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Disaster Management System using Artificial Neural Network

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Abstract: Malaysia's National Security Council Directive No. 20 (MNSC No. 20) was established to ensure a disaster could be managed in an integrated, systematic and coordinated manner. When disasters occur, quick decisions must be taken to prevent more damage to property and loss of lives. Although, MNSC No. 20 had been established, since the year 1997, the system used by responders to manage the disaster is not effective. Conventionally, the first responder operation system during disaster is conducted through writing the disasters information on paper forms and there is no standardize report forms. There are often difficulties in updating and conveying any new information to other responders as well as possibilities in missing some of the important information regarding the disaster. Additionally, the disadvantage of conventional system is that it consumes a lot of time for the responders to decide, the type and number of rescue transport, man power and logistic needed in a limited time frame when the expertise is not available at the disaster site. A new system that can institute a quick and reliable decision for disaster and complies with the standard issued in MNSC No. 20 that is highly demanded. The disaster management system will fully be developed using Matlab software and the main source of data are from Fire and Rescue Department Malaysia (FRDM), MNSC No.20 policy and other Standard Operating Procedure (SOP). The objective of designing the system is to help and assisting responders especially FRDM in proposing the number of resources needed and determining the level of disaster during response phase effectively and efficiently.

Key words: Artificial neural network, disaster management, FRDM, MATLAB Software, MNSC No. 20, policy

INTRODUCTION

Definition of disaster: A disaster can be defined as a serious disruption of the functioning of civilization, causing widespread human or material losses which exceed the ability of affected local organization to cope using only their own resources (Mohammad, 2007). A disaster also can be defined as a form of event that occurs in a sudden manner or a catastrophe that causing an outrage damage that crack-up the daily activities of a local community, economic and their environment (Hassan *et al*., 2011).

Disaster types have been studied and reviewed for the past few decades and it was found that the disaster can be classified into 3 main type which are natural, man-made and hybrid disasters that cover all types of catastrophic events (Shaluf and Ahmaddun, 2006). Conventionally, disaster are natural hazards events which include, floods, tsunami, earthquake, volcano eruption, drought and many more (Baharin *et al*., 2009).

Now a days, there are man-made disasters such as industrial accident (technological disaster), transportation accidents (transport failures), structure collapse and much more have emerged rapidly (Shalut and Ahmadun, 2006). In certain cases, a man-made disaster may trigger a natural disaster and vice versa. This kind of disaster is also known as hybrid disaster (Furedi, 2007).

However, some explanation classified the disaster only into 2 main type which are the natural and man-made disaster (Malek, 2005; Mohammed, 2008; Negara, 2012). From those definition, a disaster generally contained several factors such as huge devastation to assets, human life and enormous impact to the local social and economic. Facts about disaster are, it may happen anytime, anywhere and cannot be avoided (Baharin *et al*., 2009).

Disaster management: Disaster management can be interpreted as the organization and management of assets and responsibilities for dealing with emergencies, peculiarly preparedness, response and recovery in order to lessen the impact of disasters (Amailef and Lu, 2011). Minimizing or reducing the effect of disaster includes, curtailing casualties by saving innocent lives and sidestep major damages or loss towards environment and

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property, yet in the event of a massive-scale disaster, it will be a huge challenge for the local authority having jurisdiction to manage the disaster themselves (Kusumasari *et al*., 2010). During response phase of disaster, responders face countless challenges especially during decision-making process which would be almost impossible to be accurate all the time (Khairilmizal *et al*., 2016). The timeliness and accurate decision made by responders shapes the effectiveness of emergency response efforts. Routinely, an expert will be appointed to lead the decision making-process (Khairilmizal *et al*., 2016). Accurate and effective decision made by experts is based on years of experience as well as knowledge gain from training and exercise (Hussin, 2012). The problem is that, human expertise is expensive, irreplaceable and not always available at the disaster site to lead and assist responders. This leads to difficulty in finding domain expert with relevant knowledge and experience to manage the disaster (Shaluf and Ahamadun 2006) especially during initial respond. Thus, a computerize system that is capable in assisting responders to make decision is highly demanded (Hussin and Wang, 2010). Due to this, researcher came with a solution by introducing a system called "Disaster Management System Using Artificial Neural Network".

Artificial Neural Network in general: An artificial neural network or in simple term known as ANN is a computational learning model based on the functions and structure of biological neural networks such as brain or neurons (Sharma, 2014) whereas the data and information are the processing paradigm (Naim *et al*., 2011). ANN are problem-solving tools that has become one of the alternative modelling method to non-physical and physical systems with mathematical or scientific basis. Just as human brains can be trained to master some assignment or tasks through experiential knowledge and training, ANN can be trained to learn the characteristic, behaviour and perform optimization through a training process (Mohamad *et al*., 2010).

Multi Layer Perceptron (MLP) is a subset of ANN. Generally, MLP consist of a system of massively distributed parallel that have natural tendency for storing and utilizing experiential knowledge (Mohamad *et al*., 2010). It is a network that contains one or more layers of hidden unit that are not part of input and output of the network. The hidden units enable MLP to learn complex assignment from the input and output relationship. Typically, MLP consist of three or more layers and can be used in classify a nonlinear pattern (Ghaffari *et al*., 2006).

MATERIALS AND METHODS

Before developing the ANN System, literature review on MNSC No. 20 policy, Artificial Neural Network concept and FRDM background (current system, disaster records and other Standard Operating Procedure (SOP)) being studied by researcher to gain more understanding regarding the disaster and disaster management in Malaysia. The stepwise procedure in developing the "Disaster Management System Using Artificial Neural Network" are as follows (Datt *et al*., 2015; Hussin *et al*., 2016).

Collecting and analysing disaster case dataset: This project, begins with collecting data (past disaster records) from Fire and Rescue Department Malaysia (FRDM). About 1489 records were collected and each records being classified based on the MNSC No. 20 Deterministic Factor (Hussin *et al*., 2014). (Type of building, area covered, height, type of disaster, etc.) (Fig. 1).

Training accuracy and testing accuracy: Training process is similar with a learning process (Naim *et al*., 2011). The step consists of input, output and hidden layer. For this project, researcher used 1 hidden layer connected to input and output layer with 12 neurons. The training of an ANN is by using feedforward method and the weight of an input is adjusted using Levenberg-Marquardt rule (LMA). Prior to training, the dataset being split into 60:20:20 (training: validation: testing) ratio. The training set is used to update the

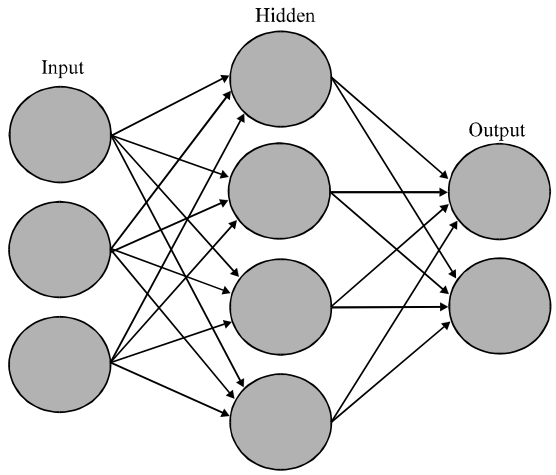

Fig. 1: ANN architecture consist of input layer, hidden layer and output layer (Naim *et al*., 2011)

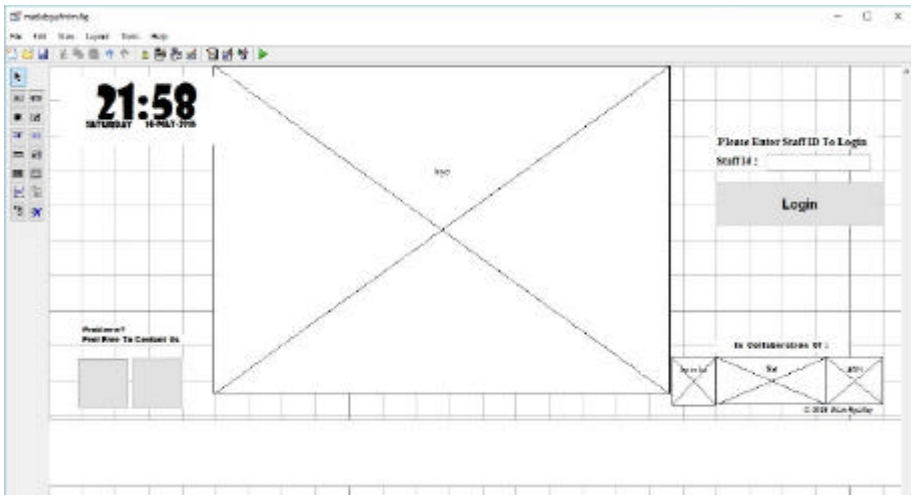

Fig. 2: GUIDE layout editor for the first page of the system

weights and the Mean Square Error (MSE) in the independent validation set is monitored. The process is that the input of disaster past record is inserted to train the network and at the same time recognize or classified each of the disaster pattern and characteristic in order to differentiate with others input given. The data input must be not too little or too many because if too little input, the network cannot learn properly if it too many, over-generalization might occur. Testing accuracy part, is on testing the disaster data which had been trained earlier. This process is done to determine whether the network learn properly or not.

Developing system user interface using MATLAB Graphical User Interface (GUI): After both processes mentioned in A and B, the researcher designed the user interface for the model. MATLAB Software Version R2015B was used in designing the system. Using the GUI Development Environment (GUIDE) Layout Editor, researcher graphically design the system UI. GUIDE then automatically generates the MATLAB code (M-File) for constructing the UI which contains a framework for the GUI callbacks (the routines that execute in response to user-generated events). Codes were added to the callbacks using the M-File editor to perform actions and modify behaviour of the apps. Figure 2 shows the GUIDE layout editor for the first page of disaster management system.

RESULTS AND DISCUSSION

Disaster Management System Using Artificial Neural Network is successfully built. The system consists of (5_pages (login page, main menu page, input page1and 2 and report page). Further, description on how the system works is as follow.

The system begins with users login the system by entering their staff id. After that, users need to click the LOGIN button and they will be directed to the main menu page. At this page, users need to choose what action they want to do whether continuing to use the system by clicking the DiMS button or ending the session by clicking the LOGOUT button. Figure 3 shows the first page of the system which is login page.

Upon clicking the DiMS button, users now will be directed to the next page of the system which is the input Page 1 as shown in Fig. 4. At this page users need to choose the scale of the disaster which is based on the Deterministic Factors MNSC No. 20 policy. Users then need to click RUN button to calculate which level of disaster should be activated and what is the warning level for the disaster. After that, users need to click the NEXT button to proceed to the input Page 2 (Fig. 5).

At this page users will need to key in the information regarding the disaster. After that, they need to click save button. This time, the system will compute the required resources using ANN technique. Users can check whether the system already finish computing the information or not in the status bar located at the bottom page of the system. The last page is the report page. The output of the system will be displayed at this page. All the information key in before will be used to generate the report which consists of name of officer, date and time, level of disaster, warning level, type and number of rescue engines and the number of man power needed to handle the disaster. All the information can be saved in excel form by clicking the save button.

Fig. 3: Login page

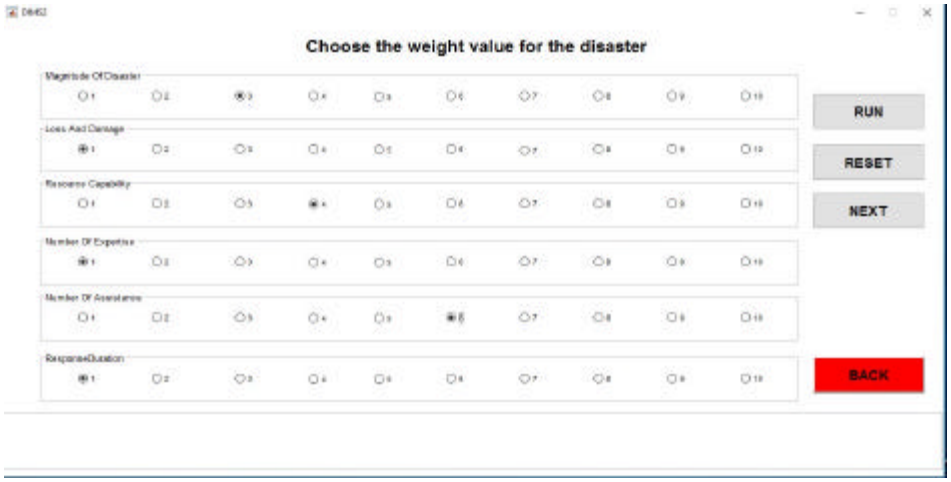

Fig. 4: Input Page 1

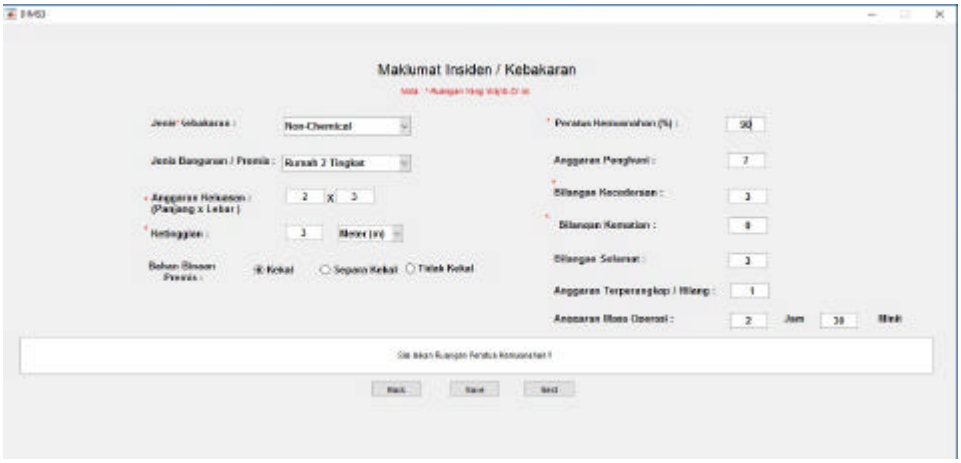

Fig. 5: Input Page 2

CONCLUSION

"Disaster Management System Using Artificial Neural Network" presents a modern system by applying Artificial Neural Network knowledge to FRDM information. The system design is based on MNSC No. 20 policies and capable of managing disaster by providing the level of disaster, proposing suitable type of rescue engines and its number needed and also other resources needed to the FRDM. The system is expected to be relatively faster and more efficient than the current system used by FRDM. Besides this system can help and assist FRDM in planning the rescue tactical mission as well as avoiding miscalculation of resources needed during disaster.

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