Digital Operative Guides for Helping First Responders in Public Buildings During Emergency Interventions

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Abstract. Graphical tools for firefighters in emergency interventions have been proven to be very effective. Particularly, paper-based operational guides and digital guides with 360° images were already assessed during the drills developed, during a training program in a real, but obsolete and not in use, hotel. The obtained results were considered very interesting, being part of the study previously published by this research team. In the previous study, three different methods (two of them based on graphical contents) were compared in order to communicate the features of a building to firefighters, five minutes before starting a victim rescue during the drills of the mentioned live fire training program. These good results encouraged us to continue the development of the digital guides and this paper describes the first one created for a real building, placed in Zaragoza (Spain), which is in use nowadays. In this study, two versions of the digital guide are presented, one based on a PDF file and another one implemented with online 360° images.

Keywords: Guides · Firefighters · Emergency interventions · Digital tools

1 Introduction

One of the main factors that is very important in an emergency intervention is the time. This factor can be decisive in a rescue intervention of a victim, in which every second counts on the possibilities of rescuing the victim alive.

Any firefighter assistance tool that serves to improve intervention time, while improving firefighter safety conditions, should be taken into account [1, 2].

Within tools, it should be emphasized that they are not only working equipment, such as thermal cameras or personal protection equipment. Other tools, like protocols, practices or drills, should also be considered [3–7]. There is a graphical tool that could be among those ones, which is the base of this paper, in order to consider the information of the place where the emergency occurs. Places where there is a high-risk level have documents (e.g.: self-protection plans) with information related to the building based on text and technical drawings [8]. The problem is that, in general, these documents are too extensive and contain too much information that is not relevant for first responders

in emergency interventions. For this reason, self-protection plans are not considered useful by firefighters, according to the opinion of all the professionals interviewed for this study. The reason is that, just before the intervention, they do not have time enough to select the information that is really useful for them [9]. In addition, these documents contain many technical drawings that can be hard to interpret for firefighters that have just 5 to 10 min before arriving at the emergency area.

In this paper, we describe two methods, based on graphic content, applied to a real public building. On the one hand, self-protection plans are summarized extracting the information that is really required by firefighters before the emergency and, on the other hand, to add more graphical information, trying to make rescues easier for firefighters. The chosen public building, which is currently in use, is the Ebro Hydrographic Confederation, placed in Zaragoza, Spain.

Both methods have been tested, in a previous study, by simulating a rescue in an abandoned hotel. More than 150 firefighters were involved in this study, based on the use of graphical tools for helping firefighters in rescues, conducted by researchers from the University of Zaragoza [10]. The results of this study demonstrated that these methods significantly reduced intervention times.

2 Method

The two methods previously mentioned are based on graphical tools. These tools are technical documents used to describe the most critical aspects of buildings and their main features. They are based on the self-protection plans or emergency plans, which companies and other organizations make in order to prevent and control risks, to optimize the first response in emergencies. These plans comply with the regulations and help firefighters to act with the greatest diligence, speed, effectiveness and decision in their interventions. The differences between the two methods are that one includes conventional pictures, with a classical paper-based document structure, while the other one is based on interactive guides made up of 360° images, which include relevant information on them. Although the first documents could be consulted in digital format, e.g. with a tablet, or printed on paper, the second ones can only be accessed by means of a digital device.

These two types of methods were developed in a public building, built between 1933 and 1946, which has been declared a site of cultural interest [11], thanks to its unique features. This is the reason why the building has problems to comply the self-protection plans, because in some cases, modifications are not allowed and in others, their costs are too high to be all assumed at once.

This building has four floors of offices and a basement. Its theoretical capacity is 746 people, but the real occupancy is 377 people. We can face a range of risks in the basement such as a boiler room, a power generator, a processing plant and a large room for storing documents.

The self-protection plan would be the tool that firefighters would use in the event of an emergency in the building. The self-protection plan, despite of being incomplete and having some sections which doesn't comply the regulation [12, 13], has an extension of 138 text pages and 20 technical drawings in ISO-A3 format.

These self-protection plans are not helpful for firefighters, because when they are in an emergency, they only have 5 or 10 min to review them before arriving to the emergency place.

Therefore, both methods mentioned before were developed, based on self-protection plans, in order to optimize the first response in emergencies. With each method, firefighters have access to the most relevant information in just a few minutes, optimizing their interventions and significantly reducing intervention times.

2.1 Operational Guide

The first graphical tool developed was the Operational Guide. According to a previous research study [14] which examines the information requirements for interventional procedures, too much information could overload the receptors. In fact, too much information is usually considered as problematic as a lack of it. This study emphasizes the use of operational information which must be “accurate, relevant and timely” focused on the requirements of all the personnel in the emergency environment.

In a similar way, trying to develop a useful tool for first responders in emergencies, a group of professional firefighters, which included construction experts and occupational health and safety specialists, defined three key rules to be followed [10]:

1. They should be concise, with only the information elements considered relevant for emergency situations.
2. Graphical information is a totally relevant aspect, so the innovative tools should include appropriate maps, conventional images, 360° images. Beyond that, highlighting their most important aspects to facilitate a quick and clear communication.
3. Order and clearness of the included information must be always preserved.

The operational guide developed for the building used in this study is based on carefully chosen information, according to the previously described rules, and it has a total extension of 28 text pages.

Fig. 1. Route from one of fire stations and building aerial view.

The guide sections are:

- Route from the closest fire stations to the building and its placement, as shown in Fig. 1.
- Contact phones.
- Surroundings of the building (Fig. 2).

Fig. 2. Main entrance and roof of the building.

- Remarkable features of the building.
- Main risks.
- Preferential protection points with special danger.
- Fire protection.
- Evacuation routes and exits (Fig. 3).

Fig. 3. Different emergency exits of the building.

Finally, technical drawings with the most relevant information for firefighters are included such as:

- Location technical drawings of the risk elements.
- Evacuation route on technical drawings.

It is developed from the Operational Guide. One of the most important needs for firefighters, before the first response in an emergency, is graphical information. In the Operational

Guides, graphical information can be included, but it must be limited to avoid excessive number of pages. In the case of this building, it was necessary to reduce the graphical information to decrease its number of pages, obtaining an additional version, i.e. the Reduced Operational Guide.

Due to the problems of the previously described tools, the Digital Operational Guide (DOG) was developed. The most important difference of these DOGs is the possibility to include 360° images and the intuitive interaction. Users can easily navigate through the guide, touching icons, being possible to go from a 360° image to another one, virtually visiting the building (Fig. 5).

Fig. 5. One of the 360° images (flattened).

To develop this guide, strategic points to make the 360° images were carefully selected, after thoroughly studying the technical drawings. The main idea was that, with the lower number of images, all the required graphical information should appear.

Additional information was added over these 360° images. This additional information was the same that the Operational Guides included. This additional information was added using small icons, as signs of different types, to indicate hazards, etc. The small size of the signs makes possible to understand the images easily. It is possible to rotate or zoom the images without difficulty, touching the digital device screen and moving fingers on it.

When one of the placed signs is clicked, additional information is displayed or access to a different location is given. The intention of this user interface is to be simple and very intuitive, to make the learning process very fast. All the contents of the Digital Operational Guides are accessible via internet connection (after previously being uploaded to a server), although they could also be stored on tablets, to ensure their functionality in places with a difficult access to online data.

3 Results and Conclusions

The graphic tools described show digital guides of a building in use, made with real images in 360°, adapting and improving the preliminary guides. Those initial guides were made in a much simpler building, in order to experimentally compare the use of virtual 3D images with 360° photographs.

The results show us that it is possible to adapt a building of great complexity and large size to a format of digital guides. These guides facilitate, using a tablet, the transmission of the relevant information for a real emergency. Firefighters can consult the guides before and during the emergency.

As these guides have been developed recently, they have only been shown to the members of the Occupational Risk Prevention Department and several firefighters, receiving positive feedback. We have not used them in a drill yet, to obtain quantitative data in order to test and compare them. Future drills have already been considered to be implemented in further research.

The digital operational guide can be considered a robust and flexible tool which can be used without an internet connection by storing the guides in the tablet's internal memory (or memory card). The tools help processing and using the information in a graphical way, so they could be adapted to different fields, attending their magnitudes and the characteristics of their associated risks.

4 Limitation and Further Research

This study will continue in order to solve its limitations. It can be expected that these digital tools will help firefighting professionals in their first response activities, although the results of their application to real emergency services must be assessed during their future implantation, as they have only been previously tested under research conditions.

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