Assessment of effective transportation's attributes in crisis management's methods

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Abstract

According to the statistics, Iran has been always one of ten disaster prone countries in the world. Statistics for casualties show, when transportation network is in crisis, the number of victims in less developed and developing countries are more than developed countries. One of the most effective reasons in increasing or reducing casualty rate when a disaster occur is existence or lack of existence of a sufficient crisis management system. Reviewing experiences and statistics which gained from the past accidents in Iran and other countries, it can be found out that lack of coordination between responsible organizations to control the crisis is the main problem when a disaster occurs. In this paper considering transportation's effective attributes, the Linear Assignment as a kind of MADM's methods is used to assess the best solution for controlling crisis management. Finally Several Organizations with Coordinated Management approach is selected between four presented approaches.

Key words: crisis management, transportation network, transportation indexes, MADM, linear assignment

1.Introduction:

Statistics show human casualties due to accidents in developing and less developed countries is much higher than developed countries, it means that vulnerability against disasters are not natural in these communities, in another word the vulnerability increase depend on rate of underdevelopment in these communities.

According to the past statistics and experiences which gained from the past accidents in Iran and other countries, this can be found out that lack of coordination between responsible organizations in controlling the crisis is the main problem when disasters occur. Thus finding a crisis management approach which can lead responsible organizations with a unit conductor is essential.

The purpose of this study is assessing common crisis management approaches in transportation system, presenting basic criteria and attribute for crisis management during crisis. These attribute include processing time reduction, coverage increase, delays reduction, safety improvement, waste costs reduction, certain trustee for each activity, experts quantity, experts' operation quality and decision time reduction. These attributes are assessed by distributing surveys and forms and gathering experts' opinions. Finally with use of Linear Assignment and MDAM method the best approach is selected.

Research steps:

Step 1 - Assessing crisis management methods in transportation system and selecting approaches.

Step 2 - Preparation and planning the forms, questionnaires and surveys to gathering scholars and experts' opinions about the most important attributes of crisis management.

Step 3 - Finding the appropriate attributes based on the various crisis management systems' aims and selecting approaches regarding to numbers of compensatory attributes that each approaches has.

Step 4 - Systems Classification with use of linear assignment method to detecting the best crisis managing approach

Step 5 - Summarizing results and providing useful suggestions for selecting the most appropriate approach.

2. Crisis Definition:

Crisis is an event that naturally or by human or suddenly arise and increasing hardship

and suffering to the human society to impose

the need to resolve the fundamental and extraordinary measures.

3. Definition of crisis management:

Crisis management is applied science systematically by all the crisis and its analysis by

looking through the tool that they could have prevented the occurrence of crises, or in this

case works on reducing it and rapid relief recovery that can be attempted, or more briefly

crisis management is the set of actions planned Before, during and after crisis with the aim of

preventing or controlling inhibition crisis and eliminate its effects and return it to the

conditions that were before crisis takes place.

4. Types of available approaches in Crisis management:

- No Crisis Management System

- An Independent Crisis Management Organizations

- Several Organizations with Parallel Performance

- Several Organizations with Coordinated Management

5. Multi Attribute Decision Making method:
Multi Attribute Decision Making method is made based on several different and sometimes
opposite criteria. This model of decision making has effective usage in many fields such as
organizational and public issues in societies.
Multi Attribute Decision Making method is used as main approach in this study in which the
basic criterions are attributes. These attributes are the most important Crisis management's
objectives and attributes that are determined based on questionnaires and surveys which are
filled by scholars and experts. Selecting one option between several options is considered in
MADM method. Information processing in MADM method is based on information that
provided by decision makers and divided into two main parts:
A) Compensatory Methods: In this model attributes are exchanged, it means that changes in
an attribute are compensated by opposite change in other attribute or attributes. In this model
some methods such as: TOPSIS, ELECTR, Linear Assignment and AHP are used.

B) Non-Compensatory Methods: it is a model in which there is no exchange between the
attributes, it means that a weak point of an attribute does not compensate with advantage of

other attributes, but each attribute individually assess other attributes. The advantage of this model is its simplicity. Generally MADM's problems have following common characteristics:

5-1- Options: In MADM's problems specific numbers of options are investigated and prioritize. The number of options could be limited or unlimited.

5-2- Multiple attribute: Each MADM's problem has some attributes that decision maker should clarify them.

5-3- Scale-Free Units: All of the units are scale free.

5-4- attributes' weight: All of the MADM problems need information which is based on attributes' Weight. Attributes' weight can be assign by decision maker or scientific methods.

6. Modeling the scheme with use of linear assignment method:

Information which is collected from surveys is applied in research database after required corrections. This information includes attributes that play most effective and important role in crisis management systems. For selecting the best system, goals' effective criterions are rated then are prioritized based on experts' opinions. Finally the scheme with using of linear assignment method is modeled.

In this method, the available options of a problem (systems) are prioritized base on the scores of each attribute. Then the final ranking of attributes will be determined through a linear compensatory process.

The following algorithm determined the final ranking of options:

Step1- This MADM matter has four options (approaches) against nine attributes. The grade of each option in each attribute determined based on experts scores as following table:

Attributes / Grade	Processing time reduction	Coverage increase	Delays reduction	Safety improvement	Waste costs reduction	Certain trustee for each activity	Experts quantity	Experts operation quality	Decision time reduction
First	A4	A4	A2	A2	A4	A4	A4	A4	A4
Second	A2	A3	A4	A4	A2	A2	A3	A2	A2
Third	A3	A2	A3	A3	A3	A3	A2	A3	A3
Fourth	A1	A1	A1	A1	A1	A1	A1	A1	A1

Table1. Grade of each options based on attributes scores

Step2– Based on frequency of options in each grade, basic matrix table γ_{m*m} is formed.

Grade / Attributes	First	Second	Third	Fourth

A1	0	0	0	9
A2	2	4	2	0
A3	0	2	7	0
A4	7	3	0	0

Table2. γ_{m*m} basic matrix

Step3- Determining attributes' weights based on the results of surveys and forms that are completed by managers, experts and Delphi Group's professionals

Attributes / Grade	Processing time reduction	Coverage increase	Delays reduction	Safety improvement	Waste costs reduction	Certain trustee for each activity	Experts quantity	Experts operation quality	Decision time reduction	Total
Weights	0.148	0.112	0.118	0.126	0.118	0.081	0.096	0.096	0.104	1

Table3. Attributes weights based on the forms and survey

Step4- The attributes' weights are replaced in the basic matrix. Cumulative totals of attributes' weights for each option in each grade are counted and embedded in the basic matrix.

Attributes / Grade	First	Second	Third	Fourth
A1	0	0	0	۰.۹۹۸
A2	0.244	0.548	0.208	0
A3	0	0.208	0.792	0
A4	0.756	0.244	0	0

Table4. Cumulative totals of attributes' weights for each option in each grade

Step5- Calculating the final grade of the approach A_i:

The component γ_{ik} from γ matrix indicates the effect of A_i in final grade K. In this way when assigning an approach to a grade is harmonic that γ_{ik} has the maximum amount for that grade. Thus the problem is finding A_i for each grade K (K=1,2,…,m) that have most effect on that grade and make the objective function maximum in L-P program.

In this way L-P modeling is used as follow:

1) $\text{Max:} \sum_{i=1}^{m} \sum_{i=1}^{m} \gamma_{ik} . h_{ik}$

2) $\sum_{i=1}^{m} h_{ik} = 1 \qquad ;i=1,2,…,m$

3) $\sum_{i=1}^{m} h_{ik} = 1 \qquad ;k=1,2,…,m$

4) $h_{ik} \begin{cases} = 1 \\ = 0 \end{cases}$

In following square matrix ($H^* = H_{m*m}$) A_i is assigned to final grade k as $h_{ik} = 1$

0	0	0	1
0	1	0	0
0	0	1	0
1	0	0	0

Table5. The formed H^* square matrix

Step 6 - If H^* is consider as the optimal result of above L-P model, the optimum order of options obtain from $H^* \times A_i$. The final ranking is shown at the table below.

Approaches	Grade
Several Organizations with Coordinated Management	First
An Independent Crisis Management Organizations	Second
Several Organizations with Parallel Performance	Third
No Crisis Management System	Fourth

Table6. Final grade

Results:

Considering the modeling results, several organizations with coordinated management get the first grade because of its high score among other approaches. This approach is benefited from expert quantity and their operation quality, it uses certain trustee for each activity, can increase coverage and following that reduce processing time and waste costs. Furthermore, this approach is supported by several organizations' facilities and resources and using a coordinated management, it can identify needs and supplies and manage the crisis in an immense range and prevent from wasting costs and supplies and doing excess work.

Independent crisis management organization is selected as second precedence in controlling crisis. This approach is sufficient due to its safety and delays reduction, Moreover, experts' operation quality is caused the reduction in managers' decision making and processing time. Furthermore, because its singular structure, it can define a certain trustee for each activity and reduce the waste costs. On the other hand independency of this approach leads to be insufficient for coverage during the crisis. Totally this approach is efficient before the disaster and effective in managing small and regional crisis and not good idea for big disasters with variety of aspects.

Modeling results justify inefficiency of several organizations with parallel performance approach. While this approach has massive resources and facilities, lack of a unified management lead to waste time and cost and insufficiency in crisis management system.

Finally Several Organizations with Coordinated Management is the best approach.

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