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Determinants of Gaps in Human Behaviour in Fire Research

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Abstract. This short communication presents the findings of the work conducted by the human behaviour in fire permanent working group of the International Association for Fire Safety Science. Its aim is to identify determinants of research gaps in the field of human behaviour in fire. Two workshops were conducted in 2023 in which research gaps were identified and discussed by twenty experts. The workshops led experts through a series of questions to determine the reasons (or determinants) for these gaps in human behaviour in building fires and wildfires. Through the questions, the primary identified determinants were (1) researchers' literacy in the variety of

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methods adopted in the field, (2) difficulties associated with recruitment of study participants, (3) multi-disciplinary barriers across different research sub-domains, and (4) issues in obtaining funding for addressing fundamental human behaviour in fire research questions. Two key issues emerged from an open discussion during the workshops, namely the difficulties in attracting and training new people in the field (given the limited educational offers around the world on the topic) and the need for more regular opportunities for the community to meet.

Keywords: Human behaviour in fire, Evacuation, Fire safety, Wildfire, Building fire

1. Introduction

The International Association for Fire Safety Science (IAFSS) has established a Human Behaviour in Fires permanent working group, which started its work in conjunction with the 2021 IAFSS Symposium. In parallel with its establishment, a workshop was arranged to identify a set of initial activities for the group to pursue. The key task identified was the development of a research agenda for the field (similarly to what has been recently done to the wider fire science domain [1]) and, in pursuit of this, a set of key preliminary activities have been performed. This included the mapping of existing knowledge and its temporal evolution through a bibliometric analysis of the human behaviour in fire field, which has already been published [2]. A second item of ongoing work includes a wide review of the research gaps already identified in existing relevant literature, e.g. [3–10]. Following this work identifying research gaps, the Human Behaviour in Fires group conducted two workshops in 2023 to discuss the determinants of those research gaps. This short communication presents the results of those workshops, considering the factors affecting the occurrence of the research gaps identified in the literature review and bibliometric analysis, as well as new research gaps that emerged from the discussions.

2. Workshops on Determinants for Research Gaps

Two workshops were conducted on the 27th of September 2023 and the 2nd of October 2023. Both events were arranged remotely to facilitate the participation of experts located in different time-zones. The workshops lasted approximately 1.5 h each and involved a total of twenty active experts in the field of human behaviour in fire and related fields aiming at a wide distribution of background, expertise (covering both building fire and wildfire scenarios), geographical distribution, career level, and application fields. The participants all actively contributed to the workshops and the work conducted and are, therefore, listed here as co-authors of this short communication.

The goal of the workshops was to identify and understand the most significant determinants of research gaps (henceforth also referred to as obstacles) that may limit or hinder the advancement of human behaviour in fire research. In other words, research obstacles were rated by twenty experts in the field to identify the most critical ones. In addition, the workshops were intended to identify human

behaviour in fire research that would have been done in the past but that could not be performed currently due to such obstacles. In addition to ranking the importance of the listed determinants of the research gaps, participants were also able to identify additional key issues. This was performed in an open discussion where participants commented on the perceived importance of the obstacles and their impact on the human behaviour in fire field. It should be noted that participants were instructed to comment on the research obstacles considering not only their own sub-field of research but also taking into account the needs of the community and the wider field.

The workshops were coordinated by the two first authors of this paper. The participants were first presented with a preliminary list of research gaps identified in the previous work conducted by the Human Behaviour in Fires permanent group. These were initially grouped based on the evacuation time-line (e.g. pre-evacuation and movement phase) [11], the overall theme/method they covered (e.g. data collection, modelling, etc.), and context (i.e., building fire or wildfire). The research gaps were then matched by the two workshop coordinators with potential obstacles causing them. The obstacles were then reviewed by a sub-group of four members of the research team (led by the first author of this paper) in an iterative process aimed at refining their definitions and grouping them. This allowed for a final grouping of the obstacles into a set of core themes.

Research obstacles were presented to the workshop participants according to three main categories, namely (1) logistical obstacles, (2) research-focused obstacles, and (3) ethical/legal obstacles. The two workshops were structured in a consistent manner, including first an introduction on the goals of the workshop, followed by an online poll in which participants could vote and comment on the three categories. The last part of the workshop was left for an open discussion in which participants provided more general comments on the causes of the research gaps and could bring up further issues. After approval by the participants (at the start of each workshop), the workshops were recorded and later transcribed to ensure that their content could be analysed and later reported.

3. Determinants of Research Gaps in Human Behaviour in Fire

The initial list of research obstacles identified prior to the workshop included 17 items which were refined into a shorter list of 13 research obstacles which were later presented to the workshop participants. The process of reducing the obstacles from 17 to 13 included grouping similar obstacles into a single item. This list of identified research obstacles was grouped into the categories of five logistical obstacles, five research-focused obstacles, and three ethical/legal obstacles which are defined and discussed briefly below. It should be noted that the obstacles presented are not mutually exclusive, i.e. certain research obstacles are connected with each other.

Logistical obstacles.

(1) Difficulty in obtaining funding: This obstacle relates to the shared experience of the authors of the difficulties in soliciting funding from public or private organisations for human behaviour in fire research. Public and private funders may prioritise other areas (in fire safety or human behaviour research) deemed more urgent or viable.
(2) Regional siloing: Human behaviour in fire is an international field of research, yet the authors observed challenges in collaborating across different regions, leading to regional siloing. This is likely explained by differences in regulations, resources, and priorities across regions which can impede collaboration efforts, leading to fragmented research outcomes (or duplication of efforts).
(3) Technical limitations: Current technology may not provide accurate data collection methods for studying certain human behaviour in fire scenarios. New advanced tools and methodologies are still needed to capture relevant data reliably and accurately, e.g., [12–14].
(4) Difficulties in collecting representative samples: Empirical research on human behaviour in fire relies heavily on data from human subjects, who often volunteer (although not exclusively) to participate in research. As in other fields, there are challenges in recruiting representative and sufficient numbers of participants, e.g., underserved populations, certain age groups or people living with temporary or permanent functional limitations [3]. Though work has started to identify revealed actions in fires across different groups of people, limitations of sample size, representativeness, and generalizability are still prevalent [15].
(5) Difficulty in forming large consortia: Building and sustaining a large consortium of researchers, practitioners, and stakeholders can be associated with logistical and organisational challenges. Addressing the complexities of human behaviour in fire emergencies may require collaborations on an international scale, which often requires a very large (international and interdisciplinary) consortium. This is particularly important for instance for cross-cultural studies [16]. It should be noted though that cultural issues are not merely a logistical obstacle, but it is also associated with the lack of appreciation of the potential importance of cultural impacts on evacuation behaviour.

Research-focused obstacles.

(1) Multidisciplinary barriers: Research on human behaviour in fire requires a broad range of expertise across different disciplines such as psychology, engineering, design, fire science, sociology, toxicology, etc. Bridging disciplinary boundaries and integrating diverse perspectives can be challenging [17, 18].
(2) Limited behavioural understanding: To date, there is no consolidated human behaviour in fire theory/data which can be used to systematically investigate a given behaviour. Several theories exist, but they tend to address only a specific set of behaviour in isolation. Despite decades of research in the field, there is still a lack of comprehensive theories and consistently collected datasets that systematically address human behaviour in fire situations [19].

(3) Lack of interest: The study of certain aspects related to fire emergencies may not always attract significant scientific interest compared to other areas of research (e.g. human behaviour in a specific type of fire scenario or application). Researchers may have, therefore, limited scientific interest in a given research sub-domain.
(4) Researcher literacy: Researchers may not be familiar with a given technology or methodology. This is particularly the case for researchers from one subfield wanting to adopt a data collection method that is less popular in their sub-field (e.g. an engineering researcher approaching qualitative methods or a social scientist using a technology that is not common in their area of study). There may also be cases where certain technologies or methodologies are applied without proper knowledge about the validity of the tools or methods for the certain situation. Thus, the lack of training and resources may lead to limited researcher literacy in these areas.
(5) Out of scope: The research topic is not fully within the scope of the human behaviour in fire field. Some aspects of human behaviour in fire emergencies may fall outside the scope of research being conducted in the domain in which a researcher operates.

Ethical/legal obstacles.

(1) Ethical constraints: Conducting research on human behaviour in fire raises ethical considerations related to several key principles such as restriction of harm and suffering, informed consent and protection of integrity [20]. Obtaining ethical approval for studies in this area can be more complex and time-consuming than in other fields, potentially due to the inherent physical or psychological risk that participants might be exposed to but also potentially due to the lack of experience of ethics committees in the subject area.
(2) Country priorities/policies: A given research sub-domain may not be supported in some regions. National policies and priorities may not always align with the need for research in human behaviour in fire. Limited government support or conflicting agendas can negatively affect the chance of performing research efforts in certain regions.
(3) Legal constraints: Accessing relevant behavioural data for research purposes may be restricted by regulations, particularly concerning privacy and data protection. Navigating legal frameworks to obtain data can pose significant challenges for researchers.

An online polling tool was used to obtain the participants' rating of the importance of the research obstacles with a 5-point Likert Scale (where − 2 meant the obstacle was deemed not important at all and + 2 indicated a very important obstacle). The importance of a research obstacle related to its significance towards research gaps. The resulting voting is presented in Fig. 1, where the research obstacles are ranked from top to bottom from the one that received the highest to the lowest average importance rating. The most important obstacles were found to

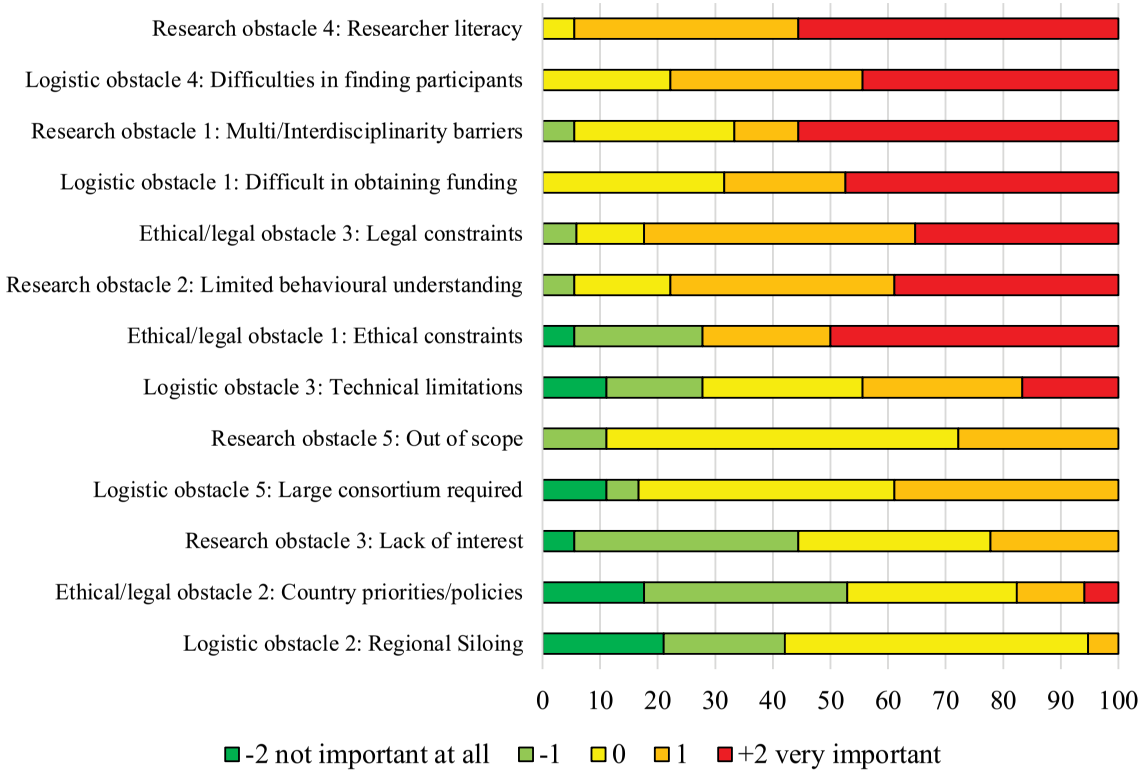

Figure 1. Frequency of Likert scale scores for the list of research obstacles leading to research gaps in the human behaviour in fire field.

be researcher literacy, difficulties in finding study participants, multi-disciplinary barriers, and funding.

4. Discussion

Considering the most important research obstacles identified in the workshop, researcher literacy refers to the fact that human behaviour in fire is a field that relates to multiple disciplines, therefore some researchers may not be fully familiar with the wide range of technology or methodologies in use. This is combined with a fairly limited set of opportunities for training and education. This includes formal education (e.g. courses at undergraduate or graduate level), short courses as well as doctorate programmes related to the domain. The discussion in the workshops indeed highlighted that it has been very difficult to attract a new critical mass of people, given the limited educational opportunities along with fewer opportunities for the community to gather. While the Human Dimensions of Wildland Fire Conference by the International Association for Wildland Fires exists for the wildfire domain, the last dedicated human behaviour in fire symposium related to the building context happened in 2015. Since then, there have been mostly workshop-type events that have been limited in terms of duration and number of participants when compared to a full conference. These workshop-type events also generally do not result in extended dissemination (e.g. they may lack proceedings), meaning that the dissemination of their results become limited. It is therefore advisable to introduce new initiatives aimed at training and educating researchers in the field. On this matter, the human behaviour in fire permanent working group currently hosts a webinar series. This can be seen as a first step towards promoting the use of different methodological approaches and enhance community knowledge exchange. Future initiatives may aim at developing further training and educational opportunities for people in related fields which may have an interest in human behaviour in fire.

Another important aspect is the ongoing debate on the need for more representative populations when performing experimental research in the human behaviour in fire field (especially in the building fire domain). For example, the latest Human Behaviour in Fire Symposium hosted a panel discussion moderated by Dr Rita Fahy highlighting how ageing populations and access to public buildings increased the challenge of providing safe evacuation for all [21]. In contrast, a large proportion of existing research is focused on healthy adult populations, with only a few exceptions, e.g., [22–24]. Research considering people with functional limitations presents challenges due to safety and ethical making it difficult to investigate this group [25]. For instance, people with cognitive limitations are almost completely neglected in the field mostly due to their inability to provide informed consent [3]. The recruitment of such populations, though, is challenging, meaning that certain areas and the impact of functional limitations remain largely unexplored.

For both individual and crowd evacuation experiments [26] as well as for community evacuation exercises [27], identifying and persuading a large number of

volunteers can be difficult. It is, therefore, not surprising that difficulties in finding study participants was ranked as one of the most important determinants of research gaps. This issue is exacerbated when the target population under consideration needs to meet specific criteria.

Finally, securing funding for human behaviour in fire research was listed as one of the key determinants. Funding research presents several challenges associated with both systematic and practical factors. The time to obtain funding is generally too long compared to the need for deploying researchers to collect behavioural data on-site when a fire occurs. In addition, funding agencies and organisations often allocate resources based on perceived societal impact, scientific novelty, and potential economic returns. Despite the repeated occurrence of devasting fires that claim multiple lives (e.g. the Mati wildfire [28] or the Grenfell Tower fire [29]), and the efforts of the fire science community to highlight the societal consequences of fires, [1], fire safety and safety in general may not be seen as a priority by national funders. Additionally, the complexity of studying human behaviour in fire scenarios adds an additional layer of complication. Conducting research in this field often requires multidisciplinary and interdisciplinary collaborations, advanced technologies, and the collection of potentially sensitive data, all of which entail significant costs and ethical challenges.

Funding agencies may be hesitant to invest in research projects with high resource requirements and ethical concerns. In the building context, the human behaviour in fire field is rooted in the fire engineering world, where resources are rarely allocated for the exploration of a fundamental understanding of a subject. Several debates concerning fire safety research funding allocation have also concerned the wildfire domain, discussing the need for a better understanding of how humans behave during emergencies [30, 31]. Moreover, there may be a lack of awareness among funding agencies and policymakers about the importance of research in human behaviour in fire, as building regulatory perspectives (and subsequent engineering analysis) often place more emphasis on fire-related elements rather than human behaviour. Despite its critical role in informing fire safety standards, building designs, and emergency management strategies, the human behaviour in fire field tends to be under-prioritised. As a result, funding allocations may be focused on other research areas that are perceived as more pressing or economically viable. Research opportunities in the field (and in many other safety fields) are often associated with the occurrence of large disasters. As a result, they are often rapidly formulated initiatives, that are ill conceived, poorly funded and resourced with unrealistic timescales that often fail to address fundamental issues. Rather than these reactive initiatives, what is required is a systematic effort to address fundamental issues. This short communication advocates for a reorientation of thinking, i.e. to switch from a funding-after-disaster approach to proactive and systematic research funding opportunities aimed at steadily improving human behaviour in fire knowledge.

5. Conclusion

This paper presents the findings of the work conducted by the Human Behaviour in Fires permanent working group of IAFSS related to the identification of the determinants of research gaps in the field. Two workshops were arranged, and the key identified research gap determinants were researcher literacy (intended as the researcher's knowledge of a variety of methods and technology used in the field), difficulties in finding study participants, multi-disciplinary barriers and funding. To face these obstacles, it is advisable for the Human Behaviour in Fires field to seek more collaborations both within and outside its community, arrange further educational opportunities, and promote activities that highlight the importance of systematic research funding.

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