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AS OF YEAR 2000, WHAT DO WE KNOW ABOUT OCCUPANT BEHAVIOUR IN FIRE?

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Abstract

This paper attempts to present the state of knowledge in the field of human behaviour in fire as of the end of the millennium. The rapid growth of the field since the 80s has produced a considerable amount of data. It is argued that there are three dimensions that interplay to explain people's response during fires: occupant characteristics, building characteristics and fire characteristics. Although a lot of data is still needed on human behaviour in fire, there is already a large pool of information available. It is proposed that researchers in the field should develop theories to organise the body of empirical data obtained and to guide future research.

Studying Occupant Behaviour

In order to study and understand occupant behaviour in fire, it is essential to take into account the characteristics of three interacting dimensions of the fire event. These dimensions are the occupant, the building and the fire. The first dimension that should be considered is the occupant characteristics. The characteristics of the occupant are an essential component that impact on their likely egress and response to a fire. Research has demonstrated that gender is one of the characteristics that could predict response in a residential fire, such as the fact that men are more likely to fight the fire, while women are more likely to call the fire department or gather family members to evacuate. It is also well documented that the speed of movement will vary with age and physical ability. Intuitively it is known that a number of other occupant characteristics such as past fire experience or familiarity with the building should play a part in the response to a fire but data is limited to back up these insights.

A second dimension of the fire event is the building where the situation is happening. In building codes, occupancies are usually classified according to their size and use. These classifications, although extremely useful for the professional in the construction industry, are ill defined to look into human behaviour in fire. The occupant response to a fire alarm signal in a theatre, a museum or an airport is likely to be different although these are all assembly buildings. Instead of looking at buildings from their occupancy classification, researchers in the field of human behaviour in fire are focusing on some specific building characteristics that could explain occupant response. For example, the overall building layout and architectural design are better indicators than the occupancy type, to predict occupant movement. The type of occupant notification system is also an important factor that could explain occupant response. It is documented that the activation of the fire alarm signal is rarely sufficient to trigger evacuation movement in public buildings, unless this signal has been supplemented with well trained staff or that live information is provided through a voice communication system. The management of a building is another very important building characteristic that can contribute to the success or failure of the occupant evacuation.

A third dimension of this complex system is the development of the fire. A smouldering or a flaming fire will provide different cues for the occupants to act upon. Fire characteristics are the third element of the equation which will impact on the occupant response. Some preliminary studies show that the smell of smoke is probably not sufficient to waken sleeping adults although smoke or heat could awake people in certain circumstances. How people tend to react to smoke according to its colour, smell, acidity or thickness is not very well known at the moment. What is known however, is that people are prepared to move through a fairly significant quantity of smoke when they believe that this behaviour is the correct response to the situation. Fire scenarios have to be thought through and taken into account when assessing the likely behaviour of building occupants.

What we know about human behaviour in fire is that the three dimensions of the fire event, namely the occupant, building and fire characteristics, interact to explain or predict occupant response to fires. A fire safety engineer developing a design should take into account how the characteristics of these three dimensions will interrelate in a specific case. This is not an easy task since data should be found on the likely occupant characteristics and their activities, the building characteristics, from the space geometry to the management of the fire safety systems, while considering a number of realistic fire scenarios.

Missing Data

For the engineer who has to make decisions on a design, data has to be collected and analysed. Some of this data is already available, but if misused can lead to fuzzy deduction. For example, it is acknowledged that a good sign system will support wayfinding in a building, however, it is not because there is a well lit fire exit sign on top of a door that occupants will leave through that door when the fire alarm goes off. Understanding the basic concepts of human behaviour in fire is necessary to envision occupants' likely response during an emergency. Beware, however, there is a lot more than simple common sense to human behaviour in fire. Human behaviour in fire is a scientific field that identifies facts, concepts and relationships established through systematic observation and experimentation.

A number of areas of human behaviour in the fire field require more systematic data to be collected. In the short term, research should be concentrated on a few main topics. One of these topics is to pin-point what information or cue will trigger a response from occupants. Traditionally the expectation was that the fire alarm signal gets activated and everybody starts evacuating. Numerous cases have demonstrated that it is not always likely to occur. What are the cues or the information that will instigate the best response according to the occupant and the building characteristics, is still an open question.

The response time is another area where more research is needed. A few case studies have been conducted to measure occupant delay time to start an evacuation after being notified. These studies represent only a small sample that can hardly be generalised at the moment. It is suspected that training can have a major impact on occupant response but no data on this dimension seems readily available yet. The presence of staff on the premises is another important factor that can influence the behaviour of occupants but there is no way to take into account this factor at the moment. The social interaction among people involved in the event can certainly influence the occupant response but this dimension lacks data. The impact of occupants with a disability is another area where the knowledge is slowly building up and where more work is required. Finally, we can question if all the data already accumulated is transferable from different continents and if cultural differences actually exist. As in many young sciences, the field of human behaviour in fire requires more data to be gathered through sound methodology in order to eventually come up with solid models that can be verified and validated.

Filling the Gap

To fill this lack of data more studies are necessary with appropriate funding to do the job correctly. There is still this myth out there that social science is easy and shouldn't cost as much as applied sciences for example. Research into human behaviour is certainly not easy and tends to be lengthy and costly.

There are a variety of means to conduct research in human behaviour. They all complement one another and add to the knowledge base of this scientific field. Invaluable data can be accumulated following actual fires. There should be a systematic method used to obtain victim and fire service accounts to create a large statistical data bank. This would help in drawing a comparison among countries and identify trends and recurring events. Specific interviews and walkthrough with fire victims contrasted with expert accounts are invaluable sources of data. Conducting field studies such as organised fire drills can also provide good insight into the possible initial behaviour and movement of occupants. Controlled experiments could obtain

precise data for well defined conditions. It is the accumulation of this data from different sources that can provide input to developing reliable models.

Looking for Theories

Researchers in the field of human behaviour in fire have been asked in the last few years to come up with straightforward equations to take into account occupant behaviour and to calculate egress time. At the end of the day, the engineer wants to know if the calculated evacuation time is shorter than the calculated time for untenable conditions to occur. Researchers have been reluctant to provide such an equation. They argue that human behaviour is too complex, therefore, an oversimplification of this phenomenon would provide unreliable results.

Nevertheless, human behaviour in fire is not so complex that it cannot be modelled. The main problem is the lack of data and the lack of structure to interpret the data available. Engineering has hundreds of years of knowledge built up, while human behaviour in fire has been studied for only a few decades. There is a lot of ground to cover. The proceedings of the 1st International Symposium on Human Behaviour in Fire is a testimony that numerous small projects have been conducted around the globe. Although much more data is needed, what is lacking most at the moment are theories to organize our findings and guide the work to be done.

The research is currently scattered in all directions since the demand is so high for findings. A concerted effort would be more valuable. The development of theories would help a more concerted effort. Theories are meant to describe, explain and predict a phenomenon. It is exactly what is required for the field of human behaviour in fire. The main concepts that come into play should be identified, defined and the relationship among the factors should be established. Theories should help explain what is happening with occupants during a fire and why they respond in different ways. Finally, theories would allow to predict the likely occupant response when specific factors are in place. Another substantial intent of theories is that they are challenging. Researchers have the duty to verify theories to confirm or refute them. This is a fascinating scientific exercise that should motivate and guide future research.

Conclusion

There is a large body of information on human behaviour in fire that is scattered around in papers, reports and unpublished documents. A systematic approach is needed to organise all this data into meaningful and useable models. It is proposed to develop theories that will drive the research effort while providing a systematic approach to understanding human behaviour in fire.