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**PRESENTING A SMART MODEL USING GENETIC ALGORITHM FOR FAST  
DISASTER PROBLEM SOLVING**

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**ABSTARCT**

The incidence of disaster is an inevitable fact which is followed by many damages. Meanwhile, making relation in road transportation network with respect to its importance, particularly in emergency conditions, is very crucial. Appropriate performance of roads networks can cause to decrease accident effects under these conditions. Also, a network which cannot provide necessary access has very low reliability, leading to wider damages. Based on a wide volume of field information as the main core, the present paper proposed a model to be used for importance degree of transportation arc. In this model, we used a genetic algorithm. The efficiency of the algorithm, compared to other algorithms, has been acceptable. Notably, in the proposed method, with respect to the dependency of problem solving to the characteristics of passages network, we were inevitable to use softwares supporting these characteristics to facilitate problem solving. Therefore, in this study, we employed Matlab and Arc Gis softwares to define routing problem and solve it in the program environment through creating respective macros.

**INTRODUCTION**

Today, as the result of the expansion of cities and the increase of urban population, one of the most important problems of people is to

find a solution to minimize the length and time of their urban trips. Meanwhile, the role of geospatial information systems (GIS) as

the science and tool to manage and analyze information related to location and activities occurring in the location are becoming more important day by day. In this regard, the capabilities of network analysis in GIS such as computing the shortest path can be very fruitful. In applying GISs for routing, particularly fire fighting vehicles and ambulances, methods in which the best path is selected based on dynamic travel time have been considered more than before. To solve such problems, it is necessary that the weight of network edges equals the edge trip time to be considered to compute the shortest path. Computing the time of passing through each edge is very complex since some issues such as the edge length, the traffic in the edge, the edge width, the type of vehicle, the type of path covering, etc. influence it. Since traffic is unpredictable and constantly changing, a simultaneous navigating system is required to control traffic changes during a day to respond users' needs. Additionally, it is required to report every increase and decrease in traffic for appropriate reaction of users to face with new status of traffic. Therefore, in such issues, due to the change of edges trip time during the path, the best route cannot be determined using the shortest static path and dynamic algorithms are

required [1-3]. When Dijkstra's algorithm was proposed in 1959 to find the shortest path, more serious attention was paid to find and propose efficient algorithms [4-6]. Moreover, some studies have been conducted to find the best path in dynamic transportation networks [7-9]. Cook was the first person who attempted to find the best path in time-dependent networks in which edge weight is changed in a predictable state. In this study, a time discrete model was used for problem solving [13-18]. Later, Chabini [45] classified the best dynamic path issues and proposed two continuous and discrete time-based methods to solve these problems. According to this classification, continuous time was introduced to isolated moving intervals with constant costs as basic strategies to solve such problems. In spite of dynamic transportation network, most of studies conducted on the shortest paths algorithms have focused on static networks in which topology and cost of taking path is constant [19]. With the limitations existing in previous computer systems capacity, considering dynamic networks have been accompanied with many difficulties.

In general, finding the best path in dynamic transportation networks are called time-dependent shortest path (TDSP) [20]. Given

to the features of dynamic transportation network and constant traffic changes, there are two algorithms to find the best path in dynamic transportation network [21]. Re-optimization is a method in which the best path is frequently computed due to instantaneous changes of network's data during the path. Re-processing method is the most important method to overcome the problems of the best path analysis in dynamic networks. In re-processing method, the best path is obtained with respect to current status of traffic and presented to user. Then, when user is moving in the presented path, in case of any change in the traffic status of the presented path or any area of the path, the best path is again analyzed. In case of finding a better path, this new path is presented as the best path. Therefore, the optimal path is recomputed to be adopted with new conditions. Regarding path re-processing methods, important researches have been conducted by Murchland [40]. In re-processing method, most of studies have focused on computing time complexity of algorithm. Accordingly, many methods have been proposed to decrease the time of implementing path computation in two statuses of increasing and decreasing traffic [22-25].

Routing algorithms are divided into two main classes of matrix algorithms and tree-structured algorithms [26]. Matrix algorithms find the shortest distance between all heads pairs in network through reiterative operations. The function of these algorithms is based on considering network as a matrix while tree-structured algorithms find the shortest path from the head of destination to other heads. In these algorithms, a tree of the shortest paths with branches radiating from destination is generated. As tree algorithms, we can refer to Dijkstra's algorithm proposed by Coreman et al. and Detcher and Pearl. Also, as matrix algorithms, we can refer to Floyd-Warshal and Johnson algorithms. Some researchers [27-31] attempted to determine network risk level to show the effects of an event incidence by presenting performance index based on the concept of access and assessing the change of some factors influencing network performance such as traffic flow, time, distance, and cost of trip. Accordingly, they analyzed network performance. Brabhaharan also attempted to prioritize risky components of network. Further, Qiang and Nagurney[32] introduced prioritizing factors of path pieces through scoring to prioritize risky components of network. In the present work, we attempt to

localize emergency stations and find optimal path.

### The Proposed Model

In the present study, firstly, the most effective factors in routing under disaster conditions were determined by interviewing respective experts. By determining the importance degree of each factor, then, factors with significant weight were considered as feasibility study factors. Additionally, the arches without desirable conditions (based on this criterion) were omitted from the feasible arches. Other criteria were also considered as risk factors. By defining a numerical index for each of them as well as defining a linear relation among them based on determined importance weights, also, an index was attributed to each of arches as risk index. This index was the base of routing. Figure 1 shows the proposed model.

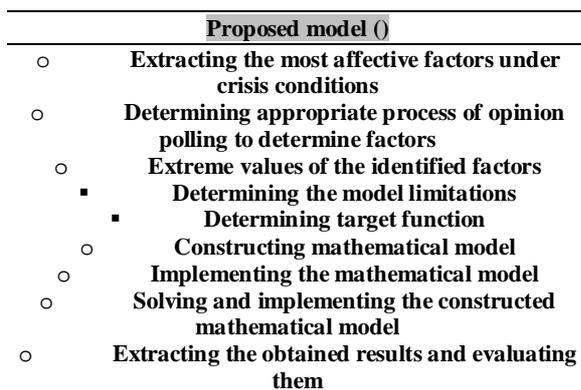


Figure 1: The stages of the proposed model

In the following, to determine the main criteria of selecting a path (trip duration,

travel time, density, difficulty degree, and perspective), providing a clear definition of each of criteria as well as introducing the proposed algorithm-based evaluation quality, the main core of the research methodology is presented. For each origin-destination pair, various paths can be proposed for a driver. Each of the proposed paths has different values in its primary features. A path may have a high value in one of features (for example, the shortest path) and a low value in another feature (for example, a high-congestion path). Therefore, drivers will have to evaluate different values of features related to each proposed path to make decision to select a path. While, on one hand, as a result of enlarging search space size (the existing target functions), it is not easy for drivers to select a solution out of Pareto optimal responses set [33]. Sometimes, desired response of driver may not exist in any sets of Pareto optimal responses. On the other hand, involving driver willingness to emphasizing each of the target functions (the primary features in path) indicates using a scale-independent method [34] which can help genetic algorithm to be highly convergent with acceptable responses (but not only Pareto optimal responses). Finally, the presented solution ensures approaching

the best target functions-compatible combination with respect to the importance degree of each target function. This fact implies the inefficiency of Pareto-based methods in this research. Given to the provided explanations, to evaluate features of each candidate path, sum of weighted global ratios (SWGR) has been used. Each of features has been designed such that their value will be between 0-1. Since features of toll and perspective were not of priority in Tehran due to lack of paying toll in urban highways and lack of attention to tourist related issues in the research, these features were excluded. We start to explain by discussing the way of making each the primary features independent from scale with respect to SWGR method.

### **Length**

If  $X_1$  indicates the feature of  $i=1$  and path  $j$  has the shortest length among the candidate paths from the first generation to current generation,  $x_1^j$  will equal 1.

### **Time**

This feature can be extended similar to trip length. If  $X_2$  indicates the feature of  $i=2$  and the path of  $j$  is a path with the least time cost among the candidate paths from the first generation to current generation,  $x_2^j$  will equal 1. To compute the time of traveling

from each of passages and cross roads, the model of travel time-volume delay function was employed for each of Tehran passages and the delay model for each of lighted cross roads [35] and lightless crossroads [36].

### **Traffic**

In the present research, given to the provided definition by Tehran traffic control center experts, all main streets between two flags introducing the beginning and end of traffic will be discerned by trained experts. That is, given to the intensity of the traffic specified by the expert, all streets located between two flags are discerned congested with respect to the coefficients of each of levels (depending on traffic intensity). The two streets with flags will have a traffic equal weighted mean (based on length) of the street level of service at two sides of the flag. It is assumed that all vehicles before joining to and after separating from traffic line have smooth traffic. Given to the lack of annular detectors in the city highways and lack of the possibility of getting result from SCATS Software (Tehran traffic control software), the proposed solution is a practical technique. However, it computationally supports semi-optimal path independent from numbers' magnitude; therefore,  $c_p$  (traffic amount pertained to street  $p$ ) is computed.

### Rigidity

Rigidity degree of each street can be a function of its type and nature. If  $d_p$  indicates rigidity degree of a street, zero value shows ideal conditions of driving in respective street. Also, the value of 1 indicates the highest rigidity degree to pass through street  $p$ . an appropriate method to determine rigidity degree of a street is to allocate various fines.

### Combination

As explained earlier, the primary features of travel length and time for each candidate path is computed at the interval of  $[0,1]$ . If paths existing in a path is considered as one of its part located between the two cross roads, each part will have various values in the primary features of congestion and rigidity degree. Since the goal is to completely compute the primary features for each candidate paths, there is a need of introducing a method to integrate the features related to each part to achieve a value for the features of congestion and rigidity from each candidate path. If  $n$  number of the parts related to the proposed path are investigated and  $c_p$  and  $l_p$  indicate length and congestion related to path  $p$ ,  $w_p$  (the weight pertained to each candidate path) is computed. Therefore, congestion level is obtained for the entire of

the proposed path. Since  $\sum_{p=1}^n w_p = 1$  and  $0 \leq c_p \leq 1$ , congestion level for the  $k^{\text{th}}$  candidate path (congestion-value  $k$ ) will be also at the interval of  $[0,1]$ . If  $X_3$  indicates the primary feature of congestion for each path, we will have  $X_3^k$  for paths existing in current generation. Similarly, the proposed method will be employed to compute rigidity degree of pertained to each of  $(X_4^k)$  pertained to each of the candidate paths existing in each generation.

### Quality

Most of quality metrics requires knowledge about optimal solutions of the investigated problem to discern approximation level of the estimated responses to optimal response(s). Since the considered objective in urban semi-optimal multi-objective routing is to provide the best compatible solution, the present study attempts to obtain optimal solution through independently implementing Dijkstra algorithm for each criterion. Therefore, an ideal path will be a path whose respective descriptive vector  $(Z_i^*)$  has been obtained through independently implementing Dijkstra algorithm for each criterion. Since the proposed metric should not be influenced by measuring scale of existing objectives, we used weighted scale-independent metric of  $L_p$ -norm to measure

the quality of the best proposed compatible response (with descriptive vector of  $Z_i$ ) [37].

### Research Hypotheses

- During the analysis period, the level of transportation demand is constant.
- The criterion of users' cost is total time of users and walking time is ignored.
- The capacity of sitting at emergency is 1.
- People randomly arrive to station with uneven distribution; therefore, mathematical hope of waiting time equals the half of time interval.
- Transportation stations are according to nodes of street network.
- Street transportation is totally continuous; that is, both street nodes are finally connected to each other by a network path.

### Definition of Network and Search Space

One of the important stages of emergency transportation network routing problem is to determine a space in which optimal path search is performed. In the present work, Zhao approach has been used to determine search space [38]. The main idea of this approach is to select the main nodes on the primary path and then, select nodes which are connected to the nodes of the respective

main paths through one or more arches. Using these nodes, new paths are generated with the focus on the main path. These paths play a basic role in optimizing the path. Emergency transportation network of  $T=T[t_{ij}]$  are arch matrices that arches on emergency transportation path are specified in each of its rows.

### Introducing Limitations of the Problem

For a discontinuous optimization, due to the difficulty of the problem and preventing getting the problem worst, a less number of decision making variables are selected. On the other hand, limitations should supply needs and perspectives of considered problem as much as possible. Holding such a view, the following limitations have been considered:

- Limitation of the continuity of a transportation option such as emergency in a path
- Limitation of the maximum time of internal travel of vehicle (or length of path) for certain emergency transportation paths: in long paths, drivers' boredom causes problem and short paths are followed by emergency planning problems.
- Limitation of navy dimensions in each line: since the number of

emergency transportation navy influences functional cost, this number is regarded as providing cost. Network optimization problem should be able to determine the best path and the best headway with by minimizing user's time. This problem should also consider limitations of the budget of provider.

- Limitation of the minimum and maximum of headway in a given path: headway of path should be in balance (not so high and not so low) to create high waiting times for users. Headways are related with pray coefficient of vehicles and it is related with the number of passengers within the vehicle.
- Limitation of path's directness: path's directness should be higher than the minimum value. In emergency transportation, users cannot use the shortest path of origin-destination.

### Computing the Weight of Criteria

In the present study presenting a new model of outing in emergency conditions, path parameters and criteria are prioritized by forming paired comparisons through investigating effective parameters in paths ending to temporary housing or pauses in

disaster. To compute the relative weight of the criteria, normalized comparisons matrix should be firstly computed. Therefore, if comparison matrix  $A$  is for  $n$  criteria, the relation of  $\hat{a}_{ij}$  is used for normalized comparisons matrix. Finally, the matrix of relation  $\hat{A}$  will be obtained.

$$A = \begin{bmatrix} a_{11} & \dots & a_{1n} \\ \vdots & \dots & \vdots \\ a_{n1} & \dots & a_{nn} \end{bmatrix}$$

$$\hat{a}_{ij} = \frac{a_{ij}}{\sum_{i=1}^n a_{ij}}$$

$$\hat{A} = \begin{bmatrix} \hat{a}_{11} & \dots & \hat{a}_{1n} \\ \vdots & \dots & \vdots \\ \hat{a}_{n1} & \dots & \hat{a}_{nn} \end{bmatrix}$$

Then, the mean of the number of each row of the normalized comparisons matrix is computed which is the same relative weight of decision criteria.

$$W_i = \sum_{j=1}^n \hat{a}_{ij}$$

Where  $W_i$  indicates the relative weight of the criterion  $i$ . Finally, to compute the final weight of the criteria, the relative weight of each criterion is multiplied by the higher criteria weights. However, to compute the value of each option and select superior option in order to manage displacement in disaster conditions of passages network, the final relation and model of the study is stated as following:

$$\text{Alternative Point} = \sum_{i=1}^n U_i \times F_i$$

Where  $F_i$  indicates the normalized level of the considered sub-criteria

Table 1: Symbols employed in the model

Explanation	Symbol
$LV_{min}$	The best length value in total populations
$LV_{max}$	The worst length value in total populations
$TV_{min}$	The best time value in total populations
$TV_{max}$	The worst time value in total populations
$CV_{min}$	The best congestion value in total populations
$CV_{max}$	The worst congestion value in total populations
Traffic = 1	Very heavy traffic
Traffic = 0.7	Heavy traffic
Traffic = 0.4	Moving traffic
Traffic = 0	Smooth traffic
D=0	Highway with negative slope
D=0.1	Highway without slope
D=0.2	Highway with positive slope
D=0.4	The first grade arterial out of the central range
D=0.5	The first grade arterial within the central range
D=0.6	The second grade arterial
D=0.8	Accumulator and distributor
D=1	Local access
$x_1^k = (LV_{max} - LV_k) / (LV_{max} - LV_{min})$	Length
$x_2^k = (TV_{max} - TV_k) / (TV_{max} - TV_{min})$	Time
$x_3^k = (CV_{max} - CV_k) / (CV_{max} - CV_{min})$	Congestion
$w_p = l_p / (\sum_{p=1}^n l_p)$	Weight
$\sum_{p=1}^n w_p * c_p$	Congestion
$f(R_k) = w_1 * x_1^k + w_2 * x_2^k + w_3 * x_3^k + w_4 * x_4^k, \sum_{i=1}^4 w_i = 1$	Cost function
$w_1=0.25, w_2=0.25, w_3=0.25, w_4=0.25$	C1
$w_1=0.2, w_2=0.2, w_3=0.2, w_4=0.4$	C2
$w_1=0.1, w_2=0.1, w_3=0.1, w_4=0.7$	C3

**Genetic Algorithm**

Coding and creating the primary population: in the classic genetic algorithms, operations are performed on chromosomes with constant length. In the proposed genetic algorithm, the length of each chromosome is variable. This issue depends on the condition in which the length of each chromosome should not exceed the maximum N (the number of nodes existing in the network). Therefore, a chromosome is a sequence of positive integers which refer to unique code of each of nodes showing a path from origin node to

destination node. A path (chromosome) is created using topological information stored in the considered network. Such that, the considered path exists and there is no loop (reiterative pass through a node) in it. To create a path, modified Dijkstra algorithm was employed which was based on d-heap's with d2 to manage memory to cope with big implementation networks [39]. Accordingly, randomly, it is weighted with an even distribution in each time of path creation. Cost function: given to the previously mentioned method, to evaluate each method,

cost function is computed based on SWGR method. If  $R_k$  is the  $k^{\text{th}}$  candidate path in the population, cost function is computed.  $W_i$  specifies the importance degree of each target function from the behalf of driver.

**Selection:** in the proposed genetic algorithm, without-replacement tournament selection (size of 2) was employed such that two paths were randomly selected through random number generation with even distribution. The path with the highest fitness was selected. Notably, two paths would not be the same.

**N-point crossover:** in the proposed genetic algorithm, multi-point crossover method was employed [40]. The proposed n-point crossover is not similar to its traditional method. In the proposed method, two selected paths should have at least one gene (node) in common other than the origin and destination nodes; however, there is no need to share the place of common nodes. To this end, common nodes are found in both paths and according to the number of crossover points, multi-point crossover is performed.

**Mutation:** to apply mutation operator on the considered path, two genes (node) with even distribution is randomly selected; then, random routing is performed between them

based on modified Dijkstra algorithm and the previous path is replaced with the new path.

**Repair function:** as mentioned earlier, in the structure of each path, reiterative pass through a gene (node) leading to the creation of loop in path is not allowed; while, it is possible to create loop in the path after applying n-point crossover operators. Therefore, it is necessary to repair each of paths after n-point crossover operators and mutation to create a path without loop.

**Elitism:** in the investigated method, after ordering chromosomes in ascending way and selecting D people of the best members of parents set,  $\rho \cdot D$  people (where  $\rho$  indicates random number with even distribution in the interval of [0,1]) will be directly transferred to the next generation. Notably, D people have been selected based on the criterion of the least competency such that it includes individuals with at least 50% of the best member of the population's fitness [41-45]. Figure 2 shows the overall process of the designed general genetic algorithm.

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```

Goptim()
  G=Generation
  For G= 1 to GMax
    G.rand()
    G.Fitness()
    G.Elitism()
    G.Select(A, B).rand()
    G.n-point-Crossover()
    G.Mutation()
    G.repair()

```

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Figure 2: The overall process of the designed general genetic algorithm

**RESULTS**

**Genetic Algorithm**

In the both above mentioned cases, mutation rate was considered from 0.1 to 0.9, the highest generation number was 500 and population size was 20. Figure 3 presents the average fitness of 50 independent implementations for each change rate. As observed, the best rates of n-point crossovers and mutation is 0.7 and 0.2, respectively. Figure 5 shows the average fitness of 50 independent implementations for various

populations of 10, 20, 30, and 50 in 100 generations with point crossover rate of 0.7 and mutation rate of 0.2 when all the criteria have equal importance. Figure 5 shows the way of change in the fitness average and the average of the best cost of individual during 50 independent implementations with a population size of 50 and point crossover rate of 0.7 and mutation rate of 0.2 with the weights introduced for each criterion. Table 2 presents the results obtained from genetic algorithm.

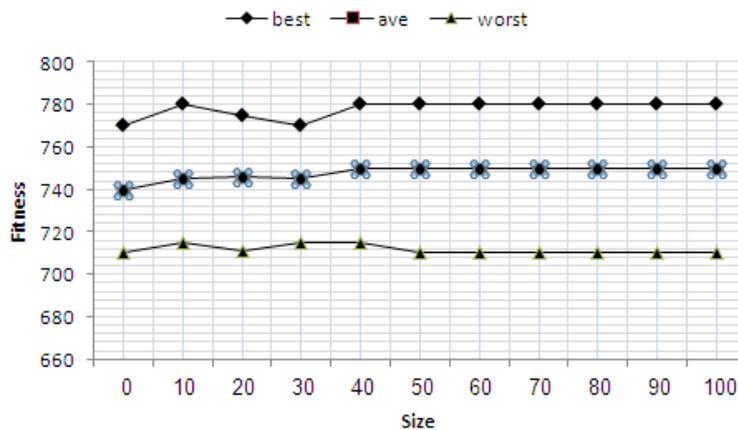


Figure 3: The best, worst and average fitness

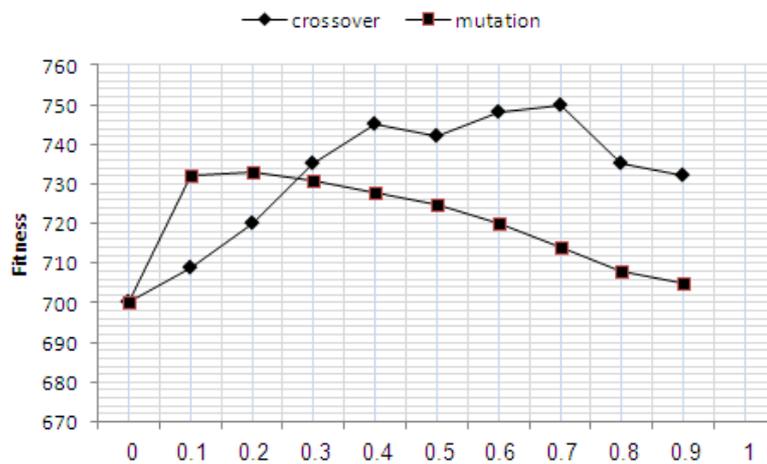


Figure 4: The average of crossover and mutation rates

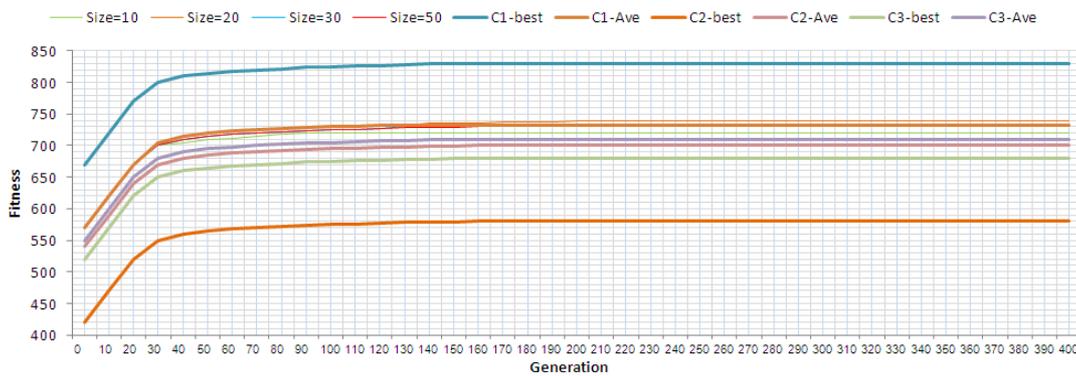


Figure 5: Fitness in different modes

Table 2: The distance of Parameters to the ideal response

Condition	Difficulty	Traffic	Time	Length
C1	152%	1%	26%	9%
C2	184%	18%	26%	10%
C3	104%	17%	22%	14%

**Simulation**

To investigate the efficiency of the proposed method, the algorithm was implemented using MATLAB and ArcGIS Softwares and tested on the simulated data. For simulation, a graph with 20000 heads and random position of  $0 < xy < 1$  was created and Delaunay triangulation was performed. The sides of the triangle indicate the graph's edges (in this example, 1000 edges). In the next stage and randomly, a weight at the interval of (1-10) as well as movement direction was allocated to each edge. Then, to ensure the accuracy of the algorithm's performance, on a non-directional network, by displacing the origin and destination points, round trip path between the two heads of the network was independently explored by the method. As observed, the paths are completely overlapped. After repeating the

test for several modes with various origins and destinations, the accuracy of the algorithm performance was ensured. In the second test, the efficacy of the global and local optimal path between the two heads was evaluated. To evaluate the local optimal path, 5000 edges were explored and a path including 39 heads with the cost of 10714 was obtained. On the contrary, to determine the global optimal path, 1897 edges were explored and a path with 32 edges and the cost of 104.06 was obtained. As observed, by applying relatively identical computational time to search the global and local optimal path, the final result is highly different. Such a fact indicates the necessity of searching the global optimal path compared to the local optimal path. To ensure the performance of the algorithm in two modes of global and local, the above test was performed on 100

heads of origin and destination. According to the obtained results, on average, the improvement level of the global optimal path cost, compared to the local optimal path, was about 30% and in 55% of the cases, no improvement was observed due to the identical paths. On the other hand, the computational cost applied to find the global optimal path, compared to the local optimal path, had an increase of about 90%. Accordingly, the efficiency of the algorithm to find the global optimal path was higher than the local one. With an increase of 9% in computational cost, instead of local optimal paths, global primal ones can be determined. Of course, this result indicates the high complexity of the simulated network.

In the third test, the performance of the proposed algorithm for simultaneous search of optimal paths between one origin and several destinations was investigated. To determine an optimal path, 10000 edges and

to simultaneously determine five optimal paths, 2107 edges were explored. In other words, with an increase of 27% of the computational cost, instead of an optimal path, five global optimal paths were found. This fact indicates that in emergency evacuation operations of each building block, several optimal paths should be suggested in order to use another path in case of enclosure of a path. Therefore, the efficiency of the algorithm is very appropriate. The overall efficiency of the proposed algorithm was estimated. Hence, for each pair of the simulated networks, based on the features of Table 6, the algorithm attempted to search the global optimal path for ten times. The average time of processing and the percentage of the explored edges were recorded in figures 7 and 8. According to the obtained results, on average, about 22% of the network edges were processed for global optimal search.

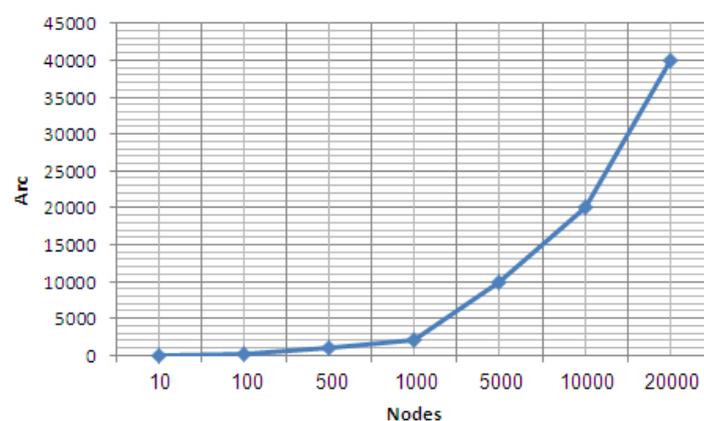


Figure 6: The number of network edges

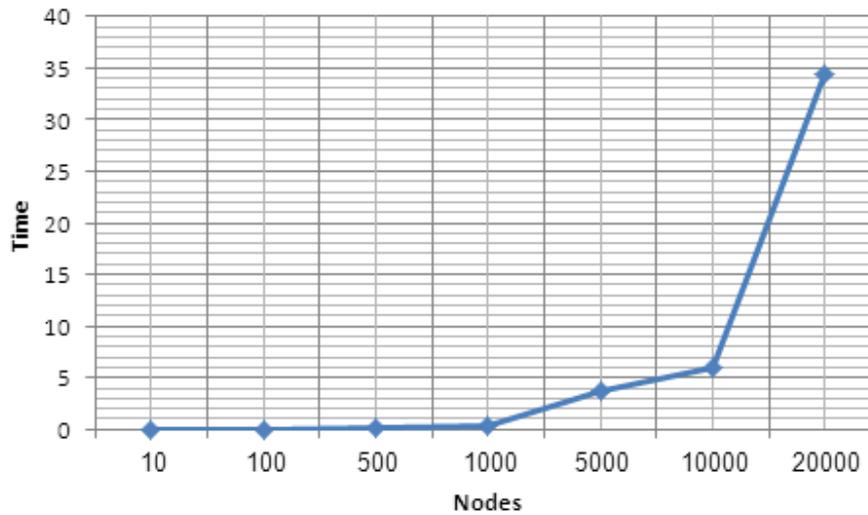


Figure 7: The average time of processing (sec)

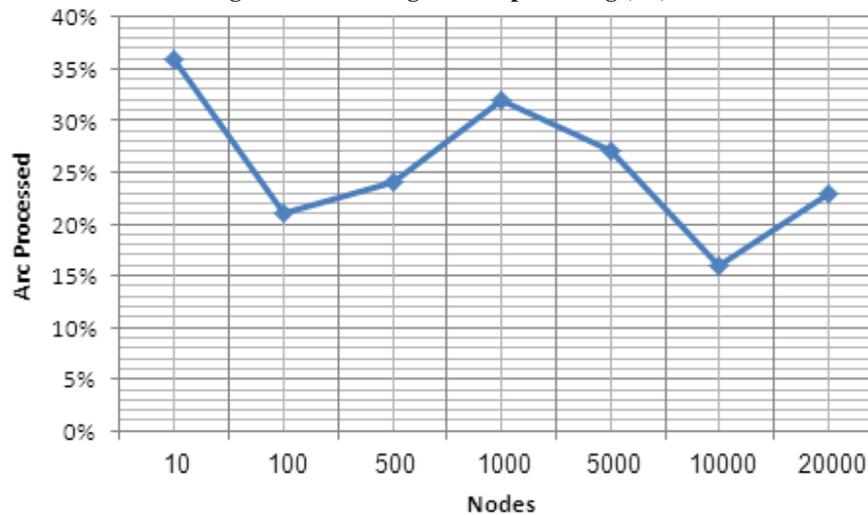


Figure 8: The explored edges (percentage)

The proposed algorithm was implemented on the problem events. Given to the existence of the random mechanism to select neighboring responses in the algorithm, the provided response is not identical for each implementation by the algorithm. The results provided for the proposed algorithm is the best result obtained from five times sequential implementations of the algorithm.

The results of other algorithms have been directly extracted from related articles. As shown in Figures 9 and 10, the proposed algorithm presents similar responses compared to the best existing algorithms. Regarding three cases, the proposed algorithm presents the best known response. It is good to remind that the algorithms selected to solve the designed emergency

problem have not adequate flexibility to solve problems with various limitations. Therefore, given to the fact that the proposed algorithm presets a response which can be compared to the best algorithms, applying it can lead to effectively solve practical problems. Since each algorithm has been implemented on a machine with specific speed and features, it is not possible to compare the time consumed for direct problem solving by algorithms. Altogether,

we can state that based on the performed experiment, the proposed algorithm has the ability of competing with advanced algorithms in terms of quality of responses and speed.

In this experiment, the proposed algorithm has been compared with known algorithms in the literature. Algorithms selected for comparison include the recent algorithms [45-52].

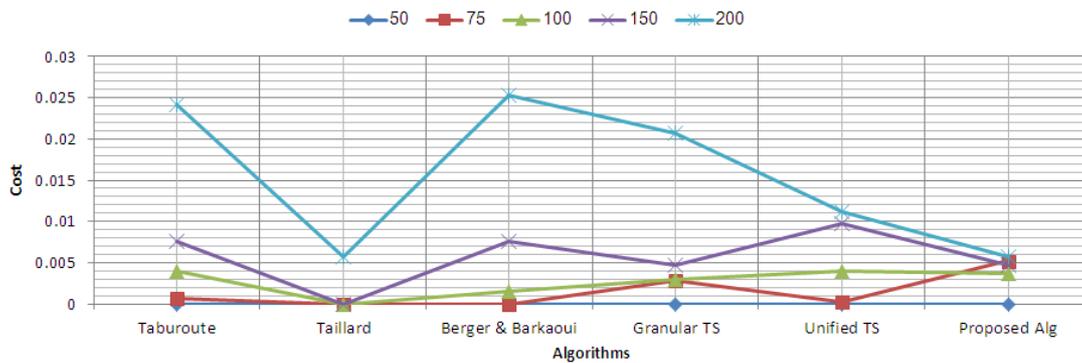


Figure 9: Evaluating the cost of the proposed algorithm compared to the selected algorithms

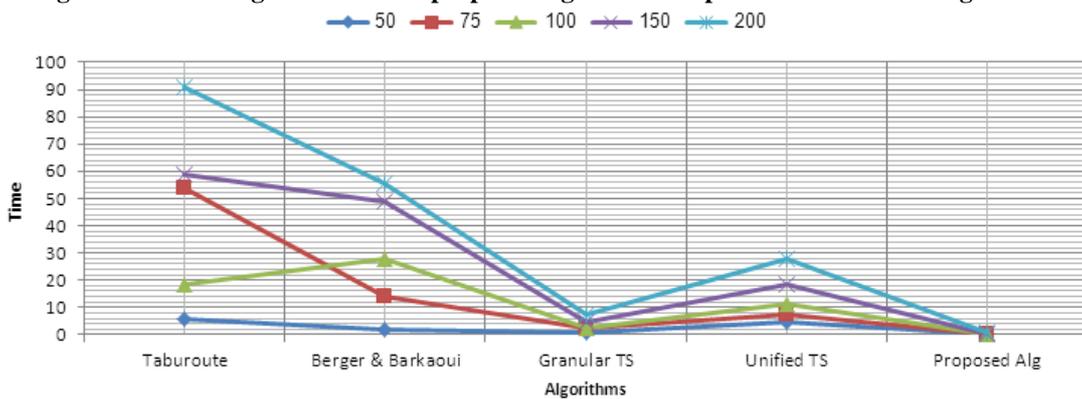


Figure 10: Evaluating the time of proposed algorithm compared to the selected algorithms

CONCLUSION

The incidence of disaster is an inevitable fact which is followed by many damages. Meanwhile, making relation in road

transportation network with respect to its importance, particularly in emergency conditions, is very crucial. Appropriate performance of roads networks can cause to

decrease accident effects under these conditions. Also, a network which cannot provide necessary access has very low reliability, leading to wider damages. Highways are one of the important urban uses due to their performance compared to other urban services. During the recent years, due to rapid growth of urban population and lack of a comprehensive planning and management in Iran's urban system, just like other urban services, these spaces face many problems. These problems mostly drive from lack of appropriate and balanced distribution, lack of optimal localization and lack of necessary prediction for users at the level of cities. In the present research, based on a wide volume of field information as the main core, the present paper proposed a model to be used for importance degree of transportation arc. Applying the model proposed in this study based on genetic algorithm showed that the method cannot only be used to select important projects and foster and reconstruct network arches during disaster. Therefore, we can state that using the proposed model by itself is not adequate for importance degree of transportation elements against disaster. Generally, in this model, an arch is highly important which disconnecting it decreases the access of

entire the network compared to normal access. To determine the shortest travel time between origins and destinations (O-D), we used Dijkstra's algorithm with weighted arches. This algorithm is a graph survey algorithm which analyzes the problem of the shortest path for various graphs. Finally, creating tree, it provides the shortest path tree from origin to destination. Notably, in the proposed algorithm, given to the dependency of problem solving to passages network characteristics, it was inevitable to use softwares supporting these characteristics to facilitate problem solving. Therefore, in this study, MATLAB and ArcGIS were employed and by creating respective macros, the considered routing problem was defined and solved in the softwares' environment.

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