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Public buildings safety: Addressing a pilot evacuation exercise

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ABSTRACT: The safety conditions regarding an emergency evacuation of the building of the Faculty of Letters, University of Lisbon, were investigated. Some traps inside the building were found and thus a group of researchers created their own emergency plan. The plan includes escape routes and a meeting point outside of the building. The goals of this experience were to test the emergency plan by conducting a pilot-evacuation exercise and also to analyze the behavior of the participants. In fact, this was the first time such an emergency evacuation exercise was performed at the Lisbon University main campus. The findings of this study raise some questions that may have policy implications: how to communicate the risk and how to include participation in planning escape; is hazard prevention education and training important for people awareness; are risks awareness a priority of public institutions.

1 INTRODUCTION

Recent experiences related to disasters around the world have caused a significant number of casualties, as well as millions of costs in damage. As a consequence, the general population and stakeholders are more aware of the safety procedures and the importance of regular practice of emergency drills in urban areas, including neighborhoods, public buildings and facilities. Even in academic literature, some studies focus on the practical ways that common building users can deal with fires and other hazards (Ramachandran, 1990).

In recent years, a new dimension to emergency preparedness emerged to ensure rapid and safe evacuation of occupants of buildings in the event of a fire: human behavior. The success of fire safety measures depends to a great extent on the behavior of building occupants who are under stress at the time of a fire (Ramachandran, 1990). Moreover, crisis management researchers have becoming more proactive in assessing the safety conditions of their academic institutions by developing and enhancing their disaster response plans (Beggan, 2011). In addition, a study showed that schools that had a disaster plan were more prepared for earthquakes than those that did not have a disaster plan (Ocal, 2011), thus showing the importance of having one. Moreover, the analysis of the survivors' accounts of the 2011 Tohoku Tsunami (Santos & Queirós, 2013) showed that knowledge about emergency plans combined with regular drills and evacuation exercises prepared many people to evacuate safely during the tsunami.

For the above reasons, the authors investigated the safety conditions of the Faculty of Letters building of the University of Lisbon (FLUL), Portugal, located at the main university campus. The authors noticed a chilling reality about the exit doors: most of the doors of the basement are permanently closed, as shown in Figure 1a, b. Although this is a security measure, the locked basement doors do not ensure the safe and quick evacuation of the building in emergencies. In addition, the building itself has several traps. Figure 1c shows a door locked with a chain, which allows access to an interior garden but no possible path to the exterior of the building. Constant building modifications, which include the creation of narrow corridors and the division of wide rooms into smaller ones, full until the roof with books and research objects, also make emergency evacuations from the building challenging.

Therefore, FLUL community should be aware of these aspects of the building, which are a threat and should practice emergency evacuation procedures.

Portuguese Law has several national regulations related to the fire and earthquake safety for educational buildings (ME, 2003, SNBPC-CML, 2005).

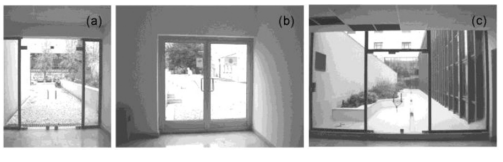

Figure 1. Photos of the exit doors in the basement of the FLUL taken on December 30, 2011: (a) and (b) are permanently locked; (c) is closed with a chain.

Under Portuguese Law, public buildings must have an emergency plan, which in the case of FLUL complies with all of safety guidelines. However, the authors have never had access to or knowledge about such an emergency plan for the FLUL building. The authors have also investigated past events that might have occurred in the building, but did not find records of any previous incident such as a fire, gas leak, or any other type of hazard endangering the building users.

Thus, the members of the Research Group on Environmental Hazard and Risk Assessment and Management (RISKam) decided to create their own emergency plan that includes escape routes and an emergency evacuation meeting point outside of the FLUL building. Thus, the objectives of the study are to test the emergency plan by conducting an evacuation exercise and to observe and discuss the human behavior of the usual occupants of the building during the pilot evacuation exercise.

This was the first time that an emergency evacuation study was conducted at the FLUL building. In fact, it was the first time such an emergency evacuation exercise was performed at the Lisbon University campus. The trigger event of this evacuation exercise was a hypothetical earthquake; also a basic training on how to safely evacuate the building was tested. Portugal is not a country prone to earthquakes. Nevertheless, the concern about earthquakes is related to the fact that in the past there were severe damage and fatalities due to earthquakes (ANPC, 2010).

In several other countries, the impact of extreme weather events motivates a variety of strategies for pre-disaster preparedness (Greenough et al., 2001). An example of the consequences of harsh weather conditions during an emergency evacuation was observed with the 2011 Tohoku Tsunami. The first author participated in the 2012 UNESCO Technical Field Trip to the areas affected by the 2011 Tohoku Tsunami. When the group was visiting Onagawa, it was snowing and it was about 1ºC outside. It was cold, and the weather conditions were similar to the day of the disaster. Because it was snowing on March 11, 2011, some people did not feel the urgency to evacuate, which is one of the many reasons that some people did not evacuate in time to escape the tsunami (Santos, 2011). As a consequence, weather conditions should be taken into consideration when an outdoors exercise is organized.

2 WHY CONDUCT DRILLS?

The increased interest in the study of risk mitigation is due in large measure to the rise of the "risk society", a recent societal and ideological reflexive context (Queirós & Henriques, 2009). However, this concern has resulted in a variety of scientific efforts to determine objective risk (hazard and quantification of human exposure to these hazards) rather than to actually study how risks are assessed and integrated into the practices of everyday life. A good knowledge of human perceptions and actions in response to risks is essential to the implementation of preventive and mitigation measures for increasing the safety level of the population. Buildings contain a variety of people, some who will be able to escape in most circumstances, some who will have extreme difficulty, and some who will not attempt to escape, and others will take the risk of fighting the hazard (Ramachandran, 1990). These facets of behavior were confirmed by the accounts of survivors of the 2011 Tohoku Tsunami (Murakami et al., 2012; Santos & Queirós, 2013). Behavior during an emergency is influenced by psychological, physiological and circumstantial factors (Ramachandran, 1990); it can also be influenced by the severity of threat posed by the hazard, the design of the building in which an emergency takes place, and the protective devices installed in the building. In addition, previous involvement in hazard incidents is also important in the risk perception (Queirós et al., 2007; Momani & Salmi, 2012). The role of risk perception in shaping people's behavior in the face of hazards has long been debated in the disaster research. Slovic's (1987) analysis for years explain that people tend to be intolerant of risks that they perceive as being uncontrollable, having catastrophic potential or bearing an inequitable distribution of risks and benefits. In its view assessments of risk can be more accepting of the role of emotions and cognition in people conceptions of danger, thus it is relevant to aid decision-makers by improving interaction with the public, by better directing educational efforts.

Several studies have been focusing on evacuation procedures based on simulations and models (Xudong et al., 2009). However, the best approach to test such models is to conduct drills and evacuation exercises (Kobes et al., 2010). Considering that regular building users are not safety professionals (like fire-fighters, civil protection agents or first aid experts), practice is the key for a successful emergency evacuation. In fact, the only way people have to practice emergency evacuations and be able to learn about safety procedures is handling with drills and evacuation exercises. For this reason, drills across Japan are made on a persistent basis. For example, Japanese drills are conducted annually on September 1 to mark the anniversary of the 1923 Great Kanto Earthquake (NHK World, 2011, 2012). Furthermore, evacuation drills help

to develop "muscle memory" (Dengler et al., 2011) in individuals to prepare themselves to appropriate responses to the natural warning signals of local tsunamis. Evacuation drills also provide an opportunity to test evacuation routes, and to provide input to officials and stakeholders for improving evacuation models. While drills are organized on regular schedules in Japan, in Portugal the number of evacuation exercises and drills are rare.

3 METHODOLOGY

After investigating about evacuation procedures on public buildings (Rodriguez et al., 2006; ISDR, 2007; Oreta, 2009; Machado, 2011; Penuel & Statler, 2011; Wisner et al., 2012; Handmer & Dovers, 2013) the authors decided to elaborate an evacuation plan. The most challenging part was to choose which path to follow as some offices have only one exit door, while other offices have at least two options of path leading to the street. Therefore, the criterion was to leave the building by using the shortest path, away from windows or narrow corridors. The plan determined indoors evacuation routes according to the location of the offices in the FLUL, and defined the place for the evacuation meeting point outside of the FLUL building. The evacuation plan was executed based on the authors' experience in collaboration with a highly skilled teacher of emergency plans for schools (see Machado, 2011).

In order to test the emergency plan, a pilot-evacuation exercise was organized. The participants agreed in advance that the exercise would start at 16:00 Lisbon Time (16:00 UTC) on March 21, 2012, with a situation of calm and nice weather. The participants had synchronized watches and were on their desks. At 16:00 all participants left their offices by following the evacuation route indicated on the emergency plan to the designated meeting point, outside the FLUL building. Those who were sharing the same office walked in order, others walked alone.

When the participants reached the meeting point, they answered the questionnaire shown in Figure 2, which was prepared by the authors. The participants did not know anything about the contents of the questionnaire until it was administered to ensure that participants would not prepare answers in advance. Some questions given in questionnaire seem to be to some extent naïve (for ex. 2.6, 3.1, 3.5). However, since this was the first time that such an approach was undertaken at the university campus, it was the authors' intention to ask even the most basic and obvious questions to test human ability to sense signs and codes present in the environment related with safety measures.

1. Personal Information
1.1 Sex
1.2 Age
1.3 Classify your motivation to this exercise.
1.4 Classify your health.
1.5 Have you ever participated in a drill?
1.6 Have you ever used a fire extinguisher (drill/real situation)?
1.7 Have you ever participated in a Civil Protection course/workshop?
1.8 Write the following phone numbers:
National Emergency Number/INEM _____
Nearest Fire department _____
Nearest police station _____
Building security _____

2. Drill
2.1 How long did you take to reach the meeting point?
2.2 Did you follow the path initially established?
2.3 During the evacuation did you noticed any exit sign?
If you answered *yes* to question 2.3, go to question 2.4. Otherwise, go to question 2.5.
2.4 Did your path coincide with the observed signs? 2.5 During the evacuation did you see any fire extinguisher?
2.6 During the evacuation did you see any emergency buttons?

3. Evaluation
3.1 Now that you finish the drill, do you feel safer in the building?
3.2 Now that you finish the drill, do you feel more prepared to deal with an emergency situation?
3.3 Now that you finish the drill, do you think the initial emergency plan is adequate?
3.4 Now that you finish the drill, do you recommend that others did it also?
3.5 Would you like to participate in future drills?
If you answered *yes* to question 3.5, go to question 3.6. Otherwise, go to question 3.7.
3.6 What kind of situations would you like to practice?
3.7 Comments and suggestions.

Figure 2. Questionnaire answered by the participants of the evacuation exercise.

Also, to understand if the experience of the exercise provides more self-awareness of how individuals think about and respond to risk (Slovic, 1987).

4 RESULTS

The answers given by the participants to the questionnaire were treated as descriptive statistics. The study population was a sample of sixteen participants who are professors, researchers and PhD students.

The questionnaire's results are shown in Figure 3. The responses to question 1.1 indicate there was a balanced distribution of genders (50% male and 50% female). The average age was 34 years, ranging from 25 (minimum) to 56 (maximum) years old. The most frequent value of ages was 37 years old; 44% of participants in the exercise were in the age range between 30–40 years (44%), and the standard deviation for the ages of the respondents is about 9 years. For 94% of the respondents, the motivation for participation (question 1.3) in the evacuation exercise was high or very high, corresponding to 15 people; only one person answered sufficiently motivated. Regarding the health status of the participants, not all of the participants felt healthy

Question	%
1. Personal Information	
1.1 Sex:	
Male	50
Female	50
1.2 Age:	
Age group 20-30	31.25
Age group 30-40	37.5
Age group 40-50	12.5
Age group 50-60	12.5
No reply	6.25
1.3 Motivation:	
High or very high	93.75
Sufficient	6.25
1.4 Health	
very healthy	31.25
Healthy	56.25
Sufficient	6.25
sick	6.25
1.5 Participation in a drill:	
Yes	25
No	75
1.6 Use of fire extinguisher:	
Yes	12.5
No	87.5
1.7 Participation in course on civil protection:	
Yes	6.25
No	93.75
1.8 Knowledge of emergency phone numbers:	
INEM	100
Others	6.25
2. Drill	
2.1 Evacuation time (minutes):	
3:00-3:30	6.25
3:30-4:00	12.5
4:00-4:30	81.25

Question	%
2.2 Followed the route initially established:	
Yes	100
2.3 Observation of emergency signs:	
No	100
2.5 Observation of fire extinguishers:	
Yes	37.5
No	62.5
2.6 Observation of emergency buttons:	
No	100
3. Evaluation	
3.1 Feel safer after this exercise:	
Yes	25
No	75
3.2 Feel better prepared to act in an emergency situation:	
Yes	81.25
No	18.75
3.3 Initial emergency plan adequate:	
Yes	62.5
No	37.5
3.4 Repetition of the exercise:	
Yes	100
3.5 recommendation that the exercise could be extended to other building users:	
Yes	100
3.6 Situations to practice:	
simple evacuation exercise	37.5
Fire	93.75
Flood	37.5
Gas leak	68.75
Earthquake	50
Other (landslide)	6.25

Figure 3. Results of the questionnaire.

(12.5%). Through their responses to questions 1.5, 1.6 and 1.7, most of the participants revealed that they did not take part of an exercise of this nature (75%). 87% have never used a fire extinguisher, and 94% have never attended a course on civil protection. Question 1.8 was related to emergency phones. Everyone knew the National.

Emergency Number, but nobody was aware of the telephone numbers of the nearest police station and the fire station. Only one participant knew the FLUL building security number.

The results of the Group 2 questions of the questionnaire are as follows: the average evacuation time (question 2.1) was 4′6″. The standard deviation of evacuation was 16″. Only one person left the building in less than 3′ 30″; 2 people took between 3′30″ and 4′ to leave the building, and 81% of the participants took more than 4’ to evacuate. All participants followed the route initially established (question 2.2), and nobody noticed the emergency signs and buttons along the building (questions 2.3 and 2.6, respectively). However, 38% observed the fire extinguishers.

In the evaluation of the evacuation exercise (the Group 3 questions of the questionnaire), participants stated they did not feel safer after this exercise (75%), but a majority experienced a feeling of being better prepared to act in an emergency situation, corresponding to 81%. However, a significant percentage of the participants (62%) stated that the initial emergency plan “was adequate”. All the participants recommend that the exercise could be extended to other building users. Also, all participants enjoyed the exercise. About 94% of the participants would like to conduct a fire drill.

5 DISCUSSION

Immediately after the pilot evacuation exercise, an indoor inspection was conducted at the FLUL building, and all distances used by the participants were measured (both inside and outside the building) till the meeting point. Figure 4 shows some of the emergency signs and equipment that are spread throughout the building. The inspection shows the FLUL building is very well equipped with all of the necessary emergency signs. All photos shown in Figure 4 were taken in areas where the exercise participants walk every day, several times a day. All the exit signs are located more than 2 m

Figure 4. Emergency signs and equipment: (a) and (b) at floor 1; (c) and (d) floor 0, (e) and (f) basement.

from the floor. However, a recent study shows that low-placed exit signs, rather than high placed signs, appear to have a positive influence on the use of the nearest fire exit (Kobes et al., 2010).

The pilot evacuation exercise shows the weaknesses in the preparation of FLUL building users during an emergency evacuation. The most significant results indicate that 100% of the participants did not see any emergency buttons (question 2.6). Initially, this question looked somehow naïve. However, this paper shows the importance of these types of evacuation exercises because the users did not noticed the existence of the emergency buttons. Although the indoor inspection shows the building is well equipped with emergency buttons, they are useless (Fig. 4c, d, e) if users do not know about the existence of these buttons; also 100% of the participants did not realize any exit signs, showing they were not aware of the signs and equipment. An example is the exit sign at the right hand side of a door that most of participants use every day, several times a day (Fig. 4a). Furthermore, the indoor inspection revealed that in some parts of the evacuation path chosen in the exercise was in the opposite direction of the exit signs. Figure 4a show the exit sign pointing to the left (conducting the users to the main exit door which is located about 390 m from the sign), while the nearest exit to the exterior of the FLUL building is located on the right (at about 50 m distance). 81% of the participants took more than 4' to evacuate. Therefore, for future emergency plans, the estimated evacuation time should be 4'30''. Those participants who used the shorted path (about 230 m) took an average velocity of 0.94 m/s, which is in agreement with the average velocity of 0.9–1.0 m/s, measured by Kobes et al. (2010). However, those participants who took the longest path (about 970 m) had an average velocity of more than 5 m/s. This shows that these last participants evacuated the building running, instead of walking. Therefore, the 2012 pilot-evacuation exercise at the FLUL confirms that more evacuation exercises are essential to avoid future panic, mishaps and human errors, as point out by Woodcok & Au (2013).

Initially, question 3.1 seems too obvious; however, 75% of the participants stated they did not feel safer after this exercise as they realized that they are unprepared to risk situations. On the other hand, question 3.2 shows a majority—corresponding to 81%—that experienced a feeling of being better prepared to act in an emergency situation. A significant number of the participants (62%) stated that the initial emergency plan "was adequate" (Fig. 3). However, the plan needs to be improved. These results show the participants may have been confused by the exercise and therefore need to practice evacuations more often. Finally, the participants were highly motivated to learn about proper emergency evacuation procedures. They would like to continue the emergency preparedness drills and evacuation exercises. They also indicated that would recommend emergency preparedness to others. These findings show that although the evacuation exercises are not incorporated in the university campus practices, the participants understood the importance to continue with these kinds of safety activities.

One of the purposes of the questionnaire was to study the human behavior in an emergency evacuation, and more specifically, to study the perception and the degree of internalization of the concept of risk by the users of the FLUL building. Through this study, the authors tried to ascertain the extent to which the idea of risk is not fully incorporated by the participants (Queirós & Henriques, 2009). After conducting the evacuation exercise, the authors can assert that there is an insufficient internalization of "being at risk" through the preparedness of the users of the building during the evacuation. Moreover, the existence of the correct emergency signs and equipment it is not enough to raise awareness to the buildings' users. Thus, the importance of the evacuation exercises to allow a more practical dissemination of information to the general users (Capel, 1973).

In traditional scientific thought, one cannot generalize on the basis of a single case (Flyvbjerg, 2006), and a case study cannot contribute to scientific development; nevertheless, the author states that this is not completely true because *one can often generalize on the basis of a single case and the case study may be central to scientific development via generalization as a supplement or as an alternative to other methods. However, formal generalization is overvalued as a source of scientific development, whereas "the force of example" is underestimated.* Deferring to conventional wisdom, because of the small size of the group that participated in the exercise and since the evacuation exercise was a single case study, the authors are cautious about generalizing the results. Still, having in mind Flyvbjerg reasons in mind, with the results achieved with this pilot evacuation exercise, the authors are convinced that this kind of research is also essential for the development of social science because this contributes to the understanding of the degree to which certain phenomena are present in a given group. Nevertheless, questionnaires are important tools to assess participant experiences (Ocal, 2011; Murakami et al., 2012), even with a small number of participants.

On the other hand, the initial traps found at the exit doors (Fig. 1) demonstrate that security measures continue to be a barrier to the safe and quick evacuation of the building in an emergency

situation. In addition, there is no exit sign in the vicinity of the doors shown in Figure 1. In fact, Figure 5 shows the emergency plan placed about 1.7 m from the ground floor, near the door shown in Figure 1a. The instructions are difficult to read, and most users are not aware of the sign. Nevertheless, a closer look reveals that the information on the board shows that the exit door shown in Figure 1a is indeed a "regular exit path to the exterior"; however, this door is permanently closed, without any alternative quick escape route nearby. In addition, no emergency plan or sign was found near the door shown in Figure 1b. These situations already have been reported to the safety management staff of the FLUL buildings and are being studied. Regarding earthquakes and fires other safety improvements are already underway such as training courses for the staff as well as measures to improve the emergency plan. However, for potential terrorist attacks the problem of evacuation is more difficult and the evacuation exercises should be supervised by external security experts, and also military and police forces.

The findings of this study have implications for risk prevention education and training on the university campus. For the foregoing reasons, drills and more emergency preparedness training should be extended to all FLUL users. Drills ought to be extended to all of the Lisbon University campuses. In addition, future drills and evacuation plans should be more complex, by informing instructions and cooperating with the rescue units. As Slovic (1987) states risk preparedness, risk management and risk communication efforts may not result in better outcomes unless they are structured as a two way process involving both building users and experts on risk assessment and management.

Finally, the findings of this pilot exercise raise some questions with policy implications: how to communicate the risk and how to include participation in planning "escape routes" in public (University) buildings. Hazard prevention education and training are important measures for people's awareness and preparedness, thus risks perceptions and acquaintance on human behavior in emergency situations should be a priority in higher education institutions.

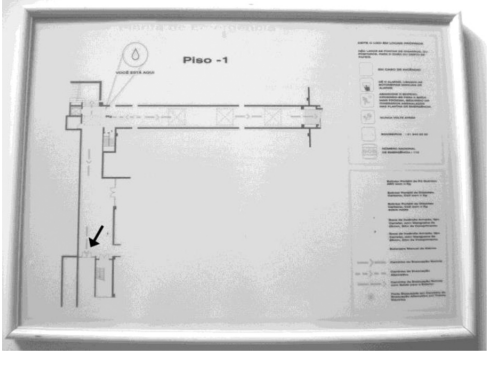

Figure 5. Emergency plan found in the interior of the FLUL building. The arrow indicates the emergency door to the exterior of the FLUL building that is locked.

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