



# Human behaviour in fire: Knowledge foundation and temporal evolution

Milad Haghani<sup>a</sup>, Ruggiero Lovreglio<sup>b,\*</sup>, Mary Langridge Button<sup>c</sup>, Enrico Ronchi<sup>d</sup>,  
Erica Kuligowski<sup>e</sup>

<sup>a</sup> School of Civil and Environmental Engineering, UNSW Sydney, Australia

<sup>b</sup> School of Built Environment, Massey University, New Zealand

<sup>c</sup> Maze Fire Consulting, UK

<sup>d</sup> Department of Fire Safety Engineering, Lund University, Sweden

<sup>e</sup> School of Engineering, RMIT University, Australia

## ARTICLE INFO

### Keywords:

Human behaviour  
Fire evacuation  
Evacuation dynamics  
Evacuation management  
Building fire  
Wildfire  
Bushfire

## ABSTRACT

Understanding human behaviour in fires (HBI<sub>F</sub>), whether in building or wildland fire contexts, is crucial for saving lives and managing evacuations. However, existing research lacks a comprehensive analysis of HBI<sub>F</sub> knowledge from both perspectives. To address this issue, we examined nearly 1900 HBI<sub>F</sub>-related research papers and their references, identifying around 6600 frequently cited references as the HBI<sub>F</sub> knowledge foundation. We focused on highly prominent items using metrics like citation frequency, burst, and centrality. By analysing co-citation patterns among these references, we unveiled current trends and waning areas of HBI<sub>F</sub> research. This study identifies knowledge gaps and potential future directions for the field, enabling both mapping of the research concerning our fundamental understanding of behavioural decision-making in fires as well as developing more effective life-saving strategies.

## 1. Introduction

Human Behaviour in Fire (HBI<sub>F</sub>) is a critical area of research that holds important implications for life safety, evacuation management, and disaster preparedness [1,2]. The term HBI<sub>F</sub>, in this context, refers to the behaviour of people *during* fire scenarios, which can include fires that occur in buildings and fires that occur in larger outdoor contexts (e. g., wildfires affecting communities). Climate change contributes to the intensification of wildfire seasons [3], posing significant challenges to land management and firefighting efforts. Simultaneously, urbanisation continues unabated, further increasing the potential impact of building fires on occupants. In both scenarios, understanding human behaviour in fire assumes an ever more pressing significance.

Whether occurring within buildings [4–6] or in wildland-urban interface environments [7–9], fires pose significant risks to human lives and infrastructure and the human response plays a great role in mitigating such risks [10]. Understanding how individuals respond to fires, make decisions during emergencies, and navigate evacuation processes is pivotal for formulating effective safety measures and devising comprehensive evacuation strategies.

The urgency of this topic is irrefutable, as fire-related incidents

continue to pose serious threats worldwide. Building fires, wildfire outbreaks, and fires involving transportation infrastructure can escalate rapidly, leaving limited time for safe evacuation. Each event underscores the need for a deeper understanding of human behaviour under such circumstances. The multidimensional nature of HBI<sub>F</sub> requires attention to various factors, such as psychological responses, cultural influences, cognitive processes, and societal dynamics. People's behaviour during a fire is influenced by factors like mental and physiological stress, familiarity with escape routes, perception of risks, and their past experiences [6]. Additionally, cultural norms, age, and functional limitations can significantly affect evacuation decisions and outcomes (Bukvic et al., 2020; Galea et al., 2010).

Despite the evident importance of HBI<sub>F</sub>, scholarly exploration of this field has not been fully comprehensive. Studies often focus on specific aspects, such as evacuation modelling or human psychology, resulting in a fragmented understanding of the topic. A holistic approach is necessary to bridge the gaps between these various dimensions and create a unified knowledge framework that can inform future research as well as policies, procedures, and safety measures.

The foundational knowledge in any field forms the bedrock on which future advancements are built. In the context of HBI<sub>F</sub>, identifying and

\* Corresponding author.

E-mail address: [r.lovreglio@massey.ac.nz](mailto:r.lovreglio@massey.ac.nz) (R. Lovreglio).

<https://doi.org/10.1016/j.firesaf.2023.104085>

Received 26 September 2023; Received in revised form 13 December 2023; Accepted 24 December 2023

Available online 30 December 2023

0379-7112/© 2023 The Authors. Published by Elsevier Ltd. This is an open access article under the CC BY license (<http://creativecommons.org/licenses/by/4.0/>).

consolidating this knowledge foundation is crucial for informed decision-making and the formulation of evidence-based policies/research agendas. The multitude of research papers and references in the field necessitates a systematic and objective analysis to pinpoint key references that provide enduring insights and influence subsequent research. Additionally, tracking trends and temporal shifts within the field is important in its own right. The evolution of research streams sheds light on emerging priorities, areas of intensification, and topics that have lost traction. Understanding these trends equips researchers, practitioners, and policymakers with the ability to anticipate challenges, adapt strategies, and allocate resources effectively.

In the multifaceted landscape of HBiF research, the analysis of authorship and co-authorship also assumes a crucial role. Collaborative efforts often drive innovative research, allowing for the fusion of diverse expertise and perspectives. Examining authorship patterns provides insights into the interdisciplinary nature of HBiF, where experts from fields such as psychology, engineering, sociology, and emergency management converge to tackle complex challenges. Co-authorship patterns unveil networks of knowledge exchange and collaboration, shedding light on influential hubs within the field. Understanding the dynamics of authorship and collaboration not only acknowledges the collaborative nature of advancing knowledge but also identifies thought leaders and research clusters that are actively shaping the trajectory of HBiF research landscape. This analysis contributes to a holistic comprehension of the field, enabling the identification of collaborative trends, emerging research alliances, and areas where interdisciplinary collaboration can be intensified to drive impactful advancements in fire safety and evacuation management.

To address the issues mentioned above, the Human Behaviour in Fires Working group of the International Association for Fire Safety Science initiated a set of coordinated efforts to map the knowledge in this domain and subsequently define a research agenda. This study represents the first step in this process and seeks to address these existing gaps in the understanding of HBiF. This is achieved by offering a comprehensive analysis of its knowledge foundation and temporal evolution. By examining nearly 1900 research papers and identifying a core set of around 6600 frequently cited references, this research aims to create a consolidated repository of this knowledge domain. The analysis of prominence using citation frequency, bursts, and centrality metrics will unveil references that have significantly influenced the field. This not only aids in identifying seminal works but also highlights the trajectory of the most impactful research directions. Furthermore, the investigation into co-citation patterns within this core set will uncover evolving trends in HBiF research. Identifying clusters of references that are cited together frequently provides insight into current focal areas, emerging concerns, and declining interests. This empowers stakeholders to align their efforts with the evolving landscape of HBiF, ensuring that research and innovations remain effective and relevant.

## 2. Data acquisition

In order to extract relevant literature on HBiF from the Web of Science, an extensive search query was constructed. The query encompassed a wide range of search terms and combinations to ensure the inclusion of relevant studies related to fire incidents and evacuation behaviours. The search terms were organised into logical groupings to capture the multidimensional aspects of HBiF research. The query employed title (TI), abstract (AB), author keywords (AK), and topic (TS) fields to maximise the scope of the search. A complex combination of logical operators (AND, OR, NOT) was applied to refine the search results.

The search query included terms related to fire, evacuation, human behaviours, building types (e.g., shopping malls, hotels, hospitals), and various related disciplines and contexts. The query also considered specific aspects such as evacuation drills, wildland-urban interface fires, and disaster response. To enhance specificity, terms associated with

other types of disasters such as earthquakes, tsunamis, cyclones, floods, and chemical spills were excluded from the results using the NOT operator.

The resulting query was designed to comprehensively capture a wide array of literature on HBiF, spanning research articles as well as literature reviews, surveys, and systematic analyses. The utilisation of multiple fields (TI, AB, AK, TS) and logical operators ensured a comprehensive search that targeted various dimensions of the topic. The search query was constructed with the goal of yielding a representative sample of literature relevant to the study's objectives, thereby providing a robust foundation for subsequent analyses and discussions. The full search query string is accessible in the Appendix of this article.

## 3. Temporal analysis

In this section, we undertake a comprehensive examination of key themes within the field, coupled with their temporal dynamics and a specific focus on citation patterns. Our analytical approach centres on the premise that co-cited references—those frequently cited together within the same papers—can effectively delineate the foundational knowledge underpinning distinct research streams [11]. By identifying clusters of references frequently co-cited, we define these research streams. Subsequently, we probe the referencing patterns in the articles associated with these clusters to determine the evolving intensity of different research avenues over time.

In our study, we identified 20 clusters, each emblematic of a significant facet of HBiF research (see Table A1 in the Appendix). The clusters exhibit varying sizes and degrees of significance within the field. A visualisation (Fig. 1) showcases these references as nodes within a document co-citation framework. The nodes align along the timeline of the publication year of the references they represent, with their size proportionate to the number of localised citations, i.e., citations originating solely from the HBiF literature. An alternate depiction (Fig. 2) employs a network view to map these clusters, positioning conceptually akin clusters in closer proximity. Nodes circumscribed by red rings denote references experiencing a sudden burst of local citations, signifying a rapid surge of citations from HBiF articles within a specific timeframe. Burst attributes encompass the onset, culmination, and intensity of the citation surge. Both visualisations are tied by co-citation connections, highlighting instances of interrelated references.

Initially, each cluster was assigned a descriptor through algorithmic analysis of titles from articles citing the respective cluster. The algorithm extracts noun phrases, assigning a log-likelihood ratio score based on frequency and coverage within the citing article. The highest-scored noun phrase is represented as the algorithmic label. While algorithmic labels offer objectivity, they sometimes fall short as descriptors. To address this limitation, alternative labels were manually determined, informed by both algorithmic outcomes and the actual content of each cluster. To succinctly present the content of the document, co-citation network and the pivotal references identified in our analysis, an informative data is included in Table A1 in the Appendix. Notably, the table does not exhaustively list all cited and citing references for each cluster, given the extensive scope—the entire network encompasses nearly 6500 frequently cited references—rendering complete listing impractical. Instead, the table highlights a subset of the most locally cited references per cluster, along with the articles that achieve the highest coverage within each cluster. This selective inclusion aims to provide a representative snapshot of the diverse network while navigating the constraints of presentation space. Fig. 3 quantifies the research activities of these research streams by quantifying cluster-level local citation indicators, including the total number of citations and the number of citing articles on a year-by-year basis. Those that did not exhibit any distinct patterns have been omitted from this visualisation. As such, Fig. 3 is essentially to appreciate the temporal trends behind the formation of the document co-citation network, which is not necessarily observable in the maps in Figs. 1 and 2.

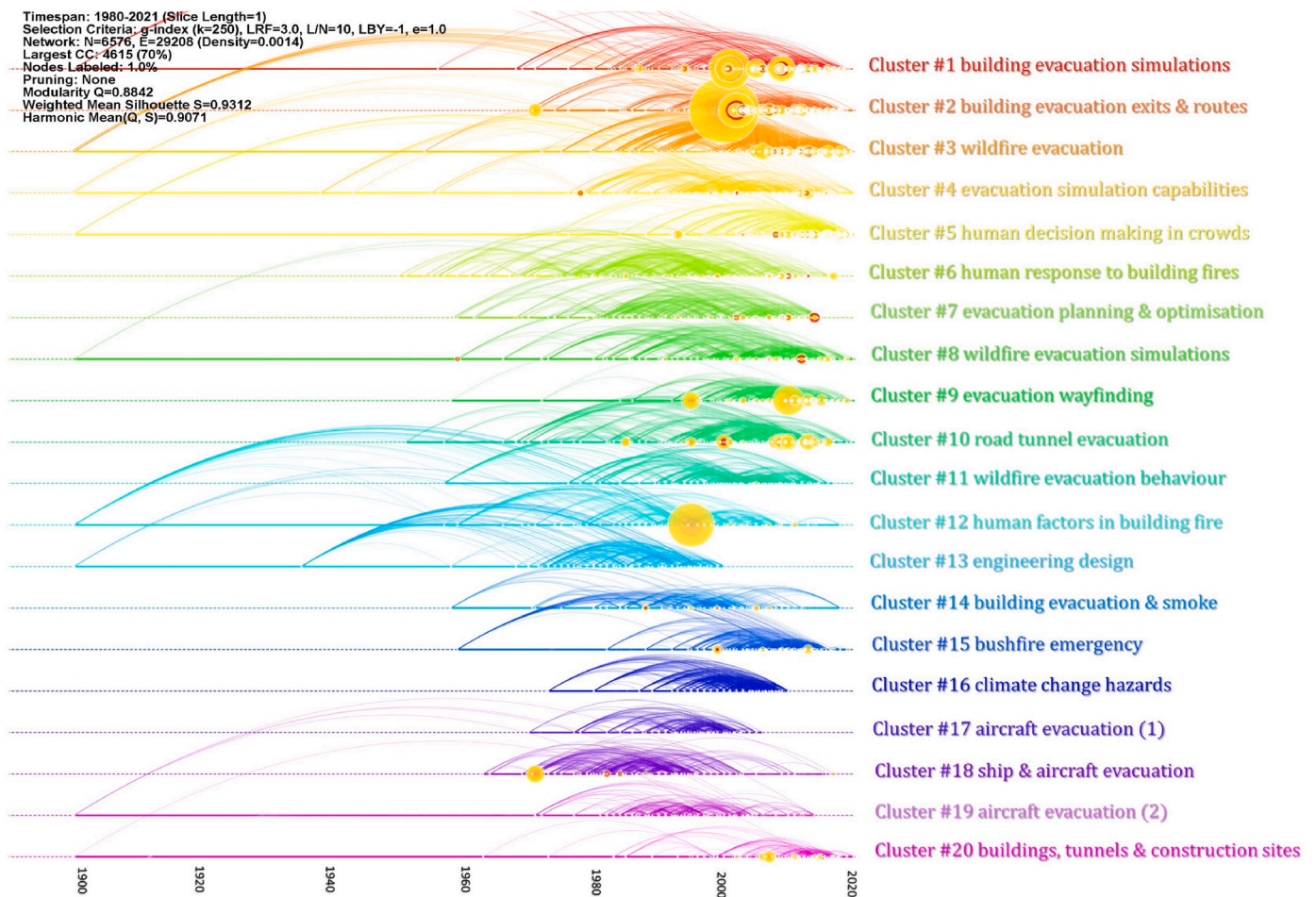


Fig. 1. Timeline view of document co-citations in HbiF literature.

Below we provide a short description of the 10 most significant clusters.

Cluster #01, *building evacuation simulations*, represents a broad stream of research focusing on the simulation of building fire evacuations using different modelling solutions. The majority of the papers belonging to this stream apply evacuation models to high-rise buildings using modelling solutions such as cellular automata approaches, see, for instance, Ding et al. [12] and Ma et al. [13]. The most cited article in this cluster is Burstedde et al. [14], which is one of the core papers in the field proposing the use of floor field cellular automata modelling to simulate building evacuations. As shown in Fig. 3, this stream started being relatively active after 2010, and it is still very active today.

Cluster #02, *building evacuation exits and routes*, represents a broad stream of research mainly focusing on exit and route choice and the impact of exit features on the evacuation process. As such, this stream includes a mix of experimental and simulation studies. The most cited works here are Helbing et al. [15] and Kirchner et al. [16], which are two key references for the social force model and floor field cellular automata model, respectively. This stream significantly started its activity after 2005 and it is showing a substantial drop after 2020.

Cluster #03, *wildfire evacuation*, relates to the wildfire research focusing on different key human behaviour topics combining review studies [17,18], theoretical studies [19] and case studies [20]. One of the recurrent subjects in this cluster is the decision to evacuate and the factors affecting this decision; see, for instance, Strahan et al. [21] Lovreglio et al. [20] and McLennan et al. (2019). This stream had a significant increment after 2010, and it shows a growing trend.

Cluster #04, *evacuation simulation capabilities and validity*, focuses on the capabilities of evacuation models in predicting different evacuation

scenarios. This stream includes several pieces of research comparing the capabilities of different building evacuation models [22] as well as papers on how to assess the validity of existing evacuation models accounting for behavioural uncertainty [23]. This stream started in 2000, and it has had fluctuations in activities in the last 20 years.

Cluster #05, is predominantly about *human decision making in crowds*. It is considered a relatively young cluster and one of the emerging trends of HBiF. Sustained activities of this cluster are detectable since 2017 and have been on the rise since. The emergence of a number of review articles in 2020 and 2021 (e.g., Haghani [24], Yan et al. (2020) and Ding et al. [12]) have been instrumental in creating this specific cluster of references and pinning them as the knowledge foundation of this stream. The cluster primarily consists of empirical references. Studies by Zhang et al. [25] and Kinatader et al [26,27] are amongst the highest cited references of this cluster.

Cluster #06, *human response to building fires*, represents a broad stream of research mainly focusing on how humans respond to building fires. This stream combines several reviews [28–32] on how people behave in a building fire as well as work focusing on how to integrate known behaviours and theories in evacuation simulations ([20]; Kuliowski et al., 2017; Gwynne et al., 2016). This stream started in 1985, and it has reached different peaks and drops in the last 40 years, as shown in Fig. 3, and it shows a substantial drop in the last years.

Cluster #07, *evacuation planning and optimization*, represents a broad stream of research focusing on how to make evacuations faster or more effective. This stream combines both building fire case studies [33,34] and wildfire evacuation optimisation [35], and it investigates different routing algorithms [36]. This stream started after 2000, and it shows substantial ups and downs over the last 20 years.

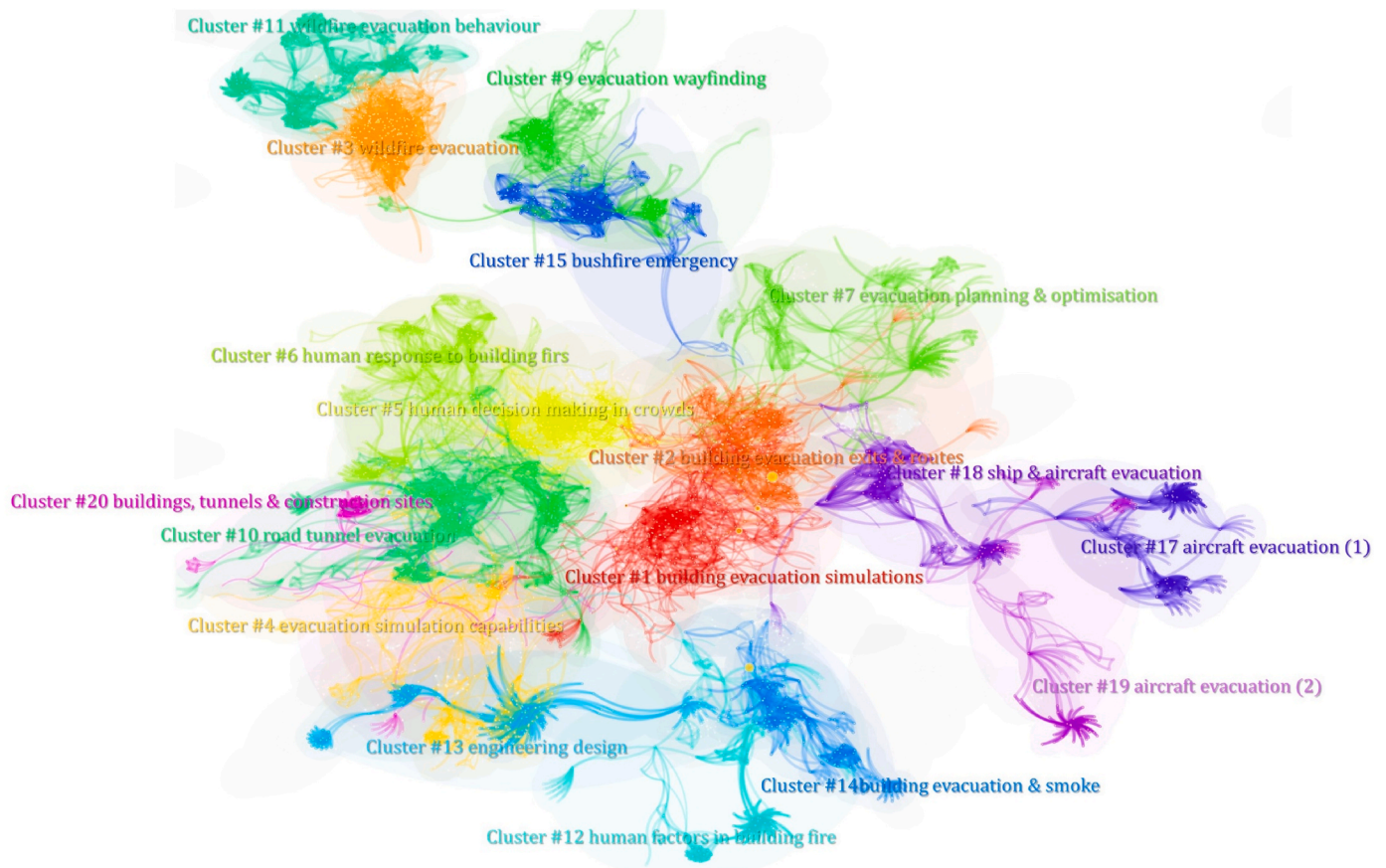


Fig. 2. Network of document co-citation in HBiF literature.

Cluster #08, *wildfire evacuation simulations*, is a stream of large-scale evacuation studies mainly focused on wildfire disasters. Several of the works belonging to this stream focus on wildfire evacuation triggers ([37]; Cova et al., 2017). Fig. 3 shows that this stream was established after 2005. It shows substantial ups and downs over the last 20 years.

Cluster #09, *evacuation wayfinding*, is a stream which collects papers proposing and testing different wayfinding systems. The stream includes both physical experiments [38,39] and virtual reality experiments [26, 27,40,41]. This stream has shown steady growth since 2010.

Cluster #10, *road tunnel evacuation*, is a stream that includes multiple works on road tunnel evacuation experiments and simulations. In fact, this stream includes several papers investigating how people respond in virtual road tunnel evacuations (Kinatader et al., 2013; [26,27]) and different simulation solutions for road tunnel simulations [42–44]. This stream started after 1995, and it had peaks and troughs in terms of citations until 2010. Since 2010, this stream has had a steady increment, as shown in Fig. 3.

Note that in this objective determination, using document co-citation patterns and clusters as indicators of research trends and divisions, several clusters could often share similar themes. For example, in our analysis, four clusters emerged on wildfire evacuation: Clusters 3, 8, 11 and 15. What tells them apart, however, is the set of references (i.e., the knowledge foundation) that they employ. This could be a reflection of differential methodologies that these research streams might have employed (e.g., mathematical optimisation and algorithmic analysis versus quantitative and behavioural studies). In the wildfire example, the set of references (i.e., citing articles in Table A1) of Cluster 3 includes review studies, theoretical studies, and case studies focusing on different human behaviours in wildfires. On the other hand, the set of references of Cluster 8 includes a group of large-scale evacuation simulations mainly focused on wildfire disasters (see Table A1).

The clustering solution based on citing articles could also reflect paradigm shifts within sub-topics of the field. If a set of traditional references on wildland fire, for example, suddenly get abandoned by the researchers of the field and a new set emerge or get adopted (e.g., as a result of the paradigm shift in thinking), then two distinguishable clusters on the same topic could emerge in a document co-citation network. This differentiation may not manifest at the lexical aspects of the papers, but the document co-citation analysis has adequate levels of granularity to unmask such distinctions, including paradigm shifts or variations in methodological approaches.

#### 4. Authorship and collaboration analysis

Patterns of collaboration between authors are investigated in this paper. This analysis was carried out using data from over 800 authors who have published at least one work in the HBiF literature. The network of collaboration is shown in Fig. 4 where each node represents an author. Fig. 4 also shows links connecting pairs of nodes. These links represent co-authorship between authors, while the thickness of each link is proportional to the number of articles on which the two authors are listed jointly (i.e., as co-authors). This metric is known in the literature as *link strength*. Using the link strengths of all the links generated by a single node, it is possible to measure the *total link strength* for each author. This second metric provides an indication of the overall extent of co-authorship activities of an author with other authors in the proposed network. The total link strength is visualised in Fig. 4 through the size of the nodes. As such, bigger nodes represent authors who have co-authored more with other authors of this network.

Using patterns shown in Fig. 4, it is possible to carry out a cluster analysis to identify groups of authors who have frequently co-authored their publications. This analysis identifies 53 clusters; the 18 biggest

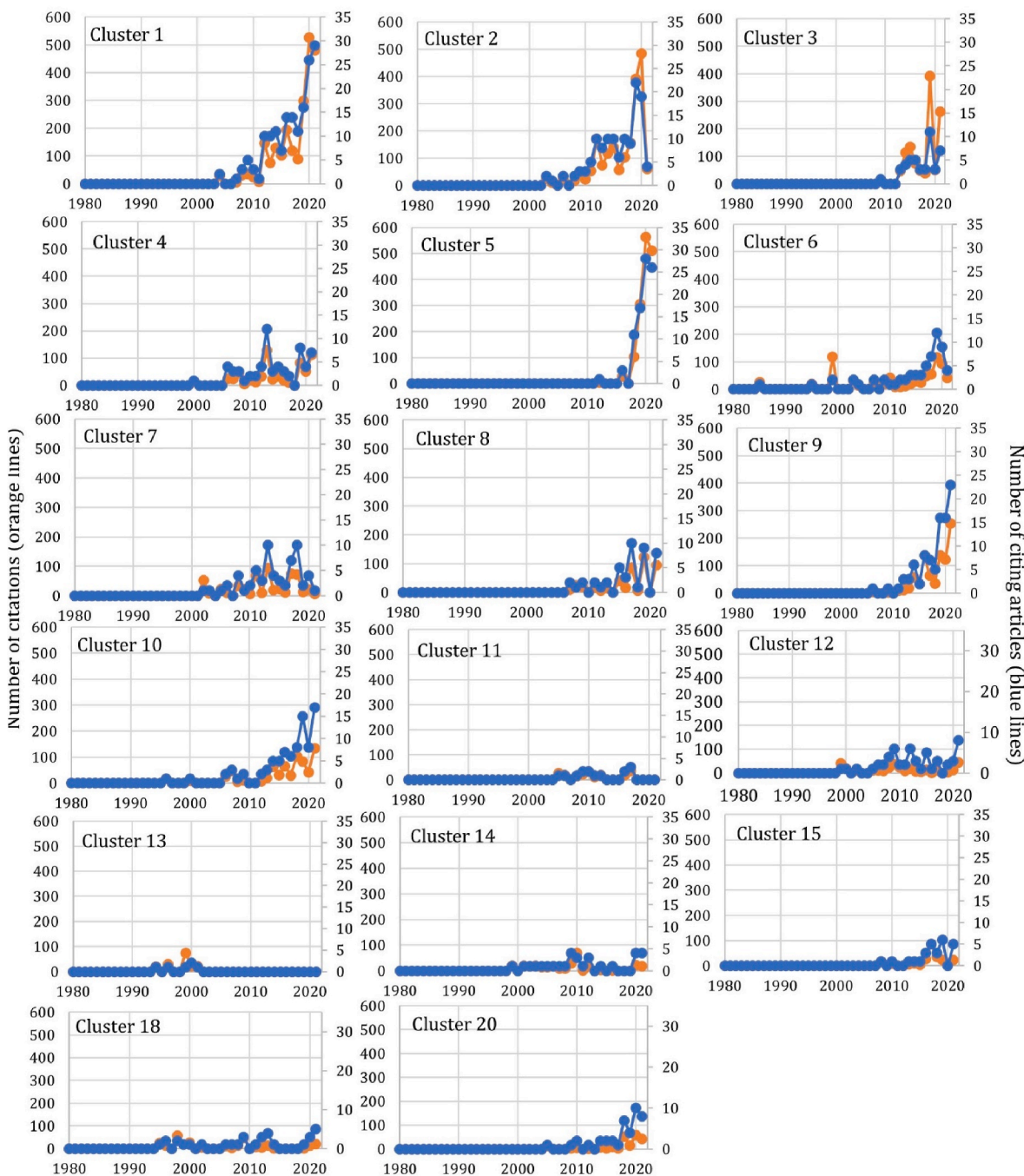


Fig. 3. Cluster-level citation activity in HBiF literature.

clusters from this analysis are visualised in Fig. 4 using different colours, while the remaining 35 smaller clusters are visualised in grey. The cluster dimensions of the top five clusters and the main three nodes in these clusters are reported in Table 1. Many of the strongest links reflect a combination of collaborations within a single university or government agency and mentoring relationships (e.g., a postdoctoral fellow and their supervisor/mentor).

### 5. Discussion

Understanding human behaviour in fire (HBiF) holds significance for safeguarding lives and effectively managing evacuation scenarios, both in building and wildland fire contexts. In addition, knowledge of the fundamental understanding of human behaviour in fire could be useful

to understand human behaviour in other hazards or in general. For instance, it is exemplary that some of the most known classical studies in social psychology relate to the emergency context ([45]; Latané & Darley, 1970).

In our paper, we undertook a comprehensive examination of the HBiF domain to bridge existing gaps in knowledge and provide insights that can steer future research, policies, and practices. By analysing nearly 1900 research papers and their corresponding references, we uncovered a knowledge foundation comprising approximately 6600 frequently cited references that underscore the bedrock of HBiF science.

In this context, we note that the domain of human behaviour in building fires has, in recent years, primarily been approached from an engineering perspective, i.e., how behavioural understanding can be embedded into fire safety engineering and used to improve building

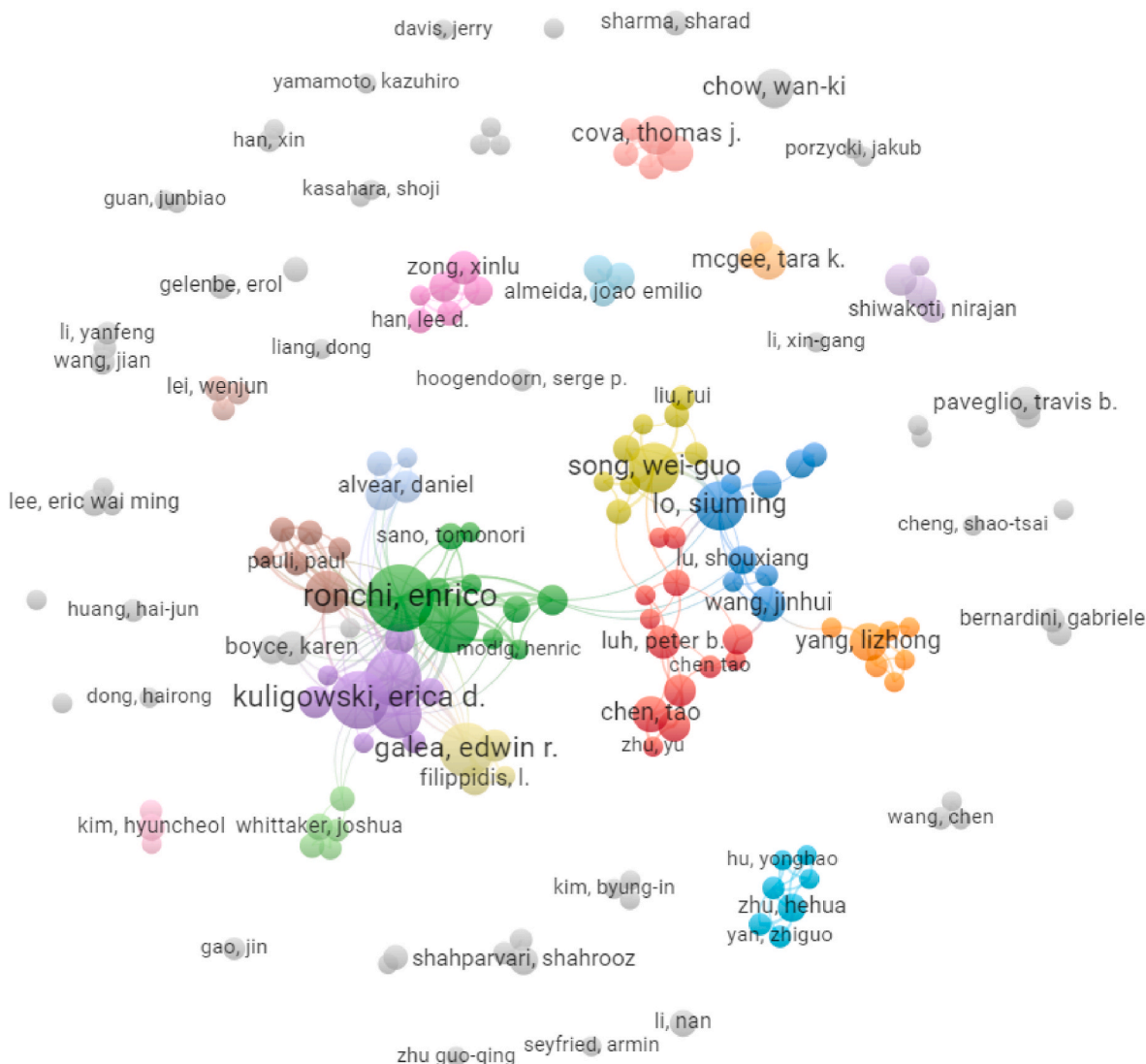


Fig. 4. Network of author collaborations in the HBIF literature. An interactive version of this map can be accessed through this [link](#).

**Table 1**  
Details of the 5 biggest clusters (TLS: Total Link Strength; D: Number of documents).

Cluster #	Cluster size	Node 1	Node 2	Node 3
1	13	Chen Tao (TLS:23, D:13)	Ding Ning (TLS:22, D:10)	Zhang Hui (TLS:18, D:10)
2	10	Ronchi Enrico (TLS:106, D:45)	Nilsson Daniel (TLS:78, D:35)	Frantzych Hakan (TLS:25, D:9)
3	9	Lo Siuming (TLS:26, D:24)	Wang Jinhui (TLS:16, D:12)	Lu Shouxiang (TLS:14, D:8)
4	9	Song Wei-Guo (TLS:38, D:25)	Lv Wei (TLS:13, D:7)	Cao Shu-Chao (TLS:10, D:6)
5	9	Kuligowski Erica (TLS:64, D:33)	Gwynne Steven (TLS:85, D:31)	Lovreglio Ruggiero (TLS:46, D:23)

evacuation design. Nevertheless, its knowledge foundation relies on a set of core experimental and theoretical work which is largely based in the social sciences ([46]; Darley & Latane, 1968; Deutsch & Gerard, 1955; Latané & Darley, 1970 [47]; Tajfel et al., 1979) and human factors and ergonomics fields [48–50]. In fact, seminal reviews were conducted by Bryan [28] and Shields and Proulx [51] that highlight key studies upon which the field of human behaviour in building fires was built.

Such fundamental studies may not be visible in full in scientific databases (as some of them were published in the form of books or government reports that are not indexed in Web of Science); even so, they represent a significant portion of the knowledge foundation in the field. Another important set of references is the list of publications from the Human Behaviour in Fire Symposia series. This conference series started in 1998 (with the latest conference in 2015), and over the years, only a selection of papers ended up being published in journals special issues associated with the conference. This means that a significant portion of the scientific contributions of the conference are not fully visible in our review, although the HBIF Symposia series has represented for years the meeting point for researchers in this field.

While this review focuses only on human behaviour *during* fires, we should acknowledge that the domain of human behaviour in outdoor fires, and more specifically, wildfire events, encompasses a wealth of social science literature on other important topics, including homeowner mitigation, public acceptance of fuels treatments on government-owned lands and perceptions of fire management practices (e.g., prescribed burns), the social impacts of fire, post-fire recovery, and wildland fire planning and policy [52]. Much of the early work in wildfire evacuation originated from the fields of environmental science (e.g., ecology, resource management), geography, and psychology. This includes work in the U.S. as early as 2006 [53] to understand the factors

that influence homeowners' decisions to evacuate, and in Australia (2005) and the U.S. (2009) to discuss the safest approaches for protection during bushfires [54]. The 2009 Black Saturday fires in Australia, which resulted in the deaths of 173 people, provided the impetus for increased focus on and funding for evacuation research, some of which was published in trade journals or as organisation reports and, therefore, may not be captured by our systematic review [55–57].

As we steer the trajectory of future HBiF research, several avenues emerge from our analysis that warrant further exploration. (i) With rapid urbanisation, the complexities of wildfire (and even building) evacuations intensify. Research should delve into the influence of urban layouts, community knowledge and experiences, and transport infrastructural elements on evacuation efficiency, particularly under scenarios of high population density and limited building and community egress options. (ii) Deeper exploration of how cultural norms, socio-economic disparities, and the needs of vulnerable populations influence evacuation behaviours can guide the development of tailored evacuation strategies that are inclusive and equitable. (iii) Furthermore, harnessing the potential of emerging technologies and approaches beyond the existing levels—such as virtual reality, augmented reality, machine learning, and sensor-based monitoring systems—can contribute to the dynamic evolution of fire safety and evacuation research. (iv) Building on the growing interest in decision support systems, future research can focus on the development of real-time tools that aid decision-makers during fire emergencies. These tools could leverage real-time data to offer tailored evacuation recommendations and enhance the efficiency of disaster management. This is also associated with data-driven approaches that can be coupled with traditional theory-based approaches to deepen our understanding in this domain.

In the pursuit of these directions, interdisciplinary collaboration remains paramount. The ensemble of expertise from fields including psychology, engineering, urban and regional planning, geography, computing technologies, sociology, and emergency management must converge to address the multifaceted challenges that arise from the interplay between human behaviours and fire incidents. Recent research efforts tend to go in the direction of more and more collaborative cross-disciplinary collaborations, highlighting how research siloing is an issue that can be overcome.

An important aspect to highlight is how the HBiF field is closely interconnected with the related fields of fire safety engineering and pedestrian and evacuation dynamics. This allows researchers and practitioners to take advantage of research in related fields to establish new research directions and agendas. In this context, a particular challenge is linked to the use of controversial terminology (e.g., panic, herding, stampede, etc.). This is an issue which has been discussed in several HBiF-related fora [58,59], where several misconceptions appear to still be present [60–62]. Attempts to harmonize and advise on the appropriate use of terminology have been conducted (Adrian et al., 2019). This is likely going to facilitate a dialogue across disciplines.

## 6. Conclusions

Our analysis delved into the core references, identifying highly prominent items based on a range of metrics, including citation frequency, bursts of local citations, and centrality. These metrics allowed

us to discern references that have profoundly influenced the field and have contributed significantly to shaping its contours. This method of discerning prominence brings forward a refined understanding of the most impactful works, thereby facilitating a focused exploration of human behaviour in fire (HBiF) essential components.

The exploration of co-citation patterns among these references unveiled the trends and dynamics within the realm of HBiF research. Our analysis highlighted the emergent streams that are currently shaping the field, as well as the areas that have shown diminishing prominence over time. This dual perspective—of active trends and waning interests—empowers stakeholders to adapt their strategies, allocate resources, and align their endeavours with the ever-evolving landscape of HBiF.

The collaborative nature of HBiF research is a hallmark of its complexity and interdisciplinary scope. Co-authorship analysis uncovers the vibrant networks that underpin this field, where experts from diverse domains coalesce to tackle multifaceted challenges. The visualisation of co-authorship networks reveals hubs of collaboration, highlighting influencers and areas of collective strength.

In conclusion, our study contributes to the holistic understanding of HBiF by not only consolidating existing knowledge but also paving the way for future research endeavours. The urgency of this endeavour is underscored by the increasing frequency of fire-related incidents and the ever-evolving dynamics of disaster response.

## CRedit authorship contribution statement

**Milad Haghani:** Conceptualization, Formal analysis, Methodology, Writing – original draft, Writing – review & editing. **Ruggiero Lovreglio:** Formal analysis, Writing – original draft, Writing – review & editing. **Mary Langridge Button:** Formal analysis. **Enrico Ronchi:** Conceptualization, Writing – original draft. **Erica Kuligowski:** Conceptualization, Writing – original draft, Writing – review & editing.

## Declaration of competing interest

The authors do not have any conflict of interest.

## Data availability

Data will be made available on request.

## Acknowledgments

The financial contribution of the Australian Research Council (ARC) to this work is acknowledged by Milad Haghani (Grant No. DE210100440) and Erica Kuligowski (FT220100618). The authors wish to acknowledge the International Association for Fire Safety Science for its support of the Human Behaviour in Fires permanent group within the association. Dr. Lovreglio thanks the NZ Ministry of Business, Innovation & Employment and Royal Society Te Apārangi for funding his research thorough the Marsden Fast Start (MAU2204) and the Rutherford Discovery Fellowship (RDF-MAU2201). The contribution to the work by Dr Ronchi was partially funded by the European Union Civil Projection (Project GA 101101169 WUITIPS UCPM-2022-PP).

Appendix

Table A1

Details of the document co-citation network in HBIF

Cluster ID Name Objective descriptors Author descriptor	Cluster statistics		Influential references					Highest coverage citing articles			
	- size	- silhouette score	Highest local citation count	Strongest citation burst (strength, duration)		Highest centrality					
<b>Cluster #1</b>	S	329	[14]	116	[14]	8.91	2008–2015	[63]	0.03	[24]	120
	SS	0.811	[64]	74	[65]	8.64	2006–2010	[66]	0.03	[12]	73
- high-rise building	MY(ref)	2006	[67]	72	[68]	8.63	1996–2009	[69]	0.03	[70]	71
- high-rise building evacuation	YR(ref)	1900–2019	[72]	48	[67]	8.45	2011–2015	[68]	0.02	[73]	46
- merging flow	MY(citing)	2017	[65]	46	[64]	7.81	2006–2010			[74]	43
- crowd guidance	YR(citing)	2004–2021	[68]	35	[75]	6.4	2003–2012			[76]	42
- tall building			[78]	33	[79]	6.31	2011–2017			[23]	40
			[79]	29	[80]	5.9	2009–2017			[81]	37
			[82]	28		5.43	2014–2017			[13]	34
				28	[13]	5.15	2013–2017				
			[13]	28							
<b>Cluster #2</b>	S	320	[15]	253	[83]	6.92	2011–2014	[84]	0.02	[24]	102
	SS	0.873	[16]	89	[16]	6.69	2010–2015	[85]	0.02	[86]	49
- pedestrian evacuation	MY(ref)	2006	[87]	46	[88]	6.63	2013–2017	[89]	0.02	[90]	47
- evacuation efficiency	YR(ref)	1970–2020	[91]	36	[92]	5.89	2012–2015	[93]	0.02	[73]	46
- evacuation dynamics	MY(citing)	2016	[94]	36	[95]	5.72	2008–2015			[96]	43
- evacuation assistant	YR(citing)	2003–2021	[97]	36	[98]	5.68	2011–2015			[73]	42
- turning behavior			[99]	35	[87]	5.52	2011–2017			[73]	39
			[95]	35	[100]	5.12	2007–2010			[76]	37
			[101]	34	[99]	5.01	2011–2017			[102]	33
			[103]	33	[84]	4.93	2011–2016			[81]	32
			[104]	33							
<b>Cluster #3</b>	S	287	[53]	50	[105]	5.91	2009–2015	[106]*	0.05	[21]	85
	SS	0.905	[107]	32	[108]	5.55	2014–2019		0.04	[18]	75
- rapid systematic review	MY(ref)	2008	[109]	31	[110]	4.72	2016–2019	[53]	0.02	[111]	64
- wildfire threat	YR(ref)	1900–2020	[112]	31	[107]	4.58	2012–2016	[113]	0.02	[17]	54
- wildfire evacuation	MY(citing)	2017	[108]	31	[114]	4.35	2010–2015	[116]	0.02	[20]	50
- early literature	YR(citing)	2009–2021	[118]	29	[54]	4.23	2009–2015	[119]	0.02	[120]	47
- bushfire part			[121]	29	[122]	4.17	2014–2017	[123]	0.02	[19]	45
			[124]	28	[125]	3.91	2009–2015	[126]	0.02	[127]	42
			[128]	26						[129]	41
<b>Cluster #4</b>	S	250	[2]	43		4.7	2010–2014	[130]	0.03	[131]	52
	SS	0.924		31		4.18	2006–2009			[23]	29
- using polynomial chaos expansion	MY(ref)	2001	[132]	27	[133]	4.01	2013–2018			[134]	24
- uncertainty analysis	YR(ref)	1900–2020	[133]	24	[135]*	4.01	2010–2013			[22]	23
- occupant evacuation	MY(citing)	2014	[136]	18		3.95	2006–2012			[137]	21
- building fire	YR(citing)	2000–2021	[135]*	15						[138]	16
- building fire risk			[139]*	14						[140]	16
			[141]	13						[142]	16
			[143]	11						[144]	16
<b>Cluster #5</b>	S	238	[25]	33	[27]	5.3	2016–2019	[145]	0.02	[24]	94
	SS	0.86	[27]	31	[25]	5.13	2009–2015			[70]	53
- human crowd	MY(ref)	2012	[146]	29	[146]	4.12	2015–2021			[147]	52
- collective egress	YR(ref)	1900–2020	[148]	28						[12]	49
- lecture hall	MY(citing)	2020	[149]	27						[131]	48
- agent-based modeling approach	YR(citing)	2012–2021	[150]	27						[86]	42
- decision strategy			[151]	26						[90]	41
			[152]	25						[73]	41
			[117]	24						[71]	39
<b>Cluster #6</b>	S	203	[153]	31	[154]	6.5	2007–2014	[46]	0.06	[28]	78
	SS	0.906	[155]	27	[143]	4.89	2013–2018	[46]	0.04	[30]	41
- modeling pre-evacuation	MY(ref)	1993	[154]	21	[156]	4.19	2015–2019	[155]	0.03	[157]	40
- world trade center tower	YR(ref)	1950–2017	[158]	21	[159]	4.01	2014–2018	[160]	0.03	[155]	26
- interface communities	MY(citing)	2015	[46]	20						[161]	24
- model user (	YR(citing)	1985–2021	[162]	19				[163]	0.02	[164]	21
- representing human behaviour			[143]	17					0.02	[165]	20
			[156]	16						[20]	19
			[166]*	15						[167]	18
			[168]	15							
<b>Cluster #7</b>	S	199	[169]	31	[170]	6.48	2010–2014		0.02	[171]*	53
	SS	0.936	[172]	31	[173]	5.26	2010–2017	[174]	0.02	[175]	39
- evacuation planning	MY(ref)	1999		26	[172]	4.99	2017–2021	[176]	0.02	[177]	23
- shelter location	YR(ref)	1959–2015	[174]	20	[178]	4.98	2009–2016	[179]	0.02	[36]*	23
- routing algorithm	MY(citing)	2014	[170]	19		4.69	2008–2018			[34]	22
- benders decomposition approach	YR(citing)	2002–2021	[180]	19	[174]	4.64	2010–2018			[181]	22
- evacuation route assignment			[178]	18	[182]	4.04	2010–2016			[183]	20
			[184]	17	[169]	4	2011–2016			[115]	20

(continued on next page)

Table A1 (continued)

Cluster ID Name Objective descriptors Author descriptor	Cluster statistics		Influential references				Highest coverage citing articles		
	- size	- silhouette score	Highest local citation count	Strongest citation burst (strength, duration)	Highest centrality				
			[173]	16			[34]	20	
<b>Cluster #8</b>	S	182	[185]	31	[186]	5.26 2015–2019	[187]	0.03 [37]	34
	SS	0.911	[186]	27	[188]	4.88 2015–2019	[188]	0.02 [120]	31
- national address point database	MY(ref)	2004	[189]	20	[190]	4.13 2012–2017	[191]	0.02 [192]	24
- wildfire public safety	YR(ref)	1900–2020	[187]	18	[193]	3.9 2007–2011		[194]	19
- relative effectiveness	MY(citing)	2016	[193]	17				[124]	17
- urban evacuation	YR(citing)	2007–2021	[195]	16				[196]	15
- environmental hazard			[190]	16				[23]	15
			[197]	15				[198]	15
			[188]	14				[20]	15
			[199]	14					
<b>Cluster #9</b>	S	175	[30]	93	[200]	4.58 2012–2016	[201]	0.05 [12]	35
	SS	0.892	[202]	51	[203]*	4.23 2016–2019	[202]	0.02 [204]	29
- italian-style historical theatre	MY(ref)	2008	[77]	45				[205]	26
- virtual environment	YR(ref)	1958–2020	[206]	39				[39]	26
- photoluminescent wayfinding	MY(citing)	2018	[207]	32				[26]	25
- occupants evacuation	YR(citing)	2006–2021	[208]	28				[38]	23
- architecture modification				25				[41]	21
			[209]	24				[210]	20
				21				[70]	20
								[211]	19
<b>Cluster #10</b>	S	167	[31]	54	[212]	9.45 2006–2009	[45]	0.03 [213]	28
	SS	0.937	[214]	53	[215]	5.35 2013–2018	[215]	0.02 [216]	26
- road tunnel	MY(ref)	2000	[212]	53	[214]	4.26 2009–2015	[31]	0.02 [42]	24
- social influence	YR(ref)	1951–2020	[217]	48	[218]	4.07 2005–2009	[219]	0.02 [220]	22
- virtual reality	MY(citing)	2017	[221]	45	[222]	3.82 2008–2011		[26]	22
- evacuation behavior	YR(citing)	1996–2021	[29]	39				[44]	20
- emergency evacuation			[215]	37				[26]	20
			[222]	32				[12]	19
			[26]	31				[74]	18
			[47]	31				[40]	18
<b>Cluster #11</b>	S	161	[223]	16	[223]	4.73 2007–2011		[224]	27
	SS	0.954	*	8				[53]	20
- rodeo-chediski fire	MY(ref)	2003	[225]	8				[122]	19
- fragmenting influence	YR(ref)	1957–2017	[224]	7				[226]	19
- wildland fire	MY(citing)	2012	[228]	5				[229]	16
- santa fe fire protection district	YR(citing)	2005–2017						[227]	16
- local approaches								[105]	15
<b>Cluster #12</b>	S	152	[230]	155		4.31 2005–2008	[231]*	0.02 [232]	41
	SS	0.958	[233]	18	[234]	3.81 2008–2015		[235]	20
- engineered fire safety design	MY(ref)	1995	[236]*	18				[237]	15
- integrating human factors issue	YR(ref)	1900–2018	[234]	10				[79]	15
- fire safety science	MY(citing)	2013	[238]	8				[12]	13
- occupant evacuation model	YR(citing)	1999–2021	[239]	7				[234]	12
- kin behavior				7				[240]	11
								[32]*	11
<b>Cluster #13</b>	S	151		5				[28]	74
	SS	0.985	[241]	5				[242]	29
- scholarly study area	MY(ref)	1986						[64]	22
- engineering design standard	YR(ref)	1900–2000		3				[68]	20
- mass-transport vehicle	MY(citing)	1998	[243]	3				[244]	20
- toxic product yield	YR(citing)	1994–2001		3				[235]	2
- human behaviour									
<b>Cluster #14</b>	S	131		24		5.42 2003–2012		0.04 [30]	38
	SS	0.956	[245]	19		5.16 2002–2013	[246]	0.04 [247]	19
- high place	MY(ref)	1997	[248]	17	[246]	4.32 2002–2012		[246]	19
- smoke hazard	YR(ref)	1958–2018			[248]	4.21 2003–2013		[249]	19
- sports stadium	MY(citing)	2011	[246]	16				[250]	18
- future issue	YR(citing)	1999–2021	[251]	14				[252]	17
- motivation level				13				[29]	16
			[253]	10					
<b>Cluster #15</b>	S	125	[254]	27		3.88 2013–2017	[255]	0.03 [175]	37
	SS	0.957	[256]	26	[254]	3.85 2002–2008		[175]	35
- australian case study	MY(ref)	2007	[257]	9				[112]	17
- bushfire emergency evacuation	YR(ref)	1959–2019		9				[258]	16
- short-notice bushfire emergency evacuation	MY(citing)	2017						[259]	14

(continued on next page)

**Table A1** (continued)

Cluster ID Name Objective descriptors Author descriptor	Cluster statistics - size - silhouette score - mean year (ref) - year range (ref) - mean year (citing) - year range (citing)		Influential references				Highest coverage citing articles				
			Highest local citation count	Strongest citation burst (strength, duration)		Highest centrality					
- possibilistic scheduling	YR(citing)	2008–2021					[260] 11				
- robust stochastic vehicle							[261] 11 [262] 10 [265] 51				
<b>Cluster #16</b>	S	115	[263]	2		[264]	0.05				
	SS	0.998	[266]	2							
- plant health	MY(ref)	2003	[267]	2							
- landscape management	YR(ref)	1973–2010	[268]	2							
- global change	MY(citing)	2010	[264]	2							
- emergency evacuation	YR(citing)	2010–2010	[269]	2							
- pedestrian evacuation											
<b>Cluster #17</b>	S	110	[270]	6			[271] 32				
	SS	0.985	[272]	6			[274] 23				
- catastrophic event	MY(ref)	1996	[275]*	5			[276] 15				
- aircraft evacuation certification	YR(ref)	1970–2006	[272]	4			[277] 13				
- commercial aircraft-cabin egress	MY(citing)	2002		3							
- current state	YR(citing)	1998–2006	[278]*	3							
- future research			[279]	3							
<b>Cluster #18</b>	S	103	[280]*	59	[281]	9.15	1995–2013	[280]	0.05	[282]	48
	SS	0.949	[281]	26	[283]	5.23	2009–2013	[281]	0.04	[284]	26
- transport airplane	MY(ref)	1990	[283]	17	[242]	4.55	1998–2011	[283]	0.02	[285]	24
- evacuation system	YR(ref)	1963–2017	[286]	15						[177]	20
- considering evacuation route	MY(citing)	2010	[242]	10						[287]	20
- basic principle	YR(citing)	1995–2021	[288]	7						[282]	18
- building evacuation problem										[289]	14
										[290]*	11
										[273]	10
<b>Cluster #19</b>	S	100	[276]	15	[276]	3.97	2001–2009		0.02	[272]	38
	SS	0.976	[291]	10						[30]	34
- aviation accident report	MY(ref)	1993	[292]	8						[282]	15
- human experience	YR(ref)	1900–2014	[274]	7						[293]	14
- aircraft accident statistics	MY(citing)	2010								[29]	12
- aircraft accident database	YR(citing)	1998–2018								[294]	11
- defining building evacuation route											
<b>Cluster #20</b>	S	94	[295]	32	[296]	4.11	2017–2021			[42]	18
	SS	0.945	[297]	21						[74]	13
- quantitative risk assessment	MY(ref)	2007	[296]	20						[298]	13
- stochastic-based approach	YR(ref)	1900–2020	[299]	20						[300]	10
- underground road tunnel	MY(citing)	2018	[40]	13						[43]	9
- quantitative risk assessment method	YR(citing)	2005–2021		11						[301]	8
- thermal radiation			[302]	11							

## Search Query

*TI=(Fire\* AND evacuation\*)*

*OR*

*TI=("fire\* evacuation" OR "fire\* evacuations")*

*OR*

*AB=("fire\* evacuation" OR "fire\* evacuations")*

*OR*

*AK=("fire\* evacuation" OR "fire\* evacuations")*

*OR*

*TS=(("building fire\*") AND ("human behaviour\*" OR "human response" OR "evacuation behaviour\*" OR "escape behaviour\*" OR "evacuation\* response" OR "egress behaviour\*"))*

*OR*

*TS=(("shopping mall" OR "shopping centre\*" OR hotel OR hospital OR stadium OR theatre OR school) AND fire\* AND ("evacuation behaviour\*" OR "escape behaviour\*" OR "evacuation\* response" OR "egress behaviour\*"))*

*OR*

*TS=(("shopping mall" OR "shopping centre\*" OR hotel OR hospital OR stadium OR theatre OR school) AND fire\* AND (emergency OR evacuation OR escape) AND ("human behaviour\*" OR "human response"))*

*OR*

*TS=(("built environment\*" AND fire\*) AND ("human behaviour\*" OR "human response" OR "evacuation behaviour\*" OR "escape behaviour\*" OR "evacuation\* response" OR "egress behaviour\*"))*

*OR*

*TS=(("fire safety" OR "fire evacuation\*") AND ("evacuation\* behaviour\*" OR "evacuee\* behaviour\*" OR "human behaviour\*" OR "occupant\* behaviour\*" OR "egress behaviour\*" OR "evacuation model\*" OR "evacuation simulation"))*

*OR*

*TS=(("evacuation time\*" OR "pre-evacuation\*" OR "pre-movement time" OR "evacuation efficiency" OR "evacuation delay") AND (building\* OR facility\* OR "built environment\*" OR occupant\* OR "resident\*" OR evacuee\*))*

OR

TS=((*human\* behaviour\* in fire\**) OR *building\* fire evacuation\**)

OR

TS=(*evacuation procedure\** AND *emergency\** AND (*occupant\* OR resident\**))

OR

TS=((*evacuation drill\** OR *egress drill\** OR *evacuation trial\** OR *evacuation exercise\**) AND (*building\* OR pedestrian\* OR crowd\* OR built environment\* OR confined space\* OR evacuee\* OR occupant\**))

OR

TS=(*fire evacuation drill* OR *fire emergency drill*)

OR

TS=((*human behaviour\** OR *human response* OR *evacuation\* behaviour\** OR *escape behaviour\** OR *egress behaviour\**) AND *fire* AND (*building\* OR built environment\* OR ship\* OR tunnel\* OR aircraft\* OR vessel\* OR subway station\* OR metro station\* OR train station\* OR airport\**))

OR

TS=((*aircraft evacuation\**) OR (*ship evacuation\**) OR (*vessel evacuation\**) OR (*tunnel evacuation\* AND fire\**) OR (*train evacuation\**) OR (*building emergency evacuation\**) OR (*building evacuation\* AND fire\**) OR (*indoor emergency evacuation\**) AND *fire\**) OR (*aircraft emergency evacuation\**) OR (*ship emergency evacuation\**) OR (*vessel emergency evacuation\**) OR (*tunnel emergency evacuation\**) OR (*train emergency evacuation\**))

OR

TS=((*wildfire\** OR *bushfire\** OR *wildland fire\** OR *forest fire\** OR *mega fire\** OR *megafire\** OR *wildland-urban interface fire\** OR *WUI fire\**) AND (*evacuation behaviour\** OR *evacuee\** OR *evacuation response* OR *evacuation\** OR *household\* evacuation\** OR *household\* response* OR *household preparedness* OR *homeowner behaviour\** OR *human\* behaviour\** OR *human\* response* OR (*traffic* AND *simulation*)))

OR

TS=((*wildland-urban interface* OR *WUI* OR *Urban-wildland* OR (*fire\** AND *community\**) OR *fire risk mitigation* OR *wildfire risk mitigation*) AND (*evacuation behaviour\** OR *evacuee\** OR *evacuation response* OR *evacuation\** OR *household\* evacuation\** OR *household\* response* OR *household preparedness* OR *homeowner behaviour\** OR *human\* behaviour\** OR *human\* response*))

)

NOT

TS=(*earthquake* OR *Tsunami* OR *cyclone* OR *flood* OR *chemical spill* OR *chemical leakage* OR *storm* OR *hurricane* OR *A decomposition approach for the stochastic asset protection problem*)

. (continued).

## References

- [1] E.D. Kuligowski, The Process of Human Behavior in Fires, US Department of Commerce, National Institute of Standards and Technology, 2009.
- [2] E. Kuligowski, Predicting human behavior during fires, *Fire Technol.* 49 (1) (2013) 101–120.
- [3] W.M. Jolly, M.A. Cochrane, P.H. Freeborn, Z.A. Holden, T.J. Brown, G. J. Williamson, D.M. Bowman, Climate-induced variations in global wildfire danger from 1979 to 2013, *Nat. Commun.* 6 (1) (2015) 7537.
- [4] R.L. Paulsen, Human behavior and fires: an introduction, *Fire Technol.* 20 (1984) 15–27.
- [5] S. Gwynne, E. Kuligowski, D. Nilsson, Representing evacuation behavior in engineering terms, *J. Fire Protect. Eng.* 22 (2) (2012) 133–150.
- [6] E.D. Kuligowski, Human behavior in fire. SFPE Handbook of Fire Protection Engineering, 2016, pp. 2070–2114.
- [7] A.P. Hoover, L.L. Langner, People and Wildfire: an Overview, UNITED STATES DEPARTMENT OF AGRICULTURE FOREST SERVICE GENERAL TECHNICAL REPORT NC, 2002, pp. 1–3.
- [8] D.R. Field, D.A. Jensen, Humans, fire, and forests: expanding the domain of wildfire research, *Soc. Nat. Resour.* 18 (4) (2005) 355–362.
- [9] E. Kuligowski, Evacuation decision-making and behavior in wildfires: past research, current challenges and a future research agenda, *Fire Saf. J.* 120 (2021) 103129.
- [10] M. Haghani, E. Kuligowski, A. Rajabifard, C.A. Kolden, The state of wildfire and bushfire science: temporal trends, research divisions and knowledge gaps, *Saf. Sci.* 153 (2022) 105797.
- [11] C. Chen, CiteSpace II: detecting and visualizing emerging trends and transient patterns in scientific literature, *J. Am. Soc. Inf. Sci. Technol.* 57 (3) (2006) 359–377.

- [12] N. Ding, T. Chen, Y. Zhu, Y. Lu, State-of-the-art high-rise building emergency evacuation behavior, *Phys. Stat. Mech. Appl.* 561 (2021).
- [13] J. Ma, S.M. Lo, W.G. Song, Cellular automaton modeling approach for optimum ultra-high-rise building evacuation design, *Fire Saf. J.* 54 (2012) 57–66.
- [14] C. Burstedde, K. Klauack, A. Schadschneider, J. Zittartz, Simulation of pedestrian dynamics using a two-dimensional cellular automaton, *Phys. Stat. Mech. Appl.* 295 (3–4) (2001) 507–525.
- [15] D. Helbing, I. Farkas, T. Vicsek, Simulating dynamical features of escape panic, *Nature* 407 (6803) (2000) 487–490.
- [16] A. Kirchner, A. Schadschneider, Simulation of evacuation processes using a bionics-inspired cellular automaton model for pedestrian dynamics, *Phys. Stat. Mech. Appl.* 312 (1–2) (2002) 260–276.
- [17] K. Strahan, J. Gilbert, Protective decision-making in bushfire Part 1: a rapid systematic review of the ‘wait and see’ literature, *Fire* 4 (1) (2021).
- [18] K.W. Strahan, J. Gilbert, Protective decision-making in bushfire Part 2: a rapid systematic review of the ‘leave early’ literature, *Fire* 4 (3) (2021).
- [19] J. McLennan, S. Cowlishaw, D. Paton, R. Beatson, G. Elliott, Predictors of south-eastern Australian householders’ strengths of intentions to self-evacuate if a wildfire threatens: two theoretical models, *Int. J. Wildland Fire* 23 (8) (2014).
- [20] R. Lovreglio, E. Kuligowski, S. Gwynne, K. Strahan, A modelling framework for householder decision-making for wildfire emergencies, *Int. J. Disaster Risk Reduc.* 41 (2019).
- [21] K.W. Strahan, J. Whittaker, J. Handmer, Predicting self-evacuation in Australian bushfire, *Environ. Hazards* 18 (2) (2018) 146–172.
- [22] E. Ronchi, Testing the predictive capabilities of evacuation models for tunnel fire safety analysis, *Saf. Sci.* 59 (2013) 141–153.
- [23] E. Ronchi, Developing and validating evacuation models for fire safety engineering, in: *Fire Safety Journal*, 120, 2021.
- [24] M. Haghani, Empirical methods in pedestrian, crowd and evacuation dynamics: Part I. Experimental methods and emerging topics, *Saf. Sci.* 129 (2020).
- [25] J. Zhang, W. Song, X. Xu, Experiment and multi-grid modeling of evacuation from a classroom, *Phys. Stat. Mech. Appl.* 387 (23) (2008) 5901–5909.
- [26] M. Kinatader, M. Müller, M. Jost, A. Mühlberger, P. Pauli, Social influence in a virtual tunnel fire – influence of conflicting information on evacuation behavior, *Appl. Ergon.* 45 (6) (2014) 1649–1659.
- [27] M. Kinatader, E. Ronchi, D. Gromer, M. Müller, M. Jost, M. Nehfischer, A. Mühlberger, P. Pauli, Social influence on route choice in a virtual reality tunnel fire, *Transport. Res. F Traffic Psychol. Behav.* 26 (2014) 116–125.
- [28] J.L. Bryan, Human behaviour in fire: the development and maturity of a scholarly study area, *Fire Mater.* 23 (6) (1999) 249–253.
- [29] M. Kobes, I. Helsloot, B. de Vries, J. Post, Exit choice, (pre-)movement time and (pre-)evacuation behaviour in hotel fire evacuation — behavioural analysis and validation of the use of serious gaming in experimental research, *Procedia Eng.* 3 (2010) 37–51.
- [30] M. Kobes, I. Helsloot, B. de Vries, J.G. Post, Building safety and human behaviour in fire: a literature review, *Fire Saf. J.* 45 (1) (2010) 1–11.
- [31] M. Kobes, I. Helsloot, B. de Vries, J.G. Post, N. Oberijé, K. Groenewegen, Way finding during fire evacuation; an analysis of unannounced fire drills in a hotel at night, *Build. Environ.* 45 (3) (2010) 537–548.
- [32] M. Kobes, N. Oberijé, M. Duyvis, Case studies on evacuation behaviour in a hotel building in BART and in real life, *Pedestrian and Evacuation Dynamics 2008* (2010) 183–201.
- [33] Z. Fang, Q. Li, Q. Li, L.D. Han, D. Wang, A proposed pedestrian waiting-time model for improving space-time use efficiency in stadium evacuation scenarios, *Build. Environ.* 46 (9) (2011) 1774–1784.
- [34] Z. Fang, X. Zong, Q. Li, Q. Li, S. Xiong, Hierarchical multi-objective evacuation routing in stadium using ant colony optimization approach, *J. Transport Geogr.* 19 (3) (2011) 443–451.
- [35] S. Shahparvari, B. Abbasi, P. Chhetri, Possibilistic scheduling routing for short-noise bushfire emergency evacuation under uncertainties: an Australian case study, *Omega* 72 (2017) 96–117.
- [36] Q. Lu, B. George, S. Shekhar, Capacity Constrained Routing Algorithms for Evacuation Planning: A Summary of Results, SSTD, 2005.
- [37] D. Li, T.J. Cova, P.E. Dennison, Setting wildfire evacuation triggers by coupling fire and traffic simulation models: a spatiotemporal GIS approach, *Fire Technol.* 55 (2) (2018) 617–642.
- [38] M. D’Orazio, S. Longhi, P. Olivetti, G. Bernardini, Design and experimental evaluation of an interactive system for pre-movement time reduction in case of fire, *Autom. Construct.* 52 (2015) 16–28.
- [39] G. Bernardini, M. Azzolini, M. D’Orazio, E. Quagliarini, Intelligent evacuation guidance systems for improving fire safety of Italian-style historical theatres without altering their architectural characteristics, *J. Cult. Herit.* 22 (2016) 1006–1018.
- [40] E. Ronchi, M. Kinatader, M. Müller, M. Jost, M. Nehfischer, P. Pauli, A. Mühlberger, Evacuation travel paths in virtual reality experiments for tunnel safety analysis, *Fire Saf. J.* 71 (2015) 257–267.
- [41] E. Ronchi, D. Nilsson, S. Kojić, J. Eriksson, R. Lovreglio, H. Modig, A.L. Walter, A virtual reality experiment on flashing lights at emergency exit portals for road tunnel evacuation, *Fire Technol.* 52 (3) (2015) 623–647.
- [42] P. Ntzeremes, K. Kiriopoulou, Applying a stochastic-based approach for developing a quantitative risk assessment method on the fire safety of underground road tunnels, *Tunn. Undergr. Space Technol.* 81 (2018) 619–631.
- [43] P. Ntzeremes, K. Kiriopoulou, A Stochastic-Based Evacuation Model for Risk Assessment in Road Tunnel Fire Accidents and the Importance of Educating Users, 2018, pp. 2185–2191.
- [44] P. Vidmar, S. Petelin, Methodology of using CFD-based risk assessment in road tunnels, *Therm. Sci.* 11 (2) (2007) 223–250.
- [45] B. Latane, J.M. Darley, Group inhibition of bystander intervention in emergencies, *J. Pers. Soc. Psychol.* 10 (3) (1968) 215–221.
- [46] D. Canter, Fires and human behaviour: emerging issues, *Fire Saf. J.* 3 (1) (1980) 41–46.
- [47] J.D. Sime, Movement toward the familiar: person and place affiliation in a fire entrapment setting, *Environ. Behav.* 17 (6) (1985) 697–724.
- [48] J.L. Bryan, 1956, in: *A Study of the Survivors Reports on the Panic in the Fire at the Arundel Park Hall in Brooklyn, Maryland on January, 29, University of Maryland, 1957.*
- [49] P.G. Wood, The behaviour of people in fires, *Fire Saf. Sci.* 953 (1972), 1–1.
- [50] J.L. Bryan, Smoke as a Determinant of Human Behavior in Fire Situations: (Project People), US Department of Commerce, National Bureau of Standards, 1977.
- [51] T. Shields, G. Proulx, The Science of Human Behaviour: Past Research Endeavours, Current Development and Fashioning a Research Agenda, Canada’s Construction Technology Centre, Institute for Research in Construction, 2000.
- [52] E.L. Toman, M. Stidham, S. McCaffrey, B.A. Shindler, Social Science at the Wildland-Urban Interface: A Compendium of Research Results to Create Fire-Adapted Communities, US Department of Agriculture, Forest Service, Northern Research Station, 2013.
- [53] P.J. Cohn, M.S. Carroll, Y. Kumagai, Evacuation behavior during wildfires: results of three case studies, *West. J. Appl. For.* 21 (1) (2006) 39–48.
- [54] S.M. McCaffrey, A. Rhodes, Public response to wildfire: is the Australian “Stay and Defend or Leave Early” approach an option for wildfire management in the United States? *J. For.* 107 (1) (2009) 9–15.
- [55] J. Handmer, S. O’Neil, D. Killalea, Review of Fatalities in the February 7, 2009, Bushfires, Bushfire CRC, Centre for Risk and Community Safety, RMIT University, Melbourne, 2010. Report Prepared for the Victorian Bushfires Royal Commission April 2010.
- [56] J. Whittaker, J. Handmer, Community bushfire safety: a review of post-Black Saturday research, *Aust. J. Emerg. Manag.* 25 (4) (2010) 7–13.
- [57] J. McLennan, G. Elliott, ‘Wait and see’: the elephant in the community bushfire safety room?, in: *Proceedings of the Bushfire CRC & AFAC 2012 Conference Research Forum*, 2012.
- [58] E.L. Quarantelli, The nature and conditions of panic, *Am. J. Sociol.* 60 (3) (1954) 267–275.
- [59] R.F. Fahy, G. Proulx, L. Aiman, Panic or not in fire: clarifying the misconception, *Fire Mater.* 36 (5–6) (2012) 328–338.
- [60] M. Haghani, M. Sarvi, L. Scanlon, Simulating pre-evacuation times using hazard-based duration models: is waiting strategy more efficient than instant response? *Saf. Sci.* 117 (2019) 339–351.
- [61] M. Haghani, M. Sarvi, Z. Shahhoseini, When ‘push’ does not come to ‘shove’: revisiting ‘faster is slower’ in collective egress of human crowds, *Transport. Res. Pol. Pract.* 122 (2019) 51–69.
- [62] M. Haghani, M. Sarvi, Z. Shahhoseini, M. Boltes, Dynamics of social groups’ decision-making in evacuations, in: *Transportation Research Part C: Emerging Technologies*, 104, 2019, pp. 135–157.
- [63] C. Xudong, Z. Heping, X. Qiyuan, Z. Yong, Z. Hongjiang, Z. Chenjie, Study of announced evacuation drill from a retail store, *Build. Environ.* 44 (5) (2009) 864–870.
- [64] D.A. Purser, M. Bensilum, Quantification of behaviour for engineering design standards and escape time calculations, *Saf. Sci.* 38 (2) (2001) 157–182.
- [65] S. Gwynne, E.R. Galea, P.J. Lawrence, L. Filippidis, Modelling occupant interaction with fire conditions using the buildingEXODUS evacuation model, *Fire Saf. J.* 36 (4) (2001) 327–357.
- [66] N.C. McConnell, K.E. Boyce, J. Shields, E.R. Galea, R.C. Day, L.M. Hulse, The UK 9/11 evacuation study: analysis of survivors’ recognition and response phase in WTC1, *Fire Saf. J.* 45 (1) (2010) 21–34.
- [67] X. Zheng, T. Zhong, M. Liu, Modeling crowd evacuation of a building based on seven methodological approaches, *Build. Environ.* 44 (3) (2009) 437–445.
- [68] E.R. Galea, J.M. Perez Galparsoro, A computer-based simulation model for the prediction of evacuation from mass-transport vehicles, *Fire Saf. J.* 22 (4) (1994) 341–366.
- [69] G.G. Lovås, Modeling and simulation of pedestrian traffic flow, *Transp. Res. Part B Methodol.* 28 (6) (1994) 429–443.
- [70] Y. Feng, D. Duives, W. Daamen, S. Hoogendoorn, Data collection methods for studying pedestrian behaviour: a systematic review, *Build. Environ.* 187 (2021).
- [71] Y. Feng, D.C. Duives, S.P. Hoogendoorn, Using virtual reality to study pedestrian exit choice behaviour during evacuations, *Saf. Sci.* 137 (2021).
- [72] D. Helbing, L. Buzna, A. Johansson, T. Werner, Self-organized pedestrian crowd dynamics: experiments, simulations, and design solutions, *Transport. Sci.* 39 (1) (2005) 1–24.
- [73] M. Haghani, M. Sarvi, Simulating dynamics of adaptive exit-choice changing in crowd evacuations: model implementation and behavioural interpretations, *Transport. Res. C Emerg. Technol.* 103 (2019) 56–82.
- [74] N. Siyam, O. Alqaryouti, S. Abdallah, Research issues in agent-based simulation for pedestrians evacuation, *IEEE Access* 8 (2020) 134435–134455.
- [75] S.M. Lo, Z. Fang, A spatial-grid evacuation model for buildings, *J. Fire Sci.* 18 (5) (2000) 376–394.
- [76] C. Delcea, L.-A. Cotfas, I.-A. Bradea, M.-I. Boloş, G. Ferruzzi, Investigating the exits’ symmetry impact on the evacuation process of classrooms and lecture Halls: an agent-based modeling approach, *Symmetry* 12 (4) (2020).
- [77] J. Shi, A. Ren, C. Chen, Agent-based evacuation model of large public buildings under fire conditions, *Autom. Construct.* 18 (3) (2009) 338–347.

- [78] L. Shi, Q. Xie, X. Cheng, L. Chen, Y. Zhou, R. Zhang, Developing a database for emergency evacuation model, *Build. Environ.* 44 (8) (2009) 1724–1729.
- [79] V.A. Owen, N. Cakici, Modelling the evacuation of a high-rise office building in Istanbul, *Fire Saf. J.* 44 (1) (2009) 1–15.
- [80] K.E. Boyce, T.J. Shields, G.W.H. Silcock, *Fire Technol.* 35 (1) (1999) 35–50.
- [81] D. Miyagawa, G. Ichinose, Cellular automaton model with turning behavior in crowd evacuation, in: *Physica A: Statistical Mechanics and its Applications*, 549, 2020.
- [82] S. Wei-Guo, Y. Yan-Fei, W. Bing-Hong, F. Wei-Cheng, Evacuation behaviors at exit in CA model with force essentials: a comparison with social force model, *Phys. Stat. Mech. Appl.* 371 (2) (2006) 658–666.
- [83] Y. Tajima, K. Takimoto, T. Nagatani, Scaling of pedestrian channel flow with a bottleneck, *Phys. Stat. Mech. Appl.* 294 (1–2) (2001) 257–268.
- [84] A. Kirchner, H. Klüpfel, K. Nishinari, A. Schadschneider, M. Schreckenberg, Simulation of competitive egress behavior: comparison with aircraft evacuation data, *Phys. Stat. Mech. Appl.* 324 (3–4) (2003) 689–697.
- [85] X. Zheng, Y. Cheng, Conflict game in evacuation process: a study combining Cellular Automata model, *Phys. Stat. Mech. Appl.* 390 (6) (2011) 1042–1050.
- [86] Z. Li, W. Xu, Pedestrian evacuation within limited-space buildings based on different exit design schemes, *Saf. Sci.* 124 (2020).
- [87] A. Varas, M.D. Cornejo, D. Mainemer, B. Toledo, J. Rogan, V. Muñoz, J. A. Valdivia, Cellular automaton model for evacuation process with obstacles, *Phys. Stat. Mech. Appl.* 382 (2) (2007) 631–642.
- [88] Y. Zheng, B. Jia, X.-G. Li, N. Zhu, Evacuation dynamics with fire spreading based on cellular automaton, *Phys. Stat. Mech. Appl.* 390 (18–19) (2011) 3147–3156.
- [89] V.J. Blue, J.L. Adler, Cellular automata microsimulation for modeling bi-directional pedestrian walkways, *Transp. Res. Part B Methodol.* 35 (3) (2001) 293–312.
- [90] R. Zhu, J. Lin, B. Becerik-Gerber, N. Li, Influence of architectural visual access on emergency wayfinding: a cross-cultural study in China, United Kingdom and United States, in: *Fire Safety Journal*, 113, 2020.
- [91] R.-Y. Guo, H.-J. Huang, S.C. Wong, Route choice in pedestrian evacuation under conditions of good and zero visibility: experimental and simulation results, *Transp. Res. Part B Methodol.* 46 (6) (2012) 669–686.
- [92] W. Song, X. Xu, B.-H. Wang, S. Ni, Simulation of evacuation processes using a multi-grid model for pedestrian dynamics, *Phys. Stat. Mech. Appl.* 363 (2) (2006) 492–500.
- [93] G.J. Lim, S. Zangeneh, M. Reza Baharemami, T. Assavapokee, A capacitated network flow optimization approach for short notice evacuation planning, *Eur. J. Oper. Res.* 223 (1) (2012) 234–245.
- [94] S.M. Lo, H.C. Huang, P. Wang, K.K. Yuen, A game theory based exit selection model for evacuation, *Fire Saf. J.* 41 (5) (2006) 364–369.
- [95] D. Helbing, M. Isobe, T. Nagatani, K. Takimoto, Lattice gas simulation of experimentally studied evacuation dynamics, *Phys. Rev.* 67 (6) (2003).
- [96] M.M. Shuaib, Incorporating intelligence for typical evacuation under the threat of fire spreading, *Saf. Sci.* 106 (2018) 1–9.
- [97] R.L. Hughes, A continuum theory for the flow of pedestrians, *Transp. Res. Part B Methodol.* 36 (6) (2002) 507–535.
- [98] X. Zheng, W. Li, C. Guan, Simulation of evacuation processes in a square with a partition wall using a cellular automaton model for pedestrian dynamics, *Phys. Stat. Mech. Appl.* 389 (11) (2010) 2177–2188.
- [99] R. Alizadeh, A dynamic cellular automaton model for evacuation process with obstacles, *Saf. Sci.* 49 (2) (2011) 315–323.
- [100] S.M. Lo, Z. Fang, P. Lin, G.S. Zhi, An evacuation model: the SGEM package, *Fire Saf. J.* 39 (3) (2004) 169–190.
- [101] L.F. Henderson, The statistics of crowd fluids, *Nature* 229 (5284) (1971) 381–383.
- [102] M.A. Lopez-Carmona, A. Paricio Garcia, CellEVAC: an adaptive guidance system for crowd evacuation through behavioral optimization, *Saf. Sci.* 139 (2021).
- [103] H.-J. Huang, R.-Y. Guo, Static fire field and exit choice for pedestrian evacuation in rooms with internal obstacles and multiple exits, *Phys. Rev.* 78 (2) (2008).
- [104] M. Isobe, D. Helbing, T. Nagatani, Experiment, theory, and simulation of the evacuation of a room without visibility, *Phys. Rev.* 69 (6) (2004).
- [105] T. Paveglio, M.S. Carroll, P.J. Jakes, Alternatives to evacuation—protecting public safety during wildland fire, *J. For.* 106 (2) (2008) 65–70.
- [106] T. Drabek, *Human System Responses to Disaster*, 1986.
- [107] J. Handmer, A. Tibbits, Is staying at home the safest option during bushfires? Historical evidence for an Australian approach, *Environ. Hazards* 6 (2) (2005) 81–91.
- [108] J. Whittaker, K. Haynes, J. Handmer, J. McLennan, Community safety during the 2009 Australian 'Black Saturday' bushfires: an analysis of household preparedness and response, *Int. J. Wildland Fire* 22 (6) (2013).
- [109] A. Tibbits, J. Whittaker, Stay and defend or leave early: policy problems and experiences during the 2003 Victorian bushfires, *Environ. Hazards* 7 (4) (2007) 283–290.
- [110] J. McLennan, D. Paton, L. Wright, At-risk householders' responses to potential and actual bushfire threat: an analysis of findings from seven Australian post-bushfire interview studies 2009–2014, *Int. J. Disaster Risk Reduc.* 12 (2015) 319–327.
- [111] K. Strahan, S.J. Watson, The protective action decision model: when householders choose their protective response to wildfire, *J. Risk Res.* 22 (12) (2018) 1602–1623.
- [112] P. Mozumder, N. Raheem, J. Talberth, R.P. Berrens, Investigating intended evacuation from wildfires in the wildland–urban interface: application of a bivariate probit model, *For. Pol. Econ.* 10 (6) (2008) 415–423.
- [113] E.J. Baker, Hurricane evacuation behavior, *Int. J. Mass Emergencies Disasters* 9 (2) (1991) 287–310.
- [114] S.L. Stephens, M.A. Adams, J. Handmer, F.R. Kearns, B. Leicester, J. Leonard, M. A. Moritz, Urban–wildland fires: how California and other regions of the US can learn from Australia, *Environ. Res. Lett.* 4 (1) (2009).
- [115] T.J. Cova, P.E. Dennison, F.A. Drews, Modeling evacuate versus shelter-in-place decisions in wildfires, *Sustainability* 3 (10) (2011) 1662–1687.
- [116] T.J. Cova, D.M. Theobald, J.B. Norman, L.K. Siebenek, Mapping wildfire evacuation vulnerability in the western US: the limits of infrastructure, *Geojournal* 78 (2) (2011) 273–285.
- [117] R. Lovreglio, A. Fonzone, L. dell'Olio, A mixed logit model for predicting exit choice during building evacuations, *Transport. Res. Pol. Pract.* 92 (2016) 59–75.
- [118] R. Lovreglio, E. Ronchi, D. Nilsson, An Evacuation Decision Model based on perceived risk, social influence and behavioural uncertainty, *Simulat. Model. Pract. Theor.* 66 (2016) 226–242.
- [119] B.L. McFarlane, T.K. McGee, H. Faulkner, Complexity of homeowner wildfire risk mitigation: an integration of hazard theories, *Int. J. Wildland Fire* 20 (8) (2011).
- [120] D. Li, T.J. Cova, P.E. Dennison, N. Wan, Q.C. Nguyen, L.K. Siebenek, Why do we need a national address point database to improve wildfire public safety in the U.S., *Int. J. Disaster Risk Reduc.* 39 (2019).
- [121] K. Haynes, J. Handmer, J. McAneney, A. Tibbits, L. Coates, Australian bushfire fatalities 1900–2008: exploring trends in relation to the 'Prepare, stay and defend or leave early' policy, *Environ. Sci. Pol.* 13 (3) (2010) 185–194.
- [122] T.B. Paveglio, A.D. Boyd, M.S. Carroll, Wildfire evacuation and its alternatives in a post-Black Saturday landscape: catchy slogans and cautionary tales, *Environ. Hazards* 11 (1) (2012) 52–70.
- [123] I. Ajzen, The theory of planned behavior, *Organ. Behav. Hum. Decis. Process.* 50 (2) (1991) 179–211.
- [124] T.J. Cova, F.A. Drews, L.K. Siebenek, A. Musters, Protective actions in wildfires: evacuate or shelter-in-place? *Nat. Hazards Rev.* 10 (4) (2009) 151–162.
- [125] D.M. Theobald, W.H. Romme, Expansion of the US wildland–urban interface, *Landsc. Urban Plann.* 83 (4) (2007) 340–354.
- [126] H. Omori, E.D. Kuligowski, S.M.V. Gwynne, K.M. Butler, Human response to emergency communication: a review of guidance on alerts and warning messages for emergencies in buildings, *Fire Technol.* 53 (4) (2017) 1641–1668.
- [127] J. McLennan, B. Ryan, C. Bearman, K. Toh, Should we leave now? Behavioral factors in evacuation under wildfire threat, *Fire Technol.* 55 (2) (2018) 487–516.
- [128] J. McLennan, G. Elliott, M. Omodei, J. Whittaker, Household safety-related decisions, plans, actions and outcomes during the 7 February 2009 Victorian (Australia) wildfires, *Fire Saf. J.* 61 (2013) 175–184.
- [129] A.M. Stasiewicz, T.B. Paveglio, Preparing for wildfire evacuation and alternatives: exploring influences on residents' intended evacuation behaviors and mitigations, *Int. J. Disaster Risk Reduc.* 58 (2021).
- [130] B.E. Aguirre, M.R. Torres, K.B. Gill, H. Lawrence Hotchkiss, Normative collective behavior in the station building fire, *Soc. Sci. Q.* 92 (1) (2011) 100–118.
- [131] M. Fu, R. Liu, Y. Zhang, Why do people make risky decisions during a fire evacuation? Study on the effect of smoke level, individual risk preference, and neighbor behavior, *Saf. Sci.* 140 (2021).
- [132] E. Ronchi, P. Colonna, J. Capote, D. Alvear, N. Berloco, A. Cuesta, The evaluation of different evacuation models for assessing road tunnel safety analysis, *Tunn. Undergr. Space Technol.* 30 (2012) 74–84.
- [133] E. Ronchi, S.M.V. Gwynne, D.A. Purser, P. Colonna, Representation of the impact of smoke on agent walking speeds in evacuation models, *Fire Technol.* 49 (2) (2012) 411–431.
- [134] E. Ronchi, A. Corbetta, E.R. Galea, M. Kinatader, E. Kuligowski, D. McGrath, A. Pel, Y. Shiban, P. Thompson, F. Toschi, New approaches to evacuation modelling for fire safety engineering applications, *Fire Saf. J.* 106 (2019) 197–209.
- [135] National Fire Protection Association, and Society of Fire Protection Engineers, *SFPE Handbook of Fire Protection Engineering*. Quincy, Mass, National Fire Protection Association ; Society of Fire Protection Engineers, Bethesda, Md, 2002.
- [136] S.M.V. Gwynne, L.M. Hulse, M.J. Kinsey, Guidance for the model developer on representing human behavior in egress models, *Fire Technol.* 52 (3) (2015) 775–800.
- [137] C. Guanquan, S. Jinhua, Quantitative assessment of building fire risk to life safety, *Risk Anal.* 28 (3) (2008) 615–625.
- [138] Z. Li, H. Huang, N. Li, M.L. Chu, K. Law, An agent-based simulator for indoor crowd evacuation considering fire impacts, *Autom. Construct.* 120 (2020).
- [139] M.J. Hurley, *SFPE Handbook of Fire Protection Engineering*, Springer, New York, 2016.
- [140] G. Chu, J. Sun, Decision analysis on fire safety design based on evaluating building fire risk to life, *Saf. Sci.* 46 (7) (2008) 1125–1136.
- [141] M. Seike, N. Kawabata, M. Hasegawa, Experiments of evacuation speed in smoke-filled tunnel, *Tunn. Undergr. Space Technol.* 53 (2016) 61–67.
- [142] D. Kong, S. Lu, H. Frantzych, S.M. Lo, A method for linking safety factor to the target probability of failure in fire safety engineering, *J. Civ. Eng. Manag.* 19 (Supplement\_1) (2014) S212–S221.
- [143] K. Erica, P. Richard, N. I. o. S. Bryan Hoskins C2 - Technical Note, G. M. D. Technology, A Review of Building Evacuation Models, second ed., 2010.
- [144] E. Ronchi, P. Colonna, N. Berloco, Reviewing Italian Fire Safety Codes for the analysis of road tunnel evacuations: advantages and limitations of using evacuation models, *Saf. Sci.* 52 (2013) 28–36.
- [145] B.E. Aguirre, Emergency evacuations, panic, and social psychology, *Psychiatr. Interpers. Biol. Process.* 68 (2) (2005) 121–129.

- [146] J. Joo, N. Kim, R.A. Wysk, L. Rothrock, Y.-J. Son, Y.-g. Oh, S. Lee, Agent-based simulation of affordance-based human behaviors in emergency evacuation, *Simulat. Model. Pract. Theor.* 32 (2013) 99–115.
- [147] M. Haghani, M. Sarvi, Z. Shahhoseini, Evacuation behaviour of crowds under high and low levels of urgency: experiments of reaction time, exit choice and exit-choice adaptation, *Saf. Sci.* 126 (2020).
- [148] M. Haghani, M. Sarvi, Human exit choice in crowded built environments: investigating underlying behavioural differences between normal egress and emergency evacuations, *Fire Saf. J.* 85 (2016) 1–9.
- [149] R. Lovreglio, D. Borri, L. dell’Olio, A. Ibeas, A discrete choice model based on random utilities for exit choice in emergency evacuations, *Saf. Sci.* 62 (2014) 418–426.
- [150] G. Proulx, A stress model for people facing a fire, *J. Environ. Psychol.* 13 (2) (1993) 137–147.
- [151] M. Kinatader, B. Comunale, W.H. Warren, Exit choice in an emergency evacuation scenario is influenced by exit familiarity and neighbor behavior, *Saf. Sci.* 106 (2018) 170–175.
- [152] N.W.F. Bode, E.A. Codling, Human exit route choice in virtual crowd evacuations, *Anim. Behav.* 86 (2) (2013) 347–358.
- [153] C.M. Zhao, S.M. Lo, S.P. Zhang, M. Liu, A post-fire survey on the pre-evacuation human behavior, *Fire Technol.* 45 (1) (2008) 71–95.
- [154] A. Sekizawa, M. Ebihara, H. Notake, K. Kubota, M. Nakano, Y. Ohmiya, H. Kaneko, Occupants’ behaviour in response to the high-rise apartments fire in Hiroshima City, *Fire Mater.* 23 (6) (1999) 297–303.
- [155] D. Tong, D. Canter, The decision to evacuate: a study of the motivations which contribute to evacuation in the event of fire, *Fire Saf. J.* 9 (3) (1985) 257–265.
- [156] M.H. Nguyen, T.V. Ho, J.-D. Zucker, Integration of smoke effect and blind evacuation strategy (SEBES) within fire evacuation simulation, *Simulat. Model. Pract. Theor.* 36 (2013) 44–59.
- [157] J. Pauls, A personal perspective on research, consulting and codes/standards development in fire-related human behaviour, 1969–1999, with an emphasis on space and time factors, *Fire Mater.* 23 (6) (1999) 265–272.
- [158] E.D. Kuligowski, D.S. Mileti, Modeling pre-evacuation delay by occupants in world trade center towers 1 and 2 on september 11, 2001, *Fire Saf. J.* 44 (4) (2009) 487–496.
- [159] K. Yamamoto, S. Kokubo, K. Nishinari, Simulation for pedestrian dynamics by real-coded cellular automata (RCA), *Phys. Stat. Mech. Appl.* 379 (2) (2007) 654–660.
- [160] B.E. Aguirre, D. Wenger, G. Vigo, *Socio. Forum* 13 (2) (1998) 301–320.
- [161] B. Cornwell, Bonded fatalities: relational and ecological dimensions of a fire evacuation, *Socio. Q.* 44 (4) (2016) 617–638.
- [162] Y. Zheng, B. Jia, X.-G. Li, R. Jiang, Evacuation dynamics considering pedestrians’ movement behavior change with fire and smoke spreading, *Saf. Sci.* 92 (2017) 180–189.
- [163] J.M. Bateman, B. Edwards, Gender and evacuation: a closer look at why women are more likely to evacuate for hurricanes, *Nat. Hazards Rev.* 3 (3) (2002) 107–117.
- [164] J.G. Taylor, S.C. Gillette, R.W. Hodgson, J.L. Downing, M.R. Burns, D.J. Chavez, J.T. Hogan, Informing the network: improving communication with interface communities during wildland fire, *Hum. Ecol. Rev.* 14 (2) (2007) 198–211.
- [165] W.E. Feinberg, N.R. Johnson, FIRESCAP: a computer simulation model of reaction to a fire alarm, *J. Math. Sociol.* 20 (2–3) (1995) 247–269.
- [166] K.J. Tierney, M.K. Lindell, R.W. Perry, *Facing the Unexpected: Disaster Preparedness and Response in the United States*, Joseph Henry Press, Washington, D.C., 2001.
- [167] E.L.M. Bourhim, A. Cherkaoui, Efficacy of virtual reality for studying people’s pre-evacuation behavior under fire, *Int. J. Hum. Comput. Stud.* 142 (2020).
- [168] J.D. Sime, Affiliative behaviour during escape to building exits, *J. Environ. Psychol.* 3 (1) (1983) 21–41.
- [169] Z. Fang, W. Song, J. Zhang, H. Wu, Experiment and modeling of exit-selecting behaviors during a building evacuation, *Phys. Stat. Mech. Appl.* 389 (4) (2010) 815–824.
- [170] J.P. Yuan, Z. Fang, Y.C. Wang, S.M. Lo, P. Wang, Integrated network approach of evacuation simulation for large complex buildings, *Fire Saf. J.* 44 (2) (2009) 266–275.
- [171] H.W. Hamacher, S.A. Tjandra, *Mathematical Modelling of Evacuation Problems: A State of Art*, 2001.
- [172] E. Ronchi, P.A. Renke, R.D. Peacock, A method for the analysis of behavioural uncertainty in evacuation modelling, *Fire Technol.* 50 (6) (2013) 1545–1571.
- [173] M. Saadatseresh, A. Mansourian, M. Taleai, Evacuation planning using multiobjective evolutionary optimization approach, *Eur. J. Oper. Res.* 198 (1) (2009) 305–314.
- [174] T.J. Cova, J.P. Johnson, A network flow model for lane-based evacuation routing, *Transport. Res. Pol. Pract.* 37 (7) (2003) 579–604.
- [175] S. Shahparvari, B. Abbasi, Robust stochastic vehicle routing and scheduling for bushfire emergency evacuation: an Australian case study, *Transport. Res. Pol. Pract.* 104 (2017) 32–49.
- [176] H.D. Sherali, T.B. Carter, A.G. Hobeika, A location-allocation model and algorithm for evacuation planning under hurricane/flood conditions, *Transp. Res. Part B Methodol.* 25 (6) (1991) 439–452.
- [177] F. Garriga Garzón, S. Casadesús Pursals, Basic principle for the solution of the building evacuation problem, *J. Ind. Eng. Manag.* 2 (3) (2009).
- [178] P. Lin, S.M. Lo, H.C. Huang, K.K. Yuen, On the use of multi-stage time-varying quickest time approach for optimization of evacuation planning, *Fire Saf. J.* 43 (4) (2008) 282–290.
- [179] E.J. Anderson, P. Nash, A.B. Philpott, A class of continuous network flow problems, *Math. Oper. Res.* 7 (4) (1982) 501–514.
- [180] A. Stepanov, J.M. Smith, Multi-objective evacuation routing in transportation networks, *Eur. J. Oper. Res.* 198 (2) (2009) 435–446.
- [181] Z. Fang, Q. Li, Q. Li, L.D. Han, S.-L. Shaw, A space–time efficiency model for optimizing intra-intersection vehicle–pedestrian evacuation movements, *Transport. Res. C Emerg. Technol.* 31 (2013) 112–130.
- [182] R.M. Tavares, E.R. Galea, Evacuation modelling analysis within the operational research context: a combined approach for improving enclosure designs, *Build. Environ.* 44 (5) (2009) 1005–1016.
- [183] V. Bayram, H. Yaman, Shelter location and evacuation route assignment under uncertainty: a benders decomposition approach, *Transport. Sci.* 52 (2) (2018) 416–436.
- [184] Y.-C. Chiu, H. Zheng, J. Villalobos, B. Gautam, Modeling no-notice mass evacuation using a dynamic traffic flow optimization model, *IIE Trans.* 39 (1) (2007) 83–94.
- [185] T.J. Cova, J.P. Johnson, Microsimulation of neighborhood evacuations in the urban–wildland interface, *Environ. Plann.: Econ. Space* 34 (12) (2016) 2211–2229.
- [186] A.J. Pel, M.C.J. Bliemer, S.P. Hoogendoorn, A review on travel behaviour modelling in dynamic traffic simulation models for evacuations, *Transportation* 39 (1) (2011) 97–123.
- [187] E. Bonabeau, Agent-based modeling: methods and techniques for simulating human systems, *Proc. Natl. Acad. Sci. USA* 99 (suppl\_3) (2002) 7280–7287.
- [188] N. Dash, H. Gladwin, Evacuation decision making and behavioral responses: individual and household, *Nat. Hazards Rev.* 8 (3) (2007) 69–77.
- [189] B. Wolshon, E. Marchive, Emergency planning in the urban-wildland interface: subdivision-level analysis of wildfire evacuations, *J. Urban Plann. Dev.* 133 (1) (2007) 73–81.
- [190] E.W. Dijkstra, A note on two problems in connexion with graphs, *Numer. Math.* 1 (1) (1959) 269–271.
- [191] V.J. Blue, J.L. Adler, Emergent fundamental pedestrian flows from cellular automata microsimulation, *Transport. Res. Rec.: J. Transport. Res. Board* 1644 (1) (1998) 29–36.
- [192] X. Chen, F.B. Zhan, Agent-based modelling and simulation of urban evacuation: relative effectiveness of simultaneous and staged evacuation strategies, *J. Oper. Res. Soc.* 59 (1) (2017) 25–33.
- [193] T.J. Cova, P.E. Dennison, T.H. Kim, M.A. Moritz, Setting wildfire evacuation trigger points using fire spread modeling and GIS, *Trans. GIS* 9 (4) (2005) 603–617.
- [194] B. Zhao, S.D. Wong, Developing transportation response strategies for wildfire evacuations via an empirically supported traffic simulation of Berkeley, California, *Transport. Res. Rec.: J. Transport. Res. Board* 2675 (12) (2021) 557–582.
- [195] P.E. Dennison, T.J. Cova, M.A. Moritz, WUIVAC: a wildland-urban interface evacuation trigger model applied in strategic wildfire scenarios, *Nat. Hazards* 41 (1) (2006) 181–199.
- [196] T.J. Cova, P.E. Dennison, D. Li, F.A. Drews, L.K. Siebeneck, M.K. Lindell, Warning triggers in environmental hazards: who should be warned to do what and when? *Risk Anal.* 37 (4) (2016) 601–611.
- [197] M.J. Hurler, D. Gottuk, J.R. Hall, K. Harada, E. Kuligowski, M. Puchovsky, J. Torero, J.M. Watts, C. Wiecezorek, *SFPE Handbook of Fire Protection Engineering*, 2016.
- [198] D. Li, T.J. Cova, P.E. Dennison, Using reverse geocoding to identify prominent wildfire evacuation trigger points, *Appl. Geogr.* 87 (2017) 14–27.
- [199] A. Beloglazov, M. Almahor, E. Abebe, J. Richter, K.C.B. Steer, Simulation of wildfire evacuation with dynamic factors and model composition, *Simulat. Model. Pract. Theor.* 60 (2016) 144–159.
- [200] T.I. Lakoba, D.J. Kaup, N.M. Finkelstein, Modifications of the helbing-molnár-farkas-vicsek social force model for pedestrian evolution, *Simulation* 81 (5) (2005) 339–352.
- [201] V. Babrauskas, J.M. Fleming, B. Don Russell, RSET/ASET, a flawed concept for fire safety assessment, *Fire Mater.* 34 (7) (2010) 341–355.
- [202] G. Proulx, Evacuation time and movement in apartment buildings, *Fire Saf. J.* 24 (3) (1995) 229–246.
- [203] D. Nilsson, Exit Choice in Fire Emergencies - Influencing Choice of Exit with Flashing Lights, 2009.
- [204] M. D’Orazio, G. Bernardini, S. Tacconi, V. Arteconi, E. Quagliarini, Fire safety in Italian-style historical theatres: how photoluminescent wayfinding can improve occupants’ evacuation with no architecture modifications, *J. Cult. Herit.* 19 (2016) 492–501.
- [205] M. Occhialini, G. Bernardini, F. Ferracuti, S. Iarlori, M. D’Orazio, S. Longhi, Fire exit signs: the use of neurological activity analysis for quantitative evaluations on their perceptiveness in a virtual environment, *Fire Saf. J.* 82 (2016) 63–75.
- [206] K. Fridolf, E. Ronchi, D. Nilsson, H. Frantzych, Movement speed and exit choice in smoke-filled rail tunnels, *Fire Saf. J.* 59 (2013) 8–21.
- [207] G.-Y. Jeon, J.-Y. Kim, W.-H. Hong, G. Augenbroe, Evacuation performance of individuals in different visibility conditions, *Build. Environ.* 46 (5) (2011) 1094–1103.
- [208] C.-H. Tang, W.-T. Wu, C.-Y. Lin, Using virtual reality to determine how emergency signs facilitate way-finding, *Appl. Ergon.* 40 (4) (2009) 722–730.
- [209] R. Lovreglio, E. Ronchi, D. Nilsson, A model of the decision-making process during pre-evacuation, *Fire Saf. J.* 78 (2015) 168–179.
- [210] Y. Zhang, Y. Shen, R. Carvel, H. Zhu, Y. Zhang, Z. Yan, Experimental investigation on the evacuation performance of pedestrians in a three-lane urban tunnel with natural ventilation in a fire scenario, *Tunn. Undergr. Space Technol.* 108 (2021).

- [211] Y. Zhang, H. Zhu, Q. Guo, R. Carvel, Z. Yan, The effect of technical installations on evacuation performance in urban road tunnel fires, *Tunn. Undergr. Space Technol.* 107 (2021).
- [212] T.J. Shields, K.E. Boyce, A study of evacuation from large retail stores, *Fire Saf. J.* 35 (1) (2000) 25–49.
- [213] Y. Zhang, Z. Yan, H. Zhu, Y. Shen, Fire response performance and social behavior in tunnels distinguishing from buildings in evacuation, *Proceedings of GeoShanghai 2018 International Conference: Tunnelling and Underground Construction* (2018) 625–632.
- [214] N. Pelechano, A. Malkawi, Evacuation simulation models: challenges in modeling high rise building evacuation with cellular automata approaches, *Autom. Construct.* 17 (4) (2008) 377–385.
- [215] D. Nilsson, M. Johansson, H. Frantzich, Evacuation experiment in a road tunnel: a study of human behaviour and technical installations, *Fire Saf. J.* 44 (4) (2009) 458–468.
- [216] J. Dong, Z. Yan, Y. Zhang, H. Zhu, Research methods in tunnel fire distinguishing from buildings in evacuation, *Proceedings of GeoShanghai 2018 International Conference: Tunnelling and Underground Construction* (2018) 666–673.
- [217] D. Nilsson, A. Johansson, Social influence during the initial phase of a fire evacuation—analysis of evacuation experiments in a cinema theatre, *Fire Saf. J.* 44 (1) (2009) 71–79.
- [218] J.S.M. Li, W.K. Chow, Numerical studies on performance evaluation of tunnel ventilation safety systems, *Tunn. Undergr. Space Technol.* 18 (5) (2003) 435–452.
- [219] R.S. Kennedy, N.E. Lane, K.S. Berbaum, M.G. Lilienthal, Simulator sickness questionnaire: an enhanced method for quantifying simulator sickness, *Int. J. Aviat. Psychol.* 3 (3) (1993) 203–220.
- [220] P. Vidmar, S. Petelin, Application of CFD method for risk assessment in road tunnels, *Engineering Applications of Computational Fluid Mechanics* 1 (4) (2014) 273–287.
- [221] K. Fridolf, D. Nilsson, H. Frantzich, Fire evacuation in underground transportation systems: a review of accidents and empirical research, *Fire Technol.* 49 (2) (2011) 451–475.
- [222] P.A. Thompson, E.W. Marchant, Testing and application of the computer model 'SIMULEX', *Fire Saf. J.* 24 (2) (1995) 149–166.
- [223] T.J. Cova, "Public safety in the urban-wildland interface: should fire-prone communities have a maximum occupancy?", *Nat. Hazards Rev.* 6 (3) (2005) 99–108.
- [224] M.S. Carroll, P.J. Cohn, D.N. Seesholtz, L.L. Higgins, Fire as a galvanizing and fragmenting influence on communities: the case of the rodeo-chediski fire, *Soc. Nat. Resour.* 18 (4) (2005) 301–320.
- [225] K. Dow, S.L. Cutter, Emerging hurricane evacuation issues: hurricane Floyd and South Carolina, *Nat. Hazards Rev.* 3 (1) (2002) 12–18.
- [226] T.B. Paveglio, M.S. Carroll, P.J. Jakes, Adoption and perceptions of shelter-in-place in California's rancho santa Fe fire protection district, *Int. J. Wildland Fire* 19 (6) (2010).
- [227] T.B. Paveglio, M.S. Carroll, P.J. Jakes, Alternatives to evacuation during wildland fire: exploring adaptive capacity in one Idaho community, *Environ. Hazards* 9 (4) (2010) 379–394.
- [228] T.B. Paveglio, C. Moseley, M.S. Carroll, D.R. Williams, E.J. Davis, A.P. Fischer, Categorizing the social context of the wildland urban interface: adaptive capacity for wildfire and community "archetypes", *For. Sci.* 61 (2) (2015) 298–310.
- [229] T. Paveglio, C. Edgeley, Community diversity and hazard events: understanding the evolution of local approaches to wildfire, *Nat. Hazards* 87 (2) (2017) 1083–1108.
- [230] D. Helbing, P. Molnár, Social force model for pedestrian dynamics, *Phys. Rev.* 51 (5) (1995) 4282–4286.
- [231] National Fire Protection Association. and Society of Fire Protection Engineers, *SFPE Handbook of Fire Protection Engineering*. Quincy, Mass, National Fire Protection Association; Society of Fire Protection Engineers, Boston, Mass, 1995.
- [232] B.J. Meacham, Integrating human factors issues into engineered fire safety design, *Fire Mater.* 23 (6) (1999) 273–279.
- [233] F. Ozel, Time pressure and stress as a factor during emergency egress, *Saf. Sci.* 38 (2) (2001) 95–107.
- [234] L. Yang, Occupant evacuation model based on cellular automata in fire, *Chin. Sci. Bull.* 47 (17) (2002).
- [235] N.-J. Shih, C.-Y. Lin, C.-H. Yang, A virtual-reality-based feasibility study of evacuation time compared to the traditional calculation method, *Fire Saf. J.* 34 (4) (2000) 377–391.
- [236] A. Schadschneider, W. Klingsch, H. Klüpfel, T. Kretz, C. Rognsch, A. Seyfried, in: R. A. Meyers (Ed.), *Evacuation Dynamics: Empirical Results, Modeling and Applications*. Encyclopedia of Complexity and Systems Science, Springer, New York, 2009, pp. 3142–3176.
- [237] D. Bruck, I. Thomas, Interactions between human behaviour and technology: implications for fire safety science, *Fire Technol.* 46 (4) (2010) 769–787.
- [238] S. Gwynne, Optimizing Fire Alarm Notification for High Risk Groups: Notification Effectiveness for Large Groups, Report Prepared for the Fire Protection Research Foundation, NPPA, 2007.
- [239] L. Yang, Cellular automata pedestrian movement model considering human behavior, *Chin. Sci. Bull.* 48 (16) (2003).
- [240] L.Z. Yang, D.L. Zhao, J. Li, T.Y. Fang, Simulation of the kin behavior in building occupant evacuation based on Cellular Automaton, *Build. Environ.* 40 (3) (2005) 411–415.
- [241] G. Proulx, J.D. Sime, To prevent 'panic' in an underground emergency: why not tell people the truth? *Fire Saf. Sci.* 3 (1991) 843–852.
- [242] E.R. Galea, M. Owen, P.J. Lawrence, Computer modelling of human behaviour in aircraft fire accidents, *Toxicology* 115 (1–3) (1996) 63–78.
- [243] S. Horiuchi, Y. Murozaki, A. Hukugo, A case study of fire and evacuation in A multi-purpose office building, Osaka, Japan, *Fire Saf. Sci.* 1 (1986) 523–532.
- [244] D.A. Purser, Toxic product yields and hazard assessment for fully enclosed design fires, *Polym. Int.* 49 (10) (2000) 1232–1255.
- [245] T.T. Pires, An approach for modeling human cognitive behavior in evacuation models, *Fire Saf. J.* 40 (2) (2005) 177–189.
- [246] E. Graat, C. Midden, P. Bockholts, Complex evacuation; effects of motivation level and slope of stairs on emergency egress time in a sports stadium, *Saf. Sci.* 31 (2) (1999) 127–141.
- [247] D. Lee, H. Kim, J.-H. Park, B.-J. Park, The current status and future issues in human evacuation from ships, *Saf. Sci.* 41 (10) (2003) 861–876.
- [248] R.A. Smith, Density, velocity and flow relationships for closely packed crowds, *Saf. Sci.* 18 (4) (1995) 321–327.
- [249] G.D., G.V. Hadjisophocleous, Smoke hazards from fires in high places, *ASHRAE Journal Smoke Management* (2001).
- [250] C.E. Magdanz, An overview to designing smoke-control systems, *ASHRAE J.* 44 (2002) 32–41.
- [251] J.D. Sime, Crowd psychology and engineering, *Saf. Sci.* 21 (1) (1995) 1–14.
- [252] L.T. Wong, T.F. Cheung, Evaluating probable risk of evacuees in institutional buildings, *Saf. Sci.* 44 (2) (2006) 169–181.
- [253] S. Ko, M. Spearpoint, A. Teo, Trial evacuation of an industrial premises and evacuation model comparison, *Fire Saf. J.* 42 (2) (2007) 91–105.
- [254] S. Gwynne, E.R. Galea, M. Owen, P.J. Lawrence, L. Filippidis, A review of the methodologies used in evacuation modelling, *Fire Mater.* 23 (6) (1999) 383–388.
- [255] H. Abdelgawad, B. Abdulhai, Managing large-scale multimodal emergency evacuations, *J. Transport. Saf. Secur.* 2 (2) (2010) 122–151.
- [256] P. Murray-Tuite, B. Wolshon, Evacuation transportation modeling: an overview of research, development, and practice, *Transport. Res. C Emerg. Technol.* 27 (2013) 25–45.
- [257] H. Sbayti, H. Mahmassani, Optimal scheduling of evacuation operations, in: *Transportation Research Record: Journal of the Transportation Research Board* 1964, 2006, pp. 238–246.
- [258] S. Shahparvari, P. Chhetri, B. Abbasi, A. Abareshi, Enhancing emergency evacuation response of late evacuees: revisiting the case of Australian Black Saturday bushfire, *Transport. Res. E Logist. Transport. Rev.* 93 (2016) 148–176.
- [259] P. Wu, F. Chu, A. Che, M. Zhou, Bi-objective scheduling of fire engines for fighting forest fires: new optimization approaches, *IEEE Trans. Intell. Transport. Syst.* 19 (4) (2018) 1140–1151.
- [260] W.-m. Gai, Y. Du, Y.-f. Deng, Regional evacuation modeling for toxic-cloud releases and its application in strategy assessment of evacuation warning, *Saf. Sci.* 109 (2018) 256–269.
- [261] S. Shahparvari, B. Bodaghi, Risk reduction for distribution of the perishable rescue items: A possibilistic programming approach, *Int. J. Disaster Risk Reduc.* 31 (2018) 886–901.
- [262] A. Kulshrestha, Y. Lou, Y. Yin, Pick-up locations and bus allocation for transit-based evacuation planning with demand uncertainty, *J. Adv. Transport.* 48 (7) (2014) 721–733.
- [263] W.J. Bond, F.I. Woodward, G.F. Midgley, The global distribution of ecosystems in a world without fire, *New Phytol.* 165 (2) (2004) 525–538.
- [264] P.M. Brown, Climate effects on fire regimes and tree recruitment in black hills ponderosa pine forests, *Ecology* 87 (10) (2006) 2500–2510.
- [265] M. Pautasso, K. Dehnen-Schmutz, O. Holdenrieder, S. Pietravalle, N. Salama, M. J. Jeger, E. Lange, S. Hehl-Lange, Plant health and global change - some implications for landscape management, *Biol. Rev.* (2010) no-no.
- [266] B. Bond-Lamberty, S.D. Peckham, D.E. Ahl, S.T. Gower, Fire as the dominant driver of central Canadian boreal forest carbon balance, *Nature* 450 (7166) (2007) 89–92.
- [267] D.M.J.S. Bowman, J.K. Balch, P. Artaxo, W.J. Bond, J.M. Carlson, M.A. Cochrane, C.M. D'Antonio, R.S. DeFries, J.C. Doyle, S.P. Harrison, F.H. Johnston, J. E. Keeley, M.A. Krawchuk, C.A. Kull, J.B. Marston, M.A. Moritz, I.C. Prentice, C. I. Roos, A.C. Scott, T.W. Swetnam, G.R. van der Werf, S.J. Pyne, Fire in the earth system, *Science* 324 (5926) (2009) 481–484.
- [268] H.J.B. Birks, K.J. Willis, Alpines, trees, and refugia in Europe, *Plant Ecol. Divers.* 1 (2) (2008) 147–160.
- [269] S.A. Bhagwat, K.J. Willis, Species persistence in northerly glacial refugia of Europe: a matter of chance or biogeographical traits? *J. Biogeogr.* 35 (3) (2008) 464–482.
- [270] S.J. Blake, E.R. Galea, S. Gwynne, P.J. Lawrence, L. Filippidis, Examining the effect of exit separation on aircraft evacuation performance during 90-second certification trials using evacuation modelling techniques, *Aeronaut. J.* 106 (1055) (2002) 1–16.
- [271] M. Court, J. Pittman, C. Alexopoulos, D. Goldsman, S.H. Kim, M. Loper, A. Pritchett, J. Haddock, A framework for simulating human cognitive behavior and movement when predicting impacts of catastrophic events, in: *Proceedings of the 2004 Winter Simulation Conference*, 2004, 2004.
- [272] M. Owen, E.R. Galea, P.J. Lawrence, L. Filippidis, Aask — aircraft accident statistics and knowledge: a database of human experience in evacuation, derived from aviation accident reports, *Aeronaut. J.* 102 (1017) (1998) 353–364, 1968.
- [273] M. Owen, E.R. Galea, P.J. Lawrence, L. Filippidis, The numerical simulation of aircraft evacuation and its application to aircraft design and certification, *Aeronaut. J.* 102 (1998) 301–312.
- [274] E.R. Galea, Proposed methodology for the use of computer simulation to enhance aircraft evacuation certification, *J. Aircraft* 43 (5) (2006) 1405–1413.
- [275] E.R. Galea, J.M.P. Galparsoro, G.B.C.A. Authority, Exodus: an Evacuation Model for Mass Transport Vehicles, Civil Aviation Authority, 1993.

- [276] E.R. Galea, A general approach to validating evacuation models with an application to EXODUS, *J. Fire Sci.* 16 (6) (1998) 414–436.
- [277] M.C. Court, Commercial aircraft-cabin egress: the current state of simulation model development and the need for future research, *Simulation* 73 (4) (1999) 218–231.
- [278] E.R. Galea, K.M. Finney, A.J.P. Dixon, A. Siddiqui, D.P. Cooney, The AASK Database V4.0: Aircraft Accident Statistics and Knowledge. A Database to Record Human Experience of Evacuation in Aviation Accidents, 2004.
- [279] S. Gwynne, E.R. Galea, P.J. Lawrence, M. Owen, L. Filippidis, A systematic comparison of model predictions produced by the buildingExodus evacuation model and the tsukuba pavilion evacuation data, *J. Appl. Fire Sci.* 7 (3) (1997) 235–266.
- [280] J.J. Fruin, *Pedestrian Planning and Design*, Metropolitan Association of Urban Designers and Environmental Planners, New York, 1971.
- [281] L.G. Chalmet, R.L. Francis, P.B. Saunders, Network models for building evacuation, *Manag. Sci.* 28 (1) (1982) 86–105.
- [282] M. Owen, E.R. Galea, P.J. Lawrence, L. Filippidis, An aircraft accident database of human experience in evacuation derived from aviation accident reports, *Fire Mater.* 23 (6) (1999) 363–368.
- [283] J. Pauls, The movement of people in buildings and design solutions for means of egress, *Fire Technol.* 20 (1) (1984) 27–47.
- [284] R. Martínez-Val, J.M. Hedro, Analysis of evacuation strategies for design and certification of transport airplanes, *J. Aircraft* 37 (3) (2000) 440–447.
- [285] G.G. Løvås, On performance measures for evacuation systems, *Eur. J. Oper. Res.* 85 (2) (1995) 352–367.
- [286] W. Choi, H.W. Hamacher, S. Tufekci, Modeling of building evacuation problems by network flows with side constraints, *Eur. J. Oper. Res.* 35 (1) (1988) 98–110.
- [287] S.C. Pursals, F.G. Garzón, Optimal building evacuation time considering evacuation routes, *Eur. J. Oper. Res.* 192 (2) (2009) 692–699.
- [288] N. Ding, H. Zhang, T. Chen, Simulation-based optimization of emergency evacuation strategy in ultra-high-rise buildings, *Nat. Hazards* 89 (3) (2017) 1167–1184.
- [289] F. Pérez-Villalonga, J. Salmerón, K. Wood, Dynamic evacuation routes for personnel on a naval ship, *Nav. Res. Logist.* 55 (8) (2008) 785–799.
- [290] A. See, L. Michel, B. Xiong, P.B. Luh, S.C. Chang, Transportation and HVAC systems for building emergency evacuation, in: 2006 IEEE International Conference on Automation Science and Engineering, 2006.
- [291] Y. Liu, W. Wang, H.-Z. Huang, Y. Li, Y. Yang, A new simulation model for assessing aircraft emergency evacuation considering passenger physical characteristics, *Reliab. Eng. Syst. Saf.* 121 (2014) 187–197.
- [292] T. Miyoshi, H. Nakayasu, Y. Ueno, P. Patterson, An emergency aircraft evacuation simulation considering passenger emotions, *Comput. Ind. Eng.* 62 (3) (2012) 746–754.
- [293] E.M. Cepolina, A methodology for defining building evacuation routes, *Civ. Eng. Environ. Syst.* 22 (1) (2005) 29–47.
- [294] A. Garrett, B. Carnahan, R. Muhdi, J. Davis, G. Dozier, M.P. SanSoucie, P.V. Hull, M.L. Tinker, Evacuation planning via evolutionary computation, in: 2006 IEEE International Conference on Evolutionary Computation, 2006, pp. 157–164.
- [295] X. Pan, C.S. Han, K. Dauber, K.H. Law, A multi-agent based framework for the simulation of human and social behaviors during emergency evacuations, *AI Soc.* 22 (2) (2007) 113–132.
- [296] S.-H. Wang, W.-C. Wang, K.-C. Wang, S.-Y. Shih, Applying building information modeling to support fire safety management, *Autom. Construct.* 59 (2015) 158–167.
- [297] N. Pelechano, N. Badler, Modeling crowd and trained leader behavior during building evacuation, *IEEE Computer Graphics and Applications* 26 (6) (2006) 80–86.
- [298] L.T. Wong, Hazard of thermal radiation from a hot smoke layer in enclosures to an evacuee, *J. Fire Sci.* 23 (2) (2016) 139–156.
- [299] U. Ruppel, K. Schatz, Designing a BIM-based serious game for fire safety evacuation simulations, *Adv. Eng. Inf.* 25 (4) (2011) 600–611.
- [300] M. Gerges, P. Demian, Z. Adamu, Customising evacuation instructions for high-rise residential occupants to expedite fire egress: results from agent-based simulation, *Fire* 4 (2) (2021).
- [301] F. Mirahadi, B. McCabe, EvacuSafe: building evacuation strategy selection using route risk index, *J. Comput. Civ. Eng.* 34 (2) (2020).
- [302] D. Li, B. Han, Behavioral effect on pedestrian evacuation simulation using cellular automata, *Saf. Sci.* 80 (2015) 41–55.