire occurrence. The risk assessment tool includes 36 precautionary fire measures, classified under six groups, namely exits, fire protection systems, housekeeping measures, electrical wiring and installations, miscellaneous measures for fire prevention and hazardous materials.
- Utilizing the developed fire code-risk assessment tool, in a case study to assess the provision and maintenance of fire safety requirements. The case study required conducting a walkthrough inspection in an office building located in the Eastern Province of Saudi Arabia.
- Reporting the findings of the walkthrough inspection in the case study building, and developing a series of corrective actions to upgrade the status of fire safety in the case study office building.

LITERATURE REVIEW

A narrative review of the literature has been utilized to analyze the following dimensions:

Combustible Contents and Causes of Fire in Office Properties

Besides administration, office properties can be used for conducting several activities, such as typing, drafting, filing, book-keeping, and archiving (The Building Regulation, 2019). Thus, fire can take place in these properties, causing injuries, fatalities, and property damages, due to various ignition causes. These causes of ignition include:

- Malfunction of cooking equipment: due to electrical faults, while being unattended during their use. These are equipment, such as toasters, microwaves, water heaters and coffee machines, in kitchenettes, could draw excessive current, which causes the equipment to overheat, and cause a fire (Greenwald, 1991).
- Malfunction of electrical office equipment: due to electrical faults, lack of regular servicing or misuse. Examples of these equipment include computers, photocopiers, printers, and paper shredders (The Building Regulation, 2019).
- Accumulations of flammable paper-based products: placed in adjacent locations to heat sources. These products include files, papers, and books (Khorasani et al., 2014).
- Overloaded electrical circuits: due to the need to power multiple office equipment using a limited number of electrical power sockets (Sun and Luo, 2014).
- Defective lighting fixtures: such as flickering fluorescent bulbs, where the ballasts, which regulate the flow of current to the lighting fixture cease to function properly. This condition would usually cause the ballasts to overheat and cause a fire (Hassanain, 2008).
- Careless disposal of smoking materials: heated tobacco products, in addition to lighters and matches could cause fire if they became in contact with flammable materials, such as paper-product, floor finish, or upholstered furniture at the office (Campbell, 2013).
- Space heating equipment: including central heating systems and portable heaters. This heating equipment could cause fires, if they came into close contract with combustible contents in the building (Campbell, 2013).
- Open fire doors: that could allow flames and smoke to spread through the building and prevent safe egress from the building during fire events (McDermott et al., 2010).

Office Properties as High-Risk Facilities in Fire Events

Fire risk assessment involves comprehending the factors that contribute to fire occurrence in any given facility (London Fire Brigade, 2020). Design professionals, business owners and facility managers need to realize that it is not feasible for office properties to operate without having some potential fire hazards on the premises. Office properties are considered a high-risk facility type, in fire events, due to several factors. These factors include:

- The availability of large number of occupants: office properties, are non-domestic, commercial facilities. They are occupied by large number of occupants, within condensed floor layouts. These occupants could have different mobility levels, and perceptions to hazards that could cause fires. They could be also performing their duties in different locations of the workplace. These facilities could be also accessible by the public, who could be unfamiliar with the layout of the floor plan of the building (Home Office, 2006). This large number of users could pose significant challenges during the evacuation from the building, due to fire emergencies (Kuligowski and Hoskins, 2011). The risk is even higher, in the absence of measures for managing emergency evacuations, due to congestion at the main exits (Shang et al., 2013; London Fire Brigade, 2020).
- The availabilities of large amount of combustibles: When a fire takes place, the amount of energy that is released, and the duration of burning depend on the mass of the combustibles, or the fire load in the building (Thauvoye et al., 2008; Zalok et al., 2008). The fire load usually found in office buildings include papers, files, books, office appliances, electrical equipment, furniture, finishes, plastic and rubber products, partitions (Sun and Luo, 2014), chemicals for photocopiers, and decorations (Home Office, 2006). Large amounts these combustibles are usually present, due to the diversity of activities taking place, and the large number of occupants availably in office properties.
- Lack of proper housekeeping measures: Combustible materials, such as cleaning products need to be properly stored. Waste products, such as shredded papers, and packaging materials need to be removed from the premises, on a daily basis. Accumulation of these combustibles could significantly add the fire load in the building, and hence, add to the severity of the fire (Home Office, 2006).

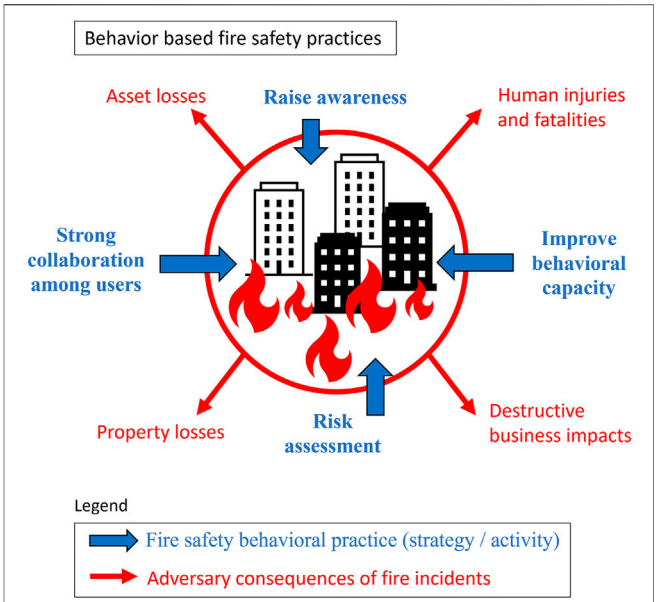

FIGURE 1 | Behavioral based fire safety practices.

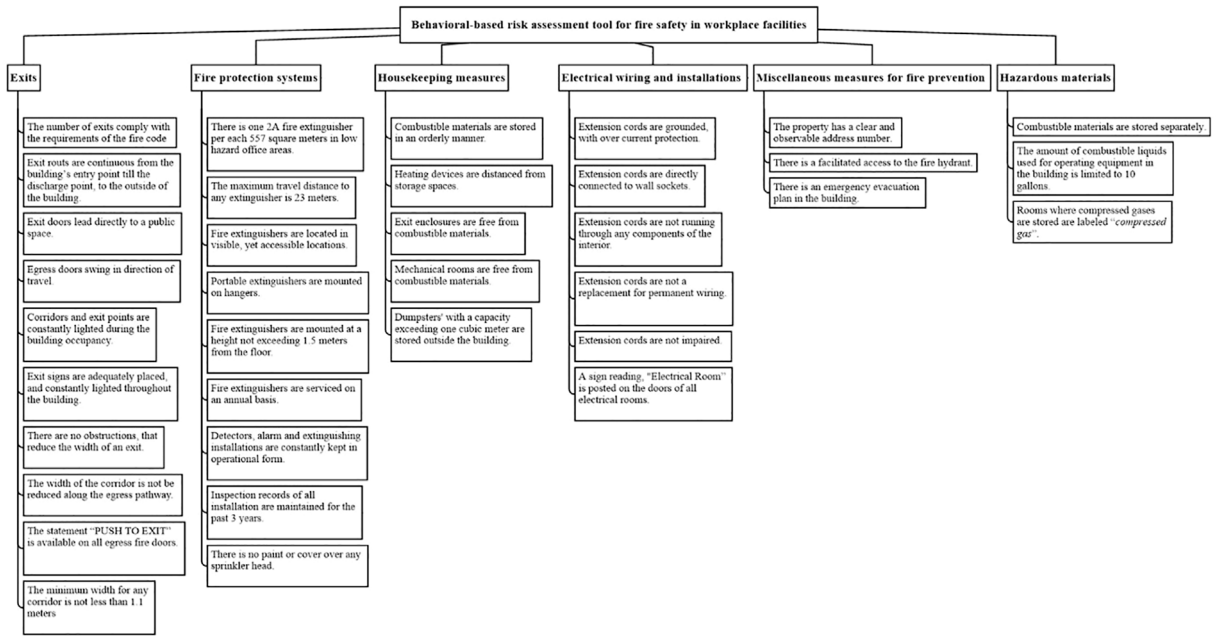

FIGURE 2 | Behavioural based risk assesment tool for fire safety in workplace facilities.

FIRE PROTECTION AND PREVENTION MEASURES IN OFFICE PROPERTIES

Insufficient fire risk assessment practices in office properties could result in overlooking hazardous conditions that lead to the development of fires. Such fires would result in business interruptions, and hence failure to satisfy business obligations, which would ultimately result in economic losses (Furness and Muckett, 2007). Active and passive fire protection and prevention measures, as mandated by fire codes, could significantly reduce fire hazards (Troitzsch, 2016). Active fire protection measures employ fire detection and notification systems, such as smoke detectors and alarm systems. These active measures also include suppression systems, such as portable extinguishers and automatic sprinkler systems (Chow, 2005). Passive fire protection measures employ the use of flame-resistant systems, such as fire-rated doors, walls, floors and ceilings. Passive measures also include the utilization of flame-retardant materials, for the containment of flames and smoke (Landucci et al., 2009). The measures are illustrated in **Figure 2**.

Exits

The provision and upkeep of adequate number of exits, through which building users can escape from the building, is a vital measure for preserving lives during fire events (National Fire Protection Association 101, 2002). Facilities managers should ensure that the building layout is not modified in a way that reduces the number of exits, or the capacity of the corridors and exit points. Further, design professionals should ensure that exit routs are continuous from the building's entry point till the discharge point, to the outside of the building, and that exit doors lead directly to a public space. They should also ensure that the minimum width for any corridor is not less than 1.1 m. Furthermore, the egress doors swing in direction of travel. Additionally, facilities managers should ensure that corridors and exit points are constantly lighted during the building occupancy, and that exit signs are adequately placed, and constantly lighted throughout the building. Moreover, there should be no obstructions, that reduce the width of an exit. In addition, the width of the corridor should not be reduced along the egress pathway. Finally, facilities managers should maintain the provision of the statement "PUSH TO EXIT" on all egress fire doors (International Fire Code, 2018).

Fire Protection Systems

As office properties are high risk type of facilities in fire events, designers and facilities managers need to ensure the adequate provision and operation of the fire protection systems in these facilities. These systems comprise fire extinguishers (National Fire Protection Association 10, 2018), smoke detectors (National Fire Protection Association 92, 2018), fire alarms (National Fire Protection Association 72, 2019), and automatic sprinkler systems (National Fire Protection Association 13, 2019). Specific measures to provide and maintain in office properties include the provision of at least one 2A fire extinguisher per each 557 square meters in low hazard office areas, and maintaining a maximum travel distance of 23 m to any extinguisher. Facilities managers need to ensure that fire extinguishers are located in a visible, yet accessible locations, and are mounted on hangers. These fire extinguishers should be mounted at a height not exceeding 1.5 m from the floor. Furthermore, the fire extinguishers should be serviced on an annual basis (National Fire Protection Association 10, 2018). Additionally, facilities managers should ensure that smoke detectors, firm alarm and extinguishing installations are constantly kept in operational form, and that

inspection records of all installation are maintained for the past 3 years. Finally, there is no paint or cover over any sprinkler head, in the building (National Fire Protection Association 13, 2019).

Housekeeping Measures

Housekeeping practices could significantly impact upon exercised initiatives for preventing fire accidents (Hassanain et al., 2018). These practices mandate the storage of combustible materials in an orderly manner. Further, facilities managers should ensure that heating devices are distanced from storage spaces. They should also ensure that exit enclosures are free from combustible materials, and that mechanical rooms are free from combustible materials. Facilities managers should also maintain that dumpsters with a capacity exceeding one cubic meter are stored outside the building (International Fire Code, 2018).

Electrical Wiring and Installations

Since faulty electrical wiring and installations are attributed as the second major cause for fire in office properties (Campbell, 2013), designers and facilities managers should ensure the provision of certain measures, that could potentially reduce fire incidents. These measures primarily relate to the use of extension cords (National Fire Protection Association 78, 2020). The measures mandate that extension cords are grounded, with overcurrent protection. They should directly be connected to wall sockets, and they should not be running through any components of the interior. Further, extension cords should not serve as a replacement for permanent wiring, and they should not be impaired. Moreover, facilities managers should ensure that a sign reading, "Electrical Room" is posted on the doors of all electrical rooms (National Fire Protection Association 70, 2020).

Miscellaneous Measures for Fire Prevention

The miscellaneous measures for fire prevention in office properties mandate that the property has a clear and observable address number. Further, there should be a facilitated access to the fire hydrant. Moreover, an emergency evacuation plan is available in the building (International Fire Code, 2018).

Hazardous Materials

According to National Fire Protection Association 400, (2022) the definition of hazardous materials incorporates "different chemical substances that are in waste or usage formats of storage and handling, that may tolerate physical and health hazards to occupants". The definition of hazardous materials in this research extends to combustible materials, liquids, and compressed gases. Facilities managers of office properties should ensure that compatible materials are stored separately. They should ensure that the amount of combustible liquids used for operating equipment in the building is limited to 10 gallons. Finally, they should also ensure that rooms where compressed gases are stored are labelled "compressed gas" (International Fire Code, 2018).

DATA COLLECTION

A case study was selected to apply and assess the identified protection measures. As a tool for risk assessment **Table 1**; **Table 2** were adopted. The data collected was as follows:

Case Study Description

The selected case study for validating the developed fire-risk assessment tool, is a three floors office building, with a gross area of 1,692 square meters. It is located in the Eastern Province of Saudi Arabia. The building is classified as "B" occupancy, as per the occupancy classifications of the International Fire Code. The classification of "B" occupancy is used to categorize buildings, or parts of, that are used for offices, for conducting professional and service transactions, and storing records and accounts (International

TABLE 1 | Reference codes checklist utilized for the development of a behavioral-based risk assessment tool.

Reference code / standard	Risk assessment measure					
	Exits	Fire protection systems	Housekeeping measures	Electrical wiring and installations	Miscellaneous measures for fire prevention	Hazardous materials
National Fire Protection Association (NFPA) 10 (2018)		Requirement			Requirement	
International Fire Code (IFC) (2018)	Requirement	Requirement	Requirement	Requirement	Requirement	Requirement
National Fire Protection Association (NFPA) 92 (2018)		Requirement				
National Fire Protection Association (NFPA) 13 (2019)		Requirement				
National Fire Protection Association (NFPA) 72 (2019)		Requirement				
London Fire Brigade (LFB) (2020)	Requirement					
National Fire Protection Association (NFPA) 70 (2020)				Requirement		
National Fire Protection Association (NFPA) 78 (2020)				Requirement		
National Fire Protection Association (NFPA) 101 (2021)	Requirement					

TABLE 2 | behavioural-based risk assessment tool for fire safety in workplace facilities.

A. Exits		**Yes**	**No**
1	The number of exits comply with the requirements of the fire code	√	√
2	Exit routs are continuous from the building's entry point till the discharge point, to the outside of the building		
3	Exit doors lead directly to a public space	√	
4	Egress doors swing in direction of travel		√
5	Corridors and exit points are constantly lighted during the building occupancy	√	
6	Exit signs are adequately placed, and constantly lighted throughout the building	√	
7	There are no obstructions, that reduce the width of an exit	√	
8	The width of the corridor is not be reduced along the egress pathway	√	
9	The statement "PUSH TO EXIT" is available on all egress fire doors		√
10	The minimum width for any corridor is not less than 1.1 m	√	
B. Fire protection systems		**Yes**	**No**
11	There is one 2A fire extinguisher per each 557 square meters in low hazard office areas	√	√
12	The maximum travel distance to any extinguisher is 23 m		
13	Fire extinguishers are located in visible, yet accessible locations		√
14	Portable extinguishers are mounted on hangers		√
15	Fire extinguishers are mounted at a height not exceeding 1.5 m from the floor	√	
16	Fire extinguishers are serviced on an annual basis	√	
17	Detectors, alarm and extinguishing installations are constantly kept in operational form	√	
18	Inspection records of all installation are maintained for the past 3 years		√
19	There is no paint or cover over any sprinkler head	√	
C. Housekeeping measures		**Yes**	**No**
20	Combustible materials are stored in an orderly manner	√	√
21	Heating devices are distanced from storage spaces	√	
22	Exit enclosures are free from combustible materials	√	
23	Mechanical rooms are free from combustible materials	√	
24	Dumpsters with a capacity exceeding one cubic meter are stored outside the building	√	
D. Electrical wiring and installations			
25	Extension cords are grounded, with overcurrent protection	√	
26	Extension cords are directly connected to wall sockets	√	
27	Extension cords are not running through any components of the interior	√	
28	Extension cords are not a replacement for permanent wiring		
29	Extension cords are not impaired	√	
30	A sign reading, "Electrical Room" is posted on the doors of all electrical rooms		√
E. Miscellaneous measures for fire prevention		**Yes**	**No**
31	The property has a clear and observable address number		√
32	There is a facilitated access to the fire hydrant	√	
33	There is an emergency evacuation plan in the building		√
F. Hazardous materials		**Yes**	**No**
34	Compatible materials are stored separately	√	
35	The amount of combustible liquids used for operating equipment in the building is limited to 10 gallons	√	
36	Rooms where compressed gases are stored are labeled "compressed gas"	√	

Fire Code, 2018). The building was constructed in 2017, and it is usually occupied by 74 users, on daily basis. **Figure 3** illustrates the floor plan of the case study office building.

Code-based Risk Assessment Tool for Fire Safety

Watts and Hall (2016) have defined checklists as "a common accessory of fire safety consisting of a listing of hazards, usually with recommended practices. A checklist is usually less generic than a model code or standard. It may even be more specific that it is intended to be applied to a single class of buildings, reflecting the special concerns of their owners". **Table 1** illustrates the developed code-based risk assessment tool for fire safety in office properties. The developed risk assessment tool includes 36 precautionary fire measures, classified under six groups as shown in **Table 2**, namely exits, fire protection systems, housekeeping measures, electrical wiring and installations, miscellaneous measures for fire prevention and hazardous materials.

FINDINGS AND DISCUSSION

A risk assessment walkthrough was carried out in the case study office building. The walkthrough was guided by the developed fire risk assessment tool for assessing the level of compliance level of

FIGURE 3 | Floor plan of the case study facility.

providing and maintaining fire protection and prevention requirements in office properties. The walkthrough findings reported on the level of compliance of the identified fire safety measures, included in this tool.

- Exits: This group included ten measures for fire prevention. The walkthrough revealed that all the identified measures for exits were satisfied, except three. These three measures include lack of compliance of the number of exits with the requirements of fire code, exit doors were found to be swinging in the opposite direction of travel; there were no signs, or instructive statements such as "Push to exit" on all egress fire doors, to indicate the operational direction of the doors.
- Fire protection systems: Nine fire prevention measures were included in this group. The walkthrough indicated that the lack of compliance of four out of nine measures. These four measures include exceeding the prescribed 23 m-travel distance to any fire extinguisher in the building. Further, the portable fire extinguishers were neither visible to the building occupants, nor mounted on hangers. Furthermore, there were no inspection records for fire safety installations over the past 3 years.
- Housekeeping measures: This group included five fire prevention measures. The walkthrough indicated that all five measures were complying satisfactorily with fire code requirements.
- Electrical wiring and installation: This group included six fire prevention measures. The walkthrough inspection revealed that two measures were not complying with fire code requirements. These include the adoption of extension cords as a replacement for permanent wiring, and the absence of posted signs reading "Electrical room" on the doors of all electrical rooms.
- Miscellaneous measures for fire prevention: This group included three fire prevention measures. The walkthrough inspection pointed out to two compliance deficiencies with fire code requirements. These include the absence of clear and observable address number on the building, as well as the absence of an emergency evacuation plan in the building.
- Hazardous materials: Three fire prevention measures were included in this group. The walkthrough inspection indicated that all three measures were complying satisfactorily with fire code requirements.

The implemented fire risk assessment in this research endorsed the utilization of a standard checklist methodology, as an efficient and cost-economic and a methodical approach for the fire safety management (Bridges, 2008; Sun et al., 2008). The developed risk assessment tool included a listing of prescribed fire safety requirements for office properties, classified as "B" occupancies. The implementation of the risk assessment tool was facilitated through a walkthrough inspection. The outcomes from the fire safety checklist provide a practical benefit for guiding facilities managers of office properties on the current level of fire safety measures in their facilities. A checklist is a practical approach to analyze a building in relevance to a code or standard. It is rare that a code or

standard applies to a single typology of buildings. The fire protection engineers, and facilities managers must focus on applicable assessment considerations that apply to each specific project, such as in this study for office buildings. A developed checklist can support this approach systematically and reduces requirements' complexities, to be easily read, understood, and tracked (Watts and Hall, 2016). The variety of codes cited in the paper did not aim to limit the regulatory system referenced for the developed checklist. As the aim is to ensure a comprehensive set of measures for the tool from different regulatory systems, to ensure wider applicability to office buildings. Especially that in Saudi Arabia the local regulations do not provide such a checklist, while it is based on different regulatory systems. In this essence, the approach of developing the tool was followed.

Legislation necessitates comprehensive assessments which ensure compliance with fire safety requirements. The British Standards Institution for example, have developed fire risk assessment code of practice for non-domestic facilities, the code was published in December 2020 and titled as (PAS 79-1: 2020). The code delivers technical information on fire safety measures required by legislation, a similar approach has been conducted in this research serving a wider spectrum of codes and standards.

CONCLUSIONS AND RECOMMENDATIONS

Office properties are considered a high-risk type of facilities in fire events. Provision and maintenance of mandated fire prevention and protection measures result in less number of fires, injuries, fatalities and property losses. This can be achieved through reducing fire hazards in built facilities. This paper presented a systematic approach to assess the level of compliance with compulsory active and passive fire protection and prevention measures, in office properties. The study provides ground for enhancing the behavioural-based fire safety knowledge of design professionals, real estate developers, owners, and facilities managers about the possible fire hazards in office properties. The study presented a risk assessment tool for assessing the compliance level for fire safety requirements, for the purpose of mitigating fire occurrence. The risk assessment tool was utilized during a walkthrough inspection in a case study office building. The level of compliance with each of the measures included in the assessment tool was identified. A plan of corrective actions, in the form of recommendations, was developed to enhance the fire safety performance of the case study building. These recommendations include:

- Adding a prefabricated staircase to correct the violation of providing insufficient number of exits according to the requirements of the fire code.
- Adjusting the swing direction of the egress door to be in the direction of egress.
- Posting the statement "Push to exit" on all egress doors.
- Installing additional portable fire extinguishers, so that the travel distance to any extinguisher would not exceed 23 m.
- Maintaining regular inspection records of all fire protection systems in the building.
- Removing the portable fire extinguishers from the cabinets and mounting them on wall hangers.
- Eliminating or minimizing the use of extension cords in the building.
- Posting the statement "Electrical room" on all the doors of electrical rooms.
- Posting a clear and observable street address number on the building.
- Developing and posting an evacuation plan in a visible location in the building.

This paper serves to expand the behavioural-based fire safety knowledge of design professionals, real estate developers, owners, and the facilities management team in office properties on the precautionary measures to mitigate the risks of fire events occurrences. In essence, it serves to raise awareness about the causes of fire and the consequences of fire events, for the purposes of protecting the lives of users and the business properties against fires.

DATA AVAILABILITY STATEMENT

The original contributions presented in the study are included in the article/Supplementary Material, further inquiries can be directed to the corresponding author.

AUTHOR CONTRIBUTIONS

MH collected the data while MA-H, and AI analyzed the data. All Authors Contributed equally to the conception, methodology and development of the discussion and findings of the research as illustrated and written in the manuscript.

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