Real-Life Exercises as a Tool in Security Research and Civil Protection – Options for Data Collections

Cornelius Dold
TH Köln – University of Applied Sciences, Cologne
cornelius.dold@th-koeln.de

Christopher Munschauer
TH Köln – University of Applied Sciences, Cologne
christopher_marc.munschauer@th-koeln.de

Ompe Aimé Mudimu
TH Köln – University of Applied Sciences, Cologne
ompe_aime.mudimu@th-koeln.de

ABSTRACT

A real-life exercise is a scientific method used by the TH Köln to generate data sets of new technologies and operational concepts derived from research projects. The Institute of Rescue Engineering and Civil Protection (German acronym: IRG) uses a real-time locating system (RTLS), video surveillance, observers and a mass casualty incident benchmark to generate motion profiles, information flows and information on the quality of care. In this practitioner paper these different methods will be discussed and the combination of different data is described. Furthermore, an outlook is given on the extent to which the method will be improved and expanded in the future. Concluding it can be said that the combination of all collected data is essential for the evaluation of a real-life exercise in security research or civil protection.

KEYWORDS

Real-Life Exercises, Data Collection, Emergency Response, Civil Protection, Large-Scale Exercises.

INTRODUCTION

New innovations in the field of civil protection require practical test series in which the innovations can be evaluated. Similarly, the effectiveness of existing emergency response concepts must be regularly reviewed, and emergency response organisations must practice their tactical procedures on scene. A generally accepted method to evaluate these situations is the performance of realistic operational exercises. It is often difficult to gain experience with a particular phenomenon except from simulating it (Kleiboer 1997). Realistic exercises are carried out because they offer a unique way to review things. To make an evaluation comprehensible, the collection of different quantitative data is necessary. The IRG, to which the authors of this article are affiliated, has gained extensive experience in the conduct and evaluation of real-life exercises. The wide range from real-life exercises in connection with research projects to the verification of alarm plans on behalf of emergency departments of large hospitals, includes all current methods of data collection. In the following, we will therefore discuss these different ways of data collection and the challenges involved during a real-life exercise.

METHODS

Exercises in emergency response have the aim of preparing the various organisations and their units for their missions. There are different types of exercises (Glass 2012). For example, drills (see Figure 1) are exercises that train specific parts of the civil protection system. Their main purpose is to train the emergency services in command and control techniques and decision-making in stressful situations. Table-top exercises are also conducted in this context. These take place in fictitious environments, under non-real time schedules. In some cases a diorama is used to perform a table-top exercise (Schmitz et al. 2019). Real-life exercises are defined by the IRG as field exercises that are carried out under conditions as real as possible with as little artificiality as possible with the aim of deriving scientific findings. For this purpose, various methods of data collection are applied.

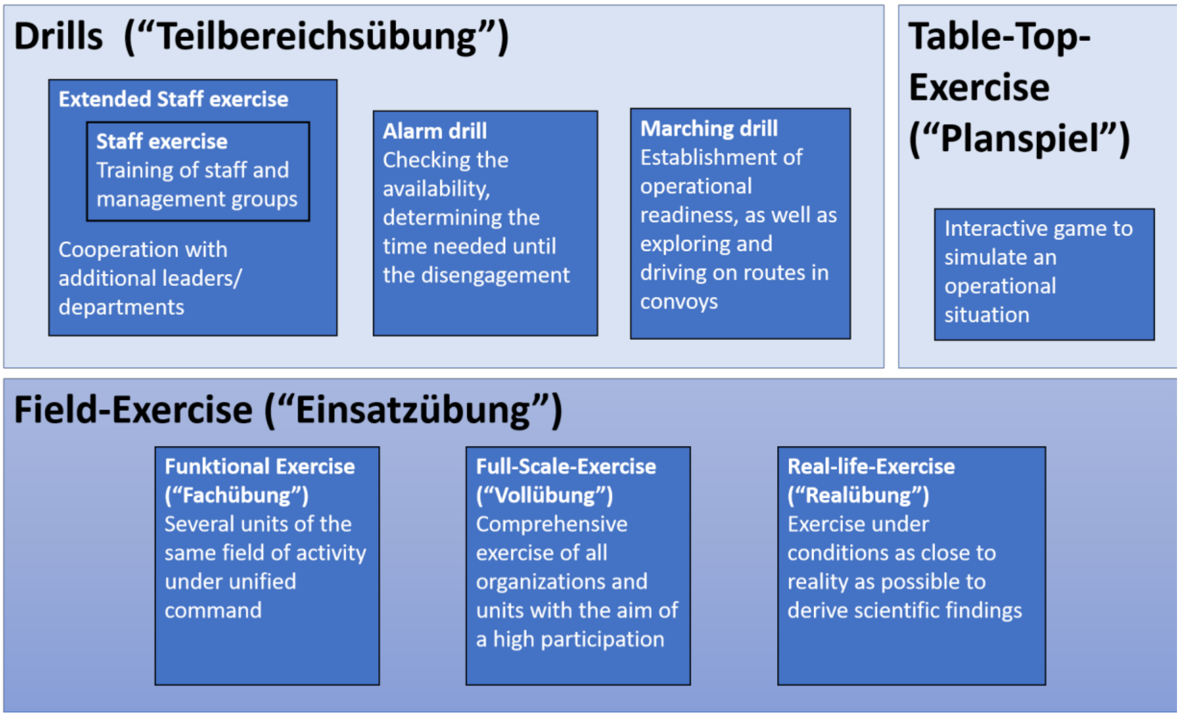

Figure 1. Types of exercises

Historically, field-exercises were initially conducted mainly by the military (Smith et al. 1999). The process of carrying out an exercise always follows the same procedures. These are described, for instance, in ISO standard 22398 "Guidelines for exercises" or the manual "Managing exercises" of the Australian Institute for Disaster Resilience (adapted from the Homeland Security Exercise and Evaluation Program of the US Department of Homeland Security) (The Australian Institute for Disaster Resilience 2012). The "Guidelines for Strategic Crisis Management Exercises" published by the German Federal Office for Civil Protection and Disaster Assistance (German acronym: BBK) in 2011 have a similar approach to exercise planning.

The execution of a real-life exercise should be seen as a circular process with the aim of achieving continuous improvement. In a first step, the need to conduct an exercise must be determined. After these requirements have been defined, objectives can be developed (Callan 2009). This includes both the definition of the overall aim of what is to be achieved with the real exercise and the development of exercise objectives or research questions. The planning phase begins with the development of a game plan that describes all parts of the exercise. This includes also an observation concept. For this phase, a time frame of at least six months should be planned. The exercise itself includes both a pre-briefing phase and a debriefing session immediately afterwards. In the evaluation phase, the extent to which the previously defined objectives were achieved is re-viewed and any necessary changes to the institutions or technologies under examination are proposed and implemented.

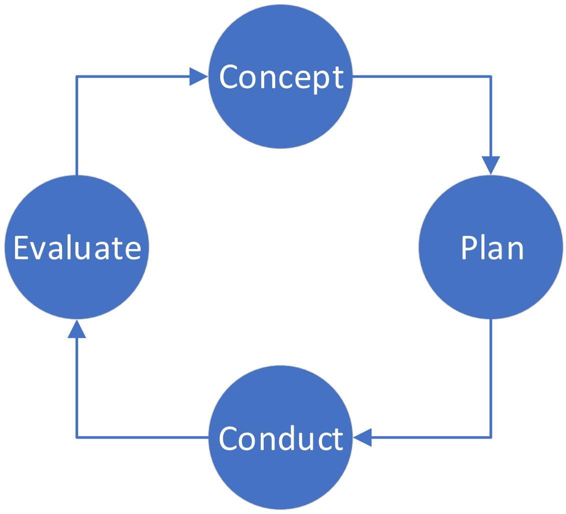

Figure 2. Exercise management model (own figure based on AIDR Handbook 3)

OPTIONS OF DATA COLLECTION DURING CONDUCT OF REAL-LIFE EXERCISES

When carrying out a real-life exercise, there are various possibilities for data collection. These differ in human and technical methods and have both advantages and disadvantages in their usage.

Observers

The internationally most frequently used method is the use of observers, who constantly accompany the most important participants or occupy key locations during the exercise. Before the start of the exercise, the observers are informed in detail about the exercise goal and are given advice on which actions and situations they should record in their notes. All observations are noted with a time stamp, so that the exercise can be retraced afterwards by means of a timeline. After the exercise, the observers write an observation report based on their notes. Ready-made forms with questions facilitate the observers' work (van Niekerk et al. 2015). The notes of the exercise participants can also serve as written sources after the exercise. These may contain additional information that was not recorded by the observers during the exercise but may prove helpful afterwards. In the oral debriefing directly after the real-life exercise, further impressions and observations of the exercise participants can be recorded (van Niekerk et al. 2015).

Video Monitoring

The first technical possibility to collect data of a real-life exercise is to use cameras focused on the exercise area (van Niekerk et al. 2015). On the one hand, they can provide an overview of the exercise area and thus record the movements of rescue personnel. On the other hand, they can be aligned to particularly important areas of operation and thus enable a more precise observation of this area (if necessary, from different angles). Due to the rapid development of drones for domestic use, they have become an affordable way of observing real-life exercises from an additional perspective in recent years.

Figure 3. Observers (black-yellow chequered vests) and emergency personnel (orange and blue vests) during a real-life exercise; Rescuer wearing the blue vest, also has a RTLS-transmitter taped to his helmet

Real-Time Locating System

Another technical possibility is the use of a Real-Time Locating System (RTLS). With this system, the positions of all exercise participants, emergency services as well as patient actors, can be tracked in real time with the corresponding software and can be analysed afterwards. The participants are provided with tags (transmitters; see Figure 3). These allow a three-dimensional tracking of their position. This is done with the help of sensors, which are mounted on tripods around the exercise area. In combination with video recordings, it is possible to fade in function names in the video images (TH Köln 2013).

Mass Casualty Incident (MCI)-Benchmark and nTED-System

The nTED system with MCI-benchmark, which was developed by the IRG, is available for mass casualty exercises and used by TH Köln in its real-life exercises in which the focus lies on the patient treatment. Each patient actor receives an injury pattern consisting of vital parameters, background information and an assigned triage category (Marten et al. 2013). The ideal treatment procedure can be derived from the type of injury and the information provided. During the exercise, the actions of the emergency services are recorded by the patient actors in an app on a tablet (see Figure 4). This enables the system to compare the actions performed during the exercise with the ideal treatment. The system allows not only for an evaluation of the quality of care, but also an assessment of the use of different resources.

Figure 4 nTED-tablet operated by a patient actor (TH Köln 2013)

EVALUATION

Various data sets are used to evaluate real-life exercises. These include movement profiles, which can be created from the data of the RTLS, video documentation and observation reports. The flow of information between the various observed command functions that are observed can also be tracked from these observation reports. Video documentation can also provide additional aspects of the information flow. Conclusions on the quality of care for the patients can be drawn from the nTED-system. The observation reports can provide further information, too. Finally, from the data sets described above, conclusions can be drawn about the effectiveness and quality of decision-making. The data sets are evaluated by comparing the actions carried out with the evaluation objectives developed in the preparation phase of the exercise.

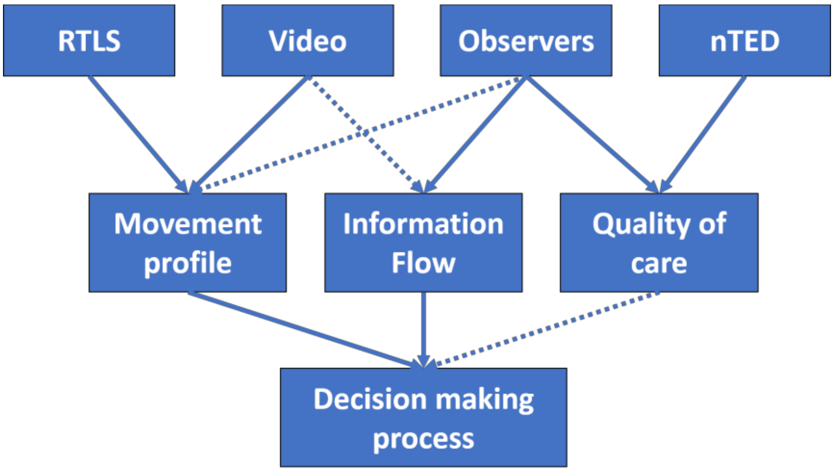

Figure 5. Options of data collection and their interpretation (own figure)

DISCUSSION – ADVANTAGES AND DISADVANTAGES

The use of exercise observers has proven to be particularly useful for real-life exercises, where communication and information transfer are of central importance. At least one observer should be assigned to each important function (officers, emergency doctors, etc.) in a real-life exercise. This is the key to ensuring that all necessary information is captured. However, this means that a correspondingly large number of observers is required to carry out large-scale exercises. In real-life exercises conducted by the IRG, students from the bachelor's degree programme in rescue engineering, serve as observers. Since many students of the institute are members of professional or voluntary fire brigades as well as members of relief organisations in civil protection, extensive experience is available and can be accessed here.

Background knowledge in this field has shown both advantages and disadvantages. For example, the observers are better able to understand the scenarios and know where they need to pay particularly high attention. On the other hand, past exercises in research projects have revealed that these experiences can tempt the observers into integrating their own interpretations into the observers' report. A further disadvantage of the use of observers is their subjective impressions could arise. Thus, a very precise and extensive briefing in advance of the real-life exercise of the observers is necessary to ensure comprehensible objective observations. To help with this issue, the notes that officers of the emergency services have written down during the exercise can be compared with the observers' reports. These enable the reconstruction of those thought processes, which were not openly communicated to the observers.

To compensate for these subjective impressions, video recordings are suitable. These video recordings allow a good comprehensibility of the overall event and can be reviewed as often as necessary. For this purpose the locations of the most important parts of the exercises must be anticipated and the camera positions chosen accordingly. In large exercise areas, however, the recognisability of the individual emergency personnel decreases relatively quickly with increasing distances.

Using an RTLS can help alleviate this. Based on the collected data, a clear location or route can be allocated to each participant. For example, this enables the evaluation of unwanted entries into hazardous areas during hazmat-operations. Therefore, for a continuous data flow the sensors must be able to identify the individual tags at any time. It hast to be noted, that in this respect weather can be a disruptive factor. Although the system is theoretically waterproof, it has caused problems in the past despite additional measures against water ingress. Another weather influence that must be considered is wind, which causes the tripods with the transmitters to vibrate and therefore leads to inaccurate measurement data. In addition, depending on the size and the terrain, the setup is time-consuming. Setting up the system, securing the tripods and laying the network cables on a 200 m^2 training ground took five employees of the institute five days for the real-life exercise from the project FOUNT[2] in June 2019 (Schmitz 2019).

Significantly quicker is the use of the MCI-benchmark, for the evaluation the quality of care of patients during MCI-exercises. As with RTLS, quantitative data can be collected here. In addition, the evaluation can be performed comparatively quickly because the system is software-based. For an error-free evaluation, however, the system depends on the patient-actors being able to correctly use their tablets. This means that a briefing on the devices must take place before the exercise.

Table 1. Comparison of options of data generation during real-life exercises

Method	Advantage	Disadvantage
Observers	- Flexible - Experienced observers understand the overall context	- Possibly subjective impressions - Observers' experiences could lead to own interpretations
Camera monitoring	- Good comprehensibility of the action - Repeats possible	- Limited operational area - Low detectability at long distances
Real-Time Locating Systems	- Quantitative evaluation possible - Linkage with camera monitoring possible	- Incorrect tracking in case of hidden tags - Weather dependant - Long assembly time depending on terrain
MCI-Benchmark	- Quantitative evaluation possible - Software-based automatic evaluation	- Depends on correct operation

A comprehensive evaluation requires as many different methods as possible to compensate for any disadvantages of a single method. Thus, the use of observers and cameras complement each other very well. If the cameras give a good overall view, a certain area can be examined more closely with the help of the observers. An RTLS with real-time tracking of the participants in the exercise fills the same gap. The time stamps of the RTLS and the timeline of the observers' reports can be used to determine the location where certain decisions were made. The use of an MCI-benchmark depends on the objective of the exercise.

OUTLOOK AND CONCLUSION

For future real-life exercises, additional possibilities for data collection are necessary in order to achieve a higher standard in evaluation. Although important positions are accompanied by observers already, in critical situations there is often an accumulation of events that can overwhelm the observers. This can lead to a loss of accuracy in those situations that would require many details for a successful observation. To prevent this, additional technology must be utilised.

For example, audio recordings bound to specific functions are a good possibility to collect additional information. Further improvements on the RTLS are also possible. Here a switch from the existing system to a GPS-based system should be promoted. Of course, the use of more cameras (overview cameras and body cams) would also be useful.

By using smart data analysis, it should be possible to not only fuse the data streams but also display areas with a high amount of activity in real time. This would allow an excellent situational awareness for exercise supervisors. However, when more data is collected, the assessment time will extend substantially. Artificial intelligence could help to clear non useful data and highlight connections between different data sets. The usefulness of data analytics supported by artificial intelligence should be looked at in future research projects.

Which methods of data collection are used for exercises mainly depends on the size of the exercise and number of participants. In addition, the purpose of the real-life exercise must be taken into consideration. In real-life exercises, which are carried out by and for local emergency response organisations, the focus is usually on the successful execution of an exercise involving as many entities as possible. If the real-life exercise is part of a research project, often the fulfilment of a specific scientific objective must be verified. The more data that is available for an evaluation, the more precise conclusions can be drawn, and errors and malfunctions can be compensated for more easily. An example of this is the real-life exercise from the RiKoV research project in 2015, which looked at the risks of a terrorist threat to rail-bound local public transport (Lechleuthner and Mudimu 2012). In conclusion, it can therefore be stated that for a successful evaluation of a real exercise, as much data as possible should be collected.

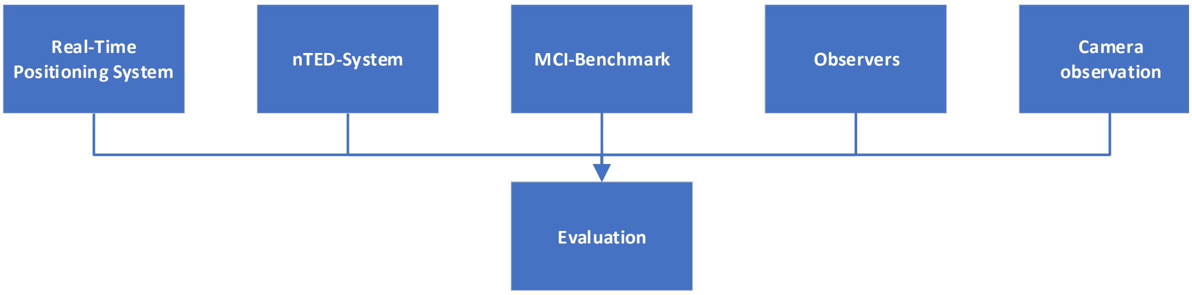

Figure 6. For a successful evaluation, the combination of all methods is essential

REFERENCES

Callan T. (2009) So, you want to run an exercise?, *The Australian Journal of Emergency Management,* 24, 2, 59–62. Available online at http://www.austlii.edu.au/au/journals/AUJlEmMgmt/2009/16.pdf, checked on 01.27.2020.

Glass W. (2012) Ausbildung - Übung - Einsatz, *Bevölkerungsschutz,* 1, 3–8. Available online at https://www.bbk.bund.de/SharedDocs/Downloads/BBK/DE/Publikationen/Publ_magazin/bsmag_1_12.pdf?__blob=publicationFile, checked on 03.11.2020.

Kleiboer M. (1997) Simulation Methodology for Crisis Management Support, *Journal Contingencies & Crisis Management,* 5, 4, 198–206. DOI: 10.1111/1468-5973.00057.

Lechleuthner A.; Mudimu O. (2012) RiKoV. Risiken und Kosten der terroristischen Bedrohungen des schienengebundenen ÖPV. TH Köln. Cologne. Available online at https://www.th-koeln.de/anlagen-energie-und-maschinensysteme/rikov_13688.php, checked on 03.16.2020.

Marten, D.; Mudimu, O. A.; Lechleuthner, A. (2013) Einsatz von Sensortechnik und Datenübertragung im Umfeld von Großschadenslagen und Massenanfällen von Verletzten. Abschlussbericht zum Forschungsprojekt: evalMANV ; Projektzeitraum: 01.09.2010 - 31.12.2012. Cologne: Fachhochschule Köln.

Schmitz S. (2019) FOUNT²: Neu entwickelte Drohne im Mittelpunkt der Verschüttetensuche nach einem Erdbeben. TH Köln. Cologne. Available online at https://www.th-koeln.de/hochschule/fount-neuentwickelte-drohne-im-mittelpunkt-der-verschuettetensuche-nach-einem-erdbeben_66588.php, checked on 03.18.2020.

Schmitz S.; Barth K.; Brüstle T.; Gleibs T.; Mudimu O. (2019) Testing the implementation of a flying localization system into emergency response using a table-top exercise. Edited by Zeno Franco, José J. Gonzáles und José H. Canós. 16th ISCRAM Conference 2019. Valencia. Available online at http://idl.iscram.org/files/sebastianschmitz/2019/1964_SebastianSchmitz_etal2019.pdf, checked on 03.12.2020.

Smith W.; Dowell J.; Ortega-Lafuente M. (1999) Designing Paper Disasters. An Authoring Environment for Developing Training Exercises in Integrated Emergency Management, *Cognition, Technology & Work,* 1, 2, 119–132. DOI: 10.1007/s101110050038.

TH Köln (2013) Lokales Positionierungssystem (LPS). Unter Mitarbeit von Konrad Barth. Cologne. Available online at https://www.th-koeln.de/anlagen-energie-und-maschinensysteme/lokales-positionierungssystem-lps_19512.php, checked on 01.26.2020.

The Australian Institute for Disaster Resilience (2012) Managing Exercises. 2. Aufl. 12 Bände. Melbourne (Australian Disaster Resilience Handbook Collection). Available online at https://knowledge.aidr.org.au/media/3547/handbook-3-managing-exercises.pdf, checked on 01.26.2020.

van Niekerk D.; Coetzee C.; Botha D.; Murphree M.; Fourie K.; Le Roux T. et al. (2015) Planning and Executing Scenario Based Simulation Exercises. Methodological Lessons, *Journal of Homeland Security and Emergency Management,* 12, 1, 193–210. DOI: 10.1515/jhsem-2013-0077.