

CASE STUDY

Identification and prioritization of effective factors in fire incidents preparation programs

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ABSTRACT: One of the major challenges in mega cities is the degree of the preparedness of organizations, institutions and people in facing with critical conditions and their immediate reaction according to pre-defined instructions. Identification of priorities and acting accordingly is an undeniable factor in urban crisis management. The purpose of this research was to identify the priorities of preparedness and readiness to immediate responses in case of large fire incident occurrence in the urban areas. District 9 of Tehran municipality was selected as a case study. Considering the Specific regional conditions of this area such as high population, old unstable housing constructions, presence of Mehr-Abad airport at the heart of the district, and the gas transmission pipeline mark this district as a vulnerable area to fire incidents. According to the crisis management readiness index, 2 types of questionnaires were distributed among members of the crisis department and fire rescue forces of the District 9. The results revealed that the most important priorities were basic training to residents, equipping the gas valves with automatic cutoff switches in an emergency situation, training the responsible personnel to act efficiently in the early hours of accident and performing maneuvers. SPSS software was used for statistical analysis and Cranach's alpha coefficient was used to test the reliability of the questionnaire and to test the hypotheses single-sample T-test was used.

KEYWORDS: *Effective factor; Fire incident; Immediate reaction; Preparation programs; Urban crisis.*

INTRODUCTION

Human societies are conflicting with numerous natural and unnatural disasters that result in fatality and financial losses. These events are of different types which can lead to secondary accidents if not controlled with rational response (Beringer, 2000). Even with the most advanced safety systems happening of an accident cannot be prevented Industrial, technological, social and terroristic crises happen even in the countries with the most advanced security and safety systems (Elsworth *et al.*, 2009). Natural disasters in the third-world countries has caused many crises and because of the unsuitable welfare and relief conditions,

they cause much fatality. During the last twenty years, unexpected incidents has caused the death of nearly 14 million individuals and has cost more than 1444 billion dollars. In such a short era, nearly 1 billion people were involved directly or indirectly by such incidents (Galiana-Martin *et al.*, 2011). Due to the geographical situation, climate and geological status, Iran is also considered one of the most disaster-prone countries. Every year due to floods and other natural disasters, a lot of damages and fatality happens in this country (Hasani, 2004). In addition to the items listed, poor quality of urban construction will affectively increase the harmful effects of natural disasters. Furthermore, the lack of awareness and preparedness of the people

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and officials will also exacerbate injuries and deaths from disasters. Therefore, no groups nor any organization can secure themselves against disasters and crises (Mahdavih *et al.*, 2012). Having this said, what can man do is to minimize the possibility of man-made incidents and also creating the software and hardware preparation conditions against natural and man-made emergencies (Günay *et al.*, 2009). Crisis and its management is one of the most important urban management concerns. Different crises threaten cities; among those many threatening crises is the vast urban fire (Elsworth *et al.*, 2009). Considering the elements of crisis management, the first step is prevention which in this step, the risks of vast urban fire occurrence are identified and assessed, and then it is tried to minimize or diminish them (González-Olabarria and Pukkala, 2011; Galiana-Martin *et al.*, 2011). According to the fire crisis management point of view, a complex of scientific schemes and programs should always be prepared for future possible changes inside societies and organizations and managers should concern themselves with the future possible incidents and be ready to face the unknown (Konoshima *et al.*, 2010). Considering the fact that we are not and will never be utterly safe, thus we should attend to the preparation phase. The concept of preparation is one of the most important matters which reduces the crises impacts (Lampin-Maillet *et al.*, 2009). One of the comprehensive crisis management procedures is preparation, which means that the major organizations that should come in action when the crisis occurs, should be previously identified and their responsibilities and duties should be defined (Benyi *et al.*, 2008). In other words, preparation against crisis includes activities such as creating a quick and regulated reaction mechanism which results in the limitation of natural dangers and their impacts (Diekman and Huitric, 2010). Such activities are performed by identification and assessment of dangers. The preparation phase is performed before the natural incident and includes the complex of crisis management abilities (Franklin *et al.*, 2002). In other words, preparation is a set of actions which is performed for increasing the functional ability and creating accommodations for effective reaction against the upcoming possible incident (Hwang *et al.*, 2006). Mehrdadi *et al.* (2005) investigated the basic mechanisms of fire formation after earthquakes in urban areas. Thus, considering the especial post-earthquake conditions, a set of variables and parameters were

discussed and studied as the most important reasons for fire occurrence in such conditions. In other researches, Arghami *et al.* (2009) and Jalal and Islam (2009), have orderly studied the fire incidents driven from the urban gas network after earthquakes occurrences and the importance of gas shut-off valves during earthquakes and its effective role in fire catastrophe prevention after earthquakes. In these articles, the conditions and possible options for safety status elevation of the natural gas network in the occurred post-earthquake fire incidents were discussed. Aside from studying the different mechanisms of fire formation, some other researches such as Taghavi and Karimi (2009) and Arvan (2012), have pointed out the social cooperation role in controlling the disasters' impacts. Thus, we can claim that identifying the preparation priorities and also elevating the preparation level of reaction against fire incidents in these various researches are enormously essential. In the city of Tehran, many fire incidents occur every year which cause a considerable amount of damage and fatality. Considering the inadequate architecture of Tehran and lack of segregation between residential, administrative, commercial and sometimes even industrial areas in Tehran which also include District 9 of Tehran's municipality, it is necessary not only to provide a comprehensive emergency preparation scheme so the vast urban fire risk factors can be identified, but also to raise the level of preparedness and elevating timely response and proper reaction in case of incidents.

This study has been performed in District 9 of Tehran's Municipality in 2015 (Fig. 1).

MATERIAL AND METHOD

District 9 of Tehran has very special features such as high population, old and unstable housing constructions, presence of Mehr-Abad airport at the heart of the district, and the gas transmission pipeline which make this district extremely vulnerable to the possible fire incidents.

The research includes two phases: In the first phase, the NFPA (national fire protection association) standard and FEMA (federal emergency management agency) guidelines were used for preparation against fire incident factor extraction which in general 15 main factors were extracted in this matter, as it stated in Table 2.

In the next phase, the 15 factors identified in the previous phase were transformed into the first questionnaire and it was distributed among 45 experts

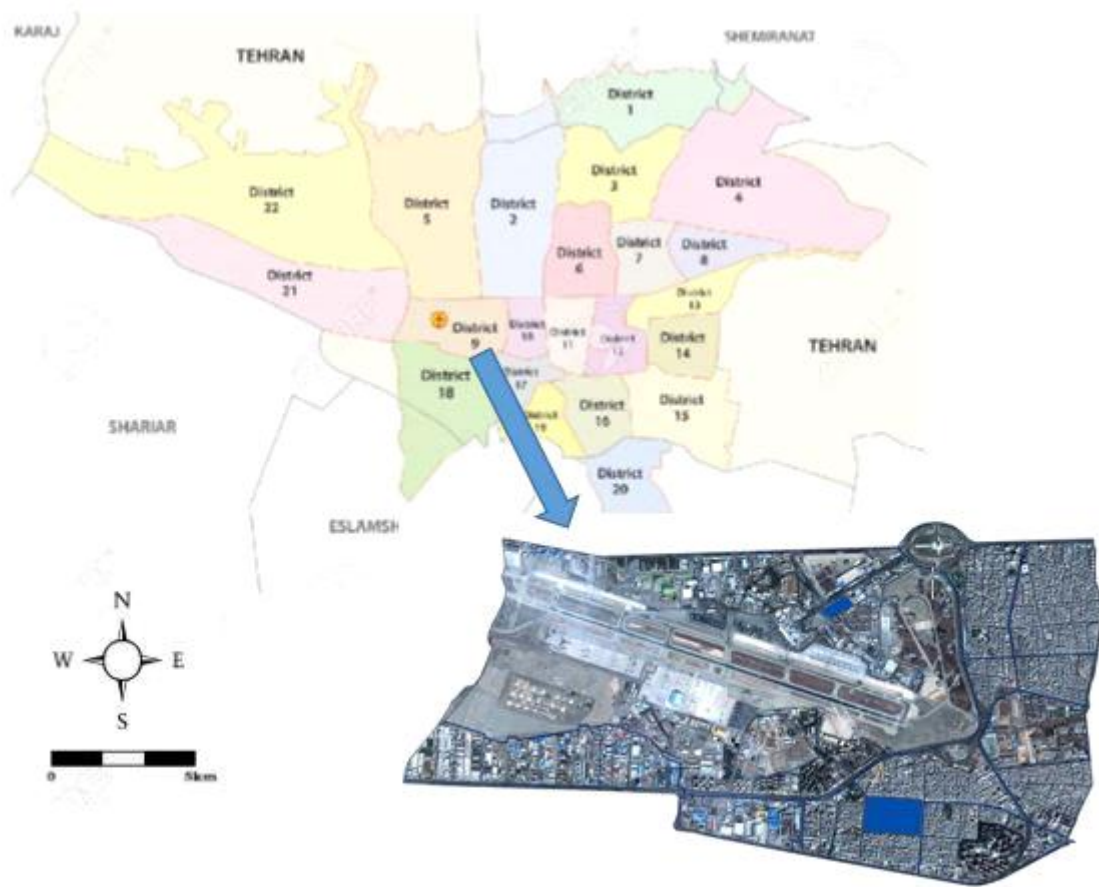


Fig. 1: Aerial pictures of District 9 of Tehran's municipality

and crisis management specialists who were familiar with crisis management program.

In the second phase, after extracting a short list of factors, 10 major factors were considered according to the priorities and the second questionnaire were conducted in order to determine the priority of each of these 10 factors based upon the districts conditions.

The second questionnaire were distributed among 40 fire and crisis management specialists who were familiar with the concept of crisis management and fire engineering and also the especial features of District 9 of Tehran's municipality.

In this step, the completed questionnaires were analyzed using the one-sample T test and in which four-fold priorities were identified. All these steps are shown in Fig. 2.

Statistical population

The statistical population in the first questionnaire was 45 individuals and in the second questionnaire were 40 persons, including employees working in District 9 municipality of Tehran Headquarters for Disaster Management and also the fire department experts working in this district. Table 1 and Fig. 3 show the occupational history of the statistical population.

Questionnaire conduction method

In this research, the first questionnaire were conducted with the purpose of identifying and contrasting the major factors of urban fire incidents according the NFPA standards and FEMA guidelines, using the secondary study and closed interview with experts and elites, and the second questionnaire were conducted upon the district's vulnerability in face of fire incidents, crisis management needs and the preparation indicators of crisis

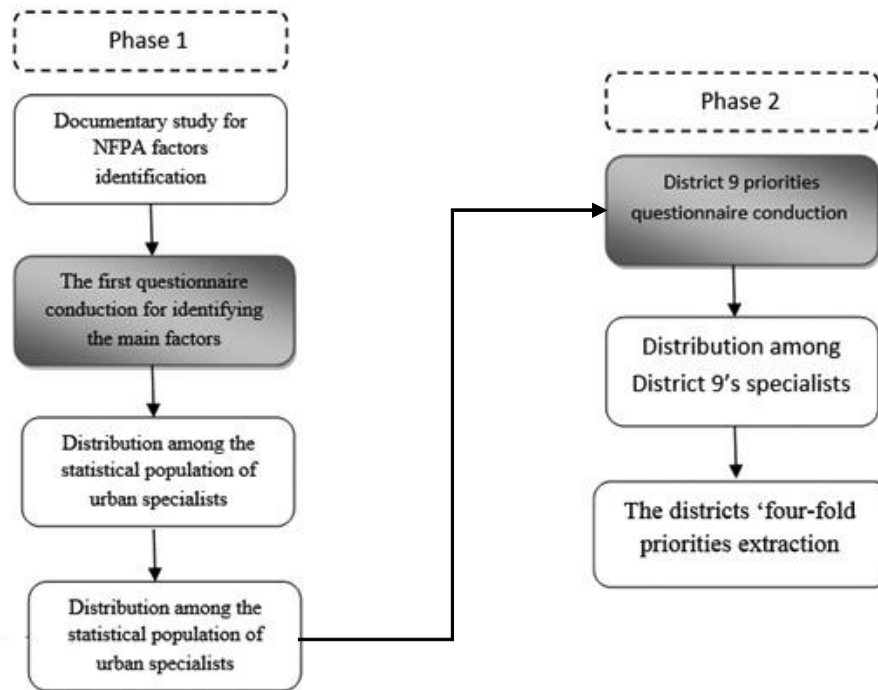


Fig. 2: Flowchart of research steps

Table 1: Occupational history of the statistical population

Statistical component	Value
Valid	48
Missing	0
Mean	12.35
Median	13.00
Mode	15
Minimum	2
Maximum	20

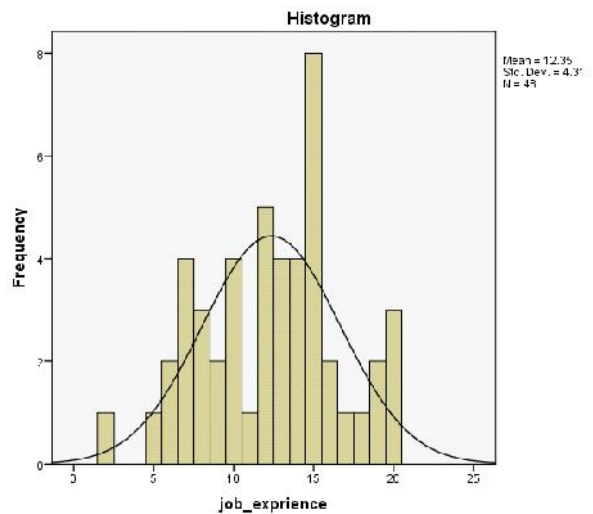


Fig. 3: Occupational history distribution of the statistical

management and upon the major factors extracted from the first questionnaire (Table 2).

Questionnaire's reliability and validity

Finally, in order to assess the validity of these questionnaires, they were completed by the qualified

experts working in the Headquarters for Disaster Management (HDM) in dDistrict 9, fire department experts working in the district and also some of the supervising professors related in this field. In order to evaluate the questionnaires' reliability, the Cronbach's alpha test were used and considering that the reliability

were higher than 0.7 ratio, the questionnaires were of decent reliability. These statistical results are summarized in Table 3.

Statistical analysis

In order to perform a statistical analysis, the SPSS ver. 16 was utilized, and the Cronbach's alpha test for reliability assessment and the one-sample T-test were used for hypothesis examination.

In order to investigate the research questions, values were dedicated to each 5 questions and then

according to the rankings, the priorities of the preparation program were determined.

RESULT AND DISCUSSION

The research hypothesis is defined: preparation priorities against fire incidents in District 9 of Tehran's municipality include general and specialized trainings, awareness and correction of the software and hardware substructures. After analyzing the questionnaires which were segregated in two divisions of the City of Tehran and District 9, and considering the rankings,

Table 2: Elements of preparation against fire incidents in the two questionnaires

Number	Elements of preparation against urban fire incidents (the first questionnaire)	Elements of district 9's preparation against urban fire incidents (the second questionnaire)
1	Firefighting equipment distribution among citizens	Responsible organization's staff training
2	Resource (financial, staff, equipment) management	Obliterated contexture renewal
3	Creating adequate management structures	Relocating the factories of this district to the suburbs
4	Continuous practices and operational maneuvers	Identification of risk potential in the district
5	Awareness and recognition of the weak points	Public training of the residents
6	Public training	Equipping the gas regulator devices with the emergency gas shut-off technology
7	Identification the responsible organizations and the clarity of their duties	Relocating the gasoline lines to the suburbs
8	Increasing the quality and the quantity of organization equipment	Factories immunization and equipping them with firefighting factors
9	Existence of a crisis management information bank	Immunization of fuel stations and equipping them with firefighting factors
10	Increasing the operational power level of the responsible organizations' staffs	Practicing and operating maneuvers
11	Having accurate information of fire occurrence and when it turns into a critical status	
12	Describing and setting up an incident management system	
13	Transformation the structure of the obliterated contexture	
14	Availability of completed schemes and planning for reaction	
15	Industrial and strategic contexture immunization	

Table 3: Statistical results of the Cronbach's alpha test ratio

Type of questionnaires	Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	Number of items
first questionnaire	.918	.921	45
second questionnaire	.922	.939	40

the data of both sections were determined and finally, by prioritizing the factors of the second questionnaire, the most important priorities of the preparation program of District 9 of Tehran’s municipality were ranked (Fig. 4).

It is noteworthy that considering the normality of the distributions, in order to assess the items relevant to the research hypotheses, the one-sample T-test were

used. As it is shown in Table 5, considering the meaningful level lower than 0.05 ($p < 0.05$) for all the items related to the research hypotheses, it can be concluded that the research hypotheses are approved considering the intended priorities where listed in Table 6. Also, Fig. 6 demonstrates results of the preparation priorities ranking at the times of fire incidents.

Table 5: Table of the most important priorities in urban fire preparation

Rank	Title	T score	Sig*. (2-tailed)	Score
1	General training	23.592	P < 0.05	223
2	Equipping the gas regulator devices with the emergency gas shut-off technology	22.489	P < 0.05	222
3	Responsible organization’s staff training	17.592	P < 0.05	221
4	Practicing and operating maneuvers	14.885	P < 0.05	210

*The significance level

Table 6: T-test of priorities in district 9’s preparation against urban fire incidents

Item	Test Value = 3						Score
	T	Df**	Sig*. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference		
					Lower	Upper	
Item 1	17.592	9	.000	1.625	1.44	1.81	221
Item 2	10.007	9	.000	.875	.70	1.05	200
Item 3	9.402	9	.000	.896	.70	1.09	195
Item 4	8.271	9	.000	.875	.66	1.09	188
Item 5	23.592	9	.000	1.646	1.51	1.79	223
Item 6	22.489	9	.000	1.604	1.46	1.75	222
Item 7	7.265	9	.000	.979	.71	1.25	179
Item 8	13.592	9	.000	1.646	1.51	1.79	180
Item 9	10.634	9	.000	1.125	.91	1.34	191
Item10	14.885	9	.000	1.375	1.19	1.56	210

*The significance level

**Degrees of freedom

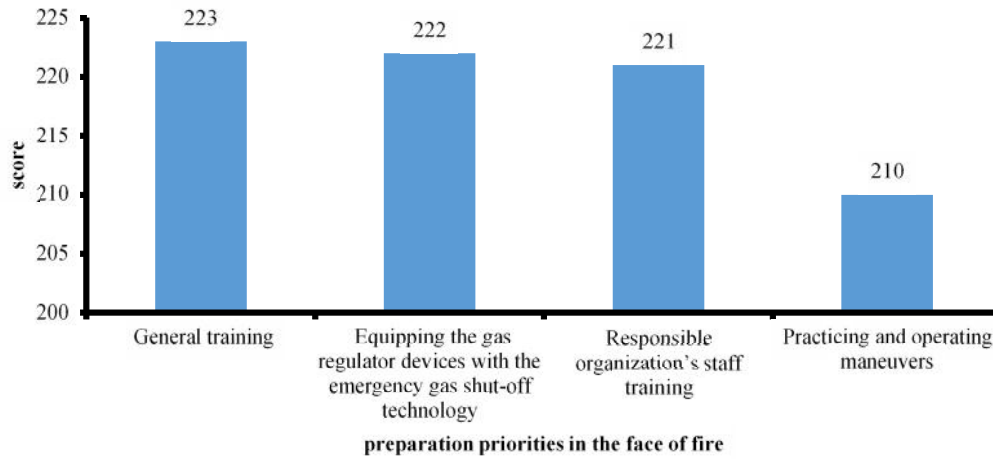


Fig. 4: The results of the preparation priorities ranking at the times of fire incidents

CONCLUSION

Generally, crises activities can be divided into three groups of before crisis, during crisis, and after crisis. As these preparation concepts are parts of the actions done before the crisis, it was tried to identify all the significant preparation activities before fire incidents (Beringer, 2000). The result which concluded from this study, the most important preparation priorities include general trainings, Equipping the gas regulator devices with the emergency gas shut-off technology, Primary responsible organization's staff training, Practicing and operating maneuvers. Considering the conditions of the growing speed of fire spread and the golden time which during that, the fire must be quenched, more delay in reaction time results in the progressive increasing speed of fire spread (Galiana-Martin *et al.*, 2011). Thus, it is necessary to spread general trainings across the society and different groups so that in the early moments of fire when the degree of fire is low, the fire could be quenched by the individual him/herself (González-Olabarria and Pukkala, 2011; Galiana-Martin *et al.*, 2011). Trained citizens as vulnerary firefighters play an undeniable role in elevation of immunity ratio by using their knowledge of immunization and safety with two approaches of prevention (before incidents) by training and autoimmune and the reactive approach (during and after incidents) by helping the medical assistance force or other-assistance actions until the arrival of expert and professional responsible forces.

Thus, how these group is instructed needs to be planned in quality and distribution (Konoshima *et al.*, 2010; Lampin-Maillet *et al.*, 2009). Taghavi and Karimi (2009) and Keshvaridoost (2011), each in different studies attempted to investigate the role of citizens training and cooperation in urban fire control for urban crisis management and planning and both have shown results similar to the results of this study, and that is general training and increasing the society's awareness of the different methods are among the most important preventive activities in urban safety provision. About awareness and recognition of the weak points, in case of achieving this goal, the risks can be predicted across the society and in different circumstances, and by preventive actions, the necessary preparation for showing a suitable reaction were put into agendum (Galiana-Martin *et al.*, 2011). One of the examples of this matter is the danger of the urban gas regulator devices which is identified as one of the preparation priorities in this research and it is recommended that the urban gas regulator devices be equipped with the latest and localized gas shut-off technologies. Arghami *et al.* (2007; 2009) in separate investigations identified the danger of the urban gas regulator devices as one of the important fire factors after earthquakes. Increasing the operational capacity of the responsible organization's staffs by training and instructing the primary responsible organization's staff are of the other

elements and priorities of preparation against fire in this research (Benyi *et al.*, 2008). In case of spread of fire and turning into a vast fire, it is necessary that the professional operational forces of the responsible organization come in action, which in this case, by presenting training suiting different incidents, these staffs would be prepared to act upon different aspects of incidents and by designing similar operations, the forces readiness were assessed so that they could take a re-training course if necessary. Continuous practices and operational maneuvers were of other elements and priorities of preparation against fire incidents. Similar circumstances to the real incidents would be created during the practices and maneuvers and forces should become aware of their strong and weak points during crisis and try to demolish the weak points and strengthen the strong ones (González-Olabarria and Pukkala, 2011; Galiana-Martin *et al.*, 2011; Mehrdadi *et al.*, 2005).

It is recommended to carry out further research to be conducted similar research in other areas of Tehran city. Also, more comprehensive researches it should be conducted with more detailed criteria in this area.

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CONFLICT OF INTEREST

The authors declare that there are no conflicts of interests regarding the publication of this manuscript.

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