AN INNOVATIVE APPROACH FOR TOOL-BASED FIELD EXERCISE-SUPPORT TO GAIN IMPROVED PREPAREDNESS IN EMERGENCY RESPONSE

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Abstract

In order to maintain a high level of preparedness, rescue operations need to be trained regularly. In this article, we present a tool which is to support rescue organisations in the execution and analysis of such exercises. An IT based gathering and exploitation of data describing relevant aspects of the exercise is well suited for this task, in particular with respect to data preparation and visualisation. A reasonable presentation of the exercise results allows to identify deficiencies and thus to identify measures for improvement. Hence, we present in this paper how the tool may be deployed in an exercise, which data is handled by the system and how the corresponding user interfaces are designed.

Keywords: exercise support, emergency response, triage, training

1 INTRODUCTION

For mass casualty incidents (MCI) like bus accidents, it is important to maintain optimal preparedness with regard to the rescuers' capabilities and the allocation of rescue resources. Rescue organizations like the German Red Cross (GRC) thus regularly perform field exercises to improve the overall rescue performance in case of emergencies.

Currently exercises are analysed and evaluated by collecting quantitative data during the exercise using standard software tools, sometimes quantitative data is not collected at all. However, within the GRC there is up to now no standardized methodology and toolset to support exercises from an IT perspective. In consequence, the exercise outcome assessment cannot be based on facts and figures or, at least, is time-consuming to prepare. Further, it does not follow a standard scheme and always strongly depends on know-how of involved key personnel on site. Currently, there is no way to compare different exercises and their outcomes to each other, e. g. in different GRC regional brances, which reflects a fundamental need of the GRC with respect to capability assessment and improvement.

To overcome this gap, an IT-solution is desired, which supports exercise assessment by improving on site exercise data capturing and analysis, and also exercise debriefing by providing a schema-guided data visualization capability. The most important end user requirements to be met by the solution are easy handling of the support tool by any user regardless of his/her IT-skills, and mobile employment of the tool to ensure applicability in every local-specific exercise-scenario context. Furthermore, employment of the tool shall be focused on patient care including triage and evacuation as the most essential features of MCI-operations [1].

2 RELATED WORK

With regards to tool-based exercise support, there are several solutions introduced to the market varying in their technical maturity; none of them is capable to fulfill the specific requirements of the GRC that serve as a basis for the research work to be presented in this paper. Two of the most inspiring systems designed for a cognate problem space are Exonaut™ and RescueLab.

The Exonaut™ Training and Exercise Manager (TEM) application [4] allows tool-based design, realization and evaluation of field exercises. Its web-based information system is also available on mobile devices and can provide and archive exercise documents. The underlying software is not specifically designed for requirements of mass casualty trainings.

The aim of the RescueLab project [5] is to increase the quality of exercise runs by using information systems. Exercise data capturing is done using different kinds of embedded sensors. RescueLab data postprocessing capability allows to superposition information streams captured from different sensor sources (video, speech/audio, GPS data) in order to generate and display a comprehensive picture about performed activities of rescue trainees. The RescueLab approach focuses on support of exercises of technical relief organisations like THW and fire brigades.

3 SYSTEM DESCRIPTION

This chapter summarizes briefly the main aspects characterizing the system. After a short description of the purpose of the system, it will depicted what type of data may be captured by the system and how it will be processed and visualised. Some short remarks about the implementation of the system conclude this chapter.

3.1 Purpose of the system

The goal of exercises in the field of emergency response is to maintain and improve the capabilities of first responders in order to assure a rapid and reliable handling of an emergency situation. The proposed tool is to support this goal by summarizing and aggregating data gathered during the exercise in a way that allows assessing the outcome of an exercise, identifying shortcomings and deriving measures for improvement. In detail, the system supports the following activities:

a) Prior to the exercise, storing of main data related to the response scenario, as location of the incident, participating actors and the injury patterns which are to be shown by the actors playing the injured

b) During the exercise, capturing of data which constitutes the basis for exercise analysis and assessment

c) After the exercise, instantaneous processing of the captured data and presentation of results for analysis and assessment, complemented by the possibility to compare the just finished exercise with older ones

The following sections describe in more detail how the system is supporting these different phases. The description is focussing on the user perspective, i.e. on data input/output and user interfaces. Due to space limitations, we limit our description to activities mentioned in b) and c).

3.2 Data input during the exercise

The data which will be gathered during the training on the field will, in the end, reflect the performance of the involved first responders, as their activities determine the success of a rescue operation. The most important parameters should illustrate the first responders' activities including triage, treatment and evacuation. Consequently, the following data can be logged:

a) Communication events between first responder and headquarter

- Communication of alerts (type of alert, time stamp, comments if adequate)
- Request of resource vehicles for evacuation (time stamp, number and type of vehicle requested)

This data is captured by a so called data steward, who is a neutral observer of the exercise.

b) Type of care measures

The actual care measures (see Figure 1) done by the first responder are indicated by a Yes/No flag. Typically, these flags are set by actors playing the injured. Depending on the setup of the data capturing process, they note the application of care measures with paper and pencil which are, at the end of the exercise, transferred into the system. At a later stage of development, mobile devices may be used to capture this data.

In addition, the result of the triage respectively pre-triage process is captured in a separate widget.

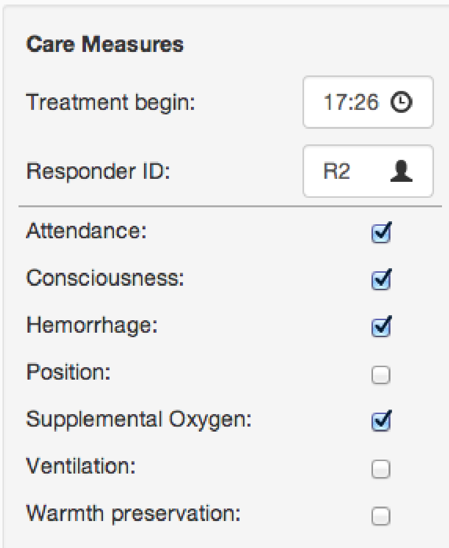

Figure 1: The care measures widget

c) Spatial planning activities

Spatial planning includes the definition of the hazard zone, the vehicle depot and the patient depot ("tactical areas"). They are entered by dragging and dropping the appropriate symbol on a map, or alternatively, by entering a geographical position. In addition, a time stamp indicating when a tactical area was set up has to be indicated.

3.3 Provided information after the exercise

Once the input data is entered into the system, it can be processed and aggregated in order to produce the desired output data. Basically, output data is created by simple statistical means, leading to both single parameter values, and also time dependant readings. The latter are displayed in different graphical form (bar charts, pie charts, graphs).

The simple aggregation of the type of dataset (vehicle on site, tactical area, pre-triage, triage, evacuation) and respective timestamps results in the mission phase timeline.

On the basis of the log data about communication events, it is possible to inspect the flow of resources (vehicles) in a table, complemented by the points in time when they were requested.

The statistical processing of data about care measures gives, for every actor playing an injured person, an absolute number of applied care measures. This allows to identify if responders are able to decide which care measures to apply in which situation. The total number of classification errors occurred during the pre-triage and triage phase is another indication worth evaluating.

The data on spatial planning is used to create a chronological order the composition of the different tactical areas.

The resulting data from the exercise is presented on a debriefing view. This debriefing view consists of an overview page, which shows the essential information about the exercise. The widget element on the right hand side presents different aspects of the exercise to choose from (see Figure 2). The selection of one of these items gives a new screen visualizing key information about this particular exercise aspect (see Figure 3).

Using reference data from a previous exercise (run) is possible.

Figure 2: Debriefing view (overview)

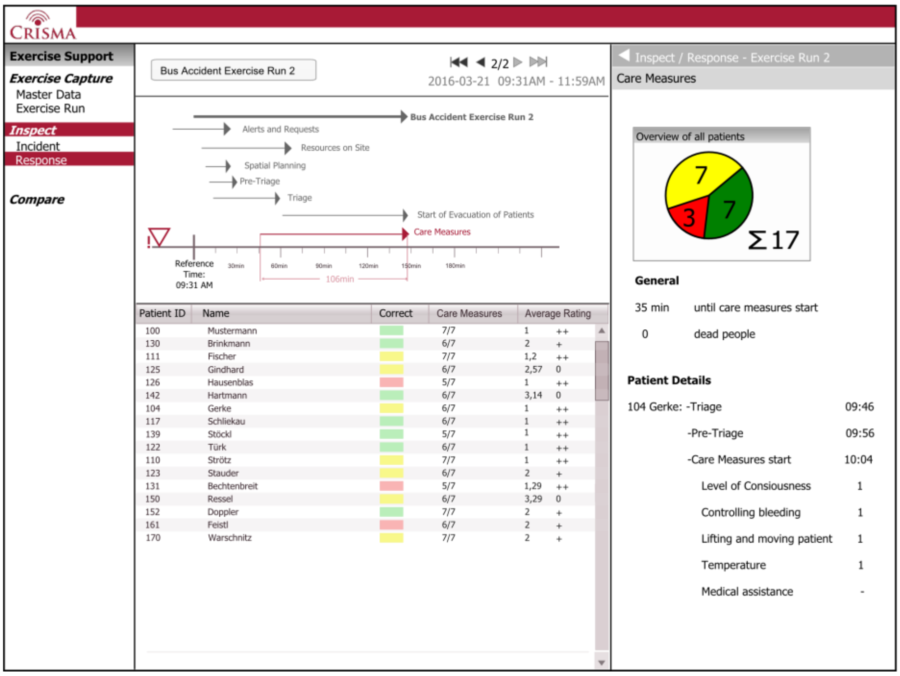

Figure 3: Debriefing view (care measures view)

Among others, to perform such a comparison, a number of indicators were defined that provide a high-level view on a particular exercise. These indicators are:

- Time until last patient is transported to the hospital
- Time until red patients are away from the incident scene
- Ratio of medical responders per patient
- Ratio of medical responders per patient per interval
- Time until all patients are pretriaged
- Time until all patients are triaged
- Number of vehicles involved
- Number of application of basic measures on scene
- Patient assessment of basic measures
- Ratio of vehicle per patient

The implementation of this functionality is in progress.

3.4 Implementation aspects

To implement the system, a web based client-server architecture was chosen. This approach implicates a number of advantages, in particular with respect to scalability:

- The *number* of devices deployed for data capturing is scalable
- There is no restriction with respect to the *type* respectively mix of devices deployed for data capturing is (mobile devices, laptops, desktop PCs, …)

All user interfaces are designed and implemented using the Wirecloud platform [6], which is a mash-up platform enabling developers and users combing different widgets on a dashboard. The widgets themselves are coded in HTML5 and Angular JS [7].

The described frontend communicates with services provided by the CRISMA crisis management infrastructure. The incident scenario data as well as the data captured during the exercise are stored in the Integrated Crisis Management Middleware (ICMM) service. More information about both can be found in [8].

The so far developed user interfaces are designed for deployment on a PC or laptop. It is planned to design user interfaces which can be used also on mobile devices. As widgets are modular components of the current web based user interfaces, it is possible to rewire them in order to obtain adequate user interfaces also for mobile devices.

4 DEPLOYMENT IN EXERCISES

Prior to an exercise the incident scenario and exercise concept [2] has to be defined. The concept includes a detailed description of the scenario and defines parameters like number of involved patients, distribution of injury patterns [3], number of available responders and rescue vehicles, as well as location specification. Once the concept is developed, the injury pattern can be assigned to the set of (fictive) patients who are mimed by actors. This includes information on type of injury, triage category and the patient's identity. All this information is to be registered before the exercise.

In a second step the patients and rescuers are equipped with exercise-IDs, the patients additionally receive a care measure evaluation sheet where they have to fill in times of (pre-) triage, care measures and evacuation as well as the kind of performed care measures. Due to limited space around the damage zone, a so-called vehicle queue area and a treatment area may be established by the rescuers. For every exercise a data steward needs to be nominated, who is in charge of collecting the sheets and typing the given information into the application forms in the software.

When data collection has been completed, the application provides key performance indicators as numerical values as well as charts that depict further data of interest. The exercise leader then has all instruments available to analyse the performance of the exercise and to discuss the results in a debriefing session together with all involved responders. The leader is enabled to detect weak points in a structured way.

Proceeding this way the developed IT-tool is not changing the elaborated structure and process of field exercises but complementing them.

5 VERIFICATION ACTIVITIES

The first version of the application, which has been developed in an interdisciplinary team of researcher, practitioner and end-user, shall be tested in summer 2014 in a real exercise environment. The German Red Cross in close collaboration with the Bavarian Red Cross organizes two exercises, simulating a bus accident in a rural district area (in the first scenario 9 patients are involved; in the second scenario 25 patients). In the course of this exercise, smooth-functioning and usability of the application will systematically be tested and evaluated.

6 FURTHER DEVELOPMENT

The advanced version of the application will introduce a couple of new functionalities. To facilitate multi criteria analysis of rescue trainings, a capability for criteria- and value-based comparison of different exercises will be provided.

The advanced tool shall also enable storage of domain expert knowledge so that a rating for the indicators can be provided automatically.

Furthermore, the advanced version of the application is intended to support semi-automatic parametrization and calibration of software models that aim at simulating different aspects of real live rescue operations for the purpose of process improvement.

7 CONCLUSION

In this article, we presented a tool designed to support emergency response exercises in the preparation, execution and debriefing phase. After the tool was used to gather all relevant data before and during the exercise, it provides essential insights in form of a debriefing view, which comprises not only a general overview on the exercise results, but also more detailed information on essential aspects related to the medical care of patients and the organisation of the operation. The usability of the tool will be evaluated within two practical exercises organized by the German and Bavarian Red Cross. This allows keeping the development of the tool in-line with the user expectations.

8 ACKNOWLEDGEMENT

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