Intelligent system of prediction and management of maritime crises using neural networks

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Abstract
Current study is modeling a system by utilizing neural network to predict and control crisis. Main advantages of the suggested method would be summarized as being updated by latest data, forecasting and also managing crisis to improve the efficiency of system.

Keywords: Crisis management, Marine hazards, Neural Fuzzy Network.

Introduction
Forecasting and warning marine hazards is one of the least cost approaches in dealing with the sea risks which may cause both physical and environmental unpleasant events. Physical properties and hydrodynamic environment have considerable impact on the distribution of biological hazards such as algal bloom. Sometimes the influences of the marine hazards are also clear in hundreds of miles far lands. In fact, climate conditions of lands including storms, floods and draughts are strongly influenced by oceanic cycle and climate changes.

Predicting and warning marine crises not only reduce human, economic and social costs, but also develop coastal, marine and land strategies. Therefore, identifying and managing marine hazards has a crucial rule in development programs. In order to forecast and manage marine risks, a close cooperation between experts and scientist in different fields especially marine physics, marine environment, marine phenomenon's modeling, coastal and oceanic engineering, marine chemistry, marine geo physics as well as oceanographic satellites, is needed. Above all mentioned expertise, management is another necessary field to identify, assess and control marine hazards.

In order to reach reliable results, selecting the most appropriate method is important. Regarding to the large amount of data, utilizing non-intelligent models for assessment and forecasting may ignore some influential data. On the other hand, past experience of marine hazards is a valuable data source which has not been considered in previous methods. Infact, the only usage of past experiences has been presenting a simple model of forecasting which has not been considered as a professional approach towards hazard identification. Furthermore, most of the available forecasting models have designed generally so, it is hard to make them localized. Also, predictions' errors are different in each forecasting center.

This study is seeking to find an intelligent solution to fulfill all stated issues by suggesting an accurate forecasting method. The next part will be detailed description about crisis management. Following this, there will be a discussion on various types of marine

hazards. Then, the most appropriate method to forecast the marine risks will be presented. Results and the recommendation will be provided in the last section.

Crisis Management

Traditional approach of crisis management believed, crisis management is only a management of expectations. In other words, crisis managers are expecting deterioration of activities and routine processes in order to reduce the impact of failure after an unpleasant event (Robert 2002). This approach has been presented since organizational crisis management first emerged as an independent discipline after the 1982 Tylenol poisoning in United State as well as Chernobyl crisis of 1986 in Europe (Heath, Palenchar 2009). During the time the concept of crisis management has changed to the professional tactic focused on incident response. To put it more simply, crisis management displays what to do when a crisis happens and how to prepare for it in case it occurs. According to new approach, there should be a set of operational plans to deal with possible changes within companies. Such functional activities are critically important for all organizations to response and recover the crisis, an unplanned but not necessarily unexpected change, as well as making long term policies (Coombs 2007). Moreover, managers should also be prepared to response any possible future events quickly by making appropriate strategies. Therefore, crisis management is strongly focuses on the importance of prediction and preparation of disciplines to deal with any internal and external events which may threat organizations' reputation, profitability, operation and life cycle. Basically, crisis management is a part of strategic management which enables managers to maintain the organization against undesired situations (Preble 1997).

Before addressing the specifications of crisis situation and presenting an effective systematic approach, it should be noted that crisis might be occurred as a result of both internal and/or external unfavorable event which needs a systematic evaluation approach. Infact, it is the responsibility of crisis management to make the effective decisions according to accurate information in order to reduce the losses and control the crises quickly. So, there is a need to understanding the systematic interactions in order to make the decision making process possible otherwise it would be nothing except trial and error method. On the other hand, time limitation, possible threats and surprises are the main three factors which make the usage of trial and error approach irrational (Rosenthal, Pijnenburg 1991).

As far as crisis management concept is concerned, defining the crisis is also crucial. In general term it refers to any high degree of instability which may create extreme negative results that can endanger the continuity of the organization (Barry 2009).According to system's definition, there is an interaction between system’s components based on a determined set of criteria. In all systems, the variable elements of constituent parts should be maintained in a certain range. Any changes in the set range will break and/or eliminate the balance of system completely. As a consequence, in systematic approach, crisis is characterized as a situation which disturbs the main order of whole system or some parts of it. In other words, a sudden change in one or some parts of variable factors of a system is also considered as crisis. It is significant to note that the strength of crisis is strongly related to influential factors as well as management techniques (Doran, 1991). In addition, operational vision is defined crisis as any undesired changes in routine operation including both internal and external environment. People, process and systems are internal causes while external events are the main external causes (Jones 1995).

One of the basic tasks of crisis management studies is, recognizing the most vulnerable parts of each system in disaster time. Clearly, these sensitive parts are belonged to the components which require high attentions. Moreover, organizations should be responsible in front of their society about chosen policies, planned strategies and their outcomes

.However scientific management is the basic step of professional management, companies those have only focused on scientific planning and organized management may obtain a horrible failure in dealing with crisis as there is no specific solution to manage crisis. Even if, a clear key was available, it would not have same quality, advantages and disadvantages for all companies (Lerbinger 2012). When the subject extends to choice, the real concerns are judgment and value which might be difference due to decision makers' attitude. The other possible problem is the confliction of beneficiaries. Since decision making has been based on human's willing, individual objectives and visions will be included in it. Normally, all decisions must answer two questions as below:

- Regarding to decision maker's objective, what is the relation between the subject's value and hazards' probability?
- What is the correlation between decision's intentions and available tools?

Generally, first correlation is discussed in strategic context where as the second question is considered as a tactics (Dimson 1979).

Marine Hazards

In modern world, transportation especially maritime transportation has a significant rule in global economy and also globalization. According to the nature of maritime transportation as a substantial factor in countries' international relationships and its direct impact on countries' businesses, sea transportation safety is a controversial issue in high level of management. Assessing the possible insecurities and events is a useful approach to prevent the repetition of undesirable occurrences. Infact, disaster and crisis are some inevitable parts of human life which can not be avoided even with modern technologies. Therefore, balancing the adverse effect of crisis is needed to achieve sustainable development (Rizzuto, Soares 2012).

Indeed, the key approach to reduce the deserve impacts of crises is understanding the crisis management process, preparing and implementing the most suitable plan which has designed based on the hazards' specification. Therefore, identifying and also evaluating the potential hazards will enable organizations to strength human forces to face the emergency situations as well as decreasing losses. Furthermore, managing the possibility of port's operational crises in order to reduce risks' occurrences and injures will improve the overall performance of that special port. Now, the notable point is estimating the rate of crises severity. Although there have been many suggested methods to determine failure rates, these approaches are not reliable for advanced studies as they only have utilized the past experiences. In this way, methods are faced with two serious challenges which are mentioned below:

- Inefficiency due to lack of accurate and updated data
- Complete mis-match due to lack of local data in evaluation

Regarding to above challenges, there is a need to introduce a reliable model which can consider all aspects of a potential dangerous including valid data(Spooner 2002).

Suggested Model:

As it stated earlier, new vision of crisis management has included crisis forecasting which has as an influential rule to reduce companies' losses. This paper is seeking to suggest a method which would be enabled to register and update data based on new events.

Past studies have shown the success of utilizing neural- fuzzy networks in weather forecasting. So, current study a modified neural-fuzzy network to forecast marine hazards

which would be a practical technique in crisis management. Artificial Neural Network (ANN) is one of the new memory approaches in systems' modeling which defines input and output according to the nature of process. At the beginning, the ANN will be trained by the existing data while the next step is checking the validity of data. Training process will be stopped once it reaches the most accurate level. Now, network is ready to operate (Hayati, Abbasi 2007).

This paper is also utilized the Radial Basis Function Artificial Neural Network with Dynamic Feedback. The main reason for choosing this type of network is, its feedback option which will be more experienced during the time. So, the possibility of errors will be reduced.

Current study has also applied the three layers network. Inputs are located on the first layer while outputs are placed in the third layer. Forecasting is presented as both daily and hourly report.

As previously mentioned, this network is including feedback option. Every day, at the end of the day, it will compare the forecast results with real outcomes which have been saved by hazards' registration system. Then, the network will improve the layers' weight based on deviation. This process will make the network more experience.

Hazards identification is the basic step for designing the system. For further studies, a list of potential hazards of Iranian southern ports with 499 identified hazards has been prepared. Data has been provided by Iran's Crisis Management Documentations Reference. This index has been created according to three approaches as follow:

- Consideration of past undesired events
- Utilization of crisis managers' experience and ports' experts knowledge
- Evaluation of other ports' experience in the subject of crisis management as well as benchmark studies.

To further explanation, the obtained results are shown in figures 1to 3.

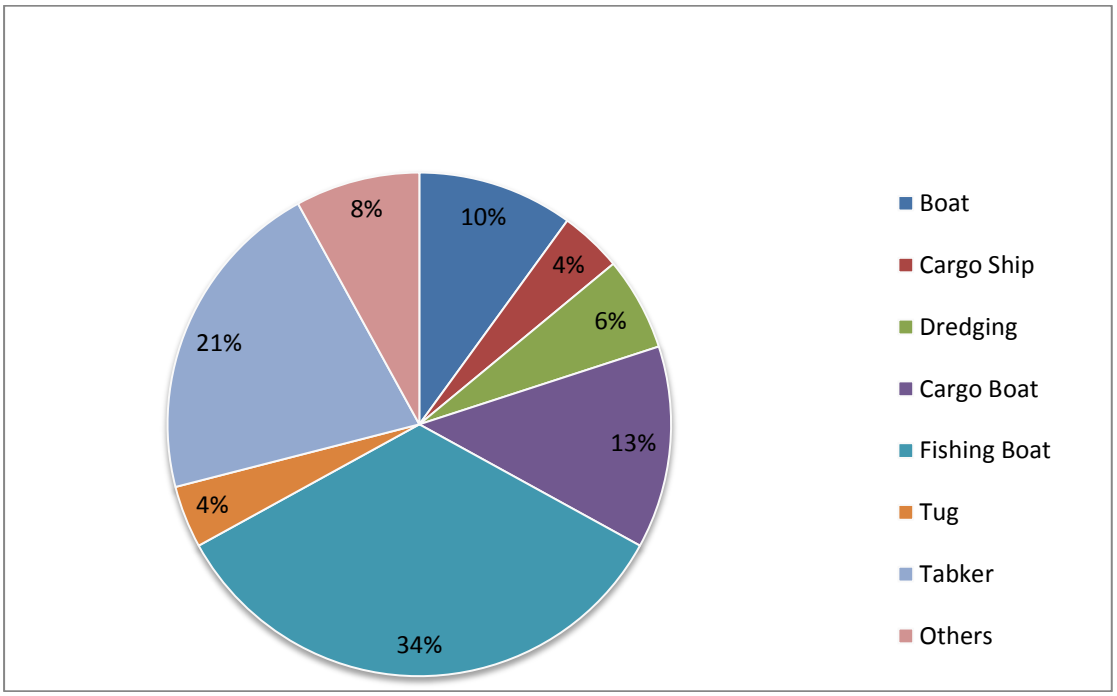

Figure1: Damages Vessels' Type

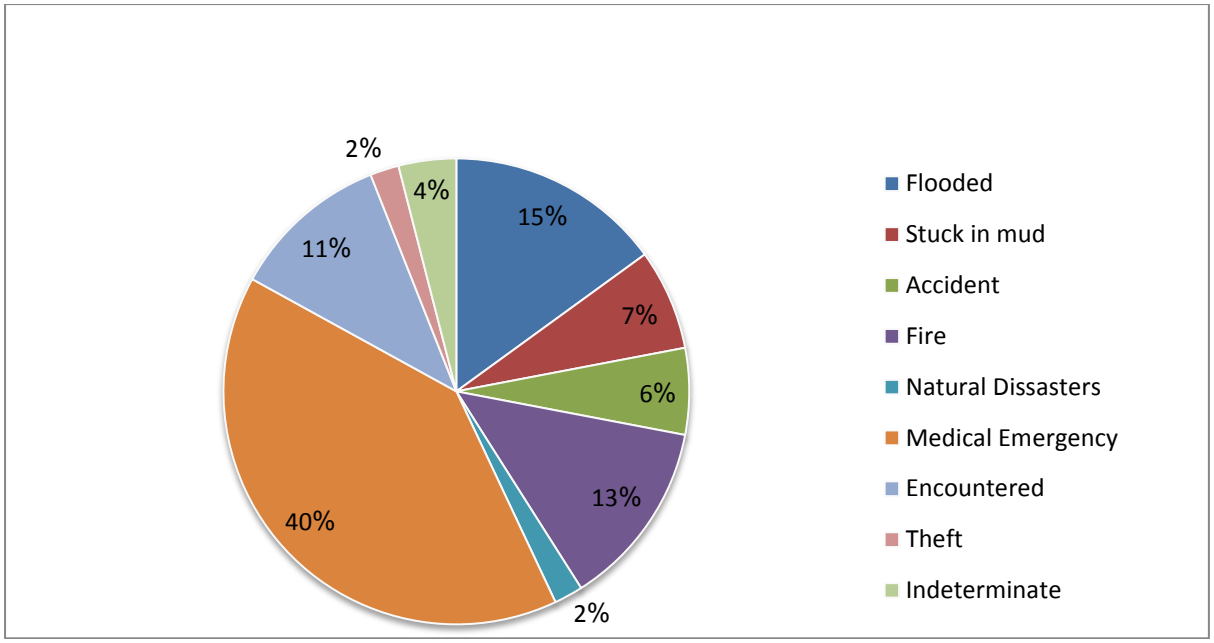

Figure2: Vessels Hazards' Types

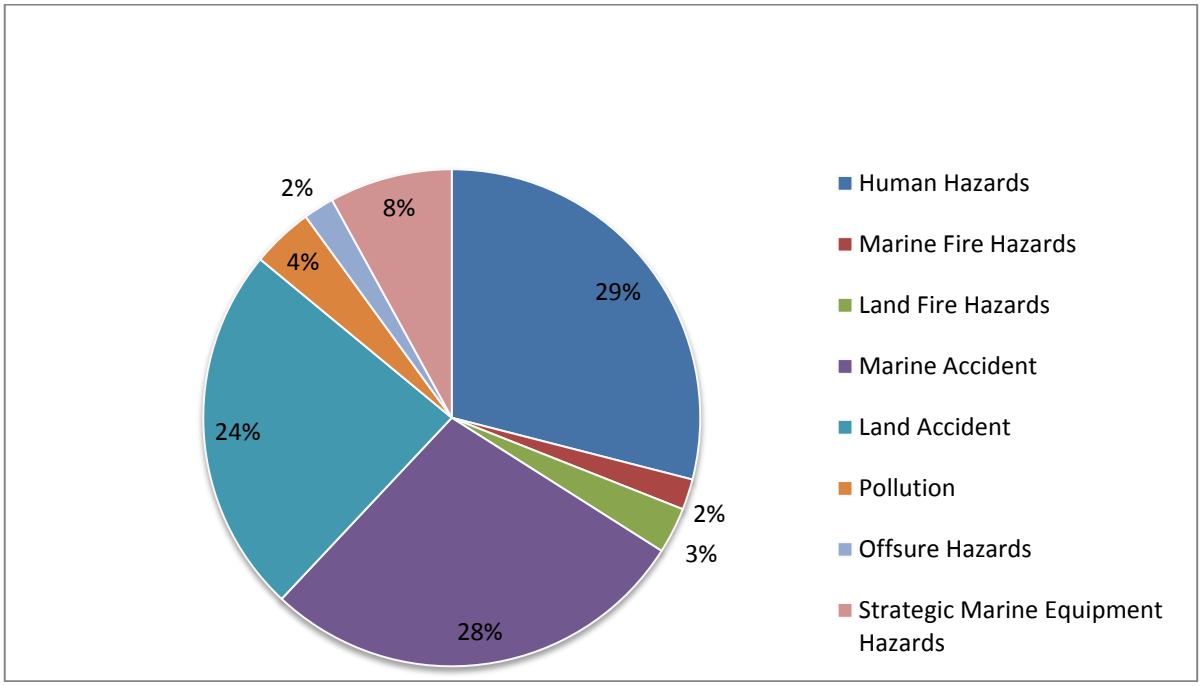

Figure3: Occurrence Percentages of Each Category

Next phase is evaluation the influential factors of marine hazards occurrences regarding to past events records as well as experts' opinions. After assessing collected data, 64 factors have been chosen which has been categorized in 6 groups as below:

1. Natural elements
2. Time
3. Work force
4. Economy and political situation
5. Physical and environmental specification of area
6. Statistic of yesterday disasters

Natural factors are referred to any climatic elements which may happen naturally such as weather temperature, wind speed, wind direction, visual rate, flood, earthquake and sonami. Time is placed as the second parameter. It is important because the probability of marine failure is high in some seasons such as winter. In addition, the quality and quantity of hazards are difference is some special days like working or off days. Even, day and night may impact the risks of disaster events. As a result, an accurate forecasting method should consider the element of time.

Following that, the third element, is work force which has a significant impact on reduction of marine hazards. The ability of vessel personnel, from one side, and the knowledge of security and regulatory teams, from the other side, will reduce the possible hazards definitely. So, the quantity and quality of human resources are important in crisis management. As vessel personnel do not access the daily updated information, the quality and quantity of control team are more considered. Utilizing this parameter will enable organizations to predict marine hazards even during the increased security projects.

As far as the importance of work force has been considered, it is also necessary to assess the stability of economic and political situation. Indeed, unstable economy will cause depreciation in vessels. In similar way, lack of budget will reduce the effectiveness of work forces. On the other hand, government could not full fill the marine section requirements. Regarding to above reasons, this paper is applied the official political and economical statistics to gain reliable outcomes.

Localization of network will be possible by utilizing physical and environmental parameter in order to increase the accuracy of system.

Final element is last day hazards' statistics which improve the weight of network to update the system. It is crucial to mention, last day statistical report will be workable if the system feedback is also considered. This information is obtained automatically from the events registration part where the validity of data is important. So, senior user will confirm the validity of data at the end of the day otherwise the network's weight will not modify.

After designing the network, in the next step, it has been trained by the last 2 years data.80% of that data has been utilized for training while the rest 20% percent has been applied for testing.

The system was tested for 3 months. At the end of 3 months, hazards' prediction accuracy was 69.6% which is an acceptable outcome. It is necessary to state that, one of the main factors in results accuracy is trained data. This claim has been approved by considering the success of monthly accuracy of system which was 66.3 in the first month, 70.5 in second month and 72.1 in the last month.

Results:

Regarding to the new vision of crisis management, and its importance to reduce organizations 'cost and losses, utilizing an accurate forecasting system is required for any fields of activity specially marine industry.

The suggested artificial neural network is the most appropriate method in hazards' prediction regarding to its high flexibility, being experience over time and fulfilling the forecasting needs. The other positive point about the designed method is, the capacity to localism which will help managers to obtain more reliable results. In order to reach accurate result, this method needs accurate data, as input data, for registration. Results strongly show, the accuracy of suggested prediction system was increased while the input data was improved. It means there is a direct correlation between those two elements. All mentioned results will help managers to forecast crisis effectively.

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