Evaluating and Prioritizing Factors Affecting Road Traffic Accident Relief in Iran

Iraj Ahmadi[1], Sajjad Ahmadi[2], Teimour Hosseini[3], Shahamat Hosseinian[4], Davoud Chegini[1], Seyed Saeid Kashfi[3]

Date of submission: 5 June 2018, *Date of acceptance:* 2 Oct. 2018

Original Article

Abstract

INTRODUCTION: Timely delivery of emergency care and reduction of the transmission time of injured people to health centers is very effective in reducing the number of deaths and injuries in accidents. The purpose of this study was to evaluate the factors affecting road traffic accident relief in Iran with an emphasis on air transport.

METHODS: The present study was performed through using Multiple Attribute Decision Making (MADM) statistical techniques and operation research like Analytic Hierarchy Process (AHP) by means of establishing hierarchy process, pairwise comparisons, combining weights, analyzing sensitivity, and ranking method, which were compatible with the research methods and type of variables. The study population consisted of 3759 managers, faculty members, experts in the field of rescue and relief, and road users. Using the Cochran sampling method, 349 participants were selected. They answered a researcher-made questionnaire about the factors affecting road traffic accident relief in Iran; the validity and reliability of the questionnaire were approved. The collected data and research hypotheses were considered through statistical tests in Expert Choice software.

FINDINGS: Human factors, equipment factors, managerial factors, and environmental conditions criteria with relative weights of 0.3810, 0.3738, 0.2149, and 0.0303, respectively, had the highest effect on human casualties in rescue operations. Assessment of the sub-criteria showed that the lack of a functional structure and appropriate organization to lead rescue operations, emergency and hospital personnel with insufficient expertise and skill, and delays in rescue, and increase in the time of rescue had the first places of importance, respectively. Finally, prioritizing rescue operations based on the type of transportation indicated that air emergency, ground emergency, and Red Crescent rescue and relief, had, respectively, the first, second, and third places in reducing human casualties.

CONCLUSION: Lack of expertise and skills of staff, equipment failure, and lack of a systematic structure in relief systems have increased damage to the injured, and, provided that the required infrastructure is created, air rescue must be prioritized over land relief due to its reduction in human casualties.

Keywords: Analytic Hierarchy Process (AHP); Road Traffic Accident; Rescue; Air Transport

How to cite this article: Ahmadi I, Ahmadi S, Hosseini T, Hosseinian S, Chegini D, Kashfi SS. **Evaluating and Prioritizing Factors Affecting Road Traffic Accident Relief in Iran.** Sci J Rescue Relief 2018; 10(3): 35-41.

Introduction

A quick look at the high rate of traffic accidents in the country can reveal the importance of road accident relief. The Red Crescent Organization and the emergency medical teams (EMT) are among the leading health and safety officials in this field, and committed to providing high quality services in this regard.

In addition, factors including the uncertain

1- PhD Student, Traffic Safety Management, Amin Police University, Tehran, Iran
2- PhD, Maragheh University of Medical Sciences, Maragheh, Iran
3- PhD, Amin Police University, Tehran, Iran
4- PhD, Amin Police University, Tehran, Iran
Correspondence to: Iraj Ahmadi, Email: ahmadidizaj@yahoo.com

[DOI: 10.52547/jorar.10.3.35]

nature of the incidents, deficiencies in timely preparedness, management of the accident scene, inadequate expertise and experience in transferring the injured, improper provision of advanced life support (ALS) and basic life support (BLS), lack of appropriate equipment, adverse environmental conditions, and several other factors provide the grounds for disruption and risk as well as reduced quality of road rescue operations. Therefore, the increased risk causes increased injuries and deaths, and ultimately high costs to the relief system and the injured individuals. One of the key elements of safety management systems is hazard identification, risk assessment, and their control, helping the experts to make reasonable decisions to reduce the probability of accidents and the severity of their consequences trough performing the necessary investigations (1).

As a medical relief system, air rescue has certain advantages such as reduced travel time and the ability to provide relief in urban and rural areas and even the seas, although these facilities are closely related to the geographical location of the region and the capability of the system. In many provinces, rescue helicopters play the role of a backup team, and their most important task is to transport patients to the nearest hospital center. The unique facilities of helicopters to deliver fast, stable, and effective services are in contrast with the planning problems and high cost of this system, which has reduced its acceptability in third world countries (2).

The injured people rescued by the air rescue system will benefit from its three main features compared to the road rescue system during the early moments of the relief operation. The important advantages of this system include access to impassable areas, reduction in initial rescue time, and faster transfer of the injured to medical centers. Therefore, from a functional viewpoint, comparing the two abovementioned relief systems, given the large number of people rescued from inevitable death by air ambulances, will yield a definite result (3).

In Iran, due to functional problems such as the lack of facilities for helicopters to be deployed in all hospitals, less attention has been paid to their use to transfer patients from one medical center to another. One of the most important issues in providing timely services to the individuals in need of rescue is the optimal location of deployment of the helicopters (4).

Establishing a base in any urban study area can provide the fastest service to patients; however, given the limitations in urban spaces and lack of access to sufficient helicopters and trained personnel, advanced studies to determine optimal locations for rescue centers, especially in residential areas is of paramount importance (5).

In a study on patients transported by rescue helicopters to Imam Khomeini Hospital in Tehran, Iran, Alamdari et al. found that out of 158 patients studied, 92% were injured by an accident and the average time between patient arrival at the emergency room and the first physician visit was 23 minutes. They concluded that the use of an appropriate criterion for screening of air rescue patients was necessary (6).

Farahani Deljoo et al. employed the Healthcare Failure Mode and Effect Analysis (HFMEA) model to identify and analyze potential errors in road rescue operations and divided the road rescue operations into 2 processes, 12 sub-processes, and 3 activities (7). They identified potential analysis and errors for each activity; in total, of the errors identified, 48%, 24%, and 11% was associated with manpower, equipment failure, method and process, respectively, with the rest related to the system, environment, and etc. (7).

Shiri et al. indicated that there was a positive relationship between different geographical, human, socio-educational, and logistic (support) factors of road rescue posts and decrease in the number of casualties leading to death in roads of Ilam, Iran (8). Additionally, equipping and upgrading road rescue posts in their different dimensions can have a positive impact on reducing road accidents in Ilam among drivers of different types of vehicles (8). Rasouli et al. have reported similar results (9).

An investigation by Rasaeipour and Ghafari showed that suitability and timeliness are among the most important determiners of the quality of services (10). In addition, Ghezavati and Soltanzadeh found that the effective location of the relief equipment prior to a crisis is one of the most important strategies to improve performance and decrease delay in relief (11).

The present study was conducted with the aim to evaluate and prioritize the factors effective on road traffic accident relief in Iran using the analytic hierarchy process (AHP) method, and to examine the facilities and limitations of air relief taking into account its costs and cost-benefit analyses on the application of this system.

[DOI: 10.52547/jorar.10.3.35]

Methods

This study was of the library type in terms of data collection, applied in terms of purpose and nature of the subject studied, descriptive in terms of the research method and area of social investigations, descriptive-analytical in terms of approach and problem-solving manner, and survey in terms of data collection method. The statistical population of the study included managers, professors, rescue and traffic specialists, and road users in Tehran, Iran. The total statistical population consisted of 3759 individuals, 349 of whom were selected based on the Cochran sampling formula.

Then, using a researcher-made questionnaire, the validity and reliability of which were examined, factors affecting traffic accident relief were identified. Then, using statistical techniques and Multiple Attribute Decision Making (MADM) operational research, including AHP, the factors affecting traffic accident relief were ranked. Moreover, the Expert Choice software (version 9, Expert Choice Inc., Pittsburgh, PA, USA) was utilized to reduce the time of conducting this study.

Findings

In this study, 4 main criteria were specified in order to prioritize the factors contributing to the increase in traffic accident casualties in rescue, including human factor, equipment factor, management and procedures factor, performance, and environmental circumstances. Then, the pairwise comparisons matrix of decision-making was obtained after construction of the model in the Expert Choice software and entry of the pairwise comparisons of indices and weight of the criteria and sub-criteria. The AHP analysis revealed that the human, equipment, management, and environmental condition criteria with relative weights of 0.3810, 0.3738, 0.2149, and 0.0303, respectively, had the highest effect on increasing relief in traffic accidents. The inconsistency rate of the pairwise comparisons was found to be 0.02, and since it was less than 0.1, these comparisons were acceptable.

In the prioritization of relief based on the type of vehicle, air relief, ground emergency, Red Crescent relief, rail relief, and marine relief with a relative weight of 0.3150, 0.3130, 0.2900, 0.0470, and 0.0350 ranked first to fifth, respectively, in terms of effect on reducing human casualties.

Table 1 demonstrates the ranking of the subscales and prioritization of the sub-criteria of the factors affecting traffic accident relief. It is observed that the lack of a common structure of the case with a relative weight of 0.2380 with the first priority had the greatest role in providing relief in traffic accidents. Furthermore, the lack of expertise and sufficient skills of the rescuers and hospital staff, delay in relief and increase of relief time, lack of air emergency facilities, lack of ground emergency equipment (motorbike and automotive), deficiency in relief and hospital equipment, inappropriate climatic conditions, and lack of a comprehensive information management system with a relative weight of 0.0900, 0.0735, 0.0690, 0.0600, 0.0549, 0.0021, and 0.0012 ranked first to seventh, respectively.

Discussion

In this study, 4 main criteria with 22 sub-criteria were identified as effective factors in increasing human casualties in road traffic accident rescue and relief. In order of impact, these criteria were human, equipment, management and procedures, performance, and environmental conditions, respectively. In addition, various potential causes of errors that could interrupt or disrupt the process were identified. After analyzing the system errors, corrective actions in the system can contribute to improving the desired process and enhancing the safety of activities.

In the ranking of the subscales, the lack of a common structure and suitable organization to conduct the rescue operations, the lack of expertise and sufficient skills of the rescuers and hospital staff, delay in relief and increase of relief time, lack of air emergency facilities, and lack of ground emergency equipment (motorbike and automotive) ranked first to fifth, respectively.

In relief prioritization by vehicle type, EMT, Red Crescent relief, rail relief, and marine rescue, respectively, had the greatest effect on reducing human casualties.

The results of the present study are consistent with those of the studies by Haghani and Oh (12), Ozdamar et al. (13), Campbell et al. (14), Rasouli et al. (9), Ghezavati and Soltanzadeh (11), and Farahani Deljoo et al. (7) Therefore, it is recommended that measures be taken to improve each of the criteria and sub-criteria and their causes in terms of education, equipment, process, technology, etc.

[DOI: 10.52547/jorar.10.3.35]

Table 1. Criteria and sub-criteria of factors affecting road traffic accident relief using the Expert Choice software

Rank in total	Relative weight	Criteria	Sub-criteria	Rank in the sub-criteria	Relative weight
First	0.3810	Human factor	Personnel depression	9	0.0543
			Insufficient expertise and skills of rescuers and hospital staff	2	0.0900
			Insufficient training (knowledge of personnel and people)	10	0.0450
			Human resources shortage	7	0.0547
			Rescue team mistaken routing	19	0.0090
			Delay in relief and increase in relief time	3	0.0735
			Fatigue and lack of motivation of staff	8	0.0545
Second	0.3738	Equipment	Deficiency in air emergency facilities	4	0.0669
			Lack of ground emergency facilities (motorbike and automotive)	5	0.0600
			Failure of hospital and rescue equipment (procedure intervention equipment, endotracheal tube, venipuncture, serum therapy, and neck collar fixation)	6	0.0549
			Lack of a common electronic system	11	0.0500
			Improper location and deployment of facilities, posts, and teams	12	0.0490
			Failure to set up and launch new rescue posts	14	0.0460
			Lack of financial resources	13	0.0470
Third	0.0303	Procedures, functions, and environmental conditions	Defective rules and regulations	20	0.0038
			Inappropriate road conditions	18	0.0100
			Inappropriate climatic conditions	21	0.0021
			Mental issues governing the scene	17	0.0144
Fourth	0.2149	Management factors	Lack of a common structure and suitable organization to conduct rescue operations	1	0.1600
			Parallel operation of the beneficiary organization in rescue	15	0.0300
			Lack of a unit management and lack of inter-organizational coordination	16	0.0237
			Lack of a comprehensive information management system using information networks	22	0.0012

[DOI: 10.52547/jorar.10.3.35]

Given the high percentage of human errors and equipment shortcomings, most of the measures must be related to these two criteria. Moreover, given the nature of these operations, which are human-centered processes, the serious attention of the organization toward specialized training of personnel involved in the relief process is required. In addition, in most cases, due to the inadequacy of the charts of the rescue teams, the relief teams encounter difficulties while delivering services; moreover, procedures such as venipuncture, emergency treatment, etc. are not performed due to a lack of technicians, which, in some cases, endangers the lives of the injured individuals. In some cases, the type and causes of errors are such that it involves all or part of the responsible organs in the rescue process. In such cases, the provision of solutions and problem-solving by the Red Crescent and the EMT alone are not effective, rather it is necessary to design some kind of interactive decision-making between the partner organizations, specify the way in which each of them operates, and reexamine their relationship.

Management criteria (lack of a suitable systematic structure for directing rescue operations, parallel operation of the organization in rescue provision, lack of a unified management lack of inter-organizational coordination, and lack of a comprehensive information management system using information networks) are also effective in increasing human relief casualties. Additionally, although the existing guidelines have separately described the tasks of each organ in traffic accidents, the lack of coordination has sometimes led to irreparable consequences; the formation of a unified organization by the merging these organs can be a solution to this issue.

It can be claimed that implementing a scientific system to document potential defects and errors (human, process, equipment, management, etc.) in road rescue procedures provides the primary information required to assess the safety and health of the rescue operations in a desirable way. It is worth noting that careful assessment and improvement of these activities can minimize the possibility of errors and their consequences in a preventive manner, provide the grounds for the improvement of the quality of services, diminish the risks of rescue operations, reduce casualties and mental and physical injuries in the injured and rescue personnel, and improve resource management in relief organizations. Haghani and Oh performed a case study on relief in crises with the consideration of a diversity of goods and networks, and assuming that the goods move from one node to the next, they allocated the shortest time to the most important goods and defined the capacity of the commodity-transmission system as a function of time (12). Their objective was to minimize travel costs. To do this, they employed a heuristic approach, assuming 3 transport models, 3 points of departure, and 2 destinations (12).

Furthermore, Ozdamar et al. addressed the logical coordination of relief operations, focusing on the transfer of the injured to relief centers (13). An important part of their model was related to the allocation of medical teams to rescue centers; however, they ignored the location of the clinics (13). Sheu modeled a logical network consisting of relief centers, commodity distribution centers, and relief demanding points, and proposed that this model be considered in the phases of predicting relief time changes, categorizing the affected areas, determining distribution priorities, and performing relief operations (15).

Tzeng et al. assessed a multipurpose relief distribution model to minimize travel costs and time, and maximize system satisfaction (4). Their network consisted of 5 warehouse points, 8 rescue demand points, and 4 commodity transfer stations (4). Moreover, Chern et al. studied a similar network consisting of 4 warehouses, 4 distribution stations, and 8 rescue demand points, in addition to refueling stations (16). They conducted their studies on the basis of two categories of demand: the input requests such as food, water, and medical relief, and the output requests such as the dead, injured, and the like (16).

In the study by Campbell et al., the average patient transfer time was 23.5 minutes, and despite using a helicopter as a fast, but costly device, the minimum patient visit time by the physician was 210 minutes after arrival (14). In a study carried out by Matsumoto et al. on using the air rescue system in Japan, it was found that the death rate was reduced by 30% and the number of people who fully recovered after using this system increased by about 150% (17).

The results of the presented study revealed that air relief ranks first among relief provision methods, and issues such as service provision in

[DOI: 10.52547/jorar.10.3.35]

times of lack of access to cars and inability to use cars in some areas, road closures and inaccessible areas, helicopter capability in sea relief, and the like are among the strengths of this system. Furthermore, the high cost of upgrading the air fleet, deploying the system comprehensively, and maintaining it are among the most important issues that have made difficulties for the planners and decision-makers in the extensive use of this system. Given the models presented, relief should be provided in such a way that the shortest distance traveled is achieved with the most productivity in the time consumed. However, due to the shortage of air rescue bases, the long distances between these bases, and the lack of rescue helicopter in the Iranian Red Crescent Society Rescue & Relief Organization, the wide and economical use of this system in the country is not feasible. In order to increase the efficiency of air relief systems, providing a suitable model for placement of helicopter bases at appropriate distances and provision of services at the shortest time with maximum speed and the shortest distance traveled can be helpful.

Conclusion

In this study, the factors affecting traffic accident relief were investigated with an emphasis on air rescue and the benefits, impacts, and limitations of using air relief systems. Based on the findings and the issues discussed in this study, the following proposals are made to modify these processes:

1. Establishing common structures and unified management in rescue and preventing the parallelism of the relevant organizations
2. Launching a common electronic system and intelligent transportation systems for relief and rescue routing and appropriate placement of rescue facilities, posts, and teams, preventing delays in relief, and increasing rescue and location time

Creating infrastructure and enhancing air emergency and ground emergency (motorbikes and automotive) facilities, and eliminating emergency equipment defects.

Conflict of Interests

Authors have no conflict of interests.

References

1. Center for Chemical Process Safety (CCPS). Guidelines for Auditing process safety management systems. Hoboken, NJ: John Wiley & Sons; 2011.
2. Taylor CB, Stevenson M, Jan S, Middleton PM, Fitzharris M, Myburgh JA. A systematic review of the costs and benefits of helicopter emergency medical services. Injury 2010; 41(1): 10-20.
3. Biewener A, Aschenbrenner U, Rammelt S, Grass R, Zwipp H. Impact of helicopter transport and hospital level on mortality of polytrauma patients. J Trauma 2004; 56(1): 94-8.
4. Tzeng GH, Cheng HJ, Huang TD. Multi-objective optimal planning for designing relief delivery systems. Transportation Research Part E: Logistics and Transportation Review 2007; 43(6): 673-86.
5. Arafeh M. Combining Lean Concepts & Tools with the DMAIC Framework to Improve Processes and Reduce Waste. American Journal of Operations Research 2015; 5(3): 209-11.
6. Alamdari S, Kalantari Meibodi M, Mohammadi P, Kariman H. Study of the demography of transferred patients to Tehran Imam Khomeini Hospital by relief helicopter. Sci J Rescue Relief 2010; 1(4): 48-52. [In Persian]
7. Farahani Deljoo F, Azhari L, Saghehei E. Identification & assessment of the potential errors in relief and rescue operations in road accidents. Sci J Rescue Relief 2012; 4(1): 1-10. [In Persian]
8. Shiri S, Soleimani Mehri M, Tardast H, Chaharsoughi Amin H, Rezania K, Nouri H. Investigating the effect of rescue and relief posts in reducing the number of road deaths and casualties in view of Ilam. Sci J Rescue Relief 2015; 6(4): 92-107. [In Persian]
9. Rasouli A, Asad-Amarji M, Rasouli N. Provide an optimal model for relief and communication of institutions in intrathecal networks. Proceedings of the 12th Transportation and Traffic Engineering Conference of Iran; 2013 Feb 19-20; Tehran, Iran. [In Persian]
10. Rasaeipour H, Ghafari K. Determining the optimal areas for the establishment of rescue vehicles for the purpose of service to the occupants with multiple objectives. Proceedings of the 12th Transportation and Traffic Engineering Conference of Iran; 2013 Feb 19-20; Tehran, Iran. [In Persian]
11. Ghezavati VR, Soltanzadeh F. Development of integrated location mapping, hierarchical ride guidance in emergency situations. Proceedings of

[DOI: 10.52547/jorar.10.3.35]

the 12th Transportation and Traffic Engineering Conference of Iran; 2013 Feb 19-20; Tehran, Iran. [In Persian]

12. Haghani A, Oh SC. Formulation and solution of a multi-commodity, multi-modal network flow model for disaster relief operations. Transp Res Part A Policy Pract 1996; 30(3): 231-50.

13. Ozdamar L, Ekinci E, Kucukyazici B. Emergency logistics planning in natural disasters. Ann Oper Res 2004; 129(1-4): 217-45.

14. Campbell AM, Vandenbussche D, Hermann W. Routing for relief efforts. Transport Sci 2008; 42(2): 127-261.

15. Sheu JB. An emergency logistics distribution approach for quick response to urgent relief demand in disasters. Transportation Research Part E: Logistics and Transportation Review 2007; 43(6): 687-709.

16. Chern CC, Chen YL, Kung LC. A heuristic relief transportation-planning algorithm for emergency supply chain management. Int J Comput Math 2010; 87(7): 1638-64.

17. Matsumoto H, Mashiko K, Hara Y, Sakamoto Y, Kutsukata N, Takei K, et al. Effectiveness of a "doctor-helicopter" system in Japan. Isr Med Assoc J 2006; 8(1): 8-11.

[DOI: 10.52547/jorar.10.3.35]