



Comprehensive plan for assessing and improving safety level of commercial centers towards the prevention of social and economical consequences of accidents



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ABSTRACT

Commercial centers are considered very important areas. Considering the huge volume of manpower and economic value of goods in these centers, this domain will assume higher importance. Possible accidents, such as fires in commercial centers can be occasion human, social, and economic catastrophic consequences. This study was an attempt to assess the safety level of Tehran's commercial centers and provide control measures to prevent possible accidents. To this end, the current state of Tehran's commercial is analyzed and available resources are identified. Then, safety indexes are extracted, some checklists are prepared, and the resources are accordingly assessed. For this purpose, the number of 48 commercial centers was selected. The results obtained from the assessment of resources indicate that the greatest gap belongs to the protection system against fire and buildings, respectively. This study proposes five alternatives for improving the safety of commercial centers, as follows: (a) implementing audit and evaluation system, (b) establishing reliability management system for fire fighting equipment, (c) monitoring and analyzing accidents and preparing GIS maps, (d) implementing 5S system in workplace and (e) establishing a reliability management system for safety trainings. Based on the results of this study, managers and other decision-makers in the area of urban planning and commercial centers can identify weak points in the system, improve their safety level, and, thereby, be effective in reducing the social and economic consequences of accidents.

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1. Introduction

Safety and security are becoming increasingly important, both in society and companies (De Koster et al., 2011). From the operations management field, it is clear that the systems focusing on enhancing safety are quite effective in reducing accidents (Shannon et al., 2001; Wallace and Vodanovich, 2003). Most high-rise buildings constructed in the past three decades are not on appropriate situations and some of them are in terrible conditions (Zhao et al., 2004). New building designs along with new concepts require the actions of fire safety so that the occupants can immediately evacuate in the face of an emergency (Wong and Cheung, 2006).

Fire safety in old high-rise buildings is of crucial significance to the general public as a consequence of several big fires during the previous years (Chow et al., 1999a; Wong, 2005; Wong and Lau, 2007). Fire safety engineering is the application of scientific and engineering principles, basics, tents, and expert opinion, based on

an insight of the phenomena and effects of fire and of people's reaction to fire, in order to protect people, property and the environment from the negative effects of fire (Borg and Nja, 2013). Some reasons such as misuse of buildings, improper fire service installations, substandard building facilities, damaged smoke stop doors, obstruction of the means of escape and emergency exits constitute the main causes of huge fire losses (Chow et al., 1999a, 2000). Although one of the necessary actions proposed for old buildings is to have a proper fire safety management procedure, improvement work for fire safety measures in such buildings is still required (Chow et al., 1999a).

Fires lead to deaths and casualties and also damage to property, the community, the economy, the environment, etc. (Baker et al., 2013). The cost of uncontrolled fires in buildings is very high both in terms of life losses and financial losses. Direct losses due to fires are yearly estimated to account for between 0.1% and 0.4% of a country's GDP (Ramachandran, 1998; Wilmot, 2002). It is important to both understand and quantify the behavior and consequences of fires in practice so that such losses can be minimized (Holborn et al., 2004).

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In fact, there are many issues in simultaneously upgrading all the fire services and continuing all the building operations as normal (Fong et al., 2005). Fire safety problems can be exacerbated during the construction period if the improvement affairs are poorly coordinated (Chow et al., 1999b; Fong et al., 2005). Hence, an improvement program should be scheduled tactfully. A fire safety ranking system that regards two equally important aspects, along with building characteristics and fire service installations, has been proposed to quantify the fire safety level of local old high rise buildings (Chow et al., 1999b). With the building score obtained through this system, prioritization of works for those buildings which urgently require improvements in fire safety measures can be identified.

Today, the issue of fire protection in high-rise buildings and commercial centers has been established in a fully systematic mode at the international level. Since the economic and financial assessment of projects and during their design and implementation, this important task is considered at international levels (Lo, 1999; Wong and Lau, 2007). However, in Iran, this important subject has not been received sufficient attention in commercial, manufacturing, educational, and healthcare buildings despite the recent attention being paid to the issue of fire protection in major industries such as oil, gas, petrochemical, refinery and auto-making domains (Razavi, 2012). This problem has become a crisis in relation to the commercial centers of large cities like Tehran which are intertwined with the overabundance of activities and population. In this regard, each year, very heavy losses are imposed upon the owners of capital as well as public property both in terms of life and finance (Razavi, 2012). Therefore, a strong need for accurate planning and solution proposal is felt.

On January 21, 2014, a 5-storey building was set to fire. In this incident which occurred in Jomhouri Street of Tehran, two female workers lost their lives. In addition, the number of 15 people and three firefighters were injured. This incident was intensified when fire rescue officers got a problem in their hydraulic ladder and, indeed, their ladder did not open. The main reason for the dysfunction of the ladder is the conduct of no maintenance services on the equipment items of Tehran fire fighting (Fire at Jomhouri Street of Tehran, 2014). In addition, on January 6, 2015, another wide fire occurred around Tehran bazaar, which quickly spread to other parts of the bazaar. This fire did not result in deaths and injuries but left huge economic losses. The main reason for the spread of fire to other parts was mentioned as the improper loading of goods. In addition, the electrical wiring has not been standard (Fire at Tehran furniture market, 2015). Such events have motivated the necessity of conducting such research more than ever.

The aim of this study is to assess the safety situation in commercial centers of Tehran and provide control measures for the prevention of accidents and its consequences. In this study, an analysis of the current situation in Tehran is first provided and, then, the available resources are identified. Moreover, some checklists are prepared from the extracted safety indexes and, accordingly, their resources are evaluated. Finally, some alternative solutions are proposed for the safety improvement of commercial centers in Tehran to meet in response to the needs at the time of crises.

1.1. Literature review

Undoubtedly, the commercial centers of Tehran as a metropolis have unique features that make it distinct from the standpoint of the safety from many other cities around the world. The existence of old textures of some of these centers like Tehran bazaar, their historical significance, cultural traits, the weakness of safety culture, the large crowd of visitors per day, the inappropriateness of the traffic routes towards some of these centers, weakness of

infrastructures and the facilities some other centers, the variety of activities, and many other factors have caused the commercial centers of Tehran to undergo undesired and at the same time rare conditions. However, it is not possible to find Tehran's commercial centers' conditions with all the elements in another part, but it is possible to find the major and basic features of these centers in the commercial areas of some major cities in the world. The examination of these features in other samples and the study of the strategies, methods and approaches used in fire safety management can help future studies promote the safety of commercial centers in Tehran. For this reason, the samples extracted from the experiences of other countries have also been selected by such an approach. In several studies, examples of commercial centers in major cities around the world have been studied. These examples include the commercial center of Melbourne, the Grand Bazaar of Istanbul, the commercial capital Dar es Salaam, Tanzania, the Central District of Hong Kong's commercial part, and shopping centers of Bangladesh.

Liu and Kim (2003) reviewed progress in fire detection technology and discussed some problems related to current fire detection technologies. The findings of this study showed that video fire detection systems are very useful in monitoring and sensing fire. In addition, advanced control panels can decrease false alarms and provide more accuracy information on fire in high-buildings. Another suggestion of the study is real time control based on Internet to increase efficiency for building management operations. Wong and Lau (2007) studied the situation of old high-rise buildings by considering fire safety standards during a period of 10 years. They surveyed fire safety levels of 122 old buildings in Hong Kong by a universal fire safety evaluation (FSE) checklist. The results of their survey indicated that only less than 5% of the samples achieved the required standards. Some major problems were exit signs, missing emergency lightening, illegal constructions, and messy electricity wiring. Zmud (2008) conducted a study on high-rise building safety, emergencies and evacuation procedures in Chicago, USA in 2006 and indicated that almost all occupants knew where fire exits were located. The findings of their study supported the need for public education about emergency evacuation procedures in high-rise buildings. Updating emergency evacuation procedures, new occupant training, and focusing education efforts on encouraging residential building managers were recommendations of the study for high-building owners. Gul and Gorun (2010) investigated the condition of the Grand Bazaar of Istanbul in Turkey. It comprises approximately 3600 small shops from different sectors. It also has 21 main gates and more than 25,000 staff work in the shops. The purpose of the study was to assess the Grand Bazaar's emergency evacuation vulnerability. The evacuation vulnerability factors question the width, length and natural illumination of the evacuation route, maintenance of the roof, presence of hazardous materials, door specifications as size, material, opening direction, maintenance and difference in elevation on the route and exit area such as staircase and thresholds. Kachenje et al. (2010) did a survey in the Central Business District of Dar es Salaam City in Tanzania. They examined urban fire risk with respect to public awareness on the use of fire fighting facilities and preparedness level in the event of fire outbreaks. Public buildings with at least 4 storeys were surveyed. The data was collected through observation and interview with users and managers. The study revealed high fire disaster risk in most buildings of the study area. The findings indicated 60% building's users did not know how to operate the facilities and only 29% had received training.

Sierra et al. (2012) did a research work about the status of fire precaution systems in hotels in Spain. In general, 146 hotels during 2004 were investigated in order to examine fire safety by using an official checklist. The results of their research revealed that beach

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