

Technology for Decision Support during Biological Incidents Responses

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Abstract: - The paper describes the importance of decision support tools, modeling and simulation utilized for effective and efficient decisions made during the biological emergency situations. It aims to outline the general structure of decision support. The NBC CREST software tool serves as a template for suggested system. Furthermore, the initial phase covering the system environment analysis is examined and available data sources are identified and described. The end users of the decision support system outcomes are suggested. Moreover, further research, focused on the particular useful methods and processes resulting in intended outcomes valuable for decision makers, is discussed.

Key-Words: - Decision making process, decision support, modeling, loss prediction, NBC CREST, software tools

1 Introduction

The decisions are crucial especially during the casualties and emergency situations related to biological or chemical incidents. A lot of factors should be considered and evaluated in effort to make the decision as efficient as possible. This should ensure losses minimization and effectiveness of resources utilization. However, biological or chemical incidents belong to the group of semi-structured or unstructured problems [7], which are hard to automate or algorithmically expressed. Therefore, decision makers are mostly people. The problem is that their decisions are influenced by emotions, intuition, previous mistakes, situational context, etc. Human brain is obviously limited to a certain level of complexity and so is its reliability. Therefore, several tools or techniques, which support decision making, have already been developed (see for instance [6]). The software tools belong to this category. They enable to support decisions of various users. The employment of software decision support systems allows them to make meaningful decisions. Furthermore, modeling and simulation can be applied. Nevertheless, the complexity of environment and the level of dynamics reduce feasibility of computer-based simulations of emergency situations. Moreover, the number of incidents and the extent of their consequences are also increasing - especially because of more sophisticated technologies, methods and knowledge of potential violators. The main objectives of this paper are to outline the general structure of decision support during the emergency situations caused by biological incidents (both intended and unintended), to describe the available data sources which are crucial for the initial phase of decision making

processes, and to identify and determine the end users of the outcomes of tools for decision support, modeling and simulation. Military-based application NBC CREST is used as a base for the research.

2 Problem Formulation

Several efforts have already been done in the area of decision support during biological incidents (see [1], [2], or [3]). However, the starting point of the conducted research was based on the Nuclear Biological Chemical Casualty and Resource Estimation Support Tool (NBC CREST). NBC CREST is a useful tool utilized currently only for the military purposes, especially within North Atlantic Treaty Organization (NATO). NBC CREST models casualty or attack scenarios “in accordance with current threat assessment and operational requirements” [4]. One of the advantages of NBC CREST is definitely the option facilitating the adjustment of input parameters which provide user-defined scenarios. It also enables advanced planning, estimation of potential requirements or the analysis of Courses of Action [4]. Various calculation formulas and analytical techniques are employed for the purposes of casualty and loss estimation and calculation. Figure 1 exemplifies the output of NBC CREST which illustrates the predicted scenario generated from the input data, respectively on the basis of the parameters from data sources about the initial state of the emergency situation.

Apparently, this tool has a potential for defense in the civil sector realm as well. The losses might be minimized while using such tool. For example, responsible governmental bodies should identify the

affected population and take steps to protect them. Similarly, this can be applied within the realm of protection of animals, properties or other tangible assets. However, the transformation and utilization within non-military sector is feasible only under certain conditions. The assumptions are for example clear and unambiguous decision rules or data availability. Nevertheless, the modification from a military focus represents a challenging task. The outcome would provide a useful support tool for defense of important assets and predictions. The technology should facilitate the option to flexibly change the input parameters according to the constantly changing conditions.

- model further development of the emergency situation
- eliminate the consequences
- estimate losses and budget
- estimate time demands
- reduce costs
- assess risk
- increase efficiency and effectiveness
- assign responsibilities clearly
- enable to predict and prevent similar situations in the future, etc.

3 System Environment Analysis

When developing a system for supporting of decision making related to biological incidents one has to perform the first important step – to determine both the data resources and the end users. During the research the method of unstructured interviews with experts on epidemiology, biology, and general medicine was used to acquire the list of potential data resources and end users. The results were consequently processed since resources and users are apparently interrelated. Generally speaking, they also vary according to a certain country or area. Moreover, the terminology including names of ministries and other institutions differ within the context of each country. Nevertheless, these are generally mentioned within the text. Therefore, these issues should be considered especially while applying the outcomes of this paper in the local context.

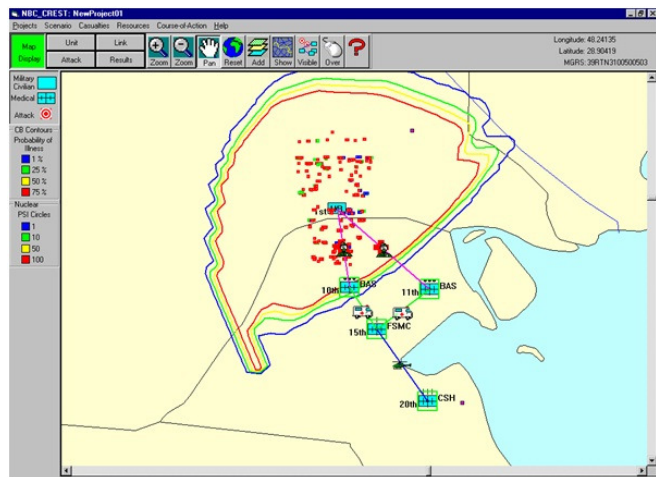


Fig. 1: The illustration of NBC CREST modeling of the emergency situation (adopted from [4])

Further assumption is that the modeling and simulation in the civil sector have to facilitate the identification of technical equipment, infrastructure, personnel and other resources. The developed model has to also enable the identification and analysis of the development and potential impact of the emergency situation. Basically, a model of incident development provides a comparison of various scenarios. On the basis of such outcomes, the potential losses can be identified more easily. Moreover, a model enables to predict required resources and costs for elimination of the impact of the incident. The predictions and scenarios facilitate the stress reduction for personnel furthered by better performance of involved parties together with appropriately timed resource utilization. Moreover, the system represents the basics for the decision support. Organizations and institutions from the public as well as private sector are usually responsible for the protection of assets. The aim is to offer the decision maker who utilizes the outcomes from software tools with a set of precautions important due to the protection of lives, properties and other important assets. Other advantages of modeling and simulation include to:

- assess the population and area affected

It is significant to realize how interconnected are the institutions and organizations which provide the input data and the end users. Moreover, these are often exactly the same subjects. The only difference sometimes remains either in department (one is providing the input data and other is receiving the outcomes) or in input/output utilization (even the same department can provide partial data for a certain emergency situation and then utilize different area of the outcomes).

3.1 Data Resources

The relevant data resources (see Figure 2) provide the contextual analysis. Currently, these are mostly not available in sufficient extent. Moreover, each institution and data source stores data in various formats. The data are usually not concentrated in one place and therefore various complications with data spread, inconsistency and irrelevancy arise. Nevertheless, the following data sources should be generally considered:

- Demographic information
- Strategic documents
- Communication strategy

- Legislature
- Environmental parameters, etc.

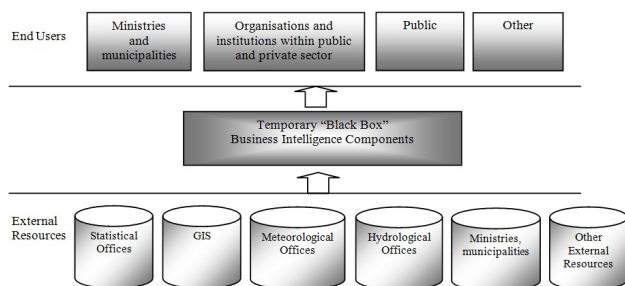


Fig. 2: The Business Intelligence utilization and its interconnectedness with data resources and end users

Demographic information is gathered from statistical offices and provides the characteristics of the population. Strategic documents are represented by pandemic strategies or emergency plans of various municipalities. These, together with the legislative framework, cover communication strategies, principles, or given responsibilities relevant to a specific emergency situation. The importance of legislative is furthered by the presence of acts which determine the recommended or compulsory course of action within certain situations. Geographic Information Systems (GIS) represent a source of information about affected area. The up-to-date weather conditions and other information about current environmental situation can be collected from the hydrological and meteorological offices. Among other resource institutions, various institutes and authorities (e.g. focused on disease prevention, drug control, vaccination, and nuclear safety) provide useful input data.

3.2 End Users

Each end user applies various attitudes to the emergency situation despite the fact that they should cooperate and act with the same aims. Their course of action should be coordinated due to the effectiveness of the decision and quicker incident solution. It is significant to harmonize the procedures and provide each decision maker with relevant recommendations and appropriate basis for decisions. Therefore, as mentioned above the outputs should be tailored to needs of the end users. Both the user friendliness and the flexibility of the technology support the trust of the end users together with the probable increase of their participation in the utilization of the technology.

The end users can be exemplified by various ministries, municipalities, organizations and institutions within public or private sector (see Figure 2 again). For Ministry of Transport, Defense, Interior, Health and

Finance the outcomes will be most useful as well as important. Among other public institutions firemen, police, hospitals and clinical laboratories, hygienic, veterinary and statistical offices, or various institutes might utilize the outcomes most probably as well as effectively. Nevertheless, the private sector should be mentioned as well. The decision makers, mostly managers of companies, might invite such tool due to the effort to improve the effectiveness, relevancy and appropriateness of their decisions.

4 Further Research

Once the necessary data resources and end user are identified, the next steps in the research process can be conducted. Therefore, the future research will be focused on the determination the structure of the “Black Box” and components within it. The processes, methods as well as necessary resources (such as financial, human, time or technological) will be defined and specified to provide the decision maker with appropriate information. ETL processes, Data Mining techniques and various types of analytical tools illustrate the examples of processes and methods which might be employed for the purposes of the intended outcomes. These are exemplified by comprehensible and tailored reports, recommendations or precautions for the end users.

5 Conclusion

Individuals and institutions, which are responsible for decision making in case of biological incidents, suffer from lack of the compact, complete and comprehensible information about the emergency situation characteristics. Therefore they can hardly make efficient and effective decisions. Nowadays, technology provides with various opportunities to model and simulate the emergency situations. On basis of such scenarios, more accurate and effective resource planning and utilization can be ensured. Moreover, technology represents a tool which enables the transformation and analysis of different data from various sources to a set of reports, recommendations and precautions which support the decision making processes. The employment of such technology apparently provides a lot of advantages. Therefore, it seems to be valuable to develop and afterwards constantly improve a software tool analogically to NBC CREST which would be widely available and utilizable.

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