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A pattern of fire risk assessment and emergency management in educational center laboratories

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ABSTRACT

Fire is one of the most important crises in educational centers especially in laboratories. This work tried to develop a quantitative risk assessment model based on empirical data in an educational center, Azad University, Sciences and Research Branch. The more important issues were fuel and chemical leakage, high pressure reservoirs, hardware failure and ignition sources as well as the human errors in educational center. Building plan, occupancy and evacuation procedure, ability of hazard detection, safety measure, are very important in fire emergency condition. All of these parameters were used as input to the pattern of fire risk assessment. Offering a model based on analytical hierarchy process and failure mode and effect analysis logic, the current study aims to determine the factors influencing the fire risk of an education center. Testing the conceptual model for fire risk assessment was performed in the proposed site. The results showed that the laboratories and chemical warehouses could be raised the level of fire risk in an educational building.

1. Introduction

Nowadays, statistic results indicate that accident loss is estimated about 70-billion dollars per year in the world. Although risk is inevitable, the loss of accident can be mitigated through an effective risk management program. The need for more effective risk management is obvious in major accidents which, often unnecessarily, cause to loss many human lives, create massive environmental damage, and enormous material losses (Lundin and Jonsson, 2002). For an organization with a strong emergency response system, the loss can be reduced to 6% for the same organization with poor emergency system (Fiedrich et al., 2001; Chen et al., 2006). Emergency planning as part of the emergency system is a guide document to insure the rapid, orderly and effective rescue in the emergency response to major accident or disaster (Liu and Liu, 2004). Educational centers are the most important centers of the society in the crisis management. Although there is a lot of safety installed systems in the educational center units such as: laboratories, libraries and warehouses but still many accidents are frequently reported from them. They have potential to make serious injury to personnel, major damage to equipment, structure, scientific and invaluable documents and disruption of educational operation. The past few decades have seen a wide range of major accidents with a number of fatalities, economic losses and damages to the invaluable documents in the educational center. In the Faculty of Law Library in Tehran University in 1995, fire had burned invaluable historical documents. Explosion in biochemistry laboratory in Tarbiat Modarres University, Tehran (1996) resulted in death of a person and loss of the laboratory equipments. While assessing the fire risk in a building, it is important to take into account how occupants can evacuate the building. Evacuation is one of the most important parameter can be facilitated through providing emergency exit and necessary tools in advance. Due to the large number of occupants and complexity of the buildings in educational centers, when the fire occurs, the evacuation is became a major problem and may result in massive people casualties. The last studies were shown that operational failures and human errors are the most common events which cause laboratory accidents (Nouri et al., 2011). While operational failures can be averted by safety-instruments systems (through monitoring and observing the desirable limits of safety integrity level (SIL); it is difficult to identify and quantify human errors. The operational failures can be mainly attributed to design the faults or improper inspection and maintenance. A laboratory development can never be completely safe, but the degree of inherent safety can be increased by selecting optimum design in terms of the installation configuration, layout and operation. This is done in an attempt to reduce the risk as low as reasonably practicable

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(ALARP) without resort to costly protective system. This requires the identification and assessment of major risk contributors, which can be accomplished using quantitative risk assessment (QRA) techniques in the laboratory life. QRA involves four main steps: hazard identification, consequence assessment, probability calculation and risk quantification (Khan et al., 2002; Kalantarnia et al., 2009). Engineers have come to view risk as a numerical value that is a function of probability and consequences (chu et al., 2007; Reniers et al., 2005). It is difficult to make a precise assessment on probability and consequences of every fire scenario, but their lower and upper bounds can be achieved based on statistical data (Chu and Sun, 2008). With development of performance-based design, some studies have been conducted on the life risk assessment in the building fires with development of performance-based design. The expected risk of loss of the life and the expected number of deaths are proposed as an evaluation objective for life risk assessment in the risk assessment models such as FIRECAM and FIERA system, respectively (Yung and Benichou, 2002; Benchou et al., 2005). Quantitative Risk Analysis is presented to quantify the risk of occupants with consideration of some stochastic factors (Frantzich, 1998). A probabilistic fire safety engineering assessment framework is presented based on stochastic model for the interaction between the spread of untenable conditions and occupant egress in building fire (Hasofer and Odigie, 2000). Estimation of ignition probability is a key step in the risk assessment for installations in which flammable liquids and gases are stored. Among the currently available models, a few are based on the assumption that ignition probability is solely a function of release rate or size of the flammable gas cloud (CCPS, 1998). Leakage or spillage of flammable material can lead to fire which is triggered by any number of potential ignition sources (sparks, open flames and so on), depending on the types of release scenarios in the laboratories of a university. Also in a chemical laboratory, the explosive atmospheres can occur inside the equipments as a result of normal process and work practices as a result of the protection failure in the shell of the equipments and releases of flammable, explosive or oxidizing substances and explosive reactions in chemical examination (environmental laboratory). The choice of the assessment method may depend on the kind of the problem and data which are available (Medasani et al., 1998). The fire assessment and material leakage risk is a multi-hierarchy and multi-factor document system. Analytical Hierarchy Process (AHP) methods which are used in many fields can be applied to deal with multi-factor and multi-hierarchy assessment problem (Chen and Zhang, 2009; Grassi et al., 2009). Rehan constructed three-level hierarchy system to asses environmental and the aggregative risk for different discharge scenarios was calculated layer-by-layer (Rehan and Tahir, 2005). In recent decades, education population increased very quickly in Iran. Despite the existence of large scale educational buildings and tall buildings in which there are number of people, makes it very difficult to evacuate at the time of fire break-out for occupants and then the number of human casualties are increased (Kobes et al., 2010; Shi et al., 2009). Hence, in order to promote safety for personnel as well as equipment, it is necessary to perform an effective fire and material leakage risk assessment which is considered. Effective assessment of fire risk in educational centers requires a suitable method for inspection, assessment and mitigation. The Object of this study is presenting a pattern for fire risk assessment in educational center laboratories.

2. Materials and methods

Aiming at improving emergency fire management through fire risk assessment in educational centers, six emergency management goals including initiate rapid response, control incident and

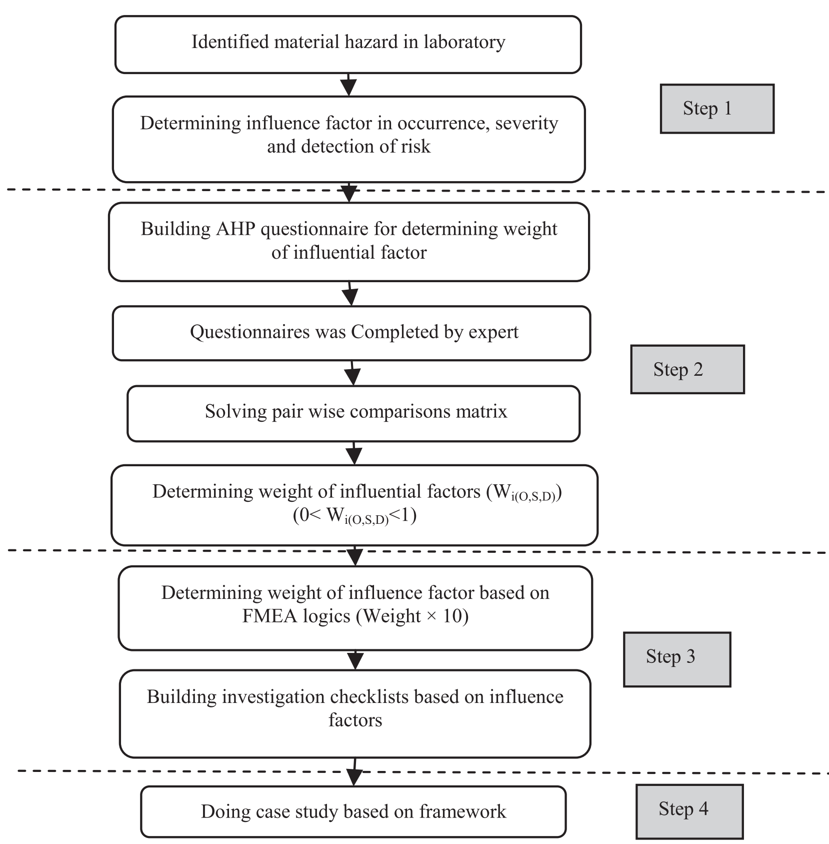

Fig. 1. Algorithm was used in this study.