

Research Article

Strategies of Crisis Management in Urban Transportation

¹Alireza Naseri and ²Masoud Naseri

¹Department of Civil Engineering, Tabriz Branch, Islamic Azad University, Tabriz, Iran

²Department of International Marketing, Central Tehran Branch, Islamic Azad University, Tehran, Iran

Abstract: Crisis management which uses the most effective traffic management solutions based on information technology in the field of urban transportation is a part of strategic management. Unquestionably it requires a systematic approach based on precise planning, managerial delicacy and organizational preparedness. In the studies regarding the management of urban transportation network for emergency situations, the entire activities and necessary measures for managing the transportation is selected and prioritized, after the current condition and the probable crises are studied. This prioritization is conducted according to assigning a certain weight to each activity and its subdivisions considering the population of regions. In order to choose the most important paths in the network, the prioritization is performed as per the classification of the existing network of passageways and the network analysis and the way junctions are controlled and their accessibility. After this stage, some of the paths are modified in order to achieve optimum performance. The aforementioned study has been conducted as a sample for the network of major passageways of Tabriz.

Keywords: Crisis management, street network, traffic management, urban transportation

INTRODUCTION

In the recent years, crisis management has been of great interest as one of the most effective and most sustainable methods of defense against threats and it is considered to be a significant approach. Through taking into consideration crisis management measures in urban regions, certain goals such as the following may be achieved:

- Noticeable decrease in vulnerability
- Creating a defensive situation and an appropriate performance when facing accidents and crises
- Creating hindrance and obstacles against natural and security threats
- Considerable saving and preserving national assets

Investigating and applying the measures and principles of crisis management in the field of urban transportation greatly contributes to the management process in critical conditions. Studying the process of transportation management in emergency situations is of special importance, particularly in metropolises with a large spread of urban space and a high rate of daily traffic in the network of passageways. It should be noted that optimum design and planning and observing performance principles in the field of urban transportation plays an important role in reducing vulnerability and also increasing preparedness against threats. Planning and management should be in such a

way that it can always fulfill the needs of citizens and users in a proper manner especially in critical conditions and take care of traffic distribution process in different levels and aid easy and suitable service providing process (Sahami, 2007). Furthermore, since some urban usages as important strategic, economic, political and demographic goals may be jeopardized, the process of accessing these important usages should be possible in all conditions through vital arteries and urban passageways. In modern cities in which urban planning proceeds urban life, infrastructures and significant usages are planned and located in the study phase. However, in the existing cities where usages develop gradually, the locating and planning of usages is gradual. It needs to be explained that locating emergency, vital and service usages should also be distributed and positioned according to the classification and the hierarchy of the spatial structure of the city.

Definitions: The following definitions may be pointed out in order for more familiarity with a group of terminology.

Vulnerability: The preparedness of a society or a part of it to withstand threat or loss, when exposed to physical phenomena of social or natural kind and difficulties upon reconstructing these damages is called vulnerability (Movahedi, 2007).

Crisis: It is the occurrence of an abrupt change and a serious disruption in the performance of society and environment in a way that they are affected by this disruption and is incapable of confronting extensive human, economic and environmental losses in normal conditions. In fact, a crisis leads to a discord between demands and resources. This means that there is a harmony between ordinary demands and the existing potentials and resources in normal conditions. As critical situations begin to arise, the existing harmony is disrupted due to the special conditions imposed on the society as well as the damage inflicted on infrastructures (Movahedi, 2007).

Crisis management: The process of predicting and preventing the occurrence of crisis, taking action and intervening in the crisis and the remedial measures after the crisis occurrence is called crisis management. Crisis management is an applied science which by means of systematically observing crises and analyzing them seeks a tool with which crises can be prevented or in case they occur, actions can be taken with regard to reducing its effects, the necessary preparedness for quick assistance and improvement of situations. The chief weak spots of crisis management are disharmony and a lack of cooperation by the organizations, lack of comprehensive regulations and dispersal and inadequacy of existing rules and limitation of financial resources (Movahedi, 2007).

Problem statement: The transportation system crises when facing emergency situations may be considered as follows:

Decrease in offer: It happens when the normal capacity of the network suddenly reduces because of damage.

Sudden change in demand: Great increase in demand for evacuation of a region so as to reduce the probable effects which could be caused by a possible crisis could give rise to another crisis.

Damage of management and control structure of the transportation network: The lack or damage of network management and control could lead to a crisis. For instance, a lack of a plan for maintenance of bridges could result in a crisis in the long run (Hosseini and Mirza Hossabi, 1999).

Moreover, studying the behavior of users is mandatory upon analyzing the network and estimating offer and demand in all stages. Citizens may be categorized into some groups for analysis: The first group is the vehicles on passageways and indeed the existing traffic load throughout the network. This can lead to the blockage of paths in case things change. The second group is the citizens who use the network with or without a vehicle for purposes such as evacuation of the region or assistance, once abnormal conditions

prevail. The third group is the assistance forces who use the network to carry out their duty. The fourth group is security forces who should control network traffic after the crisis and are in charge of opening the pathway and allocating it to assistance forces. Upon analyzing the behavior of users in abnormal conditions, a number of factors such as intensity, time of occurrence, commitment level to regulations and their degree of enforcement are influential. As a matter of fact, the more the damages, the more critical the situation will be. Furthermore, if the time of occurrence coincides with the rush hour when the passageways are providing service with maximum capacity, the problem becomes complicated (Sarraf, 2007).

Crisis management in urban areas is generally comprised of the stages of prevention, assistance, organization and reconstruction. Performing these stages properly leads to the continuation of life, economic saving and preserving economic and social centers. The precautionary measures should initially be determined and explained for this purpose. The necessary precautionary measures may be summarized as follows:

- Making a list of precautionary measures for the management of emergency situations
- Investigating the structure and geographical dispersion of executive and demographic pillars and the connective network
- Identifying the tasks of different security, assistance and service sections
- Identifying the rules and the existing and relevant processes
- Conducting analytical studies and explaining probable scenarios (Sarraf, 2007)

The correct analysis of information presents an appropriate tool for decision making. It should be considered upon gathering and organizing information that the network of vital arteries are influenced by one another during a crisis and their separate reaction cannot merely be thought of as a criterion; rather, the urban transportation system is investigated as a whole. Crisis management is substantially influenced by information management. Hence, precise and up-to-date databases should be accessible. In fact, information's quality, accuracy and the state of being up-to-date are of great importance in the field of information management (Hosseini, 2007).

RESEARCH METHODOLOGY

In order to study the transportation network in urgent conditions, the first step is to choose the network of primary paths. The network is characterized in form of links and nodes in study regionalization. The information of important service centers such as assistance centers, crisis management and police

Table 1: Categorizing the components of the transportation system and determining the major factors of each component

Network	Fleet	Terminals	Management system	Human force
Highways and the street network	Buses	Park rides	Rules and regulations	Transportation managers
Equipment and signs	Ambulances	Emergency stations	Traffic control center	Drivers
Buffer walls	Firefighting vehicles	Firefighting stations	Subway control center	Experts and specialists
Grade separation	Taxis and vans	Bus terminals	Command system	Police and security forces
Skyway	Subway train	Subway stations	Information banks	
Urban railroad	Trucks and tankers	Red crescent centers	Communication systems	
Intersections and squares	Assistance vehicles	Gas stations		

centers are then reviewed and prioritized according to network analysis and so are the most appropriate paths as per the two characteristics of urban paths' classification and also transportation network analysis in the next step.

Investigating the activities of transportation system:

The urban transportation system is categorized into the fundamental components shown in Table 1, including network, fleet, management system, terminals and human force (Pouryari *et al.*, 2007).

Method of determining investigative and executive necessities in transportation management:

In order to present an analysis regarding transportation system management, the activities are investigated and the requirements are assessed with the aid of the improvement cycle. The analysis using the improvement cycle will help to prioritize projects if necessary and make operational them by presenting required criteria and performances such as the budget allocated to each project and political, social and etc., necessities, while having a holistic look with respect to the current necessities and requirements. This model provides a framework for the betterment of processor system. In the improvement cycle or PDCA, the last step of the completion of the previous stage is the first step of the next stage. In spite of the continuity of improvement quality, the process may be always analyzed and its changes may be tested again. Using what we obtain in an experience, we can start more complex experiences. The constituents of Deming's cycle and their general concept are explained as follows:

Plan is a change or test which is considered for improvement. In this stage, the projects which are improved are analyzed and the improvable areas are found. The first step is to select those areas which are in priority. In the investigation or study phase, the positive and negative results of the plan are re-examined. This is a vital stage in the cycle. After the changes are made, it should be recognized in a short time to what extent this implementation has been effective. Has it really led to the expected improvement in the project or not? In this part, the improvement level should be adjusted and decisions should be made in proportion to assessments.

In the do stage, the changes are recorded and the cycle is reinitiated. In case this change merely leads to waste of time or its continuation makes the project encounter problems, the change may be stopped or a new change may be planned (Hwang and Lin, 1987).

Determining necessities and prioritization:

A holistic outlook on the performance of transportation management system in emergency situations may be achieved by determining the advancement process of each of the projects in the process of transportation management system in critical conditions. It is noteworthy that determining the contribution or importance of each component of the transportation system components to/in the performance of the system (W_i), the contribution of each study field to the subcomponent (W_j) and the contribution of each project in the study field (W_k) are among the necessities and prerequisites of the initiation of prioritization process in performing the proposed presented projects. This should be done by urban managers in the field of transportation. Once the criteria are determined and the weights are allocated to each criterion, this prioritization may be achieved based on the multi-criteria decision making method and also the following method, according to the requirements (Hwang and Lin, 1987).

Determining the weight of each component, each factor and each project:

$$W_i = WN + WV + WM + WT + WH = 1.00 \tag{1}$$

$$W_{ijk} = W_i * W_j * W_k \tag{2}$$

where,

- W_{ijk} = Contribution of each project to the entire space of critical transportation system
- W_i = Contribution of each component of critical transportation system
- W_j = Contribution of each study field to the subcomponent
- W_k = Contribution of each project to the study field

Determining the weight of each project in each stage of Deming's cycle:

Thus, the order of weighted contribution of the progress of each project in the improvement cycle is calculated as follows:

$$S_i = (\alpha_i P_i + \beta_i D_i + \gamma_i C_i + \theta_i A_i) / 4 \quad (3)$$

where,

- S_i = Weight of each project in the cycle
- α_i = Weight of the plan stage
- β_i = Weight of the do stage
- γ_i = Weight of the check stage
- θ_i = Weight of the act stage
- P_i = Progress percentage of the project in the plan stage
- D_i = Progress percentage of the project in the do stage
- C_i = Progress percentage of the project in the check stage
- A_i = Progress percentage of the project in the act stage

Determining the priority of each project:

$$Ranking (i) = W_{ijk} / S_i \quad (4)$$

CASE STUDY

Tabriz city is studied as a sample according to the planned method of studies. Tabriz is the center of Eastern Azarbaijan province and with an area of approximately 170 km² and population of almost 1,495,000 people, an approximate 2,800,000 daily urban trips take place in the city. A total of 21% of the trips are done by bus, 24% by taxi and the rest by other vehicles. This bulk of trips with the aforementioned composition occur in a network of passageways with the extent of 165 km first class artery passageways, 362 km second class artery passageways and 70 km main access passageways. Moreover, based on the

comprehensive studies conducted by Tabriz Transportation and Traffic Organization, 4 lines of urban train totaling 48 km have been approved which have not yet been put into operation (DTTS (Department of Transport and Traffic Studies), 2005).

Considering the shape of the passageway network and the rate of daily trips and also studying the regions and usages causing a great number of trips and density of population in Tabriz, the main managerial activities and planning and the subordinate actions were defined for the time of emergency situations and they were studied and assessed. Finally, bearing in mind the importance and quality of execution of different parts of activities, weight assignment and prioritization was conducted according to Table 2 and the contribution of each of them to each study field was determined.

It should be taken into consideration that executive and managerial priorities are constantly reviewed and reexamined given the progress level of the mentioned parameters in each of the stages of plan, do, check and act in different sections of network management in emergency situations. Identification of usages and the maps of the studied regions are presented based on the prioritized activities, information, categorization and traffic analyses of the network of passageways.

The required information for studying and analyzing the traffic of Tabriz in order to plan in the field of crisis management is presented in the identification and categorization of regions and the locations and also the network traffic analysis in the current situation are given in form of location maps of assistance, police force, public transportation and crisis management centers and the map of categorization of Tabriz passageways and the map of intersections equipped with intelligent traffic control cameras as well as the map of traffic flow analysis are presented using emme/2 software. According to Fig. 1, the dispersion and location of assistance, security and first aid

Table 2: Categorization and weight assignment for main activities and the subdivisions of the measures for management of emergency situations

Main activities	Weight	Subdivisions of main activities	Weight
Network traffic analysis	0.353	Studying and managing main passageways and junctions starting at or ending in important vital usages	0.361
		Categorizing the network of urban passageways (first and second class arteries and local)	0.229
		Traffic flow analysis (the load of normal and critical traffic flow in the network)	0.217
		Management of public transportation system	0.104
		Management of intersections and prioritization (control level of junctions)	0.089
Identification and examination of important locations and usages	0.328	Specifying the location of hospitals, clinics and the red crescent	0.359
		Specifying the location of the centers of police and security forces, crisis management headquarters and firefighting stations	0.310
		Investigating regions and usages in terms of population density	0.214
Communication and information systems	0.319	Specifying the location of main bus terminals and gas stations	0.117
		Communication and data exchange systems between the managerial and operational and assistance centers through fiber optic and wireless network	0.347
		Radio information systems in order to broadcast necessary information to the citizens such as traffic status	0.229
		Satellite information systems to communicate and sending urgent information to the central headquarter and neighboring regions	0.220
		Information dissemination in order to present useful information based on traffic conditions in form of VMS boards on the roads	0.204

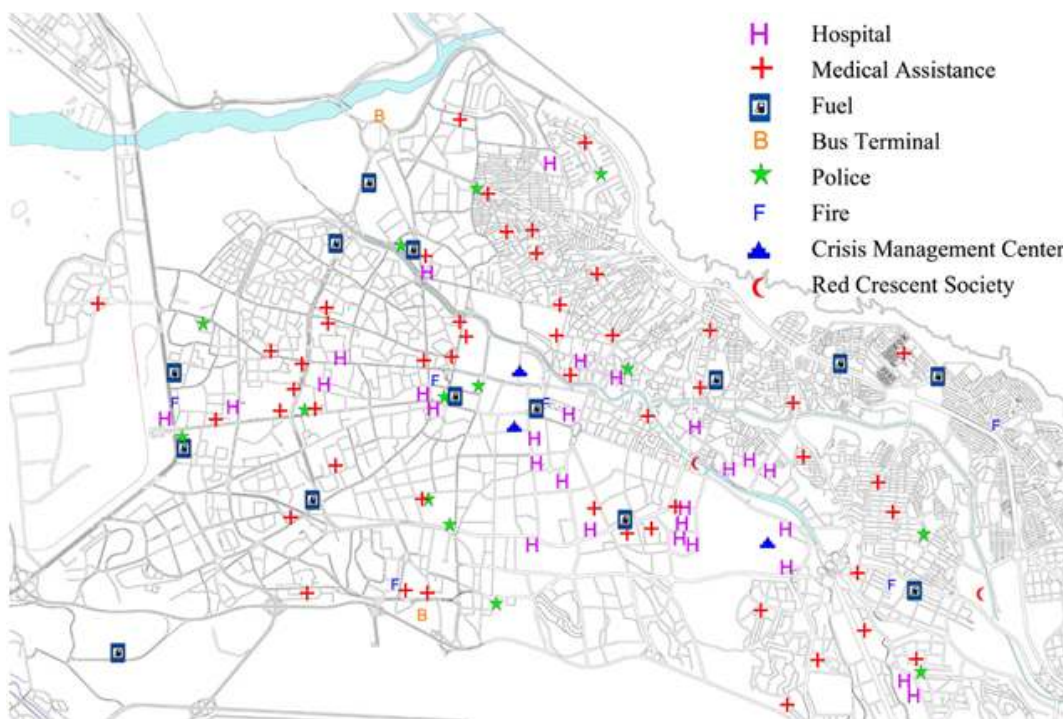


Fig. 1: Location of important places in connection with management and services in critical conditions

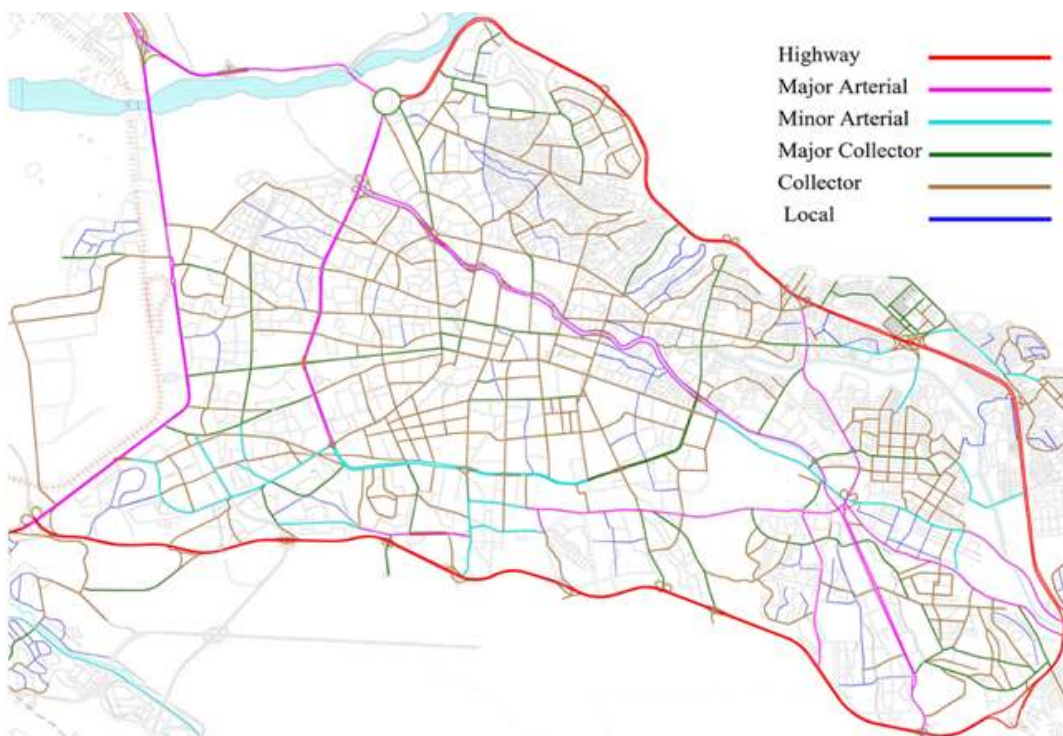


Fig. 2: Categorization of the network of passageways in Tabriz

providing centers and terminals of public transportation in Tabriz may be seen. These centers' being located in central densely populated urban areas is something which can be observed in this figure.

In Fig. 2, the study on the categorization of the existing network of passageways in Tabriz is presented with first class and second class artery passageways and main access passageways differentiated. The



Fig. 3: Position of traffic control cameras in the network of passageways



Fig. 4: Demonstration of traffic load and the v/c index in the network of passageways in Tabriz

observation and examination of the distribution of this categorization is intended for planning and prioritizing the management of passageways in emergency situations.

Attention to control equipment and intelligent traffic management and using it in the process of urban traffic management in critical conditions is also

considered a unique advantage to this end, the position of junctions and the routes equipped with traffic control cameras are specified in Fig. 3. Studying the performance characteristics of the transportation system and the service level of the network of passageways is proposed in order to prioritize and manage the emergency conditions of paths along with studying the

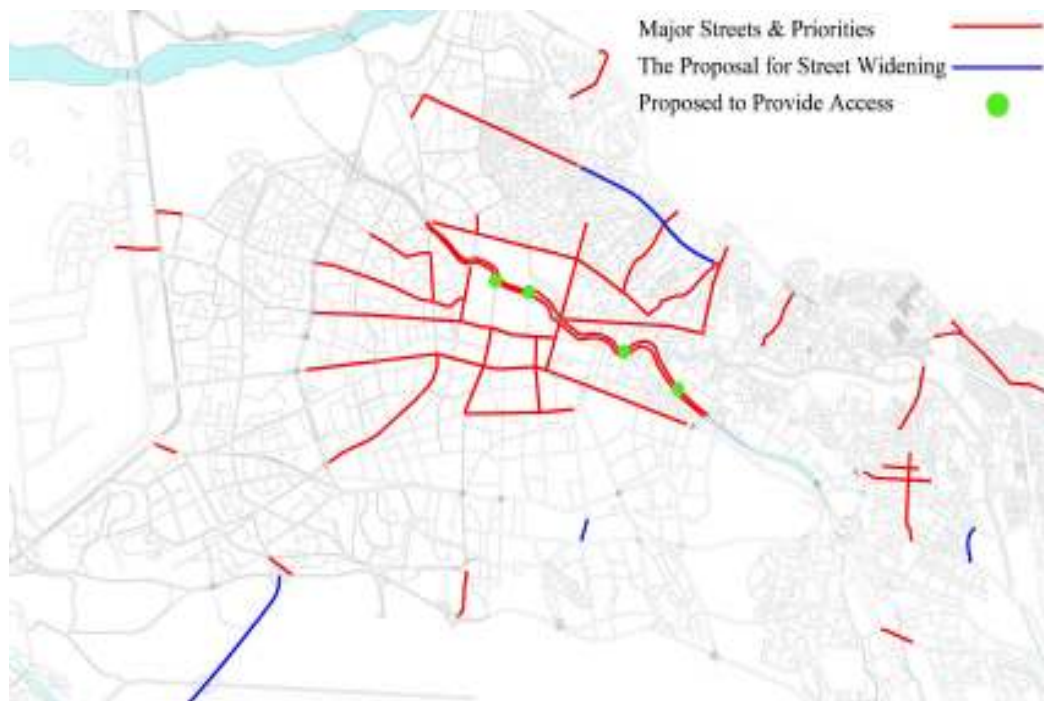


Fig. 5: Prioritized passageways and recommended routes for reopening and organizing

physical characteristics of urban transportation network of Tabriz and the location of service centers.

Thus, allocation of traffic to routes in the Tabriz traffic network which is modeled and simulated using emme/2 software is shown in Fig. 4. After studying, investigating and prioritizing traffic in Tabriz transportation system, parts of the network of passageways which are of more importance in terms of performance at the time of crisis as well as routes which need to be reopened for the completion of the network and the entrance to and exit from it, are specified. The summary of this information is shown in Fig. 5.

As shown in Fig. 5, the passageways which are prioritized in terms of access of population centers to assistance, medical and service locations are in red. Moreover, some passageways are the only access routes to residential complexes whose service providing quality control is naturally of great importance. Furthermore, the need for reopening and completion of the path of some passageways is observed by investigating network priorities and access in emergency situations. Among these passageways is the extension of Enghelab Street (42 metri) in northern Tabriz and the extension of Hafez Street downtown and reopening the route of Kuye Ostandari in eastern Tabriz and Tabriz-Sahand highway. The aforementioned passageways are in blue. In the existing network, there is a possibility for the construction of a u-turn to provide access in two spots on Chaykenar route and in two locations (Shahid Madani Street and Shahid

Motahhari Street) turns to left and right are respectively recommended.

CONCLUSION

The investigations indicate that there is a massive bulk of executable projects compared to what has already been done. The projects performed with respect to crisis management in the field of transportation have on the one hand low quantity and bulk and on the other hand they have been conducted separately and with no focus on the totality and the goal of the system. The most important shortage of the transportation section in the crisis management system is that it is not obvious to what it should respond. In other words, the patterns of demand change and the response time in critical conditions is not clear for it. Hence, the goals of emergency transportation management system should be clarified in the first step so that precise detailed planning of the system is facilitated in the next step and standardized cohesive plans may be procured and executed in the sections of management, network, fleet, terminals and human force. In addition, the temporal priority of the performance of each of the projects in the general space of the transportation system at the time of crisis should be put together and on the other hand, the exact tasks of the transportation system at the time of crisis should be investigated by examining demands. Finally, it is recommended that the capacities of intelligent transportation systems be utilized in the field

of management and information dissemination in the process of crisis management and passive defense.

REFERENCES

- DTTS (Department of Transport and Traffic Studies), 2005. Tabriz transport and traffic studies: Origin-destination database and street network. Municipality of Tabriz, 11: 58-64.
- Hosseini, M., 2007. Crisis Management. Nashr Shahr Publication, pp: 34-39.
- Hosseini, M. and A. Mirza Hossabi, 1999. Lifelines interaction effects on the earthquake emergency response of fire department in Tehran metropolis. Proceeding of the 5th US Conference on Lifeline Earthquake Engineering, Technical Council on Lifeline Earthquake Engineering, 16: 731-740.
- Hwang, C.L. and M.J. Lin, 1987. Group Decision Making under Multiple Criteria. Springer-Verlag, Berlin.
- Movahedi, N.J., 2007. Principles of passive defense. Passive Defense Engineering Research, Malek Ashtar University, pp: 46-50.
- Pouryari, M. *et al.*, 2007. The role of transportation emergency management system in Tehran. Proceedings of the 3rd International Conference on Crisis Management, pp: 86-95.
- Sahami, H., 2007. Planning and positioning. Passive Defense Engineering Research, Malek Ashtar University, pp: 24-27.
- Sarraf, H., 2007. Determination and priority setting of the passive defense measures. Proceedings of the 1st Conference on Ground Defense, pp: 125-134.