Immersive Videos as a New Addition to Emergency Training

Milica Choleva[1,*], Joy Ommer[1], Miriam Krupová[1], Adam Kolář[1], Katarína Hollá[2] and Milan Kalaš[1]

[1] KAJO, s.r.o, Sládkovičova 228/8, 014 01 Bytča, Slovakia
[2] Faculty of Security Engineering, Univerzitná 8215/1, 010 26 Žilina, Slovakia
*milica.aleksic@kajoservices.com

Abstract. As the risk of natural disasters in urban environments increases, we need unconventional ways to prepare residents. Immersive video content can improve traditional drill training. This paper provides an overview of the designed videos, which are part of the RETIME project for 2 different natural hazards, fire and earthquake, for 2 different locations in Lisbon (Portugal) and the Žilina region (Slovakia). The locations represent not only different scenarios but also buildings with different population vulnerabilities. The first hosts a high population density with tenants having low levels of formal education, and the latter is home to individuals with mental and physical disabilities. Both groups are challenged by the threat of natural hazards. Videos with clear messages for tenants, designed specifically for these buildings, should serve as an additional resource for emergency training. The paper provides an overview of the two scenarios and further explores them.

Keywords: Immersive videos, vulnerable population, emergency training

1 Introduction

Analogue materials such as evacuation floor plans and emergency exit signage are standard in regulated buildings in Portugal and in almost every building in Slovakia. In contrast, digital materials such as immersive technology are not yet widely accepted [1], [2]. In particular, in social services housing or accessible housing, drills are often impractical and do not meet the needs of vulnerable groups [3]. Because of different medical conditions, building users and tenants are not always able to familiarise themselves with emergency protocols in written form [3]. Incorporating immersive technology and realistic scenarios in the form of videos tends to enhance traditional drills [4]. This paper introduces two immersive videos prepared as part of the RETIME project [5]. The material was designed for buildings of 1) accessible housing in Lisbon (Portugal) and 2) social service housing in the Žilina region (Slovakia). Three practical considerations drove the activity of designing fit-for-purpose video material: 1) accessibility, which allows a larger group to train and use the material on standard screens, 2)

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easy publication and sharing among different institutions focusing on vulnerable tenants without device-specific deployment constraints, and 3) cost-effectiveness for familiarising staff, residents and civil protection units with evacuation procedures [5]. This paper focuses on emergency management of earthquakes (Lisbon pilot site) and indoor fires (Žilina pilot site). The main motivation behind these videos is to tailor emergency management training to end-user needs, primarily tenants, but also other stakeholder groups such as building managers and decision-makers. We chose this approach over applying a uniform format across the project's pilot sites, regardless of local relevance.

2 Description of pilot sites and their hazard profiles

The immersive videos targeting mostly vulnerable groups and their caregivers were created for two pilot sites in Portugal and Slovakia. Although they differ in hazard types, resident populations and building typologies, both of the emergency management videos were developed in the same manner; we introduce the pilot sites and their focus in more detail.

2.1 Lisbon pilot site

The first pilot site for which emergency video material was designed is Bairro da Boavista, located in Lisbon (Portugal). The whole neighbourhood covers approximately 1900 residents. This site comprises 2 residential buildings (see Fig. 1) out of five in total. These buildings are publicly owned and managed and have a high population density [5]. The buildings are part of the broader urban regeneration program, and their tenants, with low levels of formal education and limited use of digital tools, face significant socio-economic risks. Earthquakes with distant seismic sources were identified as the main natural hazard [6]. Earthquake emergency management requires a different behavioural response model, with protective action before any evacuation decision. When the earthquake occurs, residents must follow the following general rule of 3 steps [6]: 1) Dropping to the ground, 2) Taking cover under sturdy material, and 3) Holding on until the shaking stops. The emergency evacuation videos therefore follow these instructions with additional subdivision into two scenarios: one event ranging between 6.0-7.0 on the Richter scale and one minor event. The first one is expected to cause damage to structures and interiors.



Fig. 1 3D representation of the residential buildings in Bairro da Boavista, Lisbon (Portugal)

2.2 Žilina pilot site

The second pilot site is located in the village of Zástranie, located in the Žilina region (Slovakia). The single building (see Fig. 2) represents the social services care facility "Straník", mainly used by individuals with mental and physical disabilities, of whom the majority are male adults [6]. The focus of the project, and therefore the prepared material, is the enhancement of the quality of life for the residents and their caregivers. For Zástranie, we focus on emergency fire protocols [6]. Similar to the Lisbon pilot, there are two scenarios: the first represents the need for an extended evacuation after a fire breaks out, and the second represents the situation when the incident is contained and the fire is under control.



Fig. 2 3D representation of the Social Services care facility "Straník"

3 Scenario development

Scenario development for both pilot sites follows the same logic: translating each pilot site's emergency protocol into a short, scenario-based narrative. The sections below describe each scenario developed for both pilot sites, followed by the production approach used to convert Building Information Model (BIM) data into video format. These procedures and design choices are grounded in approved RETIME deliverables D4.1 (*Site specific emergency plans*) and D4.2 (*Integrated digital building information system (BIM model)*).

3.1 Scenarios

The RETIME project developed tailored emergency protocols for each pilot site building and used them to create a short narrative, later adapted into a video [5,6]. For the Lisbon pilot site, the scenario follows the "Drop, Cover and Hold On" principle during shaking. Evacuation is warranted only after a post-shaking assessment. The two scenarios covering these events are:

- Scenario 1 represents an earthquake event with a magnitude of 6.0-7.0 Richter scale. The characters experience strong shaking and act according to the principle of "Drop, Cover and Hold On" (see Fig. 3). Consequently, the main character alerts nearby residents to follow the same practice. When the shaking stops, the characters check for potential injuries and structural damage, as well

as gas leaks or potential fire hazards. After identifying damage, the fellow tenants proceed to the nearest designated safe meeting point (for Bairro da Boavista neighbourhood buildings, this is the Pina Manique stadium). Finally, residents should wait there for representatives of the Local Civil Protection Unit to tell them that it is safe to go back inside (if it is).

- Scenario 2 shows a minor earthquake without further structural damage. The characters in the video experience a brief shaking and follow the "Drop, Cover and Hold On" principle. After, they check the surroundings for any possible damage. Since they found no damage, they check with the neighbours to confirm everyone is safe, with no need to evacuate outside, and stay alert to keep evacuation routes clear.



Fig. 3 Characters follow the "Drop, Cover and Hold On" principle when an earthquake occurs

For the Žilina pilot site, two distinct evacuation scenarios were designed as follows:

- Scenario 1 shows the worst-case scenario, where clients need to be evacuated for an extended period. The scenario starts with a client noticing a fire bursting out of an electrical socket and spreading through the room. He then alerts others and uses the evacuation route to get to the designated exit. Residents then proceed to the marked assembly point, from where they are transported by the facility's designated minibus to an external shelter site for a prolonged period (see Fig. 4).
- Scenario 2 shows a contained incident that does not call for further evacuation. A staff member, while being in the kitchen, notices the fire outbreak on the kitchen stove. After noticing, he hurries to the extinguisher located in the hallway. He then brings the fire under control and checks on the other staff on call and clients. He ensures the well-being of the others, and there is no need for a prolonged evacuation.

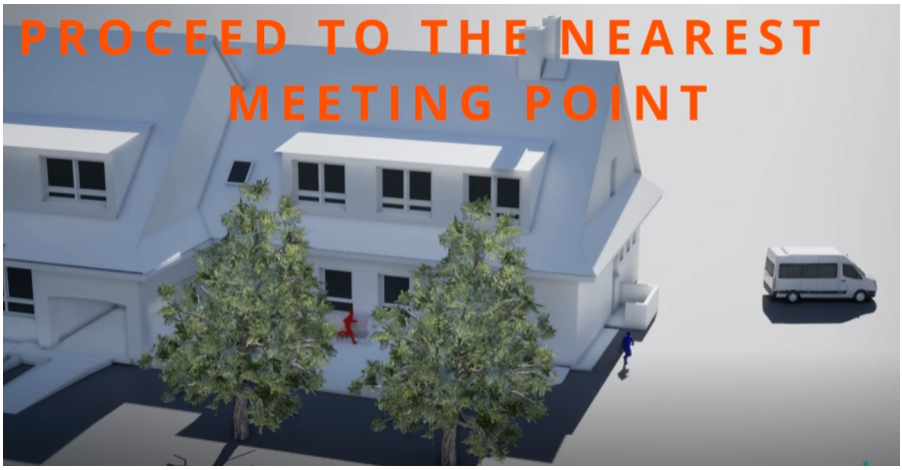


Fig. 4 Representation of the evacuation of the characters from the Social Services care facility "Straník" to the designated minibus as a primary means of evacuation transport vehicle

3.2 Production approach

Across all four scenarios, the same technical pipeline was used. The 3D environment is the product based on the BIM made prior for all pilot site buildings of the RETIME project [5]. Based on the Industry Foundation Classes (IFC) files combined with 2D architectural drawings and use of ArchiCAD and Revit models, the spatial orientation of the building environment was brought up. To be able to ensure high performance of the animation engine, some parts of the BIM models were modified, and filtered further. The optimization process was carried out with the Blender software (v4.3) where BIM models were imported via Bonsai plugin. Within Blender, the environments were further developed by adding furniture, navigational signage (directional arrows), and safety equipment (fire extinguishers) (see Fig. 5).



Fig. 5 Additionally developed features such as a fire extinguisher and the wall signage via Blender software

For final environment construction, optimized models are exported in the Filmbox (FBX) format and used in the Unreal Engine environment. There, the 'characters' routes are configured to allow movement only in designated areas within the shown environment.

As shown in the previous figures, the video content relies on on-screen subtitles with clear, effective messages in English, with translations for each pilot site's native language to follow. As part of broadening accessibility to the video material, the videos require no additional dedicated hardware and are produced in a short form, up to 2 minutes per video, which keeps attention of the user and delivers the message in an effective way [5]. Finally, the videos incorporate spatial information, the location of elements to be used in an emergency event, and, most importantly, evacuation logic. The possible sequel could include detailed information about coordinating stakeholders and emergency units with tenants and vulnerable people.

4 Testing and feedback collection

These video materials are intended for broader use among stakeholders across the pilot sites. To date, the videos have not been tested in the intended environment, but the first feedback is planned with residents of the buildings in Bairro da Boavista and professional staff at the social services institution Straník. Feedback will be collected through focus group meetings, which are organized throughout the project. Additional video presentations are planned for ideation events, which are also part of the project's agenda. Feedback will be collected through prepared questionnaires and guided discussions, which will be evaluated to further improve the materials. In this way, at least four different groups (e.g., tenants, social services workers, students, professionals working with disabled groups) will have the opportunity to review the material and share feedback. This kind of content could also add value for local civil protection units and fire departments at the pilot sites. These potential stakeholders could use this video material

for operational and training purposes, rather than for personal safety awareness from tenants' perspective.

4.1 Limitations

There are certain limitations worth considering when it comes to deployment of the video materials to certain stakeholders. First, a language gap exists because the subtitles are currently in English. Localization for Portuguese and Slovak speakers has not yet been implemented, which limits immediate accessibility for non-English-reading residents. Secondly, having subtitle-based accessibility does not address immediate access to the additional impairments which can address wider community, such as visual impairment users or low literacy users. Audio description alternatives could be added in future video iterations. Additional potential setbacks, independent of the format's design and practical considerations, include tenants' access to suitable hardware and the willingness to engage with this kind of format.
All of these constraints are subject to testing and feedback from the stakeholders listed and offer valuable future knowledge for improving this kind of emergency training material.

4.2 Future possibility for use of the video material

An additional layer could be to present this material in homes for the elderly and immobile as educational content. This way, even if the buildings shown are not the same ones they have been living in, the situation and the effective commands could be translated.

5 Conclusion

This paper presents different video materials for training in emergency events. The RETIME project developed site-specific emergency plans for different natural hazards, including earthquakes and internal fires. Focusing on buildings located in Lisbon (Portugal) and the Žilina region (Slovakia), we aimed to design effective yet simple emergency training videos understandable for broader audiences, created with having in mind vulnerable groups unique to those locations. By relying on broader accessibility and no compulsory hardware requirements, these materials are deployable across the full range of intended users and buildings. From residents and their family members, staff working in social institutions, elderly homes, and civil protection employees. Looking ahead, we will further improve the video materials, mainly by adding clear subtitles in the native languages of pilot-site residents. On-site presentations and trainings are also part of future efforts to add immersive video training in both Portugal and Slovakia.

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