Human Behavior under Fire Situations ï A caseï study in the Portuguese Society

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ABSTRACT

Among possible emergency situations, those that very likely will mostly affect human behavior are the ones related to fire, due to the many reasons associated with its initiation.
The prediction of the human behavior in the reply to a fire situation requires an integrated system that involves the people, the building and the fire. It is expectable that people will answer differently to distinct and varying fire situations, which will depend on a diverse range of factors.

This paper summarizes a case-study on the human behavior under fire situations, based on the analysis of data collected through a questionnaire, applied to the Portuguese population nationwide. There were 14 questions related to fire, to which 225 answers were obtained. Within these 225 answers, 50 originated from people that actually experienced or were involved in a fire situation.

The study was already able to point out some trends in the behavioral analysis. However, it is not ready to fully support the development of a simulation model capable of estimating the pre-movement time. With this purpose, other questionnaires are being designed, which will be associated with results gathered from the observation of a number of real-life simulated evacuation scenarios.

As a continuation the methodological approach devised in this work, and in order to implement validation and calibration techniques, a simulation software tool is being implemented, which combines the state-of-the-art concepts of multi-agent systems and serious games. These two concepts support the implementation of a virtual and interactive environment that will allow for subjectsô behavior to be elicited and classified according to different user profiles.

The resulting behavioral patterns, together with results from the first part of this study, will feed the devised model to more accurately validate it.

1. INTRODUCTION

The analysis of the implications of people's behavior under fire conditions has been studied for several years [1] [2] [3] [4] [5] [6] [7] [8] [9].

Some years ago the development of a buildings fire risk analysis model, called MARIE, was started in Portugal, consisting of eleven partial models [10].

Although a complete implementation of MARIE is still far from being a reality, some preliminary work has been done, highlighting the descriptor of the building model (DEM) and the evacuation model (MMO). As regards the MMO at the time of its development some aspect were not considered, or they were treated with extreme simplicity, among which are those related to people's behavior. When considering a building evacuation it can be considered the existence of three distinct phases. The first phase begins when the fire starts until it is detected. The second phase is related with the time between the occupants being aware of the fire and their decision to leave the building. Finally, the third phase starts when the evacuation process itself begins and ends when every occupant has left the building. The MMO simulates in detail the third phase, but ignores what happens before the occupants have deciding to leave the building.

For this reason it was considered important to initiate a study that could lead to the construction of a model that simulates the second phase to be integrated in the MMO.

In a review of different simulation models of evacuation there are some who seek to model human behavior, but the methodology used in most cases is extremely simple, by introducing some rules that donôt make a real modeling of peopleôs behavior according to their characteristics and knowledge [11]. This behavior depends on the characteristics of the occupants themselves (physical, psychic and cognitive characteristics), of the buildings (type of use, geometrical characteristics, the existence of an organization and security management) and of the fire (visibility conditions, radiation, temperature and toxic gases concentration).
The analysis and the prediction of human behavior in response to a fire situation require an integrated system that involves people, the building and the fire. People respond in a distinct way to different fire situations, depending on several factors.

Although there is some randomness in the human behavior in a fire situation, it is possible to implement standardization according to some factors.

- The knowledge of human behavior under a fire situation may be attained by resorting to the following methods:
- Appropriate questionnaire;
- Fire drill analysis;
- Artificial intelligence, particularly serious games.

In the following chapter, the main conclusions of this first phase of the study are summarized, both about the sampleôs characterization and the actions/reactions of the respondents.

2. SUMMARY OF THE INVESTIGATION ANALYSIS [12]

2.1. Characterization of the sample

2.1.1. Overall characterization

In this first phase of the study the sample in question, formed by 225 respondents, has some characteristics that, in a way, are adjusted to the Portuguese reality, namely gender, age group and fire safety training.

Thus, relatively to gender, the sample is formed from 50.2% of women and 49.8% of men. Relatively to the age of the respondents, it is verified that they are between 17 and 78 years old, with an average of 35.96 years old, meaning that the sample is in accordance with the national trend (in the last census, the national average was 39.09 years old). On the other hand, in the universe of the 225 respondents, only 72 have training in fire safety and just 19 make an annual recycle, fact that is also in accordance with the Portuguese reality.

It must be noted that there are some aspects of the sample that deviate from the Portuguese society characteristics. Regarding education levels, the sample does not represent the countryôs reality, because more than 50% of the respondents have university education, a percentage that far exceeds the national reality.

It will be necessary to evaluate, in later stages of the study, if this incongruence with the actual population influences the final conclusions and seek which new surveys reflect with more reliability the education level of the national population.

2.1.2. Characterization in subjects related with fire safety

Result of the publication of new legislation in the area of the fire safety, Portugal is experiencing important modifications regarding the organization and management of the fire safety in buildings and the generalization of training and awareness of the occupants, fact that can have consequences in their future behavior.

Regarding fire safety training it was found that a significant percentage of the respondents (65%) donôt have any training in this area.

Still reflecting the current state of the organization and management of fire safety in the country, it was conclude that 63% of the respondents are unaware of the evacuation plans of the buildings they attend; which may can be explained by the fact of the generality of the buildings have not yet implemented these plans. Concerning the ability of the respondents to identify the emergency exit it is verified that 96.89% state that they are capable of that

identification, percentage that significantly drops regarding its localization in the buildings they attend, because only 55.56% declare to have that knowledge.

Finally, we emphasize the fact that 50 of the 225 respondents had already been confronted with a fire situation, a fact that is relevant to establish correlations with those who have never had such an experience.

2.2. Influence on the reactions of the relation of the respondents with the building

In this first phase of the study a general analysis to the answers received was conducted. An additional analysis was also carried out in which the influence of certain characteristics of the respondents (gender, age, fire safety training and education levels) was evaluated.

Before initiating this study we had the idea that the reaction of the occupants during a fire could be influenced by the relation they have with the building, fact which was not confirmed in this first phase of the study, because 52.89% of the respondents said they would have the same behavior, while 44.00% stated that it would be different.

Regarding the respondents that had already been involved in a fire, 54% reported that their reaction would be the same, even if they were on the building they lived, or in the one they worked or in any other building.

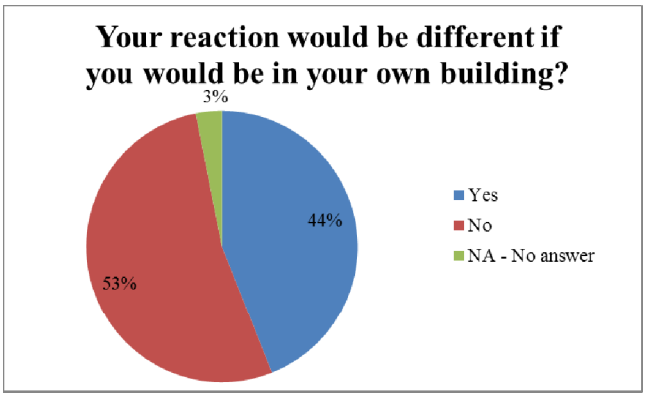

Fig. 1. Your reaction would be different if you would be in your own building?

2.3. Knowledge of the evacuation plans, escape routes and emergency exits

The implementation of certain procedures in matters of organization and management of the fire safety in buildings that the country is now entering upon as well as an increase of training, may be reflected on the behavior of the occupants in the fire safety, so were asked some questions regarding this matter.

Thus, trying to understand whether the respondents are aware of the evacuation plans of buildings that they attend, it was found that 141 responded negatively, with a percentage very similar to the masculine and feminine gender.

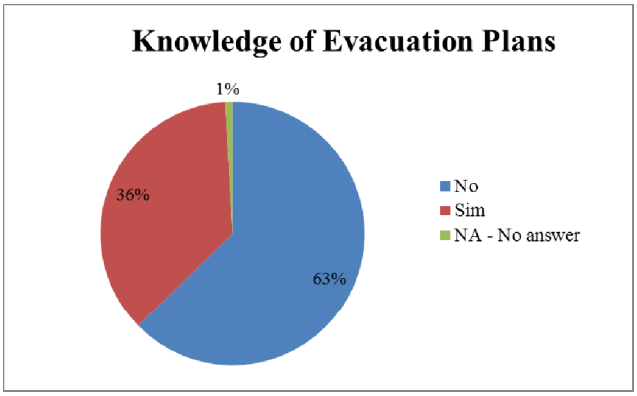

Fig. 2. Knowledge of the evacuation plans

Regarding the relation between knowledge of evacuation plans and training in fire safety verifies that, regardless of whether or not training in fire safety and their gender, a little more than 35% are aware of evacuation plans.

The same applies to the knowledge of escape routes; there is no great difference between respondents who have training in fire safety and those without.

On the other hand it was found that 96.89% said that can identify the emergency exits, that percentage drops significantly with regard to its location in the buildings that they attend, since only 55.56% declared to have this knowledge.

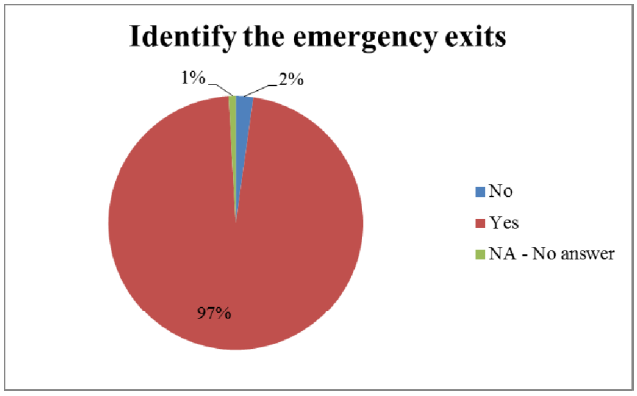

Fig. 3. Identify the emergency exits

Trying to understand if the respondents are concerned to identify the emergency exits when entering a building, the survey had a question on this subject. The conclusion reached was that when respondents have no training in fire safety, only 37% the female gender and 38% the masculine gender have this concern. When respondents have training in fire safety such percentages increase significantly, reaching 70% the female gender and 50% the masculine gender.

Trying to understand if there is any relationship between the concern to know where to locate emergency exits and knowledge of escape routes, it appears that 76% of respondents seeking to identify emergency exits know the escape routes and 63% of respondents who do not know the escape routes do not bother to identify them.
In this study it was verified that of the 72 respondents with training in fire safety 36 choose, in an emergency situation, the path they use in normal situations. Of the 153 respondents who haven't training in this area, 79 also choose the path they normally use to leave the building. These results seem to indicate that the influence of safety training in the fire behavior is not decisive, in the choice of escape routes in an emergency situation, because about 50% of respondents would choose the paths that make usual, independent they have or not training.

2.4. Chance of panic referred by the respondents

The result of some news related to incidents that occurred panic, makes the idea that it is very common and widespread. However, some researchers consider that, in a significant number of emergency situations, such it is not verified [13] [14] [15].

According to the results obtained on the survey, 93.33% of the respondents consider that in a fire situation there will be panic.

In order to evaluate the influence of the characteristics of the occupants relatively to this interpretive ability an additional analysis was made by gender, making the intervention of the fire safety training, age, education levels, previous experiences with a fire, concluding that the influence of gender, education level and training in fire safety only slightly alter the percentage of responses prevails always, unmistakably, the conviction that the panic will be present.

The possibility of panic in a fire situation among the respondents is confirmed by the answers given by those who have experienced it, having stated that the trend is very similar to the one before. In fact, from the 50 respondents that had already experienced it, 48 mentioned that people panic.

2.5. Spirit of helping others in a situation of emergency

Helping others can be crucial especially for disabled occupants. From the overview of the answers to this question reveals that 60.89% mentioned that it exists, while 38.22% think that is not the case.

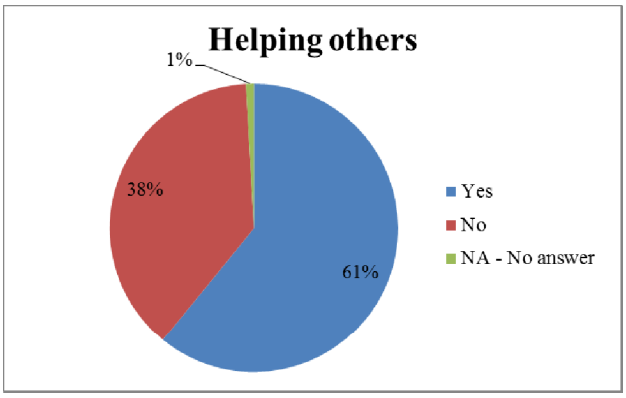

Fig. 4. Helping others

Trying to evaluate the occupantsô characteristics on this interpretive capacity, an additional analysis was made on the basis of gender, training in fire safety, education level and also the previous experience with fire, comparatively to the answers obtained with the resultants from the overall analysis.

This additional analysis showed that 66.67% of the female respondents with training in fire safety and 50% of men consider that in a fire situation there is the spirit of helping others. Regarding the influence of education level it appears that, regardless of these, more than 50% of the respondents consider that there is a spirit of helping others, with emphasis on the female gender who expresses a greater belief in that spirit than men, especially when the education level corresponds to the high-school level.

2.6. Ways to know about the fire referred by the respondents

One of the objectives of the survey was to know how people are aware of the existence of a fire. From the overall analysis of the respondents it was found that the most mentioned factor was the ñSmell of smokeò, with 36%, followed by the ñAlarmò, with 29%, while the third was concerned with the ñVisualization of smokeò, with 15%, and finally, the ñUnusual movements of the occupantsò and ñStrange noisesò, both with 10%.

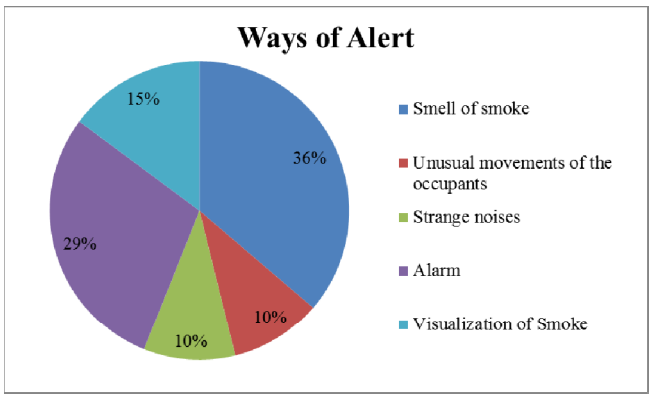

Fig. 5. Ways of Alert

With reference to the three most frequent responses in the overall analysis was conducted an additional study, relying on the several characteristics of the respondents.

That analysis shows that the most frequent answers are the same, regardless of gender and of previous experience with a fire, varying only the percentages relative to each one of them.

The same is not verified when the analysis is done regarding the training, revealing a change on the results of the overall analysis for the third most referred answer, that, for the respondents with training, is ñStrange noisesò instead of ñVisualization of smokeò.

The analysis by age has also introduced some changes to the sequence obtained in the overall analysis, namely the respondents aged up to 20 years old and those between 30 and 40 years old. Thus, for the age of 20 years, the ñAlarmò was the most referred (35%), followed by ñSmell of smokeò (31%) and ñVisualization of smokeò (17%). For the age of 40 years there is a change regarding the overall analysis, verifying that the ñAlarmò is in first place (41%), followed by ñSmell of smokeò (36%) and ñVisualization of smokeò (18%).

Regarding the possible influence of education level it is noticed that, for the respondents with high school qualifications, the second and third most frequent responses are, respectively, ñVisualization of smokeò (27%) and ñAlarmò (18%).

2.7. Action of the respondents to the alarm

Another issue of the survey is to identify the reactions of the occupants after being aware that something unusual is going on, not knowing if it corresponds or not to a fire.

From the analysis of the responses it was observed that 36% refer ñInvestigating what was happeningò, while 33% indicate ñLeave the place on his own initiativeò. Followed by ñWarn othersò with 27% and ñWait to be told what you should doò with 3% and, finally, 1% said ñContinue to do what he was doingò.

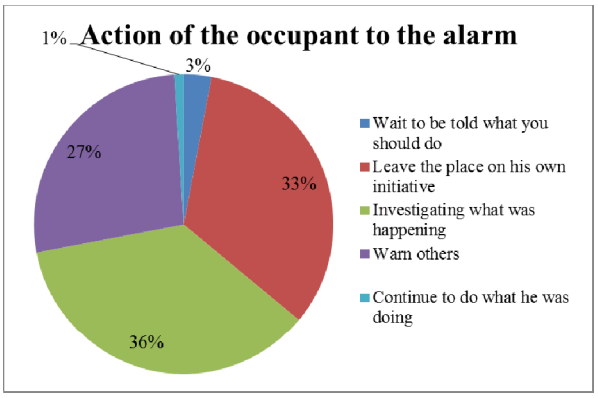

Fig. 6. Action of the occupant to the alarm

An additional analysis of the data showed that the gender has no significant influence on the responses, with the general analysis unchanged, albeit with some slight changes in the percentages.

Regarding the influence of age groups it appears that this factor is significant in some cases. For the respondents aged 20 to 30 the most given response was ñLeave the place on his own initiativeò (34%), followed by ñInvestigating what was happeningò (32%) and ñWarn othersò (32%). For the respondents aged 30 to 40, the most given reaction was ñLeave the place on his own initiativeò (38%), followed by ñInvestigating what was happeningò (34%) and ñWarn othersò (21%).

Regarding the influence of education levels, it is noted that respondents with high school education point ñWarn othersò as first reaction (36%).

Previous involvement in a fire also showed significant influence as those who have experienced it pointed ñInvestigating what was happeningò (43%) as first reaction, followed by ñWarn othersò (30%) and only then ñLeave the place on his own initiativeò (23%).

2.8. Interpretation of the alarm signal

The existence of alarm signals is now becoming widespread in many Portuguese buildings, but for these systems to represent an additional help it is crucial that occupants can identify the hazard associated to this alarm.

From the general analysis of the responses given, it is seen that 40% of the respondents indicate ñIn the uncertainty itôs considered as fireò, whilst 27% presume being before an ñExercise of Evacuationò, 13% that the alarm is the result of ñOperations of Maintenanceò and 12% that it is due to a ñReal fireò.

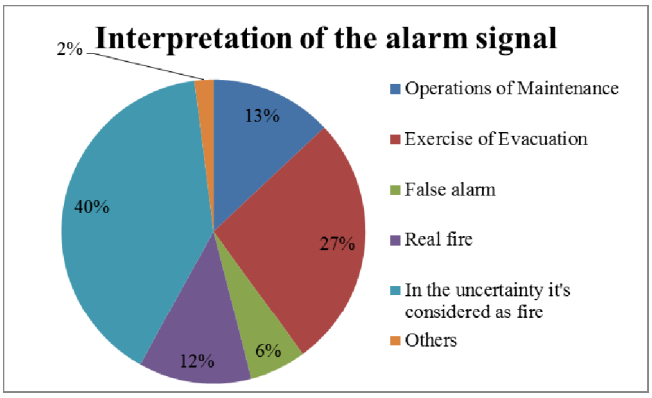

Fig. 7. Interpretation of the alarm signal

In order to evaluate the influence of the characteristics of occupants on this interpretive ability an additional analysis was carried out introducing variables such as gender, fire safety training, age group, education levels, and previous experience with a fire.

This way, with reference to the three reactions most mentioned in the overall analysis, it was found that gender, fire safety training and previous experience with a fire do not introduce any change to the order previously obtained only varying the percentages of each interpretation. Regarding the influence of age it is seen that there is a change compared to the overall analysis by respondents aged 30 to 40 years old, who indicate as the first interpretation "Exercise of Evacuation" followed by "In the uncertainty itôs considered as fire."

The analysis regarding the education levels shows a difference compared to the overall analysis, as for the respondents with high school qualifications the second most pointed interpretation was ñReal fireò.

2.9. Reaction of Respondents to the Alarm Signal

The efficacy of an automatic fire alarm and detection system depends not only on the correct interpretation of the signal, but also on the reaction that the occupants have to the alarm.

From the general analysis of the responses given, it is seen that the predominant reaction was ñFind out what is happeningò, with a percentage of 65%, which far exceeds all others , followed by ñLeave the place to leave the buildingò, at 15%. All other responses have merely residual frequencies.

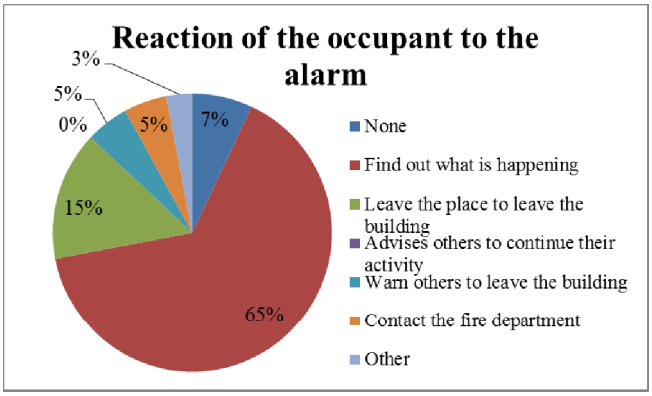

Fig. 8. Reaction of the occupant to the alarm

In order to evaluate the influence of the characteristics of occupants on their reaction to the alarm signal, an additional analysis was carried out introducing variables such as gender, fire safety training, age group, education levels, previous experience with a fire, having as reference the two most given responses.

This additional analysis showed that gender, age group, and previous experience with a fire have no significant influence on the responses, with just a slight change in the percentage frequencies. The most significant variations are relative to the residual actions, but, as such, these are not significant on the overall results.

Regarding the influence of education levels, it is seen that the second response most given is, for those with high school qualifications, ñNoneò (14%).

2.10. Reactions of respondents due to the presence of smoke

In order to understand the influence of low visibility on evacuation pathways, due to smoke, on the behavior of occupants, the inquiry contained a question on this matter.

Only 204 respondents answer to this question. Of 204 responses given, 65% show as most frequent reaction ñTry another way to get out of the buildingò, followed by ñInvestigate to fight the fireò with 26%, with all other responses having merely residual percentage frequencies.

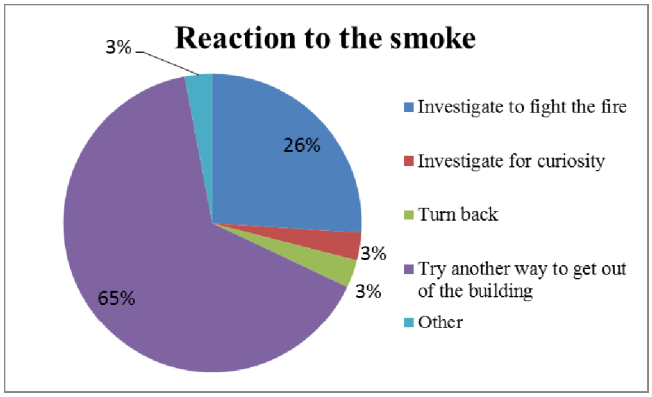

Fig. 9. Reaction to the smoke

In this question, it is noted that gender, age group, education levels and previous experience with a fire do not have a significant influence on the responses given.

Respondents with fire safety training have some different reactions, when compared to the overall analysis of responses. 56% of those with training gave the response ñTry another way to get out of the buildingò, while 32% preferred ñInvestigate to fight the fireò. Regarding respondents without fire safety training, the most given response was also ñTry another way to get out of the buildingò, with 70%, and in second place ñInvestigate to fight the fireò, with 23%.

Regarding the education levels, it is seen that respondents with high school qualifications, present a pattern of responses significantly different from all the others, but that might be due to the small number of such responders in this particular question.

2.11. Reactions of respondents face to a direct contact with the fire

The behavior of people when confronted directly with a fire will not be, most likely, the same as when they only know about the fire by hearing an alarm signal, by somebody elseôs warning or even by seeing smoke or flames.

Trying to evaluate such influence on behavior, the inquiry had a question on that matter. It is seen that 57% of respondents would react to that direct contact by ñTry other way to get out of the buildingò, followed by ñAsk for helpò (22%) and ñFight the fireò with 17%.

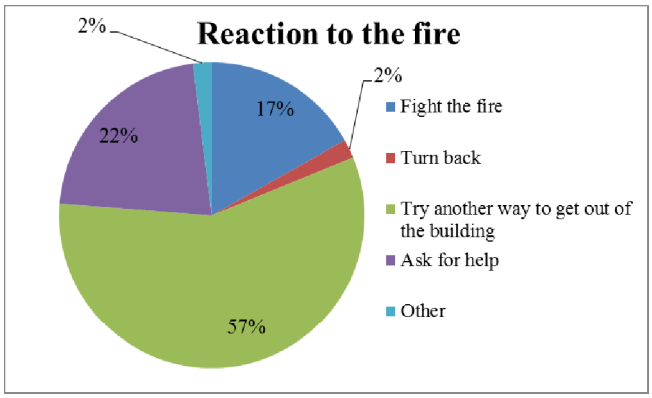

Fig. 10. Reaction to the fire.

The additional analysis shows that gender, fire safety training, age group and education levels have little influence on the responses given to this question, whilst gender and previous experience with a fire show more influence.

Regarding gender, it is seen that the most given response by women is ñTurn backò, followed by ñAsk for helpò while for men it is ñFight the fireò followed by ñTry another way to get out of the buildingò.

3. THE CONTRIBUTION OF AI FOR HUMAN BEHAVIOR ANALYSIS

Artificial Intelligence (AI) techniques have been widely used in different applications, from mimicking human behavior in robots and other physical devices to simulating reasoning and decision-making abilities within systems intended to be rather autonomous. Also, Distributed AI (or DAI, for short) is a subfield of increasing interest in which problems are tackled on a distributed basis, allowing for smaller pieces to be modeled in detail whereas the system performance emerges as a result from the combination of them all. This sort of structure very much resembles a society of several interacting entities and has inspired much research in the Social Sciences, for instance.

Agent-Based Modeling and Simulation (ABMS) is under the umbrella of DAI, for which the main modeling metaphor is the so-called agent. An agent is basically an autonomous entity, capable of perceiving the surrounding environment through a set of specific sensors and of acting upon the same environment, maybe directly affecting its current state, through a set of specific effectors. They feature reasoning mechanisms underlying their decision-making abilities and may exhibit communication channels allowing them to interact between each other[16]. When multiple agents are put together, they can perform rather socially, building

upon a multi-agent system (MAS) which makes ABMS ideal to represent many scenarios of our daily lives.

Bearing in mind the aforementioned characteristics, it is easy to understand why ABMS has gained a strong emphasis as a key instrument to model and simulate different social phenomena. Social simulation with ABMS has emerged then as a research field where computational methods are applied to Social Sciences with connections to MAS. This kind of approach is particularly adequate for representing social relations on the basis of behavioral models exploiting the emergent behavior of the system. For these reasons, ABMS has been widely used to simulate pedestrian interactions and crowds in a vast range of different scenarios, naturally including evacuations and risk situations.

Arguably, the practical application of MAS-based models is still questionable. It is reasonably consensual that much work is still needed so that one can figure out the rules that predict crowd behavior, both in normal and in emergency scenarios. Indeed, MAS still lacks adequate means for eliciting social interactions to model more realistic scenarios building upon multiple individuals interacting rather socially. One of the main issues arising in this context, therefore, is how to capture behavioral characteristics of subjects, especially under stress, in crowded environments. On the other hand, influencing behavioral patterns towards socially efficient systems is another goal to pursue in this area. In our approach, we propose to address the issues mentioned above through the combination of social simulation using ABMS and Serious Games.

The Serious Games concept has gained a great prominence in the Digital Games field within the last decade, using appealing software with high-definition graphics and state-of-the-art gaming technology. It presents a great potential of application in a wide range of domains, naturally including social simulation. Contrary to the primary purpose of entertainment in traditional digital games, Serious Games are designed for the purpose of solving a problem. Although they can and are indeed expected to be entertaining, their main purpose is to train, educate, investigate, or advertise. Sometimes a serious game will deliberately sacrifice fun and entertainment in order to make a point serious.

Flight simulators, for instance, do not replace actual flying, but are commonly used for training pilots to react accordingly in certain situations that are hard to reproduce in real life, such as emergency landing. Besides, pilots can practice and gain mileage and these systems are also used to endorse the issuing of flying permits. Imagine now a school, a services building, a shopping mall or any other highly populated environment, where fire drills are not taken seriously by occupants. If users were subjected to simulated scenarios, featuring characteristics of Serious Games, they would be expected to behave in a rather collaborative way, exposing their natural will to maximize their experience in the game (i.e. by gathering as many points as possible). Therefore, being repeatedly subjected to systems like that will certainly influence individual behavior in longer term, resulting in quicker reactive responses

whenever someone is facing a real emergency situation. We are confident, therefore, that such tools could save lives by training individuals with simulated scenarios towards the improvement of fire safety consciousness and of emergency plans, for instance. The emotion feelings that a game can provide are very realistic for the player.

In that respect, these systems can be studied from an integrated perspective for which ABMS can give a great and ultimate contribution. Our goal for applying serious games in social simulation is two-fold. First, as a tool for *behavior elicitation*, we expect to be able to capture usersô behavior into their avatars as they are subjected to a more immersive and involving environment. Our goal is to create adequate and valid behavior models to synthesize an artificial society of agents to populate microscopic simulation models of social interactions in crowd scenarios. Second, as a tool for *behavior assimilation*, we are investigating the effects serious games can have in longer-term on individualsô behavior. As users are subjected to an environment in which they are expected to behave their best way so as to maximize their profit in terms of points gathered during the game, players are expected to assimilate the used criteria into their own behavior and skills. This must have an important effect on their daily livesô behavior, and ultimately affect their response when the real emergency comes up into their lives.

Now, for the specific field of risk assessment and the analysis of human behavior under fire situations, we are featuring a computer simulation model with a 3D scenario representing the building where the user is, with all constraints and variables needed for the fire drill simulation. On top of that, add-ons of realistic emergency dynamics controlled by the simulator, such as fire, heat, smoke, screams, explosions, and other external signs to condition behavior are also needed. The user would have to steer her digital avatar throughout the building, overtaking hazards and obstacles, and taking into account all signs and situations appearing on the computer screen, possibly using other sensing abilities (e.g. sounds can be easily implemented, although smelling toxic gases and smoke, for instance, is fairly more complicated to synthesize) until reaching the safe exit outside. In her way out, the user could help other agents (computer generated agents or other real users connected on-line via LAN or over the Internet) guiding them out or exchanging information. The data generated must be saved for later analysis, and will be used to elicit behavior of users affecting their decisions while playing the game.

This project is currently under development and a proof-of-concept prototype is implemented at LIACC/University of Porto[17][18][19]. The idea of mixing virtual agents with humans represented by Avatars is neither new nor novel (e.g. games such as *The Sims* use it). In our approach, the aim is not to replace the traditional fire drills, but to help training occupants by creating immersive and more realistic simulated situations, using virtual environments. Another goal in our agenda is to compare the mixture of behaviors (human and computer agents) in the same simulation model and observe interactions between them, using the human-in-the-loop concept.

This way we expect to be able to use results to analyze, validate and calibrate evacuation strategies and plans through simulation. One possible way of validating behavioral models is by comparing the questionnaire answers presented in this paper with a set of similar questionnaires to be answered by participants in the virtual fire drills, after being subjected to the gaming environment.

4. CONCLUSION AND FURTHER STUDIES

When knowing that a fire is taking place, not all occupants decide, immediately, to leave the building, rather having reactions whose consequences will increase the evacuation time.

However, although this behavior is well known, there haven't been studies to determine the time lost due to such actions, in spite of the fact that some simulation models try to consider this issue introducing a time delay at the beginning of the evacuation, which nonetheless is not supported quantitatively by any evidence on scientific studies.

For the development of a simulation model that quantifies this time delay, it is necessary, even with the uncertainty there is, that the behavioral pattern of occupants be understood, being this study the first step in Portugal towards such goal.

This initial phase of the study is focused exclusively on the analysis of an inquiry to people used to office buildings (workplaces), and it shows several patterns on the Portuguese population, some of them different from those expected, which are now enumerated:

- The high probability of panic occurring during a fire.
- The little relevance of the fact that the occupant knows the building or not.
- Some consequences of age in the reaction to some situations.
- Little influence of fire safety training on the knowledge of evacuation pathways.
- Little influence of fire safety training on the choice of evacuation pathways during a fire.
- Little influence of fire safety training on certain reactions by occupants during a fire.
- Prediction of an almost certain widespread panic during a fire.
- Little influence of the fact that the occupant knows the building or not on their reactions during a fire.
- Little influence of previous experience with a fire.

The results presented here must be read carefully, because they only represent the actual state of the study and are therefore still far from what can be considered to characterize the Portuguese behavior in relation to fire safety, being clearly insufficient to achieve the desired simulation model of people's behavior in case of fire and not to quantify the time wasted on the actions developed by the occupants before deciding to leave the building.

Thus, it becomes necessary to expand the universe of analysis, with the development of new campaigns for data acquisition.

To follow up this study the original survey was reformulated and it was initiated a second round of data collecting that evolved users and staff of two big shopping centers of the city of Lisbon and the fire drill analysis that will, later on, be analyzed.

The study will be extended to different kinds of buildings so that we can collect enough information to make the model of general use and not just to a particularly application.

Therefore, there will be the need to distribute the survey to buildings like hotels, health related, education related, sports related and others, in addition to analyzing simulations that may occur in those buildings.

Finally it is stated that another study is being developed, in Portugal, based on multi-agent systems, using the concept of serious games with an interactive virtual environment that allows collecting userôs profiles and that will afterwards be used as towards the behavior model.

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